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SCIENCE

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FRIDAY, JULY 5, 1901.

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SOME ADVANCES MADE IN ASTRONOMICAL SCIENCE DURING THE NINETEENTH CENTURY.*

IN glancing over the field of astronomical achievement during the century recently closed, the most striking feature is undoubtedly the rise and growth during the past fifty years of an entirely new department, one totally unknown and almost undreamed of before the first half of the century had passed, that called by Professor Langley the new astronomy, more technically known as astrophysics. In considering the restrictions which must be regarded in case this address is to be kept within manageable limit, perhaps it would be well to confine my remarks to this new branch of the science. I shall, however, give the chief place to the older astronomy, touching briefly upon the newer phase.

Near the close of the seventeenth century appeared Newton's immortal work called by him 'The Mathematical Principles of Natural Philosophy.' In this treatise the law of universal gravitation as the controlling and governing principle of the planetary system was established by a rigorous course of mathematical reasoning. It was many years, however, before these conclusions were universally accepted. On the continent of Europe particularly, the

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field was already occupied by the philosophy of Descartes. The glittering generalities found here in place of the severe mathematical reasoning of Newton proved too attractive to be at once overthrown.

Fifty years elapsed before anything material was added to the science of Newton, then came a galaxy of distinguished men, including Euler, Clairaut, D'Alembert, Lagrange and Laplace, who, by a series of most brilliant and exhaustive researches, made possible by the development of much more powerful mathematical instruments than those possessed by Newton, practically disposed of every objection which the opponents of Newton's theory could discover.

Their last stronghold and one which proved extremely difficult to carry was the explanation of the secular acceleration of the moon's motion. Halley, one of Newton's disciples, had found by a comparison of ancient and medieval eclipses with those of modern times, that the lunar month is now shorter than was the case 2,000 years ago. How this could be if the motion of this body were governed by the law of gravity only proved an extremely difficult question. It was finally shown by Laplace to be one of the consequences of this law, that what is now an acceleration will in the future become a retardation, thus preserving the system essentially as we see it to-day. This took place near the beginning of the nineteenth century. We may, therefore, say that this century began its course with the law of universal gravitation firmly established. In fact no one was hereafter found to seriously call it in question whose opinion was worthy of notice.

It is not to be supposed, however, that the science of celestial mechanics was now finished. In fact we can hardly say that any branch of physical science ever has been or ever will be finished. Results depending for their value upon observations of any kind must share the inevitable imper-

fections of the observer and of his instrument.

The problems of celestial mechanics have accordingly occupied the attention of a large number of distinguished men during the century past. With the discovery of new planets and comets and stellar systems, new applications are constantly appearing calling for the most refined skill and active perseverance of its votaries. Refinements in observation and improvements in method also call for frequent revision of the old investigations. This is particularly true of the lunar theory.

The study of the moon's motions was one of the first problems to attract the attention of the ancient astronomers. Since their day we are probably safe in saying that no problem in the entire range of science has called out anything approaching the labor and ingenuity bestowed upon this one. Yet the theory is hardly in a satisfactory condition to-day. Such a statement may seem to those who have never looked into the intricacies of the problem like a confession of failure.

So far as it concerns a purely mathematical statement of the conditions the problem offers no difficulties. The relations between the coordinates of a body like the moon, acted on by any system of forces, are very readily expressed by a series of three differential equations of the second order. The forces here are the mutual attractions exerted by the sun, moon and planets. If only two bodies are present the solution offers no difficulty. If there is a third, we have the famous problem of the three bodies. In spite of all that has been done during the century in the way of mathematical advancement this problem still defies its most powerful resources. Recourse must be had to methods of approximation, expansion in the form of series being one of the most obvious. No one can form an idea of the intricacy and

complexity of the resulting expressions who has not himself looked into the problem. Delaunay, at one time director of the Paris Observatory, carried this investigation farther than any of his predecessors had done, but though it had occupied his almost undivided attention for twenty years, it was still unfinished at the time of his death. (He was unfortunately drowned at Cherbourg in 1872 by the capsizing of a pleasure boat.) We have in this country to-day three investigators who are perhaps the greatest living authorities on this subject—Professors Newcomb, Hill of New York, and Brown of Haverford.

The general problem of three bodies has proved a very fascinating one. If, for instance, Mars and Jupiter were of approximately the same dimensions as the sun, the determination of their respective motions would be vastly more complex than it now is. Mr. G. H. Darwin has been giving much attention to this class of problems bringing out some interesting results. Although the problem does not confront us in this unmanageable form in our own system it will eventually find practical application in unraveling the intricacies of the stellar motions.

Probably no achievement in the domain of science ever produced so profound an impression upon the unprofessional public as the discovery of Neptune by a purely theoretical investigation undertaken independently by Leverier and Adams, predicting its place in the heavens before it had ever been seen, or at least recognized as a planet. It is unnecessary now to rehearse the familiar story of that brilliant discovery. It was somewhat like the egg of Columbus, but up to the present time the attempts to apply the process in other regions of the planetary system have not been attended with success. The first such attempt was by Leverier himself, followed in 1859 by his confident announcement of a

planet between Mercury and the Sun. The prestige of Leverier's name, accompanied by a supposed view of the planet by Dr. Lescarbault, an amateur astronomer, proved sufficient to carry conviction generally; and Vulcan found a place with the other planets in many books written thirty or forty years ago. No one else, however, whose authority was worth much claimed to have seen the planet until the occurrence of the total eclipse of the sun July 29, 1878. At this time Professor Watson, of Ann Arbor, and Lewis Swift, of Rochester, believed they had each seen one and perhaps two planets near the sun. The reputation of both as skilled observers naturally gave great weight to their authority, but the planets were never seen again and a critical examination of the places assigned renders it practically certain that fixed stars were mistaken for planets. Vulcan as a single large planet within the orbit of Mercury is now by the unanimous verdict of the astronomical profession relegated to the realm of myths. It was very natural to attempt to apply the process to the discovery of planets beyond Neptune, but although some indications of one and possibly two such have been suspected, nothing of the kind has yet been seen.

The eighteenth century ended with a list of known planets numbering 7 not including satellites. The nineteenth began with eight, the first day of January, 1801, being distinguished by the addition to the list of Ceres, the first of the long line of asteroids to be detected. The fortunate discoverer was Giuseppe Piazzi. The scene of Piazzi's activities was the University of Palermo, where he had been diligently engaged for nine years with the most perfect instrument which the skill of that day could produce in accumulating materials for a great stellar catalogue. At the time of which we are speaking his attention was directed to a place in the constellation Taurus on account

of an error of Wollaston, one of his contemporaries, in assigning a place to a star where none existed. Piazzi found, however, an eighth magnitude star not before noted, and upon repeating the observation the following evening, it was found to be in motion. Piazzi carefully followed the planet until February 11, when he fell ill, and his activities were for some time suspended. Meanwhile letters had been sent to Oriani, at Milan, and Bode, at Berlin. About this time, however, it may be remembered that another individual, not wholly unknown to fame, was actively employed in this part of the world in the practical applications of military science. We refer to one Napoleon Bonaparte. This may explain the fact that Oriani's letter arrived at Milan two and one-half months after it was written. Olbers, however, received that directed to him at the end of two months. The planet was now lost in the sun's rays and it was greatly feared that it would not be recovered, for, with a body so minute, unless its position could be given with some approach to accuracy the attempt to find it was an almost hopeless task. This emergency brought to the front the great mathematician Gauss. At that time a young man unknown to fame, he attacked the problem, and as a result produced a method for determining an orbit from three observed positions which completely overcame the difficulty, at the same time showing its author's title to a place in the front rank of mathematicians.

The discovery of three more planets belonging to the asteroid group soon followed, Juno, Vesta and Pallas, then, after a long interval came Astræa in 1845. The discoverer was Hencke, an amateur astronomer, who had been watching the heavens during fifteen years in the hope of this reward. The number now known to exist is near five hundred, with no indication that the supply approaches exhaustion. About ten years ago the application of photography

to this purpose by Wolf, of Heidelberg, made possible what may be called a wholesale process. One plate, taken October 22, 1900, showed no less than five of these bodies. This is at present believed to be the maximum record. What is to become of this numerous family is one of the serious questions of this day. The complete investigation of the theory of one is almost the work of a lifetime.

Of satellites, or secondary planets, seven have been added to the list during the century, one of Saturn, by Bond of Cambridge, September, 1848; one of Neptune, by Lassell, soon after the discovery of the planet itself; two of Uranus, also by Lassell, 1851; two of Mars, by Hall, of Washington, August, 1877; one of Jupiter, by Barnard, of the Lick Observatory, September, 1892. We should perhaps include an eighth in this category, an additional satellite of Saturn having been announced by W. H. Pickering two years ago, but as it has not yet been confirmed, judgment must be suspended for the present.

The periods of rotation of Mercury and Venus were investigated by the German astronomer Schroeter, sometimes called the Herschel of Germany, near the beginning of the century. His conclusion was that the length of the day on both these planets differs but little from our own. These results kept their places in the text-books almost unchallenged until near the close of the century. The multiplicity of observers equipped with instruments greatly superior to those of Schroeter were apparently unable either to confirm or disprove his conclusions. In 1889, however, Schiaparelli found what he considered decisive evidence showing that the planet Mercury rotates on its axis in the same time required to complete a revolution about the sun, thus like our moon always keeping the same hemisphere presented to the primary body. Later Schiaparelli came to

the same conclusion with regard to Venus. The results obtained at Flagstaff, Arizona, by Messrs. Lowell and Douglas are in perfect agreement with these conclusions. Although probably correct, the question is still regarded by many as an open one. The spectroscope will give the final verdict. Attempts in this direction have already been made by two experienced spectroscopists, Keeler, at the Lick Observatory, and Belopalski, at Pulkowa. Keeler's career was closed by death, leaving this and many other important researches unfinished. Such references to Belopalski's results as have come to our notice seem to throw but little additional light on the question. It may be that the instrument has not yet reached that degree of mechanical perfection which an investigation of such delicacy demands; but we may confidently predict its ultimate success.

With regard to the rotation periods of Uranus and Neptune, we know next to nothing. Such scanty bits of information as have been obtained, however, point to short periods in both cases, 8 to 12 hours; here again we may look to the spectroscope to give us a final answer.

As to the physical condition of the planets themselves, their adaptability to the support of animal and vegetable life, we certainly know a little more now than was known during the early part of the century. The author of the 'Positive Philosophy' expresses what seems to have been the prevailing sentiment regarding the orthodox science of that day as follows: "With regard to the heavenly bodies, we may obtain practical knowledge of their geometrical and mechanical phenomena, but all physical, chemical, physiological and social researches for which our powers fit us on our own earth are out of the question in regard to the planets. The only case in which this rule may be too severe is in that of the temperature."

There was, however, no dearth of philosophers whose speculations disregarded these modest limitations. To such the planets, like our own earth, were the abode of vegetable and animal life with, of course, intelligent beings, perhaps greatly superior to ourselves at the head. As no other use in the economy of the universe could be suggested for these neighboring worlds, and as God could not be supposed to create anything in vain, the conclusion was obvious. More exact knowledge has, however, dissipated most of these plausible theories. It seems at present unlikely that a single one of the other planets, with the possible exception of Venus can now be in a condition to support the higher forms of life.

It is not now proposed to enter into a discussion as to the indications of the existence of intelligent beings on the planet Mars. Though there are some who assert with great confidence that such is without doubt the case, there are others whose opinion is of equal value who are certain that the last Eskimo was frozen to death on the planet's equator many thousands of years ago. As to the large planets, Jupiter, Saturn, Uranus and Neptune, on account of their great size and consequently slower development, it is certain that they have not yet reached a condition adapted to the support of life, unless it be in its lowest forms. There is every indication that a very high temperature exists in the case of all four of these planets, that they are largely gaseous, consisting to a great extent of vapors floating in atmospheres whose depth must be reckoned in thousands of miles, and that certainly no part of the solid nucleus is ever seen by us.

We have every reason for believing that the sun with the attendant planets, our earth included, had a common origin, that they are composed of the same materials, that the same chemical and physical laws pre-

vail throughout the system. We may feel very confident also that the same combinations of physical and chemical conditions which on this earth are associated with organic life will be similarly associated on other planets, that those conditions which prevent this development except in its lower forms above the line of perpetual snow will act in the same manner on Mars or Venus.

At the beginning of the century one comet was known to be a member of our system, more than one appearance having certainly been observed, viz., that of Halley. This comet is famous historically as the first whose return was successfully predicted, thus completely demolishing the vague and absurd notions which had been held regarding these bodies. At the close of the century something like a score have been observed at more than one appearance, one of which, that of Biele, has certainly gone to pieces, with many indications that a like fate is in store for all. Closely associated with the subject of comets is that of meteors, a subject to which the attention of all of us has been more or less directed within the past two years by the amount of space which the journals have given to the expected appearance of the November displays. This department of astronomy was quite unknown to science a hundred years ago. In the early part of the century writers who condescended to mention meteors at all spoke of them as atmospheric phenomena. As for meteoric stones, specimens of which are seen in all mineralogical collections, scientists would have none of them. Learned academicians ridiculed the idea that any one should be so absurdly credulous as to admit the possibility of a ponderous stone falling from heaven. When in 1790 an official statement signed by 300 eye witnesses of such an event was sent to the French Academy one of the distinguished physicists of that body wrote concerning it

“How sad it is to see an entire municipality certifying in a formal official document to the truth of a fable which can only be regarded with pity.” Finally in 1803 occurred a fall in France of so conspicuous a character and attested by such a host of credible witnesses that it could no longer be treated as a childish fable. The matter was investigated by the Academy with naturally only one possible verdict. Since then much attention has been given to this subject, but it does not appear that any part of it was shared by the minute shooting stars, with the appearance of which every one was so familiar, until the great display of 1833 had drawn attention to them. It soon began to be discovered that records of similar occurrences at various past times were to be found, and finally Professor Newton, of Yale, in 1864 brought together a series of such historic notices extending back to the year 902, October 15. It was found that these could be represented as successive recurrences of the same phenomenon at intervals of 33 years. Professor Newton, therefore, predicted with much confidence a repetition in 1866. This prediction was fully verified.

The details of the investigation, by which this was shown to be due to a swarm of meteoric bodies, of average dimensions, probably not much exceeding a grain of sand, moving in a long procession about the sun with a period of $33\frac{1}{2}$ years, we cannot enter into now. The length of the stream was found to be such that about three years were required to pass the point of intersection with the earth's orbit. In fact the particles are scattered—very thinly for the most part—over nearly the entire path.

Precisely how it came about that the display was so meager in 1899 is uncertain. Perhaps it was caused by the particles being very unequally distributed along the line and that the earth on that occa-

sion passed through a comparatively thin region. Perhaps the perturbations of the planets have changed the course of the stream to such an extent that the earth no longer encounters it. The question will doubtless receive an answer in due time.

A large number of these meteoric streams have been recognized. A list of 695 radiants, as they are called, is to be found in the *Monthly Notices*, R. A. S., for 1875. Probably, however, a considerable number of these are fictitious.

One of the most remarkable discoveries connected with this subject was announced in 1866 by Schiaparelli, viz., that the well-known August swarm of meteors moves in practically the same orbit as a bright comet seen in 1862, known as Tuttle's comet. Shortly afterwards the orbit of the November swarm was identified with that of Temple's comet of 1866. A number of other such coincidences have been found, the most remarkable being that of a swarm known as Andromedes, which appears to have taken the place formerly occupied by Biele's Comet, in short to be nothing more or less than the shattered fragments of that body. Whether, on the one hand, those streams which have not been identified with any known comet are also the remnants of such a body long since disintegrated, and, on the other, whether those comets permanently attached to our system are undergoing a like process of dissolution, we can not say with certainty, but the theory looks very plausible. One such catastrophe has been carried to completion within the memory of many now living.

Another case in which this process was rapidly developing was that of the great comet of 1882, which many of us will remember. As this body receded from the sun its nucleus was broken into seven distinct fragments which gradually separated farther and farther from each other, until the body disappeared from view.

According to the best determination of its period, this comet should return in seven or eight hundred years. When it does return, if this ever happens, undoubtedly it will be in the form of at least seven distinct comets, following each other at intervals of perhaps several years. Each of these will very likely be again subdivided, the operation continuing until nothing remains but minute fragments.

We may follow the process backward as regards this body. In 1843 appeared a splendid comet whose orbit was remarkable on account of the nearness of its approach to the sun. Again in 1880 a large body of this kind appeared whose path so closely resembled that of 1843 that it was generally believed to be the same body, though how such a conspicuous object could return to our neighborhood every thirty-seven years and never have been seen before 1843 was a puzzling question. Greatly to the surprise of astronomers, the great comet of 1882 was found to follow almost precisely the same path. The theory was at once advanced that on account of the close approach of this body to the sun, passing as it did through millions of miles of the solar corona, the resistance encountered was rapidly bringing it into the sun. A few years, possibly a few months, would suffice for completing the work. What effect this collision would produce upon the sun could only be conjectured. Would it bring disaster to our earth or not?

The comet, however, pursued its way after passing the sun, with no appreciable change in the character of its orbit. It was followed from September 3, the date of its discovery, until the following June, when its distance from the sun was 470,000,000 of miles. Abundant material therefore existed for investigating its movements. The result was that at least 650 years must elapse before its return, the time being more likely to be 800 years. It

seems almost certain, therefore, that the three comets which appeared respectively in 1843, 1880 and 1882 originally constituted one gigantic body, which, on the occasion of a previous visit, perhaps about the time of the Norman conquest of England, had been torn in pieces by the sun's action precisely as was the case with the fragment which returned in 1882.

Whether the meteoric stones of which mention has been made are in any way related to the minute shooting stars, and whether or not they also at one time formed constituent parts of comets, we cannot say with certainty, but there seems to be no clear line of demarkation between the two classes of bodies. It appears to be simply a difference of dimension. A few of the fragments are massive enough to make their way through the air, and are known as meteoric stones. The great majority are so small that they are dissipated in the upper regions of the atmosphere.

On July 8, 1842, occurred a total eclipse of the sun, the line of totality passing over central and northern Europe. Great interest in this event had been aroused, largely due to the enthusiasm of the English astronomer Francis Baily. What we may call the first of the series of eclipse expeditions, since become such a conspicuous feature, were sent out at this time. Among those who made the long journey—long for those days—were the Astronomer Royal, Baily, Struve from Poulkova, Schumacher from Altona, and Arago from Paris. Though the corona and solar prominences had been frequently seen and described in a casual manner by previous witnesses of similar phenomena, such accounts had attracted little attention. Apparently most of the observers on the present occasion were totally unprepared for the spectacle which confronted them. So far as it concerns the cause of science, these now familiar appendages of the sun may be said to date their

discovery from this occasion. Baily is particularly eloquent in his account of the corona, closing as follows: "Splendid and astonishing, however, as this remarkable phenomenon really was, and although it could not fail to call forth the admiration and applause of every beholder, yet I must confess that there was at the same time something in its singular and wonderful appearance that was appalling; and I can readily imagine that uncivilized nations may occasionally have become alarmed and terrified at such an object, more especially at times when the true cause of the occurrence may have been but faintly understood, and the phenomenon itself wholly unexpected.

"But the most remarkable circumstance attending the phenomenon was the appearance of three large protuberances, apparently emanating from the circumference of the moon, but evidently forming a portion of the corona. I never lost sight of them when looking in that direction, and when the first ray of light was admitted from the sun, they vanished with the corona altogether and daylight was instantaneously restored."

The importance of these phenomena was now for the first time brought home to astronomers, and the desirability of investigating their true character. A variety of theories were advanced, some old and some new, some not far from the truth and others very much so. Professor von Felitsch, of Griefwald, published a treatise in which he proved to his own satisfaction that corona, prominences and chromosphere were purely optical appearances.

Some of the mists and haze enveloping the subject were cleared away by the eclipse of 1851, which was successfully observed in Norway and Sweden, but it was not until 1860 that the true character of these phenomena, that of solar appendages, was firmly established. This occasion marked an im-

portant epoch in this class of investigations from the fact that photography was now for the first time generally applied. The photographs possessed the great advantage of freedom from personal bias and of forming a permanent record which could be studied at leisure. Although nothing was previously known of the character of the rays with which the impression must be taken, as it happened the results were eminently satisfactory. The comparison of plates taken hundreds of miles apart showed identically the same forms, thus disposing of the notion that they were due to personal or atmospheric causes, while those taken at the same place, in close succession, showed the moon to pass over them, gradually covering or uncovering them as the case might be.

The eclipse of 1868 was distinguished by another great advance in the practical application of the spectroscope. Now for the first time the true character of the so-called prominences was demonstrated, viz., that of glowing gases or vapors shooting up to heights of fifty or a hundred thousand miles above the sun's surface, and composed in great part of hydrogen. A conspicuous line was also seen near the D line of sodium. As this corresponded to no chemical element then known, it was called the helium line. In 1895 helium was discovered in a gas obtained from the mineral cleveite, an interesting case of a chemical element first discovered in the sun.

In connection with this eclipse it was found that these prominences could be observed at any time when the sun was visible by a proper use of the spectroscope. This important discovery was hit upon independently by M. Janssen and Mr. Norman Lockyer. Both discoverers communicated their methods to the French Academy, the letters reaching the Secretary within a few minutes of each other. In commemoration of this event a medal was

prepared bearing the effigies of both Janssen and Lockyer.

The principle employed in obtaining the images of the prominences is as follows: The light of these objects is largely monochromatic. If such a ray is passed through a prism it is bent out of its course, losing a little of its brightness by the absorption of the glass but not otherwise. The light due to the glare of the atmosphere, however, which is the cause of our inability to see these features whenever the sun is visible, being composed of all the colors of the spectrum, is dispersed and rendered so faint as not to interfere with the image of the prominence. The higher the dispersion, the darker is the background against which this image is seen. It was at first thought necessary to employ a narrow slit, thus gradually building up the prominence by taking narrow slices in succession. It was soon found that the slit could be opened wide enough to show the entire image at once. This discovery made possible the careful and deliberate study of this feature of the sun, with the result that more is probably known of it than could ever have been ascertained, had it been necessary as at first to employ only the few moments during total eclipse.

The next step in advance would seem to be in the direction of accomplishing for the corona what had been done for the prominences and thus make possible the study of this feature of the sun's environment under the same leisurely and deliberate conditions. This problem has received a great amount of attention during the past twenty years. Various methods of attack have been suggested and tried, but so far without success.

In 1882 Professor Huggins believed that he had solved the problem. By the use of plates sensitive only to the most prominent rays of the corona, he obtained photographs which had every appearance of being genu-

ine pictures of the solar appendage. The results were regarded by many as genuine, while others doubted. Much discussion followed, some of it slightly fervid in temperature.

However, the test was simple as soon as an opportunity could be had for applying it. The eclipse of 1886 gave the wished-for opportunity. Photographs taken during totality were compared with those taken by Huggins's process, but alas! the results were far from identical. The supposed coronal forms were therefore fictitious.

Though much in the way of detail has been learned of the corona in connection with recent eclipses, it still remains very much of an enigma. Unless some new method may be found for attacking the problems which it presents, apparently their complete solution will be long delayed. Here too, as in other cases, the solution of one problem is likely to suggest a score of new ones, so that eclipse expeditions seem unlikely soon to be exclusively things of the past.

At the opening of the century, it can hardly be said that astronomers were in possession of more than two or three catalogues of stars which would be of any use whatever for the exact astronomy of today. Even these were of quite limited extent as regards the number of stars contained. There were, it is true, a number of such catalogues based upon the imperfect methods of the previous century, and a considerable amount of valuable material in the form of unreduced observations existed, but the latter was of little practical service so long as it remained in this form. Even if accessible, which was not always the case, very few could undertake the drudgery of searching through the records for the wished-for material, and when found, if found at all, to apply the reductions necessary to prepare it for practical use. It is to George Biddel Airy, who became Astron-

omer Royal in 1835, that astronomers owe the introduction of the present practice of reducing and publishing observations promptly, thus making them accessible to all.

The most valuable series thus buried out of sight at the beginning of the century was that of Bradley. The observations were made at Greenwich between the years 1750 and 1762. These were first rendered accessible by Bessel, who in 1818 published under the title 'Fundamenta Astronomiæ,' a catalogue of 3112 stars constructed from all Bradley's observations. More recently a re-reduction has been published by Auwers, in which every refinement which the present state of science could suggest has been employed, in order to obtain from them the best possible results. This catalogue is of special value in such investigations as involve the stellar motions, the remoteness of the time of observation—140–150 years—being a great advantage in this respect. There was also a great mass of observed star places, the result of the untiring industry of LaCaille, D'Agelet and Lefrançais Lalande, nephew of the more widely celebrated astronomer. Most of this material was only placed in an accessible form after the nineteenth century was far advanced, the last contribution being the publication by our own Dr. Gould, in 1864, of the final reduction made under his direction of the observations of D'Agelet, all reduced to the epoch 1800.

The beginning of the century found Piazzi busily engaged at his observatory in Palermo accumulating material for his famous catalogue of 7646 stars, which finally appeared in 1814. As he possessed for this purpose an instrument superior to anything previously constructed, and was himself a careful and most industrious observer, this catalogue has been of very great value. A re-reduction of the observations is now in progress, based upon the more accurate

values of the constants which we now possess, and with improvements in method unknown one hundred years ago, which cannot fail to add greatly to its usefulness.

As time went on observations were conducted with more or less regularity at various places, each observer or institution acting independently of what was done elsewhere. As a result, many stars were observed over and over again, and others, equally important, not at all. In 1866, however, the *Astronomische Gesellschaft* of Germany organized a systematic campaign, having for its object the accurate cataloguing of all stars of the northern heavens not fainter than the 9th or 9.5th magnitude. For this purpose the entire northern heavens were divided into zones of about 5° in width, and thirteen different observatories each undertook to observe one, or in some cases two, of these zones, the work all being done on a strictly uniform plan, so that the results shall be homogeneous throughout. This work has been in progress for more than thirty years—somewhat deliberately at some places, it must be said, but is now nearly completed. The plan has since been extended to include southern stars as far as the tropic of cancer. Meanwhile our own distinguished countryman, Dr. B. A. Gould, as the result of fifteen years' labor at Cordoba, Argentina, has given us a similar catalogue of 73,160 stars between the tropic of cancer and the south pole.

The great work, instituted by the *Astronomische Gesellschaft* in 1865, is still unfinished, yet an even more ambitious undertaking was inaugurated fourteen years ago by an international congress assembled at Paris for that purpose. This calls for a photographic survey of the heavens to be participated in by a number of observatories—eighteen have joined in the undertaking—two sets of plates being taken.

The first set are to have sufficient length of exposure to give positions of all stars not fainter than the eleventh magnitude. These are to be measured and the resulting positions catalogued. When completed, this catalogue will include between two and three million stars. The second series of plates is to have a longer exposure, sufficient to show stars of the fourteenth magnitude and will furnish charts of the heavens. 22,154 plates are called for and many years will be required for its completion. The results already obtained show that star positions may be obtained in this way with an accuracy little if anything inferior to the results of meridian observation.

The problem of the past history and future destiny of the solar system has occupied much attention during the century. Near its beginning Laplace had announced his famous nebular hypothesis. For many years it seems to have been taken for granted that little if anything could be added to this theory. In a general way it may be said that it forms the foundation of whatever has been developed in this direction. Laplace began with the sun already existing, surrounded with an atmosphere of heated vapor extending beyond the farthest planet. This body revolved on its axis and gradually shrunk as its heat was radiated into space. The linear velocity of the outer parts remaining constant, the angular velocity would constantly increase until in time the centrifugal force became equal to the centripetal when the central part separated, leaving the equatorial part in the form of a ring. This ring contained the material out of which the outermost planet was formed. Successive repetitions of the process produced the different planets, and these in turn produced satellites in the same manner. The rings of Saturn were held to be almost an unanswerable piece of evidence in favor of the theory. Though, without doubt, the

system was evolved in some way from a primitive nebula, we may say with certainty that it did not follow the orderly course marked out for it by Laplace. The subsequent discovery of the great principle of the conservation of energy dispensed with the original hypothesis which started with the mass in a heated condition, at the same time that it associated with it the important question as to the supply of heat and other forms of energy which are constantly being poured out with such prodigality by the sun. If we suppose the matter composing our system to have been at one time a nebulous mass, filling the present orbit of Neptune, the temperature may then have corresponded to the absolute zero so far as our purposes are concerned. The process of shrinking and condensation to the present condition would have evolved an amount of heat quite equal to that which the problem calls for, but, unless a constant supply is furnished from some source, the present process of radiation will soon come to an end. The explanation of this supply which is generally accepted was first announced by Helmholtz in 1854. He ascribed it to the shrinkage of the sun now going on. It is capable of mathematical proof that a body consisting of matter in the form of a gas, which is the case with the sun, by the process of condensation due to the pressure produced by its own attraction, will constantly grow hotter so long as it remains a gas. This operation must end when a considerable portion of its matter is reduced to a liquid or solid form. The system, then, had a beginning, and as a consequence it must come to an end. Or more properly speaking the present condition of things can not last forever. Thus Helmholtz concludes that if the intensity of radiation has been uniform from the beginning, the present order can not have existed longer than 22,000,000 years. Others make the period less. Look-

ing into the future, at the end of 5,000,000 years, the sun will have contracted to half its present volume, and at the end of another 5,000,000 years it will be mainly if not entirely solid, and must have ceased to be self-luminous much earlier. An interesting corollary to this subject is the principle of tidal evolution developed by Mr. G. H. Darwin. Supposing the moon to have been separated from the earth by some process at a time when the matter composing them was in a liquid condition, each body would produce enormous tides in the other. Consider those produced on the earth by the action of the moon: the effect would be on the one hand to retard the earth in its rate of rotation, and on the other to drive the moon farther from the earth. Without going further into detail, we may say that Mr. Darwin finds that if no other causes were at work not less than 50,000,000 years would be required for the evolution of the system of the earth and moon as it now exists.

It was not far from the beginning of the century that Herschel attempted the solution of the greatest of all problems—that of the structure of the universe. The problem proved, as may be supposed, quite impossible of solution by methods then available. Much has been learned during the century which was unknown to Herschel, but we seem to be as far as ever from the final solution. Instead of an orderly distribution of stars, clusters and systems, we find all apparently intermingled with vast cosmic clouds and huge dark bodies, possibly burned-out suns. For anything we know these latter may be as numerous or more so than the brilliant ones. Will the labor of another century bring order out of this seeming confusion or will it only disclose still greater complexities unknown to us? Time alone can tell.

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SOME UNSCIENTIFIC REFLECTIONS UPON
SCIENCE.*

SCIENCE has its limitations and often confesses to them more or less directly, so that there must be some justification even from science for the heretical standpoint that I am now taking. Like all limitations, too, those of science are as much a source of danger as of opportunity to science itself. And also as for my being unscientific, it may be well to reflect that in these days any negative term can be looked upon as only an extreme or limiting degree—in one direction or the other—of that which it denies, so that I have at least an even chance of saying something scientifically worth while.

With regard to the limitations of science, it is a commonplace of the day that for accuracy and genuineness or purity science must be (1) independent of life, the subjective interests, whether personal or social, being perhaps science's most unsettling influences, (2) specialistic, the 'Jack of all trades' in science being anything but *persona grata* among scientific men, and (3) positivistic, all conceits about what is beyond actual experience and even all dogma about what seems really present to experience being most arrant heresy. But in every one of these requirements or conditions, that do indeed make science possible, there lurk serious dangers, which I wish to point out and emphasize. Not that they have never been seen or heard of before, but rather that certain things are sometimes so commonplace, so well known, as to be unappreciated, if not forgotten altogether.

So, in the first place, the ideal of objectivism for science tends, just in proportion as it is realized, to bury science in the deep

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grave of technique. Of course, if one believes in a resurrection, all may yet be well, but many do not or at least would blush to admit any such belief. And just what do I mean by technique? I mean everything that makes scientific work purely mechanical, for pure mechanicalism is the inevitable method of pure objectivism. Scientists have their etiquette about preempted problems or fields of research, their notions about originality as dependent on working in a new field—hence the preemption to prevent transgression or theft of originality, their conceits about bibliographical information, linguistic proficiency and technical phraseology, their satisfaction over 'publication,' 'contribution,' 'production,' and even 'research,' and a very humble deference of each to each among the different branches of scientific enquiry; and under technique I would include all these things as well as the more familiar matters of method and apparatus and material. Physicians, we are told, and not infrequently their patients, suffer from a professional ritual and etiquette, but they are far from being alone in their misery. Scientists are a close second. Of course to deny that technique has its uses would be absurd. The danger, however, not the use of it, is what now concerns us. Technique is one of the enabling conditions of science, but science that gets no further, that is only 'pure' and 'objective' and 'inductive,' is not true science; its much-vaunted observation and experiment may fill a good many pages and a good many volumes, but material, even material in books, and experiments, even carefully reported experiments, are not science necessarily.

True science, as I conceive it, and I think as all are conceiving it to-day with growing clearness, is synthetic as well as analytic, being interested in something more than a decomposable object. It is activity, not

mere passive receptivity; it is invention, not mere discovery; and what so many are pleased to call the real life, subjective as this is, the real life of a person, a society, or a race, is as important to it, as much a warrant of its conclusions, as any object, however mathematically describable, with which science was ever concerned. True science, I say, is no mere knowledge of an outer world; it is invention, the invention of a tool, the making of a great machine, with use of which human life is to become more vital or more effective, more nearly adequate to the world in which man finds himself; it is what a biologist might call an instrument of adaptation to environment. Sometimes this instrument takes visible, wholly material form; sometimes it appears as method in the practical arts; sometimes it is only an atmosphere or point of view, a habit of mind; but, whatever it is, it is useful, incalculably useful, and its invention is science's chief justification.

This, objects somebody, is sentiment, and sentiment of the sort that destroys science, making serious accurate science impossible. I can not possibly agree. Is a man less interested in having a proper edge on his razor because eventually he must use it on himself? Nothing but the truth can ever set anybody free. But, all question of sentiment or of sharp razors or of a truth that liberates aside, the consistent evolutionist is obliged to take the view of science that is here asserted, just as in general he is obliged to think of consciousness as one of the positive conditions of organic development. To be an evolutionist and at the same time to think of consciousness as only an external ornament of life, perhaps a result without being a condition of development, or of science as solely for its own sake, would be nothing more nor less than to stultify one's self completely. For the historian, too, whether evolutionist or

not, whose chief business is to remind us that the present is not all, the prevailing devotion to science for its own sake, which also in other times has possessed the minds and hearts of men, can be at best only a passing phenomenon. And then, apart from the standpoints of evolution and history, human society is sure sooner or later to resent what I venture to call the aristocratic temper that pure objective science is all too likely to acquire from the exclusiveness of its ritual or technique or say from its academic dress. Aristocratic temper, whatever its direction, is unquestionably as desirable in social life as it is inevitable; it is incident to the development of all institutions, political, ecclesiastical, industrial or educational; but the resentment which it is sure to awaken is not one whit less serviceable to society, insuring, as it does, among other things the 'extension' of science, the translation of science into life.

So for a time pure science may lord it over applied science, the perfecting of science as a tool being the absorbing interest, and inferior men or at least so-called inferior men may be the unfortunate representatives of science in industry and the arts generally, but in our own day applied science has begun to assume its proper place of honor, and those engaged in it are even often recognized as 'research men,' and in general the use of any tool, which men devise, with never mind how much cloistered seclusion and esthetic fervor, is as necessary as the making. The true scientist, accordingly, can only welcome enthusiastically the many indications in recent times of an offensive and defensive alliance between science and industry, seeing in these a conclusive answer to those who have raised the cry of science's bankruptcy. Furthermore, the conflict between pure science, science as technique and applied science is one in nature, and I think also in time, with that between ecclesias-

ticism and theology on the one hand and practical religion on the other and the close analogy between the two must help to emphasize the danger of the purism, which is the objectivism and technique of science, without seriously reflecting on its usefulness.

But besides burying science in technique, objectivism involves a most interesting expression of conservatism. I am not now thinking of the double truth or the double life which it sanctions so cordially that men can entertain advanced scientific doctrines without feeling them in any serious conflict with the traditional teachings of religion and morality, but something else, perhaps not wholly unrelated to this, is in my mind. Thus, while science is commonly supposed to be advanced and 'up to date,' if anything is, it is so only in a way that needs to be very carefully qualified, for it manages to perpetuate not indeed the letter, but still the spirit of old views. Certainly a purely objective science can at best only give a new material content to existing and time-worn forms of thought; it cannot do that in which progress must always consist, namely, develop and adopt new forms of thought, new categories; it cannot do this without betraying its objectivism. Objective science, for example, has said, relatively to a certain doctrine of creation, that spirit did not precede matter in time, but instead matter preceded spirit, and, except for the excitement of the drawn battle which this startling assertion has precipitated, it can hardly be said to have involved any great advance. Also, while deposing the First Cause, an objective science has made all things causes after the same plan, individual, arbitrary, antecedent causes, and this is only to multiply indefinitely, perhaps infinitely, the offensive creationism. Not so, some one objects, since it involves a great deal more than mere multiplication, for by making all things causes it brings into science the

important principle of the equation of action and reaction, a principle which, turning creationism fatally against itself, yields the new standpoint of mechanicalism. Readily I grant this, but a purely objective science has no right to any such development; a purely objective science has no right ever to change its standpoint.

Perhaps this does not mean very much. Then let us approach the matter in another way, risking a reference to one of science's pet conceits, the familiar 'question of fact.' It has been for science a 'question of fact' whether matter made mind or mind made matter, whether this or that thing is or is not a cause of some other thing, whether certain very low, mayhap unicellular organisms, show purpose in their activities or do not, are gifted with a natural tendency to social life, a real interest in their kind, or are not so gifted, or—to take one more case—whether the changes in the brain that precede bodily movements are or are not directed by consciousness, consciousness being in the one case in causal relation with the brain and in the other only an idle external accompaniment, an 'epiphenomenon'—but in each one of these questions of fact we can see how the scientist is given to standing in his own light, obscuring the view of what he above all others ought to see. Are mind and matter, cause and effect, purpose, society, brain-process and consciousness such well-established conceptions, as if independent constants in the scientist's formulæ, that mere external questions of fact can be asked about them? Why, when one really thinks about it, to assume, as questions of fact are usually made to assume, such is their natural objectivism, that anything either is or is not something else, is about as blinding and as ill-advised as could well be. It keeps the scientist busy no doubt, eternally busy, as busy as the sportive cat that so hotly pursues her own caudal extremity, but it does

not contribute much that is positive and progressive. To the question, for example, about lower organisms showing purpose or social feeling in their activity the scientist may answer no and be quite emphatic in his answer too, but almost at once he will appreciate that mankind, when scrutinized in the same way, is similarly deficient; and then somehow the wind is taken out of his sails, since purpose and social feeling are not to be so easily disposed of, and the question of fact simply returns for another reckoning, with Shelley's cloud, silently laughing at its own cenotaph. And what is the difficulty? The difficulty is in the assumption that purpose or social feeling is a fixed conception, so fixed and so well known that its presence or absence can be established by an experiment or two on strictly objective principles. No conception is fixed, and a science that entertains a question of fact with its 'either this or not this,' 'either that or not that,' simply needs to betray its objectivism sufficiently to *recognize* that no conception is fixed, and to recognize at the same time—for this is directly implied—that any division of the things of the world into *a* and not-*a* or *b* and not-*b* is necessarily artificial. In a real universe everything must be true of everything, nothing can be what anything else is not. Let science recognize these things and it will promptly exchange its external objective question of fact for direct internal questions of meaning. Thus, for one of the cases in hand, not Are low organisms social or purposive, but What do they testify as to the real nature of society or of purpose? Being subject to the principle, which I but just now referred to and which I think is not to be gainsaid, that in a real universe everything must be true of everything, that a real universe is really indivisible, the things of man's experience, whatever they be, must always be means to man's understanding of himself, not the

affairs of an wholly objective science. What they are not, he is not; what they are, he is. So, instead of denying purpose or social feeling, or even of assuming the possibility of their denial to lower organisms, science should simply seize the opportunity which its experiments afford of a clearer definition of purpose or society. Thus the experiments seem to show, not that there is no purposive activity or social life in low organisms, but that purpose itself, wherever exhibited, is only the urgency of expressing an existing adaptation, an adaptation that is at once realized and even consciously appreciated. A purely objective science could never assume the standpoint here illustrated, but a progressive science, a science for which let us say knowledge is as much a reaction as an action, a reflection as an observation, can take no other.

The conservatism of objective science or the viewpoint in its questions of fact, which the conservatism determines, is the chief reason for the negative attitude of science, so often an object of *just* complaint. Thus, to use still another illustration, for science to assume that God either is or is not, because He must either be or not be what men have thought Him, is simply to beg the theological question altogether, and true science, or at least true thinking, cannot be and should not be identified with such question-begging. Thus, for science's question of fact, a negative answer is a foregone conclusion, inasmuch as the very fact of the question is evidence that a new idea of God is only just below, if not already on the horizon of man's consciousness. What, therefore, we should ask is, not *Is God?* but simply and candidly, *What is He?* The business of science is to accept and interpret experience, not to question its very reality.

But, secondly, there is scientific specialism, a natural concomitant of objectivism, since the objective as innocent of all

subjective relations is necessarily manifold and discrete, and so turns scientific study into many separate ways. The peculiar danger of specialism is that it is almost certain to make vision dim, if not to induce complete blindness, or, as virtually the same thing, to create in consciousness curious fancies, strange distortions of reality, seen not with the eye at all, but with the mind, which is always so ingeniously constructive, so original, so imaginative, and one might even say so hypnotic in its power of suggestion over the senses. Specialism closes one's eyes and makes one dream. It makes the specialist among physicians see his special ailment in every disorder, and every disorder in his special ailment, and this so truly that merely to consult him is to fall his victim. Of course, he can never be wholly wrong, and his unwitting transgressions help discovery, but, nevertheless, his situation is full of humor. And in science generally, the specialist dreams, transgressing his own proper bounds without clearly knowing that he has transgressed. Why? Because thought, which although often apparently suppressed and abused never actually deserts experiment and observation, is so much greater than vision, than mere sensuous perception. In spite of the specialist being all eyes for his own peculiar interest, the thought that is within him, being bound to conserve an indivisible universe in every particular thing, leads him, thoughtless devotee that he is, patiently repeating his sacred syllable, into most wonderful visions, projecting his consciousness to regions of such logical subtlety and marvellous construction as was certainly never known before, unless, perhaps, among those Eastern sages who fed their minds on 'om.' A specialist, he sees the universe, not knowing in his blindness or in his dreaming that it is the universe; and his danger, the danger of all specialism, is that he may never awake.

Thus mathematics and physics and chemistry and biology and psychology, not to say also the social sciences, are dependent upon the visions of specialism. Each of them may indeed be special, but thought insists upon making its object conform to reality, which is never special, so that in each there do and must arise abstractions, logical constructions, for the others. When, for example, a physical scientist insists on seeing his world of material phenomena only physically, while in reality it is and must be a world of chemical process also, and even of vital and mental character, he is bound to admit to his thinking what he will call working hypotheses, formally true to his physical standpoint, but what any outsider, in order to explain why they are hypotheses that work, must call compensating conceptions, in short logical constructions that are substitutes for the neglected points of view. A science's working hypotheses are thus as if doors in the paneling by which the other sciences are secretly admitted to a room that seems tightly closed to all comers. Every science, in short, and this the more as the science is special and objective and exact, entertains the others unawares. Tennyson's 'flower in the crannied wall' is nothing in its all-inclusiveness when compared with a well-developed special science. In a sense that is indeed coming to be widely appreciated, no science ever does or ever can live unto itself alone. It may will to, but it does not and cannot.

But what are these 'working hypotheses' that work because they are 'compensating conceptions' or 'doors in the paneling'? Some illustration of the foregoing is now imperative. Illustration, however, is difficult, very difficult, for a reason which the scientists will allow me to mention. They know too much about the sciences, while I know too little. Still, as too much knowledge is often blinding and so is only a form

of ignorance, the situation is not altogether hopeless. Thus, while it is true that scientists are likely to insist, even in the face of the principle of thought preserving the unity of an indivisible universe in all the varied studies and conclusions of science, that physics is nevertheless only physics and chemistry only chemistry and biology only biology and psychology only psychology, and while also my illustrations must all come from the field of their special sciences and may therefore only set them more firmly in the willful blindness of specialism, still the principle itself, the principle of a conserving thought, is a disturbing influence which they cannot escape, and then besides I am for the moment forgetting and asking them to forget a very important fact of scientific study today. In these times the running together, or merging, of different sciences, as if through something of the nature of a chemical reaction, is a very familiar phenomenon, and it has been taking place with such persistence and confidence as actually to suggest a natural affinity, each of the sciences involved having the rich experience of discovering itself in the others. This fact, then, must make illustration at least less difficult, since in a way that is certain to appeal to science as no mere theory ever can, it proves or goes far towards proving what is to be illustrated. Moreover, specific illustration is hardly necessary in the sphere of the physical sciences or again in that of the social or of the psychological sciences, for within each one of these groups the affinity but just now referred to has been clearly exemplified, as in the interesting case of physics, chemistry and mathematics. Illustration, then, is needed only for the physical in relation to the social and psychological, and to this I now turn.

In articles already published under the titles 'Epistemology and Physical Science

—A Fatal Parallelism,'* and 'Physical Psychology,'† I have undertaken to show, and I believe I have at least made a beginning of showing, that the dualism of mind and matter, which separates the physical and psychical sciences, is logically reproduced, as if by a sort of projection, within the special spheres of each. Physical psychology is 'concerned with the substitutes or indirections for mind [for the sort of unity, intensive instead of extensive or qualitative instead of quantitative or vital and spiritual instead of physical, which is always associated with mind] that appear in all the so-called physical sciences,' and corresponding to physical psychology there is a psychological or epistemological physics, in its turn concerned with the substitutes for quantity and matter that are present in all the psychical sciences. The sensuous self, for example, with the atomism that it has always involved psychology and epistemology in, is only as if a projection of the physical on the psychical. Sensationalism, as we all know, has ever been closely associated in history with materialism. And, on the other side, in conservation,‡ in plentitude, in motion as relative, that is to say, as always under a principle of uniformity or constancy, and also as inclining to something like vibration or rotation, in which it is an expression of rest as well as motion, and finally, not to continue what might be a long catalogue, in the infinity of space and time or—as the same thing—of quan-

* See *Philosophical Review*, July, 1898.

† See *Psychological Review*, March, 1900.

‡ The case of conservation, in addition to what is to be said here and to what has been said in the two articles referred to above, may be put in this way. This is not the 'constant quantity,' not a mere quantity, but a ratio? As a ratio, even if finite, it is, like all ratios, more than merely quantitative, its constancy testifying, not to mere quantitative unity, but to a unity that quite transcends any purely quantitative differences. As ratios all quantities are both finite and infinite.

tity, the physical sciences have 'doors in their paneling' for the silent entrance of psychical. Do you fail to see this? Then, I can now only suggest, and probably I need only to suggest, that every one of these physical notions, either implicitly or explicitly, is paradoxical, and the paradox, whenever it arises, shows the thinker become a traitor to his chosen standpoint, to his accepted forms—in the case in hand, of course, to the forms and standpoint of physical science.* Moreover, such conceptions as conservation and plenitude and vibration and rotation and infinity, dependent as so largely they are upon what is agreeably known as the scientific imagination, are usually recognized as the physical basis of the very possibility of science, which I would now venture to define, not as mind's knowledge of matter, or in general of objective reality, but as mind's knowledge of itself in matter or in objective reality. Science, in other words, even special science, even objective science, is self-consciousness; say a very realistic self-consciousness, the self seen through the mirror of not-self; which, although metaphysical and almost offensive, reminds me and perhaps others of Burns:

"O wad some power the giftie gie us,
To see ourself as others see us!
It wad frae monie a blunder free us,
And foolish notion."

The bonnie Robert was too much of a specialist in poetry to see that science was the very thing he prayed for.

But now for further illustration of the way in which thought defies specialism and

* Thus conservation as quantitative is a paradox since the constant quantity cannot be finite and infinity is not a mere quantity. The plenal medium can be material only if displaced by material things and plenal only if not material and it is used, too, as an immobile, albeit elastic to an infinitesimal sensitivity, basis of motion. Motion itself is also rest. And infinity, as already implied, is a quantitative paradox, which means a 'door' for quality, for the intensive unity of mind.

conserves its universe I would mention several important facts, that are certainly not unfamiliar, as follows: Thus the social sciences imply affinity for the physical sciences, in that, besides their more special divisions, they are constantly making appeal to science in all its branches from physics to psychology; and the biological sciences, in addition to their more conventional forms, are becoming most hospitable to psychology, chemistry, and even to mechanics. Again, all the different sciences, however special, are wont to adopt the same general method, as, for example, the historical method, the consequences of which to the cause of pure specialism may easily be inferred. And, lastly, striking analogies, other than that of method, are always easily traceable among the sciences of any particular time. Atomism in physics is contemporary with individualism—consider Democritus and the Sophists—in politics; a monarchical politics with an anthropomorphic creationistic theology and a heliocentric astronomy; and a Newtonian astronomy, which makes a law or force instead of an individual body the real center of the solar system, with democracy or constitutionalism and inductive instead of deductive logic and naturalistic theology; so that at no time, whatever a scientist's interest, can he fail to have at least a formal sympathy with other sciences. Analogies among the sciences, so often recognized in these times, are not exactly 'doors in the paneling,' but they may be said to make the paneled partitions all but unsubstantial and transparent.

Specialism, then, is more formal than real. The special science needs only to develop to become, and to find itself, universal. The barriers with which it surrounds itself gradually vanish into mere imaginary lines, which only long usage can possibly make seem substantial and opaque, so that specialism by a logic of its own or by

the logic of a thought that conserves its universe even in the varied studies and conclusions of the many sciences, is destined to end in the unification of the sciences. To say the very least it is the natural fate of the special science to develop into methods of each other.

Unification of the sciences, however, implying as it does the decline of specialism and so also the decline of objectivism, brings with it the translation of science into life, in short the application of science, of which, in addition to what was said before, I would now speak again, but briefly and concisely, for the positivism of science is still to be considered.

The decline of specialism, which we have found to be natural to specialism, by making the dividing partitions unreal is bound in the first place to free the sciences from that bondage of technique, just as, for example, the decline of religious—or irreligious?—sectarianism, a form of specialism certainly, is bound to free religion from the bondage of ritual. Secondly, it must make the distinction between self and not-self, subject and object, man and nature, only a formal one, formal in the way in which the special sciences themselves are distinguished, since the unity of the objective world is one and the same with the self or subject. This we but just now saw, when we were able to define science as not mere knowledge of an outer world, but self-consciousness, realistic self-consciousness, to understand which only reflect further upon the art and literature so natural to an age of science. Art and literature are self-consciousness. But, thirdly, whether because of the freedom from technique or because the scientist does come to discover his own image in the clearing and quieting waters of science, the decline of specialism, again like the decline of sectarianism, brings what some are pleased to style the liberation of the human spirit, a libera-

tion that means freedom in, not freedom from, the natural world, and what a psychologist would call the development of knowledge into will, in short the application of science. Of course applied science must be not special, but general, because life is general; not ritualistic, but spiritual, because life is not ritualistic, making no fast distinctions between part and part or part and whole; and practically or even intuitively wise or skilled, as well as confidently volitional, not technically learned and esthetically satisfied, because life is not learned, but wise. Yes, the natural decline of specialism means the unification which is also the application of science, and, to bring the matter home, any scientific association, through which the sciences find each other out is really dangerous to the cause of pure, of objective and special science, since it can only forerun the movement of science into life.

But now as to positivism, at once the third condition and third danger of science. It can hardly be necessary to show that this is involved alike in objectivism and in specialism. Positivism confines knowledge to actual experience and to only a tentative confidence in actual experience. Scientific knowledge is positivistic, because it is obscured or refracted by the aloofness of the scientific point of view. Science is aloof from life and—in its specialism—also from itself. Then, when men who would be scientists withdraw, as we say, from affairs, it is as if they had put on distorting and discoloring glasses, through which they would see the world, the 'objective' world. The space and the time, for example, in which they see things are widely different from the space and time in which things are doing, from the space and the time of will and action. The difference is felt by us even in ordinary life, but the extreme attitude of science greatly exaggerates it. For science space and time are quantitative, divisible,

formal, independent of what is in them; for will and action they are qualitative, indivisible, inseparable from their content. Again, the scientists reduce causation to mere uniformity of coexistences or sequences, which is no real causation at all, being only so much passive existence or fatal process; while will or action is causation, the positive interaction of things that are, the active relation and conservation of what was and is and will be. And, once more, science needs elements, while will or life is the eternal denial of elements or anything like them. Says a recent writer: * "It is one of the greatest dangers of our time that the naturalistic (or scientific) point of view, which decomposes the world into elements for the purpose of causal connection, interferes with the volitional point of view of the real life, which can deal only with values and not with elements." Of the danger involved I shall speak in a moment, † but the bondage of science to elements, to thoroughly decomposed reality, is indubitable. And then, in addition to the formal space and time, the empty causality and the unreal elements, that are peculiar to the aloofness of science from life, there are in the special sciences the different 'working hypotheses,' which we found to serve the purposes of protecting conservation against specialism, but which, nevertheless, so long as retaining their projected forms, make science artificial. Science, accordingly, has no choice; it is condemned to positivism. Even the much-vaunted experience of observation and experiment, although our only possible source of knowledge, can never lead to direct knowledge of reality, can never put us face to face with that which is. Even in science we know appearances, not things.

* See Münsterberg's 'Psychology and Life,' p. 267. Houghton, Mifflin & Co. 1899.

† See also Münsterberg's 'Grundzüge der Psychologie' in the *Psychological Review*, May, 1901.

But what now is the danger? The writer quoted above says it is the interference of the scientific with the volitional point of view. With not less truth, however, it is that the two points of view will not interfere, that both science and life will fail to appreciate, as that writer has failed to appreciate, the true import of their incongruity, and so will forever stay apart, the one losing itself in a morbid intellectualism, the other in a dead monotony of mere existence. Whatever be true about their incongruity, life without science is certainly lifeless; science without life, meaningless—as meaningless, as empty, as the proverbial Greek. We know men who lead what we often abusively call the double life. They have their science, perhaps their laboratories and their books and their own pet doctrines, and they have also their social affiliations in business, in politics and in religion; and their life seems double, because their sociology and their business, or their political theory and their party ties, or their biology and their religion, simply will not mix. But is their duplicity as real as it seems? To them, as well as for us looking on, the opposition needs only to grow to make all the science meaningless and all the life dead; certainly a strange, ineffectual opposition; a double life, that can be double only in form, only numerically and that must be tedious and unhappy even in its peacefulness. And what more can be said? This. Such duplicity, the duplicity of science and life as never interfering, is not even possible. *Of course* scientific technique, with its aloofness and its logical constructions, and life that in its special affairs is only conventional and ritualistic, or say, routine in the study or the laboratory and routine in the church or the market place, can never conflict, but routine is never either real science or real life. Witness the avowed, although sometimes forgotten, positivism of technical

science and the unrest, the bravado that is so ill-disguised, of what some call 'life.' Science knows that it does not know, that it can not know, that even conscious man has always moving within him another relation to his world than that of knowledge; and life, as apart from knowledge, shows that it does not live. So again I say that the real danger of positivism, of a blind or forgetful positivism, is that the naturalistic or scientific point of view and the volitional point of view will not interfere with each other. Certainly within the laboratory and the study to keep them apart, to separate theory and experiment, would be fatal to both; the life that we call science needs their constant interference, and with every one of its experiments shows that they are not as incongruous as they seem; but what is the world, if not a great laboratory that is related to the smaller as real life to the theater, as nature to the conservatory, as an unaided vision to the microscope?

Agnosticism is another name for positivism. The positivist, the devotee of pure, objective, special science, cannot but believe in an unknowable, and this belief, in its turn often forgotten, needs always to be recognized as a part, a very important part, of the scientific consciousness, for it is only one other way in which thought conserves its universe. Thus the unknowable, whether seen as compensating for science's aloofness from life or for the dreaming that specialism induces, is a constant safeguard against the abuse of knowledge.

The unknowable is a negative that bears constant witness, not to another sphere which some mind quite different from our own might consciously comprehend, and which we, being intellectually outside, and so only creatures of faith, can merely blindly will, but to another relation than that of mere knowledge, which we *as knowing creatures* have to reality. There is, in short, an unknowable for the single reason

that to know is also to will. Or, again, the unknowable is not for knowledge, but for action.

Let us be blindly scientific, insisting on science being only for science's sake, recognizing nothing as worth while but great learning about a Greek particle or a minute insect or a mysterious element, and like a dark cloud there arises and spreads over our view the unknowable, and from this cloud a voice comes: "Only the All is and the All is One and the One is not for knowledge." But as we apply our science, breaking through the walls of specialism, and liberating the will that was for the time their not unwilling prisoner, the sky clears. The one is not for knowledge, but for life; knowledge is not for knowledge, but for will, its natural fulfillment. "The end of man is action, not thought, though it were the noblest."

ALFRED H. LLOYD.

TRUMAN HENRY SAFFORD.

A LONG, active, busy life, devoted without reserve to teaching, to research, to cares of family—such a life of science as that which closed on June 12, in Newark, cannot receive adequate appreciation in the brief space available here. But the friendship of years crowding one upon another will not let pass in silence the death of Truman Henry Safford. A few words of personal sorrow demand immediate expression; leaving a more complete summary of his life's tribute to astronomy to await dignified publication in the annals of those learned societies of which he was a distinguished member.

The friendship of years is no light thing. It was in the latter part of 1884 that Safford paid his first visit to the modest observatory of Columbia College, then situated in 49th Street, N. Y. He found there a stripling engaged in testing a level. The

youngster noticed a kindly face appearing in the doorway; conversation began about the level—and from that day on, no year has passed without the interchange of friendly visits between Safford and the writer of these words. Often and often have we sat far into the night in his 'den' at Williamstown, our talk always of astronomy and its masters. And well he knew the masters, ever recommending and emphasizing that they be studied at first-hand, not through editorially emasculated translations and editions. Gauss was an especial favorite; for Safford was first of all a teacher, and believed that mathematical instruction should always include concrete examples, especially numerical ones. The 'Theoria Motus,' with its endless ramifications of trigonometrical applications and its orbit computations, was beloved by him both for personal reading and as a text for his students. Bessel's works, even those less frequently read, like the 'Tabulæ Regiomontanæ,' he had at his fingers' ends. Text-books attracted him less. He did not use Chauvenet's astronomy, that *vade mecum* of the younger generation; it is doubtful if he owned a copy.

Indeed, a rich fund of anecdote might be collected to illustrate Safford's lovable quaintness of character. One of the cherished dreams of his life was his plan of an extended visit to Europe, its astronomers, observatories and places of historic or scenic interest. Circumstances always prevented this voyage; yet, though he was never abroad, he possessed a most intimate acquaintance with foreign countries. Few Londoners could equal his knowledge of the geography of their city. The interminable intricacies of its streets he had studied from maps until, as his friends said, he could have found his way anywhere without a guide. 'Bradshaw,' the incomprehensible British railway time-table, was an

unsealed book to him. A copy was always close at hand in his library at Williamstown, and he was never tired of extracting from it new and difficult railway problems with their solutions, to the huge amusement of his family and friends.

This ungratified longing for foreign travel showed itself in still another amusing way. On the occasions of his visits to New York, he would often go to parts of the city frequented by foreigners, and afterwards entertain his friends with odd experiences, especially in the foreign restaurants. On one occasion, in the year of the Chicago Exposition, it fell to Safford to act for a day as *cicerone* in New York to two distinguished Englishmen, one a professor, the other an admiral. All three returned from their day delighted; it had been passed at an island much liked by excursionists. Here Safford had discovered, to his great glee, a place called *Klein Deutschland*, and could imagine himself for the moment in Germany. Afterwards, it always gave him indescribable enjoyment to talk of this trip, and especially how acquaintance had been made with a man who insisted on explaining the men-of-war lying in the Brooklyn Navy Yard, and was even led on to go a little into astronomy. Neither the two professors nor the admiral made known to their informant that they had even so much as heard of stars or ships before. Safford had an inexhaustible love for the humorous and the quaint; to those who knew how to understand him, he could be most entertaining. He was passionately fond of music, and could appreciate the best.

But we must not give too much space to those characteristics which attracted his friends so strongly, to the neglect of that which the world of science owes him. Born January 6, 1836, at Royalton, Vt., he showed already in his early boyhood the extraordinary arithmetical powers which distinguished him through life; for he could

at all times multiply mentally very large numbers, knew off-hand the multiplication table to 1,000, and most of the logarithmic tables to three figures. At fourteen he is said to have calculated a cometary orbit, and he graduated from Harvard at eighteen. For some years he was observer at that university under Bond, and for a short time was acting director. In 1865 he took charge of the Chicago Observatory, where he began as his serious work the observation of one of the *Astronomische Gesellschaft* zones. But his work was cut short and his position lost through the great Chicago fire. He then entered Wheeler's astronomical survey in the far West, and worked during several years for the government scientific bureaus of Washington. It was not until 1876 that he finally settled down for life as professor of astronomy in Williams College, Williamstown, Mass.

Here was done his principal work, which related especially to star positions and star catalogues. He made an elaborate discussion of all existing observations of the stars most suitable for determining geographical latitudes in the United States. This resulted in a catalogue of 2018 stars, which was published by the Engineer's Department, U. S. Army. Later, he made a similar catalogue of 612 stars, and upon it has been based the new boundary between the United States and Mexico. This was published in the report of the Mexican Boundary Commission, Washington, 1898. Safford built at Williamstown a meridian observatory which is a model of its class. In it he installed a Repsold circle, with which he made extensive observations of the close polar stars. He liked these stars especially, and the unusually lengthy numerical calculations connected with them did not frighten him. He needed no observing list, as his memory never failed to give him the instrumental setting for each of his beloved polars in every possible posi-

tion of his instrument. These polar observations were collected and published by him in the 'Williams College Catalogue of North Polar Stars.'

But all this work belongs to a class important to pure science, though comparatively uninteresting to the general public; for Safford possessed especially that kind of devotion which can give generously to science without hope of public notice. More striking, perhaps, was his confident prediction in 1861 of the minute unseen companion of the bright star Sirius. Basing laborious calculations on the tiny irregularities in existing observations, he was able to show just where the little *comes* must be. And there it was found in January, 1862, by Alvan Clark, of Cambridgeport, Mass., while he was testing the 18-inch glass now mounted at Evanston, Ill.

Safford was a frequent contributor to astronomical and educational publications, and a member of many learned bodies. The Royal Astronomical Society, of London, honored him with an election as associate in 1866, when he was but thirty years of age. Great as were his abilities in astronomy, he was yet at his best as a teacher. Those who came under his influence at Williamstown can bear witness to this; his ablest pupils profited most from his stored learning, and some from among them are laboring for astronomy today. He was a loving and dearly loved husband and father. To him were granted these priceless blessings: a devoted wife, a united family, a few time-tested friends. A man of genuine piety, the conflict of science and religion had no terrors for him. He knew that no such conflict exists; that the foundations of belief rest not upon ponderous tomes of logic, but on simple faith. Such faith he had, as of a little child; and, like a child asleep, so shall God's acre rest him.

HAROLD JACOBY.

SCIENTIFIC BOOKS.

X *Ind.*
A Synopsis of the Mammals of North America and the Adjacent Seas. By DANIEL GIRAUD ELIOT. Publications of the Field Columbian Museum, Zoological Series, Vol. II. Chicago, Field Columbian Museum; New York City, F. P. Harper; London, R. H. Porter; Berlin, R. Friedländer & Son; Paris, J. B. Bailliere & Son. March, 1901. Pp. xv + 471. Pls. XLIX. Text figs. 94. Price, \$3.00.

Until the appearance of Mr. Elliot's synopsis, no general work on the mammals of North America had been written since 1857, the date of publication by Baird of the eighth volume of the Pacific Railroad Survey reports. The need for a work of this kind may be appreciated from the fact that the number of mammals known to inhabit America north of Mexico has increased, during the past forty-four years, from about 300 to over 1,000.

"This Synopsis," the author writes, "is an attempt to bring together all the forms of North American * mammals that have been described, and which are generally considered as entitled to some kind of recognition. * * * The present time cannot be supposed as opportune for a final and satisfactory revision of the various groups * * *. That must be the work of some future Mammalogist, who can bring to the task not only a thoroughly unprejudiced mind, but who may have acquired a more intimate acquaintance with the quadrupeds of those sections of our country, as yet little known, and whose knowledge of geographical distribution of mammals, the extent of the individual variation of crania, the relationships that apparently different forms have for each other, and the changes in color assumed by the pelage throughout the year, and in some cases adopted by the sexes, has been gained from extensive series of specimens, much greater and more complete than those possessed by any naturalist at the present day. * * * This Synopsis, therefore, may only be regarded as a starting-point upon which such a final list may be founded, and does not purport to indicate how many species of mammals there are in North America, but merely to

* Or, more correctly, species inhabiting the United States and Canada, since those confined to other parts of the continent are omitted.

show how many forms are given some kind of distinctive rank at the present time * * *." Obviously the work is intended as a reflection of current opinion, and not as a critical treatment of the subject. Therefore it will be necessary, in order to appreciate the book, to gain some understanding of the tendencies of the more recent work on North American mammals, and also of Mr. Elliot's attitude toward the conclusions that he wishes to summarize.

The object of systematic biology was defined by Cope as the accurate statement of the results of organic evolution. Convenience in naming and labeling individual specimens is no longer to be regarded as of more than secondary importance. During the past fifteen years, the period of greatest activity in the study of North American mammals, series of specimens aggregating many thousands of individuals have been collected with the special object of showing the results attained by the process of evolution at the present time. These results, though not yet thoroughly understood, have been found much more complex than had been supposed. Species and subspecies, to use for the present these obsolete terms in the absence of the single word needed to replace them, are not invariably separated from their allies by characters easy to describe. They are interrelated with every degree of intricacy, and it is through the study of the more closely allied forms that the most significant facts are to be discovered. Sharply defined species have lost their history and with it their chief interest. No systematic work, therefore, is more important than the record of minute differences; and such difficulties as are met arise from the nature of the results which the process of evolution has reached, and from the inadequacy of language to express all that can be detected by the eye. That these difficulties are not averted when ignored is the standpoint of those with whose work Mr. Elliot deals. His attitude toward it may be learned from the second paragraph of the preface:

"It is very manifest to many Naturalists that too many forms have been given distinctive rank, and without doubt a considerable number of the so-called species and subspecies contained in this volume will eventually swell the

list of synonyms, already sufficiently formidable. In late years there has been an evident inclination among some Mammalogists to unduly magnify, as it would seem, trivial dissimilarities observed among their specimens, and thus greatly increase the number of slightly differentiated individuals elevated to a separate rank, at the risk of reducing the science to one founded on labels and localities, instead of distinctive and prominent characters, and thus a knowledge of the place where an example was obtained becomes at times of more importance for its identification than are the differences that may separate it from its allies. The lack of resemblances often observed among crania is frequently but the individual variations of a type, and taking these for characters upon which to establish a new species is apt to lead to error, and in not a few instances too much reliance has been placed on such slight differences. The same may be said of shades of color, and not a few names in this Synopsis have been given to specimens so closely alike, that one author, in speaking of his key, which was intended to be the means for distinguishing the species, has been obliged to say: It will be necessary to have both skins and skulls in hand, and even then *it will be impossible to identify some of the forms without actual comparison with their nearest allies*. The scientific value of such species (?) can only be very questionable at the best, and the elevation to a separate distinctive rank of such intimately related creatures cannot be considered as helpful or beneficial to Mammalogical Science. It can be safely asserted that there is hardly a genus of North American Mammals that does not contain too many named forms, and that the science would be benefited if a considerable number were relegated to their proper place among the synonyms."

No more would be required to show that the author is not in sympathy with the tendency toward minute accuracy characteristic of the work of to-day; but this hostile attitude is so insistently brought before the reader that one more allusion to it may be made. At the end of the account of the prairie wolves, rendered exceedingly obscure by the omission of details concerning skulls and teeth (pp. 301-303) occurs the following footnote: "It is difficult to dis-

tinguish these varieties of the coyote by any description, and still more so by the skins or skulls."

It is to be regretted that an author who is admittedly unable to present his own views throughout, and who is so obviously at variance with the opinions of others, should not have been content with bringing together as impersonally as possible the multitudinous scattered papers that now make the literature of the subject a maze. In the work as it stands, personal opinion, confessedly defective, and compilation, often not free from bias, are so blended that neither is convincing; and considerable knowledge on the part of the reader is required to avoid misunderstanding.

The book is well printed, though on glazed paper that is probably ill adapted to withstand constant use. This, however, was rendered necessary by the profuse half-tone figures with which the text is illustrated. Throughout the work a tendency to abbreviation is manifested, which, while it may have curtailed the length of the volume by a few dozen pages, has not increased the usefulness of the book. The time saved to author and printer by the use of such references as Schleg. Abte. Geb., or S. S. S. does not compensate the reader for that lost in search for the meaning so effectually concealed. Probably the feature of the work which will most forcibly impress those by whom it is most needed, and that which may be said to be its great defect, is the absence of keys. Of these there are none, either to species, genera or higher groups. The diagnoses of the 10 orders, 34 families, 115 genera and 998 species and subspecies occupy about one-third of a page each. In those relating to species and subspecies there is a noticeable lack of detail concerning skulls and teeth; while the characters given are often compiled in such a manner as to be misleading. The classification is essentially that of Trouessart, with the order reversed to begin with the marsupials. Species and subspecies are arranged in accordance with their supposed affinities, and, as might have been anticipated, the result is frequently less satisfactory than a purely alphabetic sequence would have been. No allusion is made to habits or life histories, and no English names are used except in the table

of contents. The technical nomenclature departs little from accepted usage, though it may be noted that the name *Cubassous* McMurtrie, 1831, is substituted for *Tatu* Blumenbach, 1799, *Manatus* Storr, 1780, for *Trichechus* Linnæus, 1758 (as applied to the manatee), and *Dicotyles* Cuvier, 1817, for *Tayassu* Fischer, 1814. The name *Trichechus*, though based on the manatee alone, is applied to the walrus. *Aplodontia* is altered to *Haplodontia* to conform with rules irrelevant to nomenclature, but *Reithrodontomys*, *Cynomys*, *tridecemlineatus* and doubtless many others, which on the same ground might be changed, are left in their correct original form. A single new name is proposed, *Balænoptera velifera copei* (page 13). As if to compensate for the brevity of the text, the book is illustrated with a profuseness hitherto unknown in similar works. The plates and text figures contain half-tone reproductions of photographs of the skull and teeth of at least one representative of nearly every genus and subgenus. The standard of excellence of these figures is very high, and no equally successful application of photography to zoological illustration on so extensive a scale has hitherto been made.

GERRIT S. MILLER, JR.

THE MARYLAND EOCENE BOOK.

THOSE who have had to deal with official geologic surveys know how frequently it is argued that publications of a character so purely scientific as paleontology appeal to a very limited audience, too limited, it is often urged, to justify the expenditure necessary for their proper production. The counter-argument, however, gets at the facts. Toward the close of the Second Geological Survey of Pennsylvania, after a cloud of volumes upon tectonics, economics and devitalized stratigraphy had been issued, Dr. Lesley prepared a 'Dictionary of Fossils,' profusely illustrated, suffused with important facts, amusing fancies and pages of errata, but a work of great usefulness. The demand created by the appearance of this book was so much greater than the supply that the edition was gone while its reportorial predecessors were resting on the shelves waiting for inquirers. In New York, Ohio and Illinois the experience has been very much the same.

'Maryland Geological Survey: Eocene' is the title of the first of a series of monographs upon the historical geology of Maryland, that is to say, its stratigraphy and fossils, in other words its paleontology. It seems eminently appropriate that the Eocene is chosen as the subject for the initial volume of this series in view of Professor Clark's exhaustive acquaintance with this formation. The state geologist, though taking a leading part in the composition and execution of the work has brought into cooperation with himself a number of experts in various special lines of research. Thus the leading chapter on Eocene stratigraphy and sequence, 'The Eocene Deposits of Maryland,' is by W. B. Clark and G. C. Martin. Under the part assigned to descriptive paleontology the chapters are as follows: Reptilia, by Case; Pisces, by Eastman; Arthropoda, and Bryozoa, by Ulrich; Mollusca, Brachiopoda and Echinodermata, by Clark and Martin; Coelenterata, by Vaughan; Protozoa, by Bagg, and Plantæ, by Hollick. Ten plates of maps and half-tones illustrate the first part of the work, and fifty-four process plates, largely of McConnell's fine pen-and-ink drawings, are devoted to the fossils. Like the other volumes of Professor Clark's survey this is exquisitely constructed on finished lines and commends itself to lovers of well-made books, who will all pray that the supercalendered wood-paper used for the plates may last until the world has no further need of the facts registered upon them.

It is an admirable achievement, bringing together in one place all that is now known of the Eocene stratigraphy and fauna in an important political division, and long after the present quarry workings, coal mines and clay pits of Maryland shall have been exhausted and abandoned, and all the economic products of the State shall have been converted into cash, the facts here brought together will endure, with a never-lessening value to the sum of human knowledge. The book will receive a welcome from paleontologists and merits the cordial appreciation of the citizens and students of the State for whom it has been specially prepared.

JOHN M. CLARKE.

SOCIETIES AND ACADEMIES.

ZOOLOGICAL CLUB, UNIVERSITY OF CHICAGO,
WINTER QUARTER, 1901.

II.

At the meeting of February 6 the program consisted of a paper by Mr. C. M. Child, entitled 'Regulation in *Stenostomum*.'

This paper dealt chiefly with some of the phenomena of regulation following the cutting of an asexual chain of *Stenostomum*-zooids at various points. Some of the more important points are as follows:

The changes which occur after cutting a chain of *Stenostomum*-zooids differ greatly according to the position of the cut with respect to the zones of fission and according to the stage of development of the latter.

Pieces above a certain relative size, cut within the limits of a single zooid, regenerate the anterior and posterior ends without the formation of a distinct bud of new tissue, although proliferation occurs at the cut surfaces. A very rapid change of form occurs, the piece becoming longer and more slender and acquiring the 'normal' form of a *Stenostomum* individual. The time required for the completion of the regulation varies with the temperature, but is in all cases very short. At a temperature of 75° F. it is only three or four days.

If the piece consists of parts of two or more zooids, *i. e.*, if it contains one or more zones of fission, the processes of regulation are more complex. In pieces consisting of the posterior portion of one zooid and the anterior portion of the succeeding zooid the changes depend upon the stage of development of the organs about the zone of fission. If the zone of fission be at a very early stage it may disappear entirely, the whole piece becoming a single individual with head and tail at the two ends. In this case the part which was destined to become the posterior half of an individual becomes, in consequence of its separation from the chain, the anterior half, while the portion behind the zone of fission, which was destined to become the anterior half of an individual, now becomes the posterior half.

If the zone of fission is older, *i. e.*, if the new brain behind it is well established, all that por-

tion of the piece which lies in front of the zones of fission is absorbed by the part posterior to it, *i. e.*, the part which possesses the brain. This occurs even though the anterior piece is much the larger. As the anterior piece is absorbed it is reduced in size, and the zone of fission and the brain appear to migrate in the anterior direction until finally they reach the anterior end of the whole piece, *i. e.*, until the anterior part is completely absorbed. In a recent paper (*Proc. Cal. Acad. of Sciences*, Ser. III., Zoology, Vol. I., No. 6, 1901) Ritter and Congdon have asserted that the brain actually does migrate in pieces of this kind. This seems to be an error of interpretation. Continuous observation of the pieces shows that the facts are as stated above. Indeed, the migration of the intestine out of the anterior piece can be observed.

If the zone of fission has reached a late stage of development, so that the brain of the posterior zooid is well formed and the pieces are more nearly ready to separate, little or no absorption of the anterior piece occurs and the two pieces separate as they would under normal conditions, the anterior pieces developing a new head and the posterior piece a new tail at the respective cut surfaces.

The absorption, when it occurs, is always in the posterior direction, *i. e.*, the part deprived of a brain is absorbed by the part which still retains the brain. The actual disappearance of the zone of fission occurs only in the early stage when the brain posterior to it is not developed or is at a very early stage of development. In general the results depend upon the presence or absence, or the relative development, of the brains in the parts of zooids which make up the pieces.

In sexual individuals of *Stenostomum* asexual multiplication ceases, though the single individual may attain a length as great as a chain of eight or more sexual zooids. The power of regeneration in sexual individuals is not as great as in the asexual chains. The energy of the body appears to be directed in large part toward the elaboration of the sexual products, the consequence of this condition being the cessation of asexual multiplication and the reduction of the power of regeneration.

The session of the Club held on February

20 was devoted to an account by Mr. E. H. Harper of 'Regeneration in *Nais lacustris*.' The paper comprised the results of experiments on both sexual and asexual individuals of this species. The following is a brief abstract:

In the asexual forms where from one to five anterior segments are removed the same number is regenerated as was cut off. In this region in the sexual forms the head segment alone is regenerated, or frequently the surface heals over without regenerating.

When more than five segments are removed in the asexual forms a pharyngeal region of five segments is regenerated. In the sexual animals the process is much slower and in an advanced sexual stage a dwarfed region of five very short segments is produced. The clitellum and sexual organs may be regenerated. This has been seen to occur after a considerable time.

So far as could be determined mutilation never causes the disappearance of the sexual organs, but the formation of a regenerating region will under certain conditions inhibit the process of asexual multiplication and cause the disappearance of the zone of fission. This effect may be produced by a cut anterior to the zone of fission, less often by a cut posterior to it, and occurs only when the zone is embryonic. The zone is also more likely to disappear if the cut is near to it. The band of transparent embryonic tissue redifferentiates and the energy of growth is transferred to the regenerating region.

In the asexual individuals the power of regeneration is less in the anterior specialized region and also in the posterior budding region than in the middle of the body. Short posterior pieces may live a considerable time, but do not regenerate. Anterior pieces of eight or nine segments may survive a short time without regenerating, but pieces of the same length from the middle of the body regenerate freely.

Internal conditions favorable to proliferation, such as the exposure of cut surfaces of intestine and blood vessels, are present in nearly all possible experiments. But if a corner of the head segment be removed, including the prostomium, without injuring the pharynx,

the ectoderm will close over the surface and regeneration will not take place. In the sexual forms failure to regenerate may occur when the pharynx is cut through. Here the tendency to proliferate is slight and it may be that the epithelium differentiates completely over the cut surface before any appreciable amount of regeneration has occurred. And it is probable that after the epithelium is formed there is no further tendency to regenerate.

Growth takes place at right angles to a cut surface; and if the cut is oblique the bud will grow out at an angle to the axis of the body. Straightening is effected after the penetration of the lumen of the intestine into the region under the influence of its peristaltic motions.

Many of the internal phenomena of regeneration may be observed in the living animal on account of the transparency of the body wall. Migration of pigmented cells from the intestine toward a regenerating region can be seen. If a corner of the head segment be cut off, including one eye, the pigmented portion of the other eye is usually fragmented and pigment migrates in various directions.

It has been stated that the regenerative power of these animals varies with the season of the year, being less in autumn and winter. No evidence of this has been observed, but the evidence points rather, as we have seen, to an inverse correlation between regenerative power and sexual activity. Budding, *i. e.*, asexual, individuals regenerate freely and completely in December. The sexual forms are found from October to December.

The program for the meeting of March 6 consisted of two papers, 'The Excretory System of the Bryozoa,' by Miss A. W. Wilcox, and 'Montgomery on the Spermatogenesis of *Peripatopsis*,' by Mr. E. R. Downing.

Miss Wilcox reviewed the literature upon the excretory organs of the Bryozoa and gave the results of some work of her own on the Phylactolæmata. Her paper will appear in full elsewhere.

Mr. Downing's paper consisted of a review and discussion of Montgomery's recent study of the spermatogenesis of *Peripatopsis*.

C. M. CHILD.

THE NEW YORK SECTION OF THE AMERICAN
CHEMICAL SOCIETY.

THE last meeting of the season of the New York Section of the American Chemical Society was held on Friday evening, June 7, at the Chemists' Club, 108 West 55th Street. Dr. Charles A. Doremus occupied the chair.

The chairman delivered his annual address on 'The Development of an American School of Chemistry,' in which he urged the advancement of chemical engineering by the development of originality and the assumption of greater responsibilities by chemists.

The secretary's report showed a net gain in membership of sixty during the year, and that twenty-nine papers had been read at the nine meetings which were held.

The election of officers for 1901-1902 resulted as follows:

Chairman—Professor Marston T. Bogert (Columbia University).

Vice-chairman—Durand Woodman (127 Pearl Street, N. Y.).

Secretary-treasurer—Professor J. A. Mathews (Columbia University).

Executive Committee—P. C. McIlhiney (Columbia), Professor E. H. Miller (Columbia), T. C. Stearns (Jersey City).

Delegates to the Scientific Alliance: Wm. McMurtrie, Professor Marston T. Bogert, H. C. Sherman (Columbia University).

Papers were read as follows:

M. T. Bogert and L. Boroschek—'Some Experiments with the Mono-nitro-orthophthalic Acids.'

H. C. Sherman, J. L. Danziger, L. Kohnstamm—'On the Maumené Tests for Oils.'

E. F. Kern—'On the Separation and Determination of Uranium.'

The paper on the 'Maumené Test for Oils' was a brief account of the principal results obtained in a series of experiments on several varieties of oils, with different modifications of the Maumené test. The common practice of diluting oils with petroleum to prevent too violent a reaction was found to give unsatisfactory results, the figures obtained from such mixtures being too high; as was also the case when the oil was dissolved in an equal weight of carbon bisulphide or chloroform. The necessity of

taking account of the specific heats of the oils and diluents was noted. In order to avoid the necessity of diluting the oil and the resulting uncertainty in the interpretation of results, the use of a weaker acid was proposed. Sulphuric acid of about 87 per cent. can be added directly to all the common oils and the test can be carried out in exactly the same way for the drying as for the non-drying oils. Even when calculated as 'specific temperature reaction' the results are somewhat influenced by the strength of the acid used, higher figures being obtained with the more concentrated acids. It was, therefore, recommended that the test be always made with acid of such strength as will give with water a rise of 33° to 34° C.

It was announced that the courtesies of the society had been extended to Professor Van't Hoff, and a motion was made and unanimously carried authorizing the chairman and executive committee to take such measures and make such preparations as might be required for entertaining Professor Van't Hoff.

The meeting then adjourned until October.

DURAND WOODMAN,
Secretary.

DISCUSSION AND CORRESPONDENCE.

EBBINGHAUS'S THEORY OF COLOR-VISION.

IN proposing his specialization of Hering's theory of color-vision, Ebbinghaus had for an object to give it a basis in fact by showing a connection between the kind of light which must be absorbed by the colored substances in the retina and the subjection distribution of color throughout the spectrum as revealed by color-equations—especially those of the partially color-blind. The connection was a very forced one from the beginning: the visual yellow could stand very well as the absorbent of the light necessary to the production of the sensation blue, but the visual purple ought to have been *blue* in color to fulfill its function of absorbent of the light that causes the sensation *yellow*, while in reality it is not even purple (in the English sense of the word), but magenta; and the existence of a visual green and a visual red was purely hypothetical. Thus of the four colored absorbent substances to which so

fundamental a rôle was assigned, two (the red and the green) did not exist at all so far as known, and one existed only in a wholly erroneous color, and, moreover, in the fovea where vision is most acute, not even the visual yellow, the sole carrier of so large an assumption, has ever, by the most careful methods, been detected; it would seem to be far simpler to suppose that the objective color of the absorbent medium has nothing to do with the case.

The proof which was furnished by König immediately after the Ebbinghaus theory was proposed that the absorption of the visual purple is exactly what is needed to account for that increment in vision which is gradually acquired upon the oncoming of darkness, rendered the theory, of course, far more untenable still, and in fact Professor Ebbinghaus himself seems to be no longer inclined to insist upon it. He says (*Grundzüge der Psychologie*, I., 261, 262): "Ich habe vor einiger Zeit einen Versuch in dieser Hinsicht gemacht und darauf hingewiesen, dass zwischen der Art, wie die Farbenblinden Gelb und Blau im Spectrum verteilt sehen, und der Lichtabsorption des Sehpurpurs und des Sehgelb (nach der Untersuchungen Kühnes) eine auffellende Aehnlichkeit bestehe. Da nun offenbar die Bewusstseinswirkung der optischen Reize durch eine den Eindrücken entsprechende Absorption der verschiedenen Lichtstrahlen vermittelt werden muss, so nahm ich an, dass eben in dem Sehpurpur die Heringsche Blaugelbsubstanz zu erblicken sei.

"Ich sehe jedoch davon ab, die an diesen Ausgangspunkt angeschlossenen und zum Teil davon gang unabhängigen Gedanken hier zu wiederholen, weil sich bei genauerer Untersuchung des Sehpurpurs durch A. König meine ihn betreffende Annahme nur teilweise bestätigt fand. Das Sehgelb allerdings zeigte in dem einzigen Falle, in dem es erhalten werden konnte, eine mit der Blauempfindung der Farbenblinden annähernd übereinstimmende Lichtabsorption. Die Lichtabsorption des Sehpurpurs selbst dagegen entsprach vielmehr der Verteilung der Helligkeiten in dem Dunkelspectrum des normalen Auges, d. h. also auch in dem Spectrum der total Farbenblinden."

To refrain from reproducing the theory in

its author's own text-book of psychology is probably to be regarded as tantamount to withdrawing it.

C. L. FRANKLIN.

SHORTER ARTICLES.

NOVA PERSEI, NO. 2.

AN examination of the Draper photographs of the spectra of Nova Persei, No. 2, by Mrs. Fleming, shows that, like other novæ, it has been gradually changing into a gaseous nebula. The resemblance to the nebula N. G. C. 3918 is now so close that in a photograph taken on June 19, 1901, no marked difference was noted, except that the nebular line, 5007, is about eight times as bright as $H\alpha$ in the nebula, and only equal to it in the nova. The lines 3869, 3970 ($H\gamma$), 4102 ($H\delta$), 4341 ($H\gamma$), 4688, 4862 ($H\beta$), 4950, and 5007, are common to both and, except the last, have nearly the same relative intensities. Four bright lines between $H\gamma$ and $H\beta$ appear faintly in the nova and are not present in the nebula, while one, 4364, is seen in the nebula but not in the nova, perhaps owing to the proximity of $H\gamma$.

EDWARD C. PICKERING.

HARVARD COLLEGE OBSERVATORY,
CAMBRIDGE, MASS., June 25, 1901.

LIME AND MAGNESIA IN PLANT PRODUCTION.

SINCE 1899, the writer, with Dr. O. Loew, of the Division of Vegetable Physiology and Pathology of the U. S. Department of Agriculture, has been carrying on a series of experiments on the relation of lime to magnesia in the growth of plants. Some very interesting results have been attained which are to be published in a Bulletin of the Division to be issued at an early date. It may be of interest to here set forth a few of those results.

It is well known that magnesium salts form some of the more noxious alkali soils of the arid regions. In other sections it has been noticed that the soils well fertilized, especially with certain crude potash salts, after a time fail to respond to the fertilizers applied and either become sterile or their productive capacity is greatly reduced. This is apparently due to the accumulation of magnesia in the soil, it being present in some potash salts to a great

extent. One examined by the writer contained 9.37 per cent. of this element.

In our experiments in water, sand and soil cultures covering a great many trials we found that magnesia in a soluble form in very small amounts was, in the absence of lime, very toxic to plants. By the addition of lime in a soluble form in amount equal to or in slight excess of the magnesia the poisonous effect of the latter was eliminated. The plant was even enabled to withstand any bad effects from a greatly increased amount of magnesia, provided the lime was also increased in an equal or greater degree.

While the addition of other salts to the magnesia in the culture solutions variously affected the toxicity, in no case as far as tested did it have any degree of action comparable with that of the lime salts.

In sand cultures in which the lime and magnesium salts were applied as nitrates the plants made the better growth where the lime was slightly in excess of the magnesia. With lime greatly in excess there was apparently a starvation of the plant, it making a straggling growth for awhile. With the magnesium in excess the plant soon succumbed, and in moderate excess made a slow and unwholesome growth.

In soil cultures in which magnesium carbonate had been added, calcium carbonate was not efficient in overcoming the noxious influence of the magnesia. This was undoubtedly due to the less solubility of the calcium carbonate in comparison with the magnesium carbonate. By the addition of calcium sulphate the toxicity of the magnesia was readily overcome.

In the practical application of lime for its physiological effect the process could be more intelligently carried on where the amount of soluble magnesia and lime already present, *i. e.*, the portion immediately available to plants, is known. However, the danger lies in under- rather than in over-liming. In a soil containing CaO 0.144 per cent. and MgO 0.144 per cent. soluble in 1.115 per cent. of hydrochloric acid the addition of 0.8 per cent. of gypsum, and again of 0.8 per cent. of gypsum and 0.2 per cent. of magnesium carbonate, produced plants similar to those in the natural

soil. With the addition of gypsum 0.2 per cent. and magnesium carbonate 0.68 per cent. the plants made a very slow and spindling growth, too much so for profitable crops.

In liming soils for the physiological effect the sulphate is, among the more soluble forms, the best available. Where a large amount is to be added on account of a high magnesia content of the soil it is better to add small portions yearly, as has been pointed out. However, the process should be repeated until the lime content of the soil is made to equal the total magnesia content.

As stated by Wheeler in his work on Rhode Island soils, calcium carbonate is the best form of lime for overcoming an acid reaction. In applying it for this or any other purpose care should be taken that magnesian limestone be not used unless the soil is also deficient in magnesia. Again in the continued application of crude potash salts the lime and magnesian content of the soil should be known. In case there is a deficiency of lime in the soil the addition of gypsum should also be made in some excess of the magnesia contained in the fertilizers.

D. W. MAY.

U. S. DEPARTMENT OF
AGRICULTURE.

QUOTATIONS.

INDUSTRY AND RESEARCH.

LORD GEORGE HAMILTON has written to Sir Alfred Hickman, M.P., ex-president of the British Iron Trade Association, explaining why certain contracts were placed by Indian railway companies with American firms. In the course of his remarks he says: "You seem to think that orders have only gone abroad because those who gave them did not understand their business. I wish that it were so. The competition we have to face is founded on something much more formidable and substantial. Chemical research, concentration of capital, thorough technical education, improved industrial organization have made in recent years greater advance in America than here; it is with the product of these combinations and not with the assumed stupidity of Indian officials that the British engineer has to contend." Sir Alfred

Hickman replies in a long letter, which appeared in the *Times*, but his remarks refer more to alleged imperfections in American work and the value of protection than to the cause of competition. He asks what evidence exists of 'superior chemical research, technical education, etc.,' and says, "I deny the 'chemical research'" mentioned by Lord George Hamilton. Apparently Sir Alfred Hickman attaches no importance to such reports as those prepared for the University of Birmingham and the Manchester Technical Education Committee as to the position of technical education in the United States; and he can scarcely be familiar with American scientific and technical publications or he would not 'deny the chemical research' with so free a mind. It seems pretty clear, however, that the India Office official who wrote Lord George Hamilton's letter to Sir Alfred Hickman was not the one who expressed views about the chemistry at Coopers Hill and aided the efforts which have strangled the technical education of the officers of the Indian Public Works Department.—*Nature*.

CURRENT NOTES ON METEOROLOGY.

CANNON-FIRING TO PREVENT DAMAGE BY HAIL.

A MOST unfortunate report was recently made to the State Department by the United States Consul at Lyons, France. According to the summary of the report published in the daily papers, the consul states that great success has attended the experiment of firing cannon as a means of protecting orchards and vineyards from damage by hail, and goes on to say that cannon firing is now to be used in order to prevent or to lessen injury by frost. As Consular Reports are official documents, and are looked upon by most persons as authoritative, many inquiries naturally came in to the Department of Agriculture, in Washington, as to when the United States Government intended to adopt, or to experiment with, some such method of protection. It therefore became necessary that some official answer should be made to these inquiries, and by direction of the Secretary of Agriculture, the Chief of the Weather Bureau recently issued a statement to the press in

which he says that it is his conviction that "we have here to do with a popular delusion as remarkable as the belief in the effect of the moon on the weather. * * * The great processes going on in the atmosphere are conducted on too large a scale to warrant any man or nation in attempting to control them. * * * After the experience that this country has had during the past ten years with rain-makers, I am loth to believe that the bombardment of hailstorms will ever be practiced, or even attempted, in the United States, much less encouraged by the intelligent portion of the community. Every effort should be made to counteract the spread of the Italian delusion which has been imported into this country."

On this recently much-debated question as to the possibility of preventing hail by means of cannonading, Van der Linden, in *Ciel et Terre* for May 16 sums up the discussion about as follows: "We see, on the one side, many who believe in the new method; on the other side, sceptics and those who are opposed to the method are calling for clearly established facts before they commit themselves, one way or the other. Under the circumstances, it seems wisest to await further developments before forming an opinion."

CLIMATE OF MANILA.

METEOROLOGICAL data lately published by the Jesuit Observatory, at Manila, are based on pressure, temperature and humidity observations made during the years 1883-1898, and rainfall observations during 1865-1898. The normal temperatures, relative humidities and rainfall for each month follow:

	Temperature. Fahr.	Relative Humidity. Per cent.	Rainfall. Inches.
Jan.	77.0	77.7	1.193
Feb.	77.7	74.1	0.413
March	80.4	71.7	0.736
April	82.9	70.9	1.142
May	83.3	76.9	4.197
June	82.0	81.5	9.622
July	80.8	84.9	14.567
Aug.	80.8	84.4	13.866
Sept.	80.4	85.6	14.925
Oct.	80.4	82.6	7.536
Nov.	79.0	81.6	5.126
Dec.	77.4	80.7	2.134

EQUINOXES AND STORM WINDS.

At the May meeting of the Royal Meteorological Society (London) Mr. Rupert T. Smith read a paper on 'The Periodicity of Cyclonic Winds,' which was a discussion of his own observations made in the neighborhood of Birmingham during the years 1874-1890. The equinoxes do not appear to be very stormy periods, but the greatest frequency and force of cyclonic winds occurs some two weeks before the spring equinox and some three weeks after the autumn equinox.

R. DEC. WARD.

*BIOLOGICAL SURVEY OF THE GREAT LAKES
BY THE UNITED STATES FISH
COMMISSION.*

THE United States Fish Commission will continue during the present summer the Biological Survey of the Great Lakes, inaugurated in 1898. The writer withdraws temporarily from the active management of the enterprise, and the Survey has been placed for the summer under the direction of Professor H. S. Jennings of the University of Michigan, and Professor Henry B. Ward of the University of Nebraska. Active work begins June 15.

Professor Ward, with an assistant, will continue the investigations on the plankton and plankton methods carried on during previous summers.

The remainder of the work, under the immediate charge of Dr. Jennings, will have headquarters at Put-in-Bay, Ohio, on Lake Erie, although the different investigations will be carried on at such points on the lakes as are most favorable. The following is a list of the investigators who will be at work, together with the lines of research which will be carried on:

Professor H. S. Jennings, of the University of Michigan: the movements and reactions of the plankton organisms.

Professor F. C. Newcombe, of the University of Michigan, in general charge of the botanical work: physiological investigations into the relations of the lake plants to the water and substratum.

Professor R. H. Pond, of the Maryland Agricultural College: the distribution of plants and soils at the west end of Lake Erie.

Professor Julia Snow, of Rockford College: the lake Alge.

Professor S. O. Mast, of Hope College: the breeding habits of the sturgeon.

Mr. Raymond Pearl, of the University of Michigan: a statistical study of the races of whitefish and wall-eyed pike.

Mr. Leon J. Cole, of the University of Michigan: a study of the biology and feeding habits of the introduced carp, with especial reference to their supposed destruction of the eggs of other fish.

Professor Chas. Fordyce: systematic work on the Cladocera.

Mr. H. W. Graybill, of the University of Nebraska: the Echinorhynchi of the lake fish.

The University of Michigan cooperates with the Survey by allowing the use of its extensive library of the fresh-water fauna and of certain apparatus. The U. S. Fish Hatchery at Put-in-Bay will be fitted up as a working laboratory, and the steamer *Shearwater*, belonging to the Put-in-Bay station, will be employed in some of the investigations undertaken.

JACOB REIGHARD.

ANN ARBOR, MICH., June, 1901.

*THE JUBILEE OF THE UNIVERSITY OF
GLASGOW.*

ONE of the most interesting events in connection with the recent celebration at Glasgow was Lord Kelvin's oration on James Watt and Sir Joseph Hooker's address in connection with the opening of the new botanical department.

As reported in the London *Times*, Lord Kelvin said:

"The name of James Watt was famous throughout the whole world, in every part of which his great work had conferred benefits on mankind in continually increasing volume up to the present day. It was fitting that the University of Glasgow, in this celebration of its ninth jubilee, should recollect with pride the privilege it happily exercised 145 years ago of lending a helping hand and giving a workshop within its walls to a young man of no University education, struggling to begin earning a livelihood as a mathematical instrument-maker, in whom was then discovered something of the genius destined for such great things in the future. In a note by Watt appended to Professor Robison's dissertation on steam engines, he said that his attention was first directed in

the year 1759 to the subject of steam engines by the late Dr. Robison, then a student in the University of Glasgow and nearly of his own age. He at that time threw out an idea of applying the power of the steam engine to the moving of wheel carriages and to other purposes, but the scheme was not matured, and was soon abandoned. On his going abroad about the year 1761 or 1762, Watt tried some experiments on the force of steam in a Papin's digester, and formed a species of steam engine by fixing upon it a syringe one-third of an inch in diameter with a solid piston, and furnished also with a cock to admit the steam from the digester or shut it off at pleasure, as well as to open a communication from the inside of the syringe to the open air, by which the steam contained in the syringe might escape. That single-acting, high-pressure syringe engine, made and experimented on by James Watt 140 years ago in his Glasgow College workshop, now in 1901, with the addition of a surface condenser cooled by air to receive the waste steam and a pump to return the water thence to the boiler, constituted the common road motor, which, in the opinion of many good judges, was the most successful of all the different forms tried within the last few years. Watt left Glasgow in 1774 to live in the neighborhood of Dr. Erasmus Darwin, grandfather of Charles Darwin. But Greenock and the University and city of Glasgow never lost James Watt. The University conferred the honorary degree of LL.D. upon him in 1806. In 1808 he founded the Watt Prize in Glasgow College. He became Fellow of the Royal Society of Edinburgh in 1784, Fellow of the Royal Society of London in 1785, correspondent of the French Academy of Sciences in 1808, one of the eight 'Associés Etrangers' of the French Academy of Sciences in 1814. He did not know if any university in the world ever had a tradesman's workshop and saleshop within its walls, even for the making and selling of mathematical instruments prior to 1757. But whether the University of Glasgow was or was not unique in its beneficent infraction of usage in this respect, it was certainly unique in being the first British University—perhaps the first university in the world—to have an engi-

neering school and professorship of engineering. This began under Professor Lewis Gordon about 1843. Glasgow was certainly the first university to have a chemical teaching laboratory for students started by its first professor of chemistry, Thomas Thomson, some time between 1818 and 1830. Glasgow was also certainly the first university to have a physical laboratory for the exercise and instruction of students' experimental work, which grew up with very imperfect appliances between 1846 and 1856. Pioneer though it was in those three departments, it had been outstripped within the last ten or fifteen years by other universities and colleges in the elaborate buildings and instruments now needed to work effectively for the increase of knowledge by experimental research and the practical instruction of students. But there was no lagging to-day in the resolution to improve to the utmost in all affairs of practical importance, and they almost saw attainment of the further aspirations to excel over all others in the magnificent James Watt Engineering Laboratory of the University of Glasgow to be ready for work before the expected meeting of the Engineering Congress next September. Now, through the magnificently generous kindness of Mr. Andrew Carnegie to the people among whom he has made for himself a summer home in the land of his birth, all the four Scottish universities could look forward to a largely increased power of benefiting the world by scientific research and by extending their teaching to young people chosen from every class of society as likely to be made better and happier and more useful to our country by university education."

In the course of his address Sir Joseph Hooker said :

"The audience might imagine themselves carried back to the first quarter of the last century when his father was professor of botany. He had not been educated for the medical, or, indeed, any other learned profession. Having inherited ample means and having been from childhood devoted to the study and collection of objects of natural history, he determined to devote his life and his fortune to travel and scientific pursuits. Early in 1820, reduced circumstances requiring him to turn

his botanical attainments to material account, he obtained, through the influence of his friend, Sir Joseph Banks, with George III., the chair of regius professor of botany in this university. It was a bold venture for him to undertake so responsible an office, for he had never lectured, or even attended a course of lectures, and in Glasgow, as in all other universities in the kingdom, the botanical chair was, and had always been, held by a graduate in medicine. Owing to these disqualifications his appointment was naturally unfavorably viewed by the medical faculty of the University. But he had resources that enabled him to overcome all obstacles—familiarity with his subject, devotion to its study, energy, eloquence, a commanding presence, with urbanity of manners, and, above all, the art of making the student love the science he taught. After 20 years of the professorship his father retired and undertook the directorship of the Royal Gardens, Kew. Since that period great changes had been introduced in the method of botanical teaching in all our universities, due, on the one hand, to a vastly advanced comprehension of the structure of plants and of the functions of their organs, and, on the other, to a recognition of the fact that the study of the animal and vegetable kingdoms could not be considered apart. Furthermore, chemistry, physics, and greatly improved microscopes were now necessary for the elucidation of the elementary problems of plant life. The addition of the building in which they were assembled was evidence of the resolve that botany should not fall from its well-earned position. The botanical laboratory would prove an invaluable aid to research under the ægis of its distinguished director, and in that belief he now declared it open.

THE HARVARD CHEMICAL LABORATORY.

PROFESSOR T. W. RICHARDS writes in the last number of the *Harvard Graduate Magazine* in regard to research work, as follows:

“Original investigation, which has added so much to the intellectual life of the Laboratory, continues with unabated vigor. In the last five years about seventy papers have been published by the officers and students in Boylston Hall. These covered a wide range of subjects,

about half of them concerning organic chemistry, and the other half physical and inorganic chemistry. Professor Jackson’s extended researches upon the structure of aromatic substances have yielded in the hands of many students a large number of interesting new compounds and the basis for further generalization upon the mechanism of chemical action. Professor Hill’s precise and detailed study of pyromucic acid has now in part given place to an extremely interesting series of syntheses of the benzol ring. In physical chemistry several comprehensive papers on chemical thermodynamics have appeared, and various phenomena were studied in the Laboratory by both instructors and students. For example, the passage of electricity through gases received attention; modern theory of dissociation was studied in its relation to the sense of taste; a new basis for thermometric standardization has been found; and the fundamental Law of Faraday has been subjected to a verification more rigorous than ever before. The study of the law of definite proportions, the one other chemical law which seems to rank with Faraday’s in unflinching precision, has been steadily continued. In the last ten years the atomic weights of copper, barium, strontium, calcium, zinc, magnesium, cobalt, nickel, uranium and cesium have all been studied with a care which seems to carry conviction with it. This work has all been handicapped by the inadequate quarters in which it had to be performed, and we now have to face the bitter alternative of being obliged either to turn away graduate students, or else so to crowd them together as to make accurate investigation almost impossible.”

SCIENTIFIC NOTES AND NEWS.

HARVARD UNIVERSITY has conferred the LL D. degree on Dr. H. S. Pritchett, president of the Massachusetts Institute of Technology; on Professor J. H. Van’t Hoff, professor of physical chemistry at the University of Berlin, and on Professor C. S. Sargent, director of the Arnold Arboretum. The honorary M. A. was conferred on Dr. Hugo Münsterberg, professor of psychology, and on Dr. Theobald Smith, professor of comparative pathology. In conferring these last degrees, President Eliot referred to the

recipients as follows: "Professors in this University, not of Harvard nurture, distinguished for productive research—to make them children of the house."

YALE UNIVERSITY, at its commencement exercises last week, conferred the LL.D. on Dr. E. B. Wilson, professor of zoology in Columbia University. It will be remembered that the same degree was given to Professor Wilson by the University of Chicago the previous week. The honorary M.A. was conferred on Mr. Gifford Pinchot, B.A. (Yale, '89), chief of the Bureau of Forestry, U. S. Department of Agriculture.

TRINITY COLLEGE has conferred the LL.D. degree on Professor W. H. Howell, professor of physiology in the Johns Hopkins University, and on Professor F. H. Osborn, professor of zoology in Columbia University and curator in the American Museum of Natural History. It will be remembered that Professors Howell and Osborn gave the chief addresses on the occasion of the dedication of the Hall of Natural History last winter.

BOWDOIN COLLEGE has conferred its LL.D. on Dr. Alpheus S. Packard, professor of zoology and geology at Brown University.

AT the recent celebration of its ninth jubilee, the University of Glasgow conferred its LL.D. degree on 120 delegates from various universities and institutions. These included J. Mark Baldwin, professor of psychology at Princeton University; William G. Farlow, professor of cryptogamic botany at Harvard University; Dr. Adolph Meyer, lecturer on psychiatry at Clark University, and R. Mark Wenley, professor of philosophy at the University of Michigan. The foreign men of science on whom the degree was conferred are: Professor Karl Bezold, University of Heidelberg; Professor W. C. Brogger, University of Christiania; Professor Daniel J. Cunningham, Trinity College, Dublin; Professor Nicolas Egoroff, Imperial Military Academy of Medicine, St. Petersburg; Principal George Carey Foster, University College, London; Sir Archibald Geikie; Professor A. A. W. Hubrecht; Professor Kronecker, University of Berne; Dr. Joseph Larmor, St. John's

College, Cambridge; Principal Oliver J. Lodge, University of Birmingham; President James Loudon, University of Toronto; Sir William MacCormac; Professor James G. MacGregor, Nova Scotia; Professor John Perry, Royal College of Science, London; Professor F. York Powell, Oriel College, Oxford; Sir Henry S. Roscoe, Vice-Chancellor of the University of London; Professor Joseph J. Thomson, University of Cambridge; John Isaac Thornycroft, naval architect and engineer.

SURGEON-GENERAL GEORGE M. STERNBERG has left for the Philippine Islands on a tour of inspection.

DR. CH. WARDELL STILES, of the Bureau of Animal Industry, has been appointed a delegate from the U. S. Government to the International Congress of Zoologists which meets at Berlin next August.

PROFESSORS NICHOLAS SENN and D. R. Brower, of the Rush Medical College, University of Chicago, and Professor Jacob Frank, of the Chicago Polyclinic, have left New York for a trip round the world by the way of Siberia. It is expected that only fifty-nine days will be required for the traveling and one month will be spent at stopping places. They have been invited to hold surgical clinics in Moscow and Japan.

MAJOR ROSS, of the Liverpool School of Tropical Medicine, and Dr. Logan Taylor, assistant professor of pathology at Glasgow University, sailed on June 15 from Liverpool for West Africa to continue researches on malaria.

A PARTY from the U. S. Geological Survey, including Mr. W. C. Meudenhall, geologist, and L. E. Reaburn, topographer, have left Dawson for explorations in northern Alaska.

DR. S. WEIR MITCHELL, of Philadelphia, has arrived in California after a trip round the world.

DR. OSCAR UHLWORM, of Cassel, editor of the *Botanisches Centralblatt*, has been appointed director of the German Bureau for the International Catalogue of Scientific Literature.

A WALKER PRIZE, of the Boston Society of Natural History, has been awarded to Mr.

Edward W. Berry, of New York, for a memoir on *Liriodendron*.

PROFESSOR St. JOHN, of Oberlin College, and Professor Nichols, of Dartmouth College, will spend the summer working at Yerkes Observatory.

THE professors of chemistry at Harvard University, Professors Jackson, Hill, Sanger and Richards, gave a dinner to Professor van't Hoff, of the University of Berlin, on June 27. Among the invited guests from a distance were Professor Michael, of Tufts College, and Professor Bancroft, of Cornell University.

THE Rev. Joseph Cook died at Ticonderoga, New York, on June 24. Some years ago Mr. Cook attracted much attention by his Boston Monday lectures on religion and science, published under titles such as 'heredity,' 'biology,' etc.

DR. SVEN HEDIN has returned to Chaklik after a successful journey through the Desert of Gobi. He is now continuing his travels across Thibet.

THE members of the French commission entrusted with the measurement of an arc in Peru arrived at Guayaquil on June 1, and will commence their observations during the present month. They will be joined by M. Gonnessiat, who, a year ago, took charge of the observatory at Quito.

ACCORDING to the N. Y. *Evening Post* E. A. Martel, the French explorer of caverns, whose discoveries underground have attracted much attention, reports that he has found in the department of Hautes Alps a cavity in the form of a 'natural well,' whose depth exceeds that of any other known. He has sounded it to the depth of about 1,027 feet, but the actual bottom has not been reached.

KING CHARLES of Portugal and the members of the Portuguese Cabinet opened at Horta, in the Azore Islands, on June 29, the meteorological observatory in connection with the Weather Bureau at Washington.

IN the fire at Jacksonville, Fla., the herbarium of Mr. A. H. Curtis, containing about 16,000 sheets, was destroyed.

A SECOND Livingstone Exhibition was opened in London, on June 18. In addition to a collection of relics of the great explorer, lent by the Geographical Society and other contributors, there is a display of all kinds of articles conducing to the health or comfort of travelers in uncivilized regions. Not only are the special requirements of travelers represented, such as camp equipment, portable foods, clothing and general outfit, but other sections are devoted to sanitation, house-building and various matters of interest to residents in such regions. In connection with the Exposition a reception was given by the Royal Geographical Society on the eighteenth. During the evening, lectures were given in the council chamber, with the aid of the lantern, by Dr. Cornish, on 'Waves in Air, Water, Sand and Snow'; Dr. Francisco Moreno, on the 'Scenery of Argentina'; Dr. Manson, on 'Recent Malarial Discoveries'; Captain Barker, on the 'Antarctic Ship Discovery'; and Dr. Mills, who exhibited some recent geographical photographs.

AT the last International Congress of Librarians, held at Paris, Mlle. Marie Pellechet established two prizes, of the value respectively of 1,000 and 500 fr. for the best memoirs relating to the insects that destroy books. The memoirs should be sent to M. Henry Martin, secretary of the congress, rue de Sully I, Paris.

THE Rev. W. M. Beauchamp, Syracuse, N. Y., is continuing his series of archeological bulletins, published by the New York State Museum. The sixth bulletin on 'Bone and Horn Articles' is in press, and Mr. Beauchamp is now at work on metallic implements and ornaments. There will be figures of most of the native copper articles known in New York, and Mr. Beauchamp requests collectors of such articles to communicate with him.

THE census returns show the population of France to be about 38,600,000, an increase of 330,000 since 1896. To this small increase Paris and its suburbs contribute 292,000, the greater part of which number is due to foreign immigrants, so that the rest of France gives an increase of only 38,000. Since 1850 the population of France, allowing for alterations of boundaries, has only increased from 35,000,000

to 38,000,000, whereas that of the United Kingdom has risen from 27,000,000 to 41,000,000, Germany from 35,000,000 to 56,000,000, Austria from 30,000,000 to 45,000,000, and Italy from 23,000,000 to 32,000,000.

MAJOR-SURGEON W. C. GORGAS, chief sanitary officer of Havana, has presented his report for May, showing a very gratifying state of affairs in Havana. For the first time in its history, there was not a single case of yellow fever in Havana on June 1, and there was only one death from this disease in the preceding three months. Regarding the two slight outbreaks of yellow fever, Major Gorgas writes: Since March 8 outbreaks of yellow fever have occurred twice. The first time, April 21 and 22, we had two cases; and again, on May 6 and 7, four cases. Each time the infected houses and three or four contiguous houses on every side of the infected house were carefully gone over. Every room in each of these houses was closed and sealed, and insect powder burned in them at the rate of one pound to 1,000 cubic feet. All standing water was drained away where possible, and oiled where it could not be drained. The results look as if the focus of infection at that particular point had been eradicated. In the case of the patient taken sick March 8, after our disinfection, we went forty-two days till the next case. Then an outbreak occurred, April 21 and 22. We again disinfected, and went fifteen days till the next cases, May 6 and 7. We again disinfected, and have gone twenty-four days without a case. I am more particularly impressed by these figures, as we commenced our systematic destruction about the middle of February. Formerly we paid no particular attention to the mosquito, merely disinfecting for yellow fever, as we do for other infectious diseases. The only part of the process that killed the mosquito was the formaline used in one or two infected rooms.

THE Medical Society of the State of California has passed the following resolution:

Whereas, It has been shown by our local bacteriologists, and by the Commission sent by the United States Government, that the bubonic plague has existed in San Francisco, and probably does at the present time; therefore, be it

Resolved, That the Medical Society of the State of California express its confidence that the San Francisco Board of Health, the State Board of Health, and the United States Commission will be able to watch the disease, and to take proper measures for its suppression.

THE Imperial Russian Association of Fisheries will hold an international exposition in February and March, 1902, at St. Petersburg, for the purpose of showing the condition of the fresh and salt water fisheries of the world. The expense of the exposition will be defrayed by the association, the crown, the municipal government, private contributions, and by charges for exhibition space and for the admission of visitors. Premiums will be awarded in the form of gold, silver and bronze medals, diplomas of honor and money prizes. The exposition will have nine departments, as follows: (1) Fisheries in general; (2) salt and fresh water fisheries; (3) implements used in the fisheries industry; (4) products of the fisheries; (5) manner and means for preserving fish; (6) arrangement of fish hatcheries; (7) fishing sport; (8) aquariums and their inmates; (9) scientific researches concerning the lives of fishes, etc.

UNIVERSITY AND EDUCATIONAL NEWS.

MR. J. PIERPONT MORGAN has undertaken to erect for the Harvard Medical School three new buildings at an estimated cost of \$1,000,000. They are to be a memorial to his father, Mr. J. S. Morgan, who began his business career in Boston. This great gift was the result of an interview with Professors H. P. Bowditch and J. C. Warren last winter, but was communicated by cable from England at the recent commencement exercises. The Harvard Medical School can now be removed from its present site in Boston to Brookline, where twenty-one acres of land have been secured. The three buildings to be erected are for administration, for anatomy, histology and embryology, and for physiology and physiological chemistry.

It was announced at the recent commencement exercises of Yale University that it was expected that the bicentennial fund of \$21,000,000 would be collected by next autumn. The

sum required for land and buildings, \$1,185,000, has been entirely secured. The subscribers to the fund number about seventeen hundred.

MR. EZRA J. WARNER, of Chicago, has given \$12,500 to Middlebury College for the furnishing of Warner Science Hall, erected last year at a cost of over \$80,000. The college has also received a gift of \$5,000 from Dr. M. Allen Starr, of New York, to purchase books for the library.

THE cornerstone of the new science building at Drury College, Missouri, was laid on June 13. Toward the cost of this building Dr. D. K. Pearsons contributed \$25,000, and an equal amount has been made up by general subscription.

SENATOR HANNA has given \$50,000 to Kenyon College, Gambier, O., for a dormitory.

JOHN D. ROCKEFELER has promised \$25,000 to Des Moines College, Iowa, on condition that friends of the institution raise \$55,000 more.

THE College of Physicians and Surgeons, Chicago, which is the medical department of the University of Illinois, has been destroyed by fire resulting from lightning. The loss on the building and equipment is said to be \$200,000.

THE commission selected to draft plans for the Carnegie Technical School at Pittsburg has presented its report. The commission proposes three divisions, the Carnegie Technical College, the Carnegie Technical High School and the Carnegie Artisan Day and Evening Classes. It advises that experimental shops and laboratories be built, that the college support one or more publications, to give the fruits of its research to the world; that English, French, and German and Spanish be studied. It also recommends courses of study for the three divisions. The commission consists of Professors V. C. Alderson, of Chicago, Robert H. Thurston, of Cornell University, Thomas Gray, of Terre Haute, Ind., and J. B. Johnson, of Wisconsin University.

DR. F. W. SANDERS has been compelled to resign the presidency of the New Mexico College of Agriculture and Mechanic Arts (Mesilla

Park, N. M.). The following abstract from his letter of resignation has been published in the *New Mexico Collegian* for June, 1901: "I have declined to serve you longer unless you would abandon the pernicious system of annual elections, and have urged you to give this system up for a number of reasons; because, among other things, it almost inevitably lends itself to the control of the pettiest of personal and local and political influence, and makes a permanent policy impossible; but especially because it makes possible the removal of able and faithful employes for reasons that will not bear the light." The new president has not yet been elected.

THE University of New Mexico, at Albuquerque, N. M., has been unfortunate in losing its president, Dr. C. L. Herrick, who resigned on account of ill health. Dr. Herrick is at present in the field, continuing his important researches in the geology of New Mexico.

DR. TALIAFERRO, an instructor in the Pennsylvania State College, has been made President of the Florida Agricultural College.

AT the University of Colorado, a chair of geology has been established which will be filled by Dr. N. M. Fenniman. The chair of philosophy, vacant by the death of Dr. Francis Kennedy has been filled by the appointment of Dr. M. F. Libby.

KARL E. GUTHE has been promoted to an assistant professorship of physics at the University of Michigan.

DR. A. P. SAUNDERS has been promoted to a professorship of chemistry at Hamilton College.

S. P. ORTH has been promoted to a professorship of natural science at Buchtel College.

ARTHUR L. CLARK has been appointed professor of physics at Bates College.

DR. MARGARET K. SMITH has been appointed professor of psychology at the State Normal School, New Platz, New York.

DR. W. PALLADIN has been made professor of plant anatomy and physiology in the University of St. Petersburg.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

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FRIDAY, JULY 12, 1901.

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THE CARNEGIE TECHNICAL UNIVERSITY.

It was some weeks ago announced by the daily press as definitely settled that Pittsburg is to have a great technical institution, especially adapted to its peculiar needs and to be made, in its industrial field, as complete and admirable as the Carnegie Institute of that city has become in art and æsthetics. Mr. Carnegie, who has now placed the Scotch universities in a comparatively comfortable position by an endowment of ten millions of dollars, and has thus contributed to the cause of liberal education more than has ever been before given by any individual in a single gift, has now determined to do something on a liberal scale for that department which most naturally appeals to his personal sympathies—education in applied sciences—and he has agreed to supply the funds for the new foundation. The organization of the institution has been entrusted to the local Board of Trustees, already having charge of the Carnegie Institute and the Carnegie Library at Pittsburg. This body has appointed a committee 'On Plan and Scope' and this committee, in turn, has called in experienced and expert advisers to aid them

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.

in determining upon the very best plan and the most suitable scope of the institution, and of its curriculum.

These expert advisers were Dr. R. H. Thurston, Director of Sibley College, Cornell University, Professor J. B. Johnson, Dean of the College of Engineering, University of Wisconsin, Professor Thomas Gray of the Rose Polytechnic School and Professor V. C. Alderson of the Armour Institute. After their several reports had been made, they were organized into a committee to consider and report upon the schemes of the individual reports and to present a final and condensed statement of the plan upon which all could agree. This is the report which we present herewith to the readers of SCIENCE. It includes, as is seen, three different and distinct forms of school which may be combined as parts of one complete technical university that might satisfy the ambition of John Scott Russell, were that greatest of promoters of industrial education living; or they may be adopted, singly or together, on any scale which the needs of the city, the opportunities of the founder and the ambition of Mr. Carnegie and his coadjutors may seem to justify.

It is understood that this is simply a recommendation of his committees and that Mr. Carnegie is in no way bound to accept either the plan, the scope or the estimated endowment as binding upon him. It is understood that the committees will report to him the plan and scope proposed for these schools, leaving him free to found a school for artisans, a technical high school or a technical college, or, if his ambition mounts so high, a true *technical university*,

including them all, and more complete and universally fruitful of good to all sorts and conditions of men and women—it is understood that both sexes are to be provided for—than has been any institution for technical, industrial and scientific education, ever before conceived. Even this latter is entirely within the means of Mr. Carnegie, as limited by his publicly declared plans of distribution of funds for educational purposes, and it would be a glorious thing for the world, as well as for Pittsburg and our country, could the ideal technical university be thus made a reality by our greatest philanthropist.

REPORT OF THE ADVISORY COMMITTEE ON THE
CARNEGIE TECHNICAL SCHOOLS OF
PITTSBURG.

PITTSBURG, PA., June 25, 1901.

Mr. William McConway, Chairman Committee on Plan and Scope.

DEAR SIR.—Your Advisory Committee begs leave to submit the following report upon the scope of the proposed Carnegie Schools of Technology.

INTRODUCTION.

It has become clear, both to educators and to business men, that the new century demands a wide dissemination of a *new type of school training*. The new methods of concentrated capital and of wholesale production; the ready means of transport by which our antipodes have become both our customers and our sources of supply; the practical abandonment of both the apprenticeship system and of the individual manufacturer; the world-wide field of operations in all lines of trade; the infinite number of applications of scientific knowledge in all fields of modern industry; the whole-world competition which confines success to the most economic production;

and the constant supplanting of manual labor and man power by automatic machinery and by steam or electric power; these are some of the signs of the times by which it is clear that some new kind of preparation for the work of life must be introduced into the school training of both boys and girls. This, too, not only for their individual success, but for the maintenance of American leadership in manufacturing and commerce. What this new education should be for America may be exemplified by the proposed Carnegie Technical Schools of Pittsburg. Nothing short of such a complete system should be planned.

The scheme which your committee proposes may be divided as follows:

- I. The Carnegie Technical College.
- II. The Carnegie Technical High School.
- III. The Carnegie Artisan Day and Evening Classes.

I. THE CARNEGIE TECHNICAL COLLEGE.

This should be a first-grade technical college, superposed upon a high-school curriculum, with entrance requirements equal to those demanded by the best grade of existing colleges of engineering. It should be a school of both pure and applied science, and should prepare young men for leadership in the commercial as well as in the industrial pursuits. Both our manufacturing industries and our foreign commerce are now demanding the highest technical training it is possible to bestow, but this training must be fitted to particular vocations.

This college should be made attractive to the greatest scholars in the fields of physical and chemical science. To obtain and hold such men they must be given ample opportunities for research. This college must be supplied, therefore, not only with great experimental shops and laboratories for students' use, but in all departments there should be splendidly equipped laboratories of investigation and research, under the direction of the head of such depart-

ment, and with a full corps of assistants for the carrying on of lines of investigation which are now partly or wholly unprovided for in America. These well-equipped workshops and these experimental and research laboratories would form the chief distinction of this technical college, and they would also be the chief item of expense. This college would support one or more publications in which the fruits of this research department would be given freely to the world. While the number of students in this college would be small, as compared with the number in the technical high school, the work done here would be of far more benefit to the world, and it would form the chief, if not the only, feature of the whole scheme to attract attention and to extend its beneficent influences beyond the immediate vicinity of Pittsburg.

Instruction in the Technical College should include:

1. Technical courses in—
 - a. Mechanical engineering.
 - b. Electrical engineering.
 - c. Civil engineering.
 - d. Chemical engineering.
 - e. Electro-chemical engineering.
 - f. Marine engineering.
 - g. Railway engineering.
 - h. Sanitary engineering.
 - i. Mining engineering and metallurgy.
 - j. Architecture.
 - k. Commerce and transportation.
2. Courses in pure and applied sciences.
 - a. Mathematics.
 - b. Physics.
 - c. Chemistry.
 - d. Biology.
 - e. Geology.
 - f. Mineralogy.
 - g. Astronomy.
 - h. Economics.
 - i. Commercial geography.
3. Courses in modern languages.
 - a. English.

- b. German.
- c. Spanish.
- d. French.

II.—THE CARNEGIE TECHNICAL HIGH SCHOOL.

The work of this school should be superposed upon the work of the public grammar schools of Pittsburg and Allegheny. Its scope should be broad and comprehensive. The elective principle should be recognized, and graduation would depend not upon completing a prescribed curriculum, but upon completing a required number of courses, to be selected by the student under the direction of the director of the school.

In this school, the boy who wished to fit himself for industrial pursuits would find equal advantages with the boy who desired to prepare himself for professional engineering, or the girl who wished a general high school education supplemented by instruction in the home-making arts.

To make this instruction practical and fruitful of results it would be necessary to have well-equipped shops and experimental laboratories in all the courses leading toward specific employments, and these require a liberal housing, an expensive equipment and an expert direction by accomplished artisans. Such a complete school as is here proposed does not now exist in this country, but it would prove a pattern to be copied in every large city and such as the new century and the new industrial conditions demand.

Instructions should include:

1. The ordinary English high-school studies.
2. Physics, chemistry and biology, with students' laboratory practice.
3. The elements of the calculus and applied mechanics.
4. French, German and Spanish.
5. Commercial studies.
6. Domestic arts and sciences.
7. Freehand and mechanical drawing.

8. Technical studies, fitting for the industries of the locality, such as:

- a. Blast furnace and foundry practice.
- b. Glass-making.
- c. Brass-founding and finishing.
- d. Pattern-making and joinery.
- e. Metal-working.
- f. Stationary, locomotive and marine engine and boiler management.
- g. Light and power station management.
- h. Gas manufacture.
- i. Railroad transportation.
- j. Plumbing and domestic sanitation.
- k. Surveying.
- l. Clay working and ceramics.
- m. Industrial art.

III.—THE CARNEGIE DAY AND EVENING CLASSES.

These classes are proposed for the benefit of those who are unable to take advantage of the more complete courses in the Technical High School. They should be available to both sexes. Instructions should include:

- a. Elementary mathematics.
- b. Elementary physics.
- c. Elementary mechanics.
- d. Elementary chemistry.
- e. Freehand and mechanical drawing.
- f. Modern languages and elementary instruction in such technical subjects as are taught in the Technical High School.
- g. Courses of special lectures on subjects of interest to artisan classes.

In conclusion your committee desires to state that in its judgment a large tract of land, not less than 50 or 60 acres in extent, should be provided, in order that the buildings may be grouped about an attractive campus.

Furthermore, the best educational experience leads us to believe that the highest interests of these schools will be conserved by being maintained as independent insti-

tutions unhampered by public or private control.

Respectfully submitted,
(Signed) ROBERT H. THURSTON,
VICTOR C. ALDERSON,
THOMAS GRAY,
J. B. JOHNSON.

A NATIONAL UNIVERSITY.*

To the National Council of Education:

The undersigned members of the committee to investigate the entire subject of a national university and to report to the Council do now report, as follows:

The appointment of the committee was authorized by the Council at their meeting at Washington, D. C., on July 11, 1898, in the passage of the following resolution, offered by Mr. Dougherty, of Illinois:

Resolved, That the chair appoint a committee of fifteen, the majority of whom shall be members of the Council, who shall investigate the entire subject of the establishment of a national university and report to the Council.

MEMBERSHIP.

The president of the Council subsequently appointed the committee, as follows:

WILLIAM R. HARPER (*chairman*), president of the University of Chicago.

EDWIN A. ALDERMAN, president of the University of North Carolina (now president of Tulane University of Louisiana).

JAMES B. ANGELL, president of the University of Michigan.

NICHOLAS MURRAY BUTLER, professor of philosophy and education in Columbia University.

JAMES H. CANFIELD, president of Ohio State University (now librarian of Columbia University).

J. L. M. CURREY, agent of the Peabody and Slater educational funds.

NEWTON C. DOUGHERTY, superintendent of schools, Peoria, Ill.

ANDREW S. DRAPER, president of the University of Illinois.

CHARLES W. ELIOT, president of Harvard University.

EDMUND J. JAMES, professor of public administration in the University of Chicago.

*Report of the Committee of the National Educational Association.

WILLIAM H. MAXWELL, superintendent of schools, New York, N. Y.

BERNARD J. MOSES, professor of history and political economy in the University of California.

J. G. SCHURMAN, president of Cornell University.

F. LOUIS SOLDAN, superintendent of schools, St. Louis, Mo.

WILLIAM L. WILSON, president of Washington and Lee University.

MEETINGS.

The committee have held three protracted meetings: at Washington, D. C., on November 2, 3 and 4, 1899; at Chicago, Ill., on February 26, 27 and 28, 1900; and at New York, N. Y., on May 23 and 24, 1901. The first meeting of the committee was attended by all the members except Messrs. Angell, James (absent in Europe), and Moses. The second meeting was attended by Messrs. Harper, Alderman, Butler, Dougherty, Draper, Eliot and Soldan. The third meeting was attended by Messrs. Harper, Butler, Canfield, Dougherty, Draper, Eliot and Maxwell.

Mr. Moses has been absent from the country on public business, and so has been prevented from sharing in any of the deliberations of the committee. Mr. Wilson's untimely death in 1900 deprived the committee of the benefit of his cooperation in the preparation of this report.

PRELIMINARY INQUIRIES.

Before the committee came together for the first time, individual members had, at the request of the chairman, undertaken to prepare reports upon special phases of the subject referred to the committee, with a view to preparing the way for their more intelligent consideration and discussion. The reports so prepared included one by Mr. James, on the constitutionality of a national university (printed in the *Educational Review*, Vol. XVIII., pp. 451-66, December, 1899); one by Mr. Canfield, on past efforts to establish a national university and the reasons for their failure; two

by Mr. Butler, to establish a national university; one by Mr. Eliot, before the Congress, and on the disposal of any funds and requests toward the establishment of a national university, respectively; one by Mr. Harper, the steps taken by the Association of Agricultural Colleges and Experiment Stations to secure provision for further study in the government departments at Washington by graduates of those institutions; two by Mr. Eliot, on the existing educational agencies at Washington which might be affected by any scheme for a national university, and on the number, variety, extent and character of the scientific or technical departments of governmental work which might properly be included in any scheme for a national university, respectively; one by Mr. Angell, on the probable attitude of the principal universities of the country toward the project to establish a national university; and one by Mr. Maxwell, on existing organizations which are interested in the establishment of a national university.

QUESTIONS STATED.

With the information contained in these reports before them, the committee proceeded to the consideration of the following questions:

1. Should there be established a statutory university of the United States?

2. (a) If the first question be answered in the affirmative, how should such university be established and governed, and what should be its scope and functions?

(b) If the first question be answered in the negative, should the Congress be asked to place the educational facilities of the government departments at the disposal of a non-governmental institution?

3. If the question 2 (b) be answered in the affirmative, should a plan be devised by which, through the cooperation of several institutions, such a non-governmental in-

stitution might be established and maintained at Washington, this to involve its incorporation and governmental aid?

ARGUMENT FOR A NATIONAL UNIVERSITY.

In considering the first question, the committee took into careful consideration the argument advanced in favor of a statutory university of the United States, which is usually presented in the following form:

1. Such a university is needed to complete and to crown the educational system of the United States.

2. Such a university is needed to supplement the resources of existing institutions and to offer opportunities for more advanced investigation and research than are now offered by the universities of the country.

3. Such a university was urged by Washington, and has been urged by many eminent statesmen since the foundation of the government, as desirable and necessary.

4. Such a university is needed in order to coordinate the scientific work now being carried on in the several government departments at Washington, and to put that work at the disposal of advanced and adequately trained students.

CRITICISM OF THIS ARGUMENT.

Waiving all questions of the constitutional power of the Congress to provide for a university of the United States, which power is held by Mr. James, in the report above referred to, to be fully established, the fourfold argument in favor of a national university suggests the following considerations and comments:

1. There is no educational system of the United States in the formal and legal sense in which there is an educational system of each of the several States, and therefore the contention that there should be a national university to serve the nation, as each of the State universities serves its

State and the State educational system, rests upon a false analogy. In a general and popular sense there is undoubtedly an American educational system, but it consists of institutions of three different types :

A. Those which the State establishes and maintains, such as the public schools and the state universities.

B. Those which the State authorizes, such as school and university corporations, private or semi-public in character, which gain their powers and privileges by charter, and which are often exempt in whole or in part from taxation.

C. Those which the State permits, such as private-venture (unincorporated) educational undertakings of various kinds.

Each of these classes is in a true sense national, in that it reflects and represents in part the way which the American people have followed in providing general education. No inventory of the nation's educational activity is complete that does not include them all. There are in existence at the present time a group of truly national universities, some of them of the State-authorized and some of the State-supported type, and in them the national ideals and the national temper are as truly revealed and realized as are those of Germany in Berlin and in Leipzig, those of England in Oxford and in Cambridge, and those of France in Paris and in Montpellier. The argument for a statutory national university based upon the hypothesis that there is now no national university in existence is only formally true; in fact, it is without foundation.

2. The argument that a statutory national university is needed to supplement the resources of existing institutions is based upon a misunderstanding of the facts. No one of the world's universities can possibly be supreme in all departments of intellectual activity; a statutory university of the United States could not be so.

Conditions of time, place, special equipment and of individual scholarship all tend to make one university stronger in some one field of investigation than in others and to render it as unwise as it is impracticable for any one university to set before itself the hope of excelling in every branch of scholarship. The universities of the United States now offer ample opportunities for the most advanced research, and these opportunities in many departments are far in excess of the number of students wishing to avail of them. On the other hand, a university which should aim to hold mature and highly trained men indefinitely in the stage of learning without either producing or teaching would be a positive injury to the national life and character. The period of preparation for the active duties of life is already unduly prolonged.

3. An examination of the several passages in the speeches and writings of Washington that relate to a national university discloses the facts that the evil against which he wished a national university to guard has long since ceased to be possible, and that his plans and hopes have been realized with a completeness of which he never dreamed by the universities which have grown up in the United States. Washington's fear was that the youth of America, being forced to obtain their higher education in Europe, would not 'escape the danger of contracting principles unfavorable to republican government.' Obviously this fear has been utterly dispelled, and the universities that exist are far more complete and far more advanced than anything that could have been foreseen a century ago. There appears, therefore, to be no force in this phase of the argument for a statutory university at Washington.

4. That there are important opportunities for research of various kinds in connection with the government laboratories and collections at Washington is certain, and that

full advantage should be taken of these opportunities is greatly to be desired. This desire is confessed by the Congress itself in the joint resolution of April 12, 1892, to be referred to more fully hereafter, and is frequently expressed by the directors of the scientific work of the government. But it by no means follows that the only way, or indeed the best way, to make use of these opportunities is through the creation of a statutory, degree-conferring university. The objections to such an institution far outweigh any possible advantages which might follow from its establishment for the sole purpose of making fully effective the existing opportunities for higher instruction and research in connection with the government service, especially as it is possible to make these opportunities fully effective in what is in our judgment a simpler and a better way.

DECLARATION OF THE COMMITTEE.

The committee, therefore, by unanimous vote—twelve members being present and voting—adopted the following declaration on November 3, 1899 :

1. *It has been and is one of the recognized functions of the federal government to encourage and aid, but not to control, the educational instrumentalities of the country.*

2. *No one of the bills heretofore brought before Congress to provide for the incorporation of a national university at Washington commends itself to the judgment of this committee as a practicable measure.*

3. *The government is not called upon to maintain at the capital, a university in the ordinary sense of the term.*

ALTERNATIVE PLANS.

In this declaration the committee answered in the negative the first question under consideration, namely: Should there be established a statutory university of the United States?

The second question before the committee

was: Should the Congress be asked to place the educational facilities of the government departments at the disposal of a non-governmental institution?

It appears from the public record that the Congress has already done this. There are two expressions of the will and the purpose of the Congress in this matter.

The first is contained in the joint resolution, approved April 12, 1892, which is 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 sciences, 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 second is contained in the following paragraph in the general deficiency appropriation bill passed at the second session of the Fifty-sixth Congress, and approved March 3, 1901 :

That facilities for study and research in the government departments, the Library of Congress, the National Museum, the Zoological Park, the Bureau of Ethnology, the Fish Commission, the Botanic Gardens, and similar institutions hereafter established shall be afforded to scientific investigators and to duly qualified individuals, students and graduates of institutions of learning in the several states and territories, as well as in the District of Columbia, under such rules and restrictions as the heads of the departments and bureaus mentioned may prescribe.

The joint resolution of April 12, 1892, placed the governmental facilities for research at the disposal of duly qualified students of institutions of learning at Washington, D. C. The law of March 3, 1901, extends the same privilege to duly qualified students or graduates of institutions of learning wherever they may be situated throughout the United States.

It appears, therefore, that the Congress has already taken the necessary steps to make possible all that is desired in this connection, and it only remains to devise a plan by which the advanced students who wish to avail of the opportunities offered may be given such systematic information, direction and oversight as they may need in order to carry on their studies to the best advantage, and in order that such official records of their work at Washington may be kept, as will justify the several uni-

versities of the country in recognizing the period spent in study and investigation at Washington in passing upon their qualifications as candidates for the higher academic degrees.

A NON-GOVERNMENTAL INSTITUTION AT
WASHINGTON.

The remaining question before the committee for consideration was, then, this: Should a plan be devised by which, through the cooperation of several institutions, such a non-governmental institution should be established and maintained at Washington, this to involve its incorporation and governmental aid.

The subject of the best form of organization for such an institution and of its precise relations to the government has been given prolonged consideration. Advice and suggestion have been sought from the heads of the several scientific bureaus at Washington, from the representatives of the Association of Agricultural Colleges and Experiment Stations, from the presidents of the State universities and land-grant colleges, and from many others believed or supposed to be interested in the question. It seemed at first as if a solution might be found through the Smithsonian Institution, and that it might most wisely undertake the advisory and supervisory functions for which provision was to be made. The authorities of the Smithsonian Institution, however, did not view the suggestion with favor, and, in addition, they were doubtful of their legal capacity to perform such functions. Another objection was found in the fact that the Smithsonian Institution restricts itself to the field of the natural sciences, whereas students of history, political economy, and philology are also to be provided for.

An alternative suggestion was that the Bureau of Education should be asked to assume executive control of the proposed

student body. On reflection, however, it appeared that this would require far-reaching amendments to the law governing the bureau, that these might be difficult or impossible to obtain, and that the matter might become complicated with wholly extraneous considerations relating to the status of the Bureau of Education and the extension of its authority in other directions.

It has, therefore, seemed best to the committee not to propose either of the plans above mentioned.

The committee have been advised, however, of a plan for a non-governmental institution at Washington, which may be able to supply all that is desired. This plan is the outcome of action taken by the Washington Academy of Sciences and by the George Washington Memorial Association.

WASHINGTON ACADEMY OF SCIENCES.

The Washington Academy of Sciences includes in its membership all, or nearly all, the directors and officers of the scientific bureaus of the government. It was organized in 1898 and grew out of the affiliation which had previously existed between the local scientific societies. It is an incorporated body having for its main object to bring within a single organization the representatives of the varied scientific work being carried on at the capital. The academy has power to acquire and to hold real estate, to publish, to conduct or to assist investigation in any department of science, to maintain a library, and in general to transact any business pertinent to an academy of sciences. The list of members, resident and non-resident, of the Washington Academy of Sciences shows that it is national in its scope and influence, and that representatives of philosophy, history, education and political economy are included.

GEORGE WASHINGTON MEMORIAL ASSOCIATION.

The George Washington Memorial Association is an organization of women, incorporated in the District of Columbia in 1898, "to advance and secure the establishment in the city of Washington, D. C., of a university, for the purposes, and with the objects, substantially as contemplated and set forth in, and by, the last will of George Washington, the first President of the United States of America, and to increase the opportunities for the higher education of the youth of the said United States, and to this end to collect, take and hold moneys, gifts and endowments, to take and to hold by purchase, donations, or devise, real estate, to erect and furnish buildings to be used by said university, when legally established," and so forth.

In the year 1901 the certificate of incorporation of the George Washington Memorial Association was amended in due legal form, and all mention of a university was omitted from the statement of its purposes. The object of the Association is now declared to be "to aid in securing in the city of Washington, D. C., the increase of opportunities for higher education, as recommended by George Washington, the first President of the United States of America, in his various messages to Congress, notably in the first, in favor of 'the promotion of science and literature,' and substantially as contemplated and set forth in the last will of George Washington, and by and through such other plans and methods as may be necessary and suitable for the objects and purposes herein set forth, and to this end to collect, take and hold moneys, gifts and endowments, to take by purchase, donation, or devise, real estate, and hold the same, to erect and furnish buildings to be used for the purposes herein set forth, and, when necessary for the said purposes, to sell, convey, mortgage and exchange any real and personal estate which the As-

sociation may hold, and to do any and all things which may lawfully be done in carrying out the objects and purposes of this corporation."

ACTION OF THESE ORGANIZATIONS.

It appears that action has been taken by these organizations—by the Board of Managers of the former on February 26, 1901, and by the Board of Trustees of the latter on March 13, 1901—which brings the support of each to a plan for an institution of the type which has been discussed above. Both organizations have agreed to cooperate to found an institution in the city of Washington, as a memorial to George Washington, which shall be maintained to promote the advanced study of the sciences and the liberal arts, and which shall assist in carrying out the purposes and the intent of the joint resolution of April 12, 1892, and of the law of March 3, 1901.

WASHINGTON MEMORIAL INSTITUTION.

On May 17, 1901, articles of incorporation were filed at Washington, D. C., signed by Daniel C. Gilman, president of the Johns Hopkins University; Charlotte Everett Hopkins, president of the George Washington Memorial Association; C. Hart Merriam, chief of the United States Biological Survey; George M. Sternberg, surgeon-general, United States army; Charles D. Wolcott, director of the United States Geological Survey; and Carroll D. Wright, United States Commissioner of Labor, as follows:

ARTICLES OF INCORPORATION.

WE, the undersigned, persons of full age, and citizens of the United States, and a majority of whom are citizens of the District of Columbia, being desirous to establish and maintain, in the city of Washington, an institution in memory of George Washington for promoting science and literature, do hereby associate ourselves as a body corporate, for said purpose, under the general incorporation acts of the Congress of the United States enacted for the District of Columbia; and we do hereby certify in pursuance of said acts as follows:

1. The name or title by which such institution shall

be known in law is the Washington Memorial Institution.

2. The term for which said institution is organized is nine hundred and ninety-nine years.

3. The particular business and objects of the institution are: to create a memorial to George Washington; to promote science and literature; to provide opportunities and facilities for higher learning; and to facilitate the utilization of the scientific and other resources of the government for purposes of research and higher education.

4. The number of its trustees for the first year of its existence shall be fifteen.

Steps are to be taken at once by these incorporators to organize the institution, as described, and to select a body of trustees which shall be efficient and, so far as may be, representative of a variety of scientific and educational interests.

CHARACTERISTICS OF THE INSTITUTION PROPOSED.

Concerning the proposed institution, we assume:

1. That it will be independent of government support or control, as it will also be independent of the support or control of existing educational institutions. It might well appeal with peculiar force to the generosity of those men and women who are willing to increase, and who are desirous of increasing, the endowment of higher education in the United States.

2. That its objects will be:

a. To facilitate the use of the scientific and other resources of the government for research.

b. To cooperate with universities, colleges and individuals in securing to properly qualified persons opportunities for advanced study and research now obtainable only to a limited extent in Washington and not at all elsewhere.

3. That its oversight and control will be in the hands of trustees and officers representing the educational experience and ideals of the existing institutions for higher education.

4. That the arrangements between the student body and the several governmental bureaus will be made, subject to the by-laws of the trustees, in such a way as to carry out to the fullest possible extent the declared policy of the Congress. It is expected that the government officials will advise rather than instruct the students assigned to them.

5. That the sole test of admission to the privileges which the institution offers will be merit and proficiency, to be ascertained in such way as the trustees shall provide.

6. That students coming from universities and colleges for a period of study or investigation at Washington will, upon request, be given appropriate credentials, on completing their work, for presentation to the institution from which they seek a degree.

7. That students working in government laboratories or collections will be subject to the rules and regulations there prevailing.

8. That, if successfully carried out, this plan will provide a body of trained students, ready for expert work, many of whom might enter the government service, while others would become instructors in institutions of learning or be engaged as experts in a private capacity.

The departments or subjects in which graduate students could be received and the provision that could be made for them at present are unofficially estimated to be as in previous table.

ACTION OF COMMITTEE.

The committee have adopted the following resolution :

Resolved, That we approve the plan for a non-governmental institution, known as the Washington Memorial Institution, to be established and maintained at Washington, D. C., for the purposes of promoting the study of science and the liberal arts at the national capital, and of exercising systematic oversight of the advanced study and investigation to be carried on by duly qualified students in the governmental laboratories and collections, in accordance with the terms of the joint resolution of Congress approved April 12, 1892, and those of the act of March 3, 1901.

We recommend that the National Council of Education adopt the following resolution :

Resolved, That the report of the committee authorized by resolution of July 11, 1898, to investigate the entire subject of a national university be received, and the committee discharged.

WILLIAM R. HARPER,

Chairman.

EDWIN A. ALDERMAN.

NICHOLAS MURRAY BUTLER.

JAMES H. CANFIELD.

J. L. M. CURRY.

NEWTON C. DOUGHERTY.

PROVISION FOR STUDENTS.

	Possible in-structors.	Maxi-mum No. of students.
1. Animal industry	10	25
2. Anthropology and ethnology...	4	13
3. Astronomy	3	8
4. Botany.....	11	25
5. Cartography	2	5
6. Chemistry	6	10
7. Forestry.....	10	20
8. Geology	10	17
9. History (Library of Congress)..	5	10
10. History and diplomacy (State Department)	1	5
11. Hydrography	5	10
12. Library administration and methods (Library of Congress).....	5	15
13. Magnetism	1	2
14. Meteorology	5	15
15. Mineral resources.....	2	5
16. Paleontology	5	7
17. Physics	2	3
18. Standards (Bureau of).....	Now bei	ng org'd
19. Statistics.....	2	5
20. Tides	1	2
21. Topography.....	10	20
22. Zoology	34	50
	134	272

ANDREW S. DRAPER.
CHARLES W. ELIOT.
WILLIAM H. MAXWELL.
J. G. SCHURMAN.
F. LOUIS SOLDAN.

NOTE.—Mr. E. J. James was unable to attend the meetings of the Committee and declines to sign the report.

May 24, 1901.

*RADIO-ACTIVE SUBSTANCES AND THEIR
RADIATIONS.*

DURING the past five years many physicists, attracted by the freshness of the field and the promise of important discoveries, have turned their attention to the study of the newly discovered radio-active substances. The result has been a rapid increase in knowledge of and interest in the phenomena, until now the main facts are known to all scientists, but, since the knowledge of the subject is increasing so fast, a short review is now and then acceptable and necessary, especially to those whose chief interests lie along other lines. In this article an attempt is made to point out the more interesting features of the subject.

The real discovery of the persistent radiations from the uranium compounds was made by M. Henri Becquerel in 1896. It had been stated by M. Niewenglowski that under the action of sunlight certain phosphorescent salts emit radiations which can penetrate black paper. In testing whether this applies to uranium salts, M. Becquerel discovered to his surprise that with uranium salts exposure to sunlight is unnecessary; uranium compounds are all the time giving off radiations which can pass through opaque bodies and affect a photographic plate on the other side. It was soon found that the uranium radiations discharge electrified bodies in the neighborhood by ionizing the surrounding air after the manner of kathode and X-rays. Naturally, about

the first hypothesis was that the radiations are ether vibrations, perhaps of very short wave-length, and many attempts were made to find evidence of reflection, refraction or polarization, with the result that none of these properties nor any of the properties peculiar to wave motion has yet been shown to belong to these radiations.

A few months after the discovery of the uranium radiations Professor Schmidt and Mme. Curie, a Polish physicist working in Paris, independently discovered the radio-activity of thorium compounds. An elaborate study of thorium radiations has since been made at McGill University by Professors Rutherford and Owens.

A greater discovery, however, was in store for Mme. Curie; for observing that many specimens of pitchblende, the principal ore of uranium, were more strongly radio-active than the pure uranium salts, she and her husband attempted a chemical separation of the suspected more active element. The result is well known; they succeeded in isolating two substances having at least 100,000 times the radio-activity of uranium. The first of these substances, which they named polonium, follows the bismuth in the separation from pitchblende. The separation from the bismuth is effected by taking advantage of the fact that polonium sulphide is more volatile than bismuth sulphide. The second substance they named radium. It follows the barium in its chemical reactions, but its chloride is less soluble in water than barium chloride, which affords a means of separation from the barium. Another very active substance has been obtained from pitchblende by M. Debierne. He has named it actinium. Chemically it is closely allied to titanium.

No one of these three substances has been obtained free from impurity, and the amounts obtained are exceedingly small, only a few centigrams from a thousand kilograms of pitchblende.

The spectrum of radium has been carefully examined by M. Demarcay, who assigns to it several new lines, the strongest having wave-lengths 4,683 and 3,814.7, and two bands. No characteristic spectrum has yet been found for polonium or actinium. On account of the small quantities of these substances available, no accurate atomic weight determinations have yet been made, but from what has been done it appears that radium has a higher atomic weight than barium.

At first it was supposed that the uranium itself was the source of the radio-activity of the uranium salts, since often the activity of the compounds seemed to depend on the amount of uranium present, but after the discovery of radium and polonium the radio-active power of uranium began to come under suspicion. Professor Crookes found that often different specimens of the same uranium salt would have very different radio-active strength, which difference in strength could be very little changed by changes in chemical or physical conditions, the strongly active salt remaining so and the less active salt never gaining strength. Suspecting that the radio-activity was due to something other than the uranium, Professor Crookes set about separating this irrepressible element. Such was his success that, starting with active uranium nitrate, he was able to obtain from it uranium nitrate which had no effect on a photographic plate even with an exposure of seven days. At the other end of the separation he had a substance many times as active as the original salt. The best and simplest of several methods of separation makes use of ether as a solvent. The ether dissolves the uranium nitrate and leaves undissolved most of the radio-active substance. This substance Professor Crookes calls UrX , the X testifying to our present ignorance of its real nature. Professor Crookes has also tried to separate

the active material from the thorium compounds, but has so far met with only partial success. It seems not unlikely, though, that it may yet be done as completely as in the case of uranium. Meanwhile it is convenient still to speak of uranium and thorium radiations.

PHOTOGRAPHIC AND CHEMICAL EFFECTS OF THE RADIATIONS.

The photographic effect was the one first discovered and it remains the most delicate test for radio-activity, for the effect is cumulative, and the exposure may be made as long as desired. Any one can obtain very good radiographs from any of the ordinary uranium salts by using rapid dry-plates and an exposure of two days, while visible effects can be obtained with a much shorter exposure. Polonium and radium affect a photographic plate in a few minutes if sufficiently close to it. Even with a distance of a meter between the radium and the plate, radiographs have been obtained after a few days' exposure. These are very sharp, showing thus the rectilinear propagation of the radiations. Polonium radiations are so rapidly absorbed by the air that no effect is produced with a greater distance than a few centimeters.

Under the action of the radium radiations glass takes a permanent brown or violet tint. The haloid salts of the alkali metals become colored just as under the action of the X-rays. Paper is sometimes discolored and under certain conditions ozone may be formed in the neighborhood of the very active substances. Barium platino-cyanide is colored brown.

The action of the radium rays on the skin is the same as that of the X-rays. At first there is a slight reddening of the skin, but after three or four weeks' exposure severe inflammation sets in.

FLUORESCENCE.

Most of the substances that show fluorescence under the action of ultra-violet light or the X-rays also fluoresce under the action of the radium radiations, while those that fluoresce under ordinary light do not fluoresce under the radium radiations; but there are numerous exceptions to these rules.

It is a very interesting fact that when freshly prepared the radium salts are faintly self-luminous, and this property seems to be retained as long as the salt does not absorb moisture. It is this property that has excited much of the popular interest in the radium salts, for it is a case of the longed-for light without heat. In fact, it is light with no apparent source of energy whatever. If radium chloride ever becomes cheap we may be given an opportunity to court fortune by investing in preferred stock of some 'International Radium Illuminating Company.' Just at present gold is dirt cheap in comparison with these radium salts. The self-luminescence is due to the fact that under the action of its own rays either the salt itself, or some of the unavoidable impurities, fluoresces.

Some of the tissues of the eye fluoresce under the radium rays, so a sensation of light is felt when some of the salt is brought before the closed eyelids or placed on the temple.

IONIZATION OF GASES.

Any gas traversed by the Becquerel rays, as Mme. Curie has named the new radiations, is made capable of conducting electricity. This conductivity is of the same nature as that produced in gases by the cathode and X-rays. According to the accepted hypothesis, the positive and negative particles or ions of the gas are knocked apart by the radiations, and the motion of these free charged ions when directed by an electric field constitutes the electric current.

If an ionized gas is left to itself the positive and negative particles soon reunite, and, in fact, the reuniting process goes on all the time in proportion to the number of free ions in the gas, so that under any given intensity of ionizing radiation a condition of equilibrium is soon reached in which the reuniting goes on as fast as the ionizing. Since the amount of ionization may be measured by measuring the electrical conductivity of the gas, this affords a convenient means of comparing the relative strengths of radio-active substances, and one which is much more rapid and accurate than the photographic one. It is by no means certain, however, that the radiations most effective for ionization will therefore produce most effect on a photographic plate. Ionization is proportional to the absorption of the radiations by the gas, so that if a bit of radio-active substance be placed between two metal plates a greater current may be sent between them when they are two centimeters apart than when they are only one, the greater thickness of the air in the first case absorbing more of the radiations.

An ionized gas is in many respects similar to an ordinary liquid electrolyte, and Lord Kelvin has shown that when a plate of copper and a plate of zinc are connected by a wire and the air between the plates exposed to radiations from uranium compounds, a current flows through the connecting wire just as if the plates were immersed in a liquid electrolyte. It has recently been shown that the Becquerel rays decrease the resistance of selenium, just as light and the X-rays do.

PENETRATING POWER.

The radiations from the various substances are not at all homogeneous, some being very penetrative, others being easily stopped by any substance. Polonium radiations, while intense, are of the non-penetrating kind, being stopped by even the

thinnest metal foil. Uranium radiations, and therefore Crookes' UrX radiations, are much more penetrating, passing through metals, glass and in fact all substances, but with considerable loss of intensity. Thorium compounds emit radiations of at least two very different penetrating powers, one part only feebly penetrating, another as penetrating as the UrX radiations. Radium and actinium also emit both penetrating and non-penetrating rays, some of the radium rays being the most penetrating of all. Screens of sheet metal act as sieves for the rays, soon cutting off the less penetrating rays and allowing the more penetrating kind to go through with but little diminution in intensity. One sheet of tin, 0.0025 mm. thick, transmitted 44% of the radiations from one radium specimen, two sheets of the same thickness transmitted 31%, and 15 sheets 15%. A sheet of glass 0.16 mm. thick transmitted 26%, and ten plates 16%. Aluminum 0.16 mm. thick transmitted 28%, six sheets 16%. On account of the non-homogeneity of the radiations it has been very difficult to determine the law of absorption, but it appears that for the rays of the most penetrating type, at least, the absorption is proportional only to the density and thickness of the absorbing screen, the kind of material, whether platinum, paper, glass, air or other substance, making but little difference. Because some of the less penetrating rays are absorbed by the salt itself, there is a larger proportion of the very penetrating rays in the radiations from a thick layer of the salt than in those from a thin layer.

DEFLECTION IN A MAGNETIC FIELD.

Several experimenters discovered about the same time that some of the Becquerel rays are affected by a magnetic field. This brought out strongly their resemblance to the cathode rays, and further experiment-

ing proved that if a beam of radium radiations is made to pass through a magnetic field which is perpendicular to the direction of the beam, then the beam is deflected just as a beam of cathode rays would be, that is, just as a stream of negatively charged atomic projectiles would be deflected. This fact furnished the basis for the present accepted hypothesis, namely, that the deviable rays consist of a stream of rapidly moving particles, charged with negative electricity. The deflection in a magnetic field gives further proof of the non-homogeneity of the radiations. The experiment is as follows: A vertical beam is obtained by placing the radio-active salt at the bottom of a narrow hole in a block of lead, which is then placed on a horizontal photographic dry-plate or a fluorescent screen, in the horizontal field of a large electro-magnet. When the magnet is energized the vertical beam of rays is deflected in a direction always perpendicular to its direction of propagation, and also perpendicular to the magnetic lines of force, so that it is finally bent over until it falls upon the plate or screen. The impression produced is not a spot, but a band or magnetic spectrum, which could not be the case if the beam were composed of homogeneous radiations. According to the electrified-projectile hypothesis this can be explained by saying that the particles do not all have the same velocity, in which case those having the highest velocity would be the least deflected. This view has support in the fact that of the deviable rays, the least deviable are the most penetrating, as we should expect from the higher velocity of the particles. Becquerel found that for the rays from a sample of radium the product of the strength of the field into the radius of curvature of the path varied from 350 to 3,000.

There are, however, certain rays that are not deflectable in a magnetic field, and

these are of the least penetrating kind, which, according to the charged-particle hypothesis, should, on the contrary, be most deflected by the field. A satisfactory hypothesis as to the nature of these non-deflectable, non-penetrating radiations has not yet been put forth. Perhaps they consist of particles of much larger mass than those of the deflectable rays. M. Villard finds also in the radium radiations a small proportion of very penetrating, non-deflectable rays, quite similar to the X-rays.

ELECTROSTATIC EFFECTS.

Now a stream of charged particles deflectable by a magnetic field should also be deflected by an electrostatic field. This is found to be the case. Furthermore, a shower of negatively charged particles ought to impart a negative charge to an insulated conductor. Of course in this case air would not act as an insulator, for it becomes a conductor under the action of the rays. M. and Mme. Curie got around this difficulty by insulating a conductor with a thin layer of wax over its surface, then exposed it to radium radiations and found that it became highly charged negatively. Insulating some of the radium salt in the same manner with wax, they found that it became highly charged positively, a beautiful corroboration of the theory that there is a separation of the atomic particles with their charges. If, as now seems almost certain, the negatively charged part of the atom has a mass only a small fraction, a thousandth perhaps, of that of the positive part, it is very reasonable that the negative particles would be the ones to be shot out in case of interatomic commotions. The rate of charging in the experiment was about 4×10^{-12} amperes per sq. cm. of the radium salt.

VELOCITY, MASS AND ENERGY OF THE RADIATIONS.

The velocity of a charged particle and the ratio of the charge to the mass may be

found by comparing its path in a magnetic field with its path in an electrostatic field. Then assuming the charged-particle hypothesis it should be possible to calculate the velocity of the particles in the deflectable rays from the radio-active substances. This has been done by M. Becquerel. The curvature of the path in the magnetic field can be measured without much difficulty, but the deflection in the electrostatic field is very small. The difficulty of the experiment is also increased by the complex character of the radiations, making it uncertain if rays of just the same kind are being observed in the two fields. Some confidence, however, must be placed in the results, though they give for the velocity of the particles an astounding figure, about half the velocity of light. How from a quiet, peaceful bit of white salt particles can be shot off with such a velocity as this remains for explanation. The ratio of the charge to the mass of the particles is of the same order as in the case of the cathode rays, another evidence that the atomic charges are invariable and inseparably connected with the particles.

By measuring the rate at which a charge is imparted to a conductor, and then using the values of the velocity and of the ratio of the charge to the mass determined as above, the kinetic energy per second of the particles emitted may be calculated. For a sq. cm. surface of a very active radium preparation it has been found to be 5.1 ergs per second, or five ten-millionths of a watt. The mass of the particles, calculated from the same data, is exceedingly small, the loss from a sq. cm. of surface being something like a milligram in a thousand million years. M. Becquerel observes that it is of the same order as the evaporation of certain odorous bodies.

Professor Rutherford and Mr. McClung made last year some interesting experiments on the energy required to produce ionization

of gases by kathode and X-rays. Assuming that the same energy is required to produce ionization by the Becquerel rays, they estimate that a sq. cm. surface of a thick layer of uranium oxide gives off energy at a rate not less than 10^{-11} calorie per second, which is sufficient to raise the temperature of 1 gram of water 1° C. in 3,000 years. In the case of radium, 100,000 times as active as uranium oxide, the energy given off is not less than 3,000 calories per year for a gram of substance. This value for the energy is 40 or 50 times as large as the value mentioned above, obtained by the other method. That the amount of energy concerned is so small emphasizes the extreme delicacy of the photographic and ionization tests.

SECONDARY RADIATIONS.

X-rays impinging on some substances induce secondary radiations, and it was soon found that the Becquerel rays also possess this power, with the important difference that the secondary radiations induced by the Becquerel rays continue after the action of the primary rays has ceased, which is not the case with those induced by the X-rays. These secondary radiations affect photographic plates and ionize gases. The radium preparations are the most active in producing secondary radiations, and the effect is produced equally well in the case of such different substances as platinum, zinc, bismuth and even paper. Up to a certain limit the intensity of the secondary rays increases with the time of exposure to the radium; after the removal of the radium the intensity gradually weakens, disappearing altogether after some hours. The source of the secondary rays was thought to be a fine dust which escapes from the radium and settles on neighboring bodies, but it cannot be removed by washing, and the radium rays have the power of imparting it even after passing through metal screens. It seems too that this power of emitting

radiations may even be imparted to gases. A number of substances may be made strongly radio-active by precipitation from solutions containing small amounts of the most active substances, and several times these temporarily active substances have been mistaken for compounds of new elements. It is not yet known to what extent the secondary radiations are like the primary, for their intensity is so small that a comparison is difficult.

Thorium oxide gives off a remarkable vapor or 'emanation' which causes a strong secondary radio-activity. This emanation can pass through paper and even very thin metal. It gradually diffuses itself throughout the air and is carried about by air currents. Air containing the emanation retains its electrical conductivity for as long as ten minutes after the thorium oxide is removed, though ordinary ionized air loses its conductivity in a few seconds. The emanation is not removed from the air by drawing it through wool or bubbling it through water or sulphuric acid. Any substance charged with negative electricity collects and concentrates the emanation, becoming very radio-active after a few hours in the presence of thorium oxide. Sand-papering or treatment with sulphuric acid removes the emanation from a platinum wire on which it has been concentrated. On afterwards evaporating the acid a radio-active residue may be obtained. The thorium emanation much resembles a fine radio-active dust.

NATURE OF THE RADIATIONS AND SOURCE OF THEIR ENERGY.

We may say then that for one component of these complex radiations a satisfactory explanation is offered. This component is of the same nature as the kathode rays, and consists of a rapidly moving stream of minute material particles each having its charge of negative electricity.

Another component is similar to the X-rays, and is probably a phenomenon of the ether rather than of ordinary matter. Perhaps this component is produced by the action of the first component, as the X-rays are produced by the action of the cathode rays. For the rest no satisfactory explanation has been given. Many of the secondary effects seem to result from a fine dust emitted from the radio-active substance. Possibly there is only a single primary radiation, the rest being secondary effects, as the cathode rays generate the X-rays and these in turn generate their complex secondary radiations.

The chemical nature of the radio-active substances or elements is still little understood, nor is it surprising when one considers the difficulty of working with substances occurring in such minute quantities as these. Only one new element, radium, is definitely established. Hofmann and Strauss thought they had isolated another new radio-active element, but while still claiming the new element, they now admit that it is not radio-active.

The question of the source of energy in these radiations is yet unanswered. Is the energy potential in an unstable molecular or atomic structure, or is it supplied continuously by outside sources? In the first case, how long will the energy last? In either case, is it a property that matter in general may under proper conditions assume, or is it, as it seems, restricted to a very few peculiar elements? Heat or cold, high or low pressure, has little influence on the emission of the rays. Mme. Curie once put forth the hypothesis that perhaps the radiation is induced in the radio-active elements by a sort of transcendental radiation more penetrating than the X-rays and pervading all our space. Professor Geitel found that if so the exciting radiations penetrate easily hundreds of yards of rock, for radium was still active at the bottom of

the deepest mine to which he had access. Finally, the study of the radio-active substances will surely lead to a better knowledge of that which is the subject of much of the physical research of to-day, the intimate structure of matter.

GEO. B. PEGRAM,

COLUMBIA UNIVERSITY,

June 21, 1901.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THE following have completed their membership in the American Association for the Advancement of Science during the month of June.

Dr. Francis E. Abbot, Author, 43 Larch Road, Cambridge, Mass.

Ernest Kempton Adams, Scientific Investigator, 455 Madison Ave., New York, N. Y.

Harry Alexander, Elec. and Mech. Engineer, 18 and 20 West 34th Street, New York, N. Y.

E. B. Alsop, Metallurgy and Engineering, 541 Wood Street, Pittsburg, Pa.

James I. Ayer, Electrician, 5 Main Street Park, Malden, Mass.

Ralph Baggaley, engineer, Pittsburg, Pa.

Daniel Moreau Barringer, Geologist and Mining Engineer, 460 Bullitt Building, Philadelphia, Pa.

Professor Walter B. Barrows, Prof. of Zoology, Agricultural College, Michigan.

Francis Bartlett, 40 State Street, Boston, Mass.

James Newton Baskett, Author-Zoologist, Mexico, Mo.

Rev. John Mallery Bates, Botany, Callaway, Neb.

Dr. Henry Harris Aubrey Beach, Physician, 28 Commonwealth Avenue, Boston, Mass.

Professor Arthur E. Beardsley, Prof. of Biology, State Normal School, Greeley, Colo.

Bernhard Arthur Behrend, Civil and Elec. Engineer, Station H, Cincinnati, Ohio.

August Belmont, 23 Nassau Street, New York City.

Charles W. Bennett, Geologist, Coldwater, Mich.

Dr. Augustus C. Bernays, Specialist in Embryology, Anatomy and Surgery, 3623 Laeclde Avenue, St. Louis, Mo.

Solomon H. Bethea, United States Attorney, Chicago Club, Chicago, Ill.

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Dr. Arnold L. Bossi, Chemist and Colorist, Manchester Mills, 1962 Elm St., Manchester, N. H.

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Frank H. Cockard, Civil and Mining Engineer, L. B. 34, Wheeling, W. Va.

Geo. W. Curtiss, Weatherford, Texas.

Irving S. Cutter, Botanist and Zoologist, Box 732 Lincoln, Nebr.

Dr. W. H. Dalrymple, Prof. Veterinary Science, La. State University, Baton Rouge, La.

Charles F. Davis, Chemist, Fort Collins, Colo.

William H. Davis, Assistant in Psychology, Columbia University, New York, N. Y.

William W. Davis, Chemist, Virginia Iron, Coal and Coke Co., Bristol, Tenn.

William H. Dean, Chemist, 167 West River Street, Wilkesbarre, Pa.

Frederic A. Delano, Supt. Motive Power, C. B. and Q. R. R. Co., 209 Adams Street, Chicago, Ill.

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Mrs. Carolyn W. Harris, Chilson Lake, N. Y.

Frederick S. Harris, Mining, Monticello, Kans.

J. Dawson Hawkins, Chemist, Colorado Springs, Colo.

Charles I. Hays, Northside High School, Denver, Colo.

Tracy E. Hazen, Director of Museum and Botanist, The Fairbanks Museum, St. Johnsbury, Vt.

Harry E. Heath, Chief Engineer Eddy Elec. Mfg. Co., Windsor, Conn.

Junius Henderson, 1933 13th Street, Boulder, Co. l.

Conrad E. Hesse, Meteorology, U. S. Weather Bureau, 807 Mass. Avenue N. E., Washington, D. C.]

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John L. Hildreth, 14 Garden Street, Cambridge, Mass.

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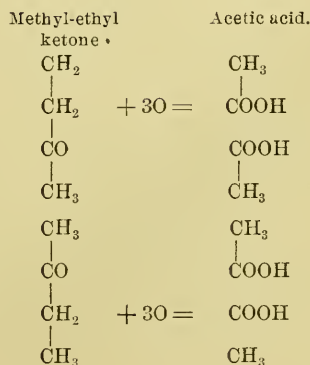
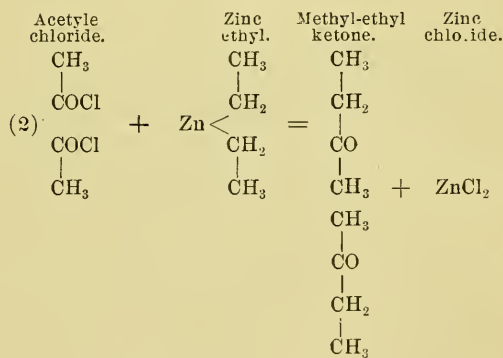
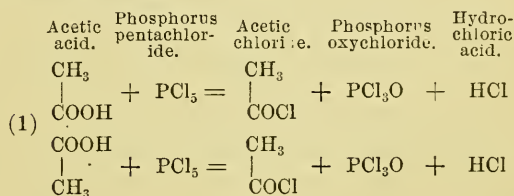
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SCIENTIFIC BOOKS.

Les problèmes de la vie. 1^{re} Partie. La Substance vivante et la cytodièrese. Par DR. ERMANNO GIGLIO-TOS. Turin. 1900.

A title, such as the author of the present volume has selected, is apt to excite suspicion by suggesting a discussion of phenomena for the explanation of which the data at our disposal seem at present hardly sufficient. The time when the biologist was content with an *ignoramus* or with the endeavor to conceal his ignorance under cover of vital force has passed away, and a school has arisen which pins its faith on the investigation of *Entwicklungsmechanik*, but which, it must be confessed, still subsists on the substance of things hoped for. The pendulum has swung from the predication of a special force to the application of the fundamental principles of physics and mechanics, but without as yet yielding the desired explanation of protoplasmic activity, possibly because the new position has not yet been sufficiently exploited.

Professor Giglio-Tos, however, believes that the lack of conclusive results is due to the pendulum having swung too far; the basis of an explanation of the phenomena of life is to be sought, in his opinion, not so much in the physical as in the chemical principles involved. The most fundamental of all the vital functions is assimilation and this he believes is exclusively a chemical phenomenon, perfectly analogous to the changes which organic chemical compounds may be made to undergo in our laboratories, acetic acid, for instance, if supplied with the proper food in the way of reagents, assimilating these and producing with their aid additional molecules of acetic acid. The example which he gives in illustration of the chemical nature of assimilation is so suggestive that it may be repeated here.



Thus *two* molecules of acetic acid supplied with the proper food (phosphorus pentachloride zinc ethyl and oxygen) have been able to assimilate additional atoms of CH.O, the result being the formation of *four* molecules of acetic acid (growth), together with certain excreta (phosphorus pentachloride, hydrochloric acid and zinc chloride). Arguing for this case, Professor Giglio-Tos lays down the following conditions as necessary in order that a molecule may exhibit the phenomena of assimilation :

1. It must be able, with the aid of assimilation, to divide into molecules similar to itself.

2. The necessary nutritive substance must be always present.

3. The nutritive and secondary (excreta) products must not act destructively upon each other.

4. The various processes of assimilation must follow one another in a definite order.

5. The physical conditions (heat, light, etc.) must be suitable.

The molecules of protoplasm, which are termed *biomolecules*, possess or exist under these necessary conditions and hence exhibit assimilation.

Having established this point, the author then proceeds to discuss differentiation. If we represent the primary molecule by *a* and the various compounds formed during the assimilative process by *b*, *c*, *d*, and *M*, the process indicated above may be graphically composed as

$$a \dots b \dots c \dots d \dots M = a + a$$

It is not necessary, however, that the resulting molecules should be identical in composition with that from which they arose, and the series may run thus :

$$a' \dots b' \dots c' \dots d' \dots M' = e' + e'$$

and finally it is possible that the two resulting molecules may differ from one another, thus

$$a'' \dots b'' \dots c'' \dots d'' \dots M'' = e'' + i''$$

As a combination of these various results of assimilation, which the author terms respectively autogenetic, homogenetic and heterogenetic, the differentiation of the biomolecules is produced. The biomolecules represent for Professor Giglio-Tos the fundamental constituents of protoplasm, but they are chemical constituents, and like many of his predecessors

he finds it necessary to postulate the existence of living particles composed of an aggregation of biomolecules and which he terms *biomores*. These he likens to a double salt and, since each biomore is composed of living molecules, it too is a living compound, and from the biological standpoint may be regarded as a symbiosis of molecules, since for the preservation of the biomore the component biomolecules must react favorably upon one another. The biomores are aggregated symbiotically to form a *bioplasma* and a symbiotic system of biomores which performs all the functions of life and constitutes a living unit, is termed a *biomonad*, while, finally, a *cell* is a biomonad 'characterized by the chemical nature of certain biomores which form its nucleus' or in other words is a differentiated biomonad.

Such in brief is the fundamental idea which the author expounds in the first five chapters of his book, and in the succeeding pages he proceeds to discuss the phenomena of cell division in the light of this idea. Reproduction is after all merely discontinuous growth and the causes which determine the growth or division of a molecule will be the same in the case of a biomore, or biomonad, or a cell. The division of a molecule depends upon the orientation of its constituent molecules, and the division of a biomonad, accordingly, is due to the orientation of its constituent biomores. It would lead us too far to attempt to follow the author in his minute analysis of the phenomena of karyokinesis, and it must suffice to quote from the concluding paragraphs of the book : "The property of division, which characterizes living substances, is not due to a special force. It is only the necessary, inevitable consequence of the constitution of this substance and of assimilation." "The force which unites the particles of living matter is the same as that which unites the particles of dead matter and is sufficient for the explanation of the phenomena of division. Division always occurs under the action of this force, whatever may be the constitution of the living substance, and the various figures which appear during division and which characterize cytodieresis are only the morphological consequences of that constitution."

In conclusion, it must be stated that notwithstanding the complexity of the problems discussed and the minute analysis to which they are subjected, the book is written with a rare degree of conciseness and lucidity. Professor Giglio Tos has certainly presented a somewhat abstruse subject in a most interesting manner and has given a new point of view, a working hypothesis which cannot fail to influence future cytological work. The book is suggestive from cover to cover, and the second volume, which is to treat of 'Ontogenesis and its Problems,' will be awaited with interest.

J. P. MCM.

A. de Bary's Vorlesungen über Bakterien. Dritte Auflage. Durchgesehen und teilweise neu bearbeitet. Von W. MIGULA. Leipzig, Wilhelm Engelmann. 1901. Mk. 3.60.

The name of DeBary's 'Lectures on Bacteria' still has power to conjure up pleasant memories in those persons who remember when this classic brochure was the only worthy book devoted exclusively to the young science of bacteriology. The ponderous tomes, too often filled with unassimilated facts, that have since appeared in abundance sometimes force us to recall with regret the days when selection of material and skilled exposition were not incompatible with completeness.

The attempt to put new wine into old bottles has always encountered certain experimental difficulties, and it cannot be said that these difficulties have been altogether overcome by Dr. Migula, although something of the charm of the original lectures has been retained. The general arrangement of the sections is the same as in the original edition, while the insertion of new facts and the dropping of outworn creeds is perhaps as skilfully carried out as could be expected. In spite of the defects to be anticipated in a rewritten work of this sort, the lectures will readily command interested readers. It will always be questioned, however, whether the successive changes in the viewpoint of a rapidly growing science do not continuously demand new methods of exposition, and whether it is quite fair to a book that has served well its day and generation to bring it again upon the stage.

E. O. J.

A Laboratory Guide in Elementary Bacteriology. By WILLIAM DODGE FROST, Instructor in Bacteriology, University of Wisconsin. Published by the Author, Madison, Wisconsin, 1901.

The development of bacteriology as a subject of general scientific importance has led in several American universities to the introduction of courses in bacteriology into the regular undergraduate curriculum, and has created a demand for a kind of laboratory training adapted to the requirements both of the college student and of the student of medicine. The book before us outlines a course of this character, elaborated during several years of experience at the University of Wisconsin. The arrangement and choice of matter will be generally commended. The ordinary technical procedures are lucidly described with the aid of many diagrams, and are in thorough accord with the latest and best practice. The book is not distorted by being wrested to special utilitarian ends, but is rather designed to lay a broad foundation for subsequent specialization in any branch of bacteriology. It is admirably fitted for this purpose.

E. O. J.

Elements of Quaternions. By the late SIR W. R. HAMILTON. Second edition. Edited by PROFESSOR C. J. JOLY. London, Longmans & Co. Vol. I., pp. xxxiii + 583; Vol. II., pp. liv + 502; quarto.

The first edition of the 'Elements of Quaternions' consisted of 500 copies; and as many of these were presented to men of science, the book soon became scarce on the market. The published price was one pound; five times that amount has been paid for a single copy. In fact it frequently happened that a student could not obtain a copy of the English edition, and was obliged to content himself with Glan's German translation. Therefore we hail with pleasure a second edition of this classic of the mathematics, especially as it is printed in two handsome quarto volumes, and can be purchased at a moderate price.

Hamilton spent the last seven years of his life in the preparation of the 'Elements,' which he designed to be the *Principia* of space-analysis. He did not live to see them published.

The successive sheets were revised by him and printed off under his direction; but at his death some intended articles remained unwritten, although everything up to them had been revised and printed off. Professor Joly testifies in his preface that he has found extraordinary accuracy both of matter and of printing in the first edition. To the new edition he has added a preface, an index, an analysis of each article in the table of contents, footnotes and an appendix containing more lengthy notes on the following subjects: 'Quaternion Determinants,' 'Miscellaneous Properties of Two Linear Vector Functions,' 'The Strain Function,' 'On the Specification of Linear Vector Functions,' 'On the General Linear Transformation in Space,' 'On the Theory of Screws,' 'On Finite Displacements,' 'On the Kinematical Treatment of Surfaces,' 'On Systems of Rays,' 'On Hamilton's Operator ∇ .'

It was Abel who said that if one wished to make progress in mathematical science he ought to study the original work of the master rather than the presentations of his pupils. This maxim applies especially to quaternions; and for facilitating the study of Hamilton's great work the Printing Board of Trinity College, Dublin, and the editor, Professor Joly, deserve the thanks of the mathematical world.

ALEXANDER MACFARLANE.

SOCIETIES AND ACADEMIES.

THE RESEARCH CLUB OF THE UNIVERSITY OF MICHIGAN.

THE Research Club of the University of Michigan was organized two years ago, its membership being made up from the University Faculties, and its aim being the promotion of research. During the year just closed, the Club has met six times, and its proceedings may be briefly summarized as follows:

At the first meeting, held in October, 1900, the theme for discussion was 'The Promotion of Research at the University of Michigan.' Dr. Vaughan, President of the Club, addressed the members on the organization and objects of the Club, and closed with remarks on the topic of the evening. Professors Wenley, Ziwet,

Adams and Reighard spoke by appointment, and they were followed *ex tempore* by Dr. Hulett, Dr. Bigelow and Dr. Dock.

At the second meeting, November, 1900, the speakers were Professors Hempl and Newcombe. Professor Hempl spoke on the formation of dialect districts in the United States, showing with the help of charts the boundaries of various dialectic differences. The speaker gave concrete examples of variation in the use and pronunciation of words and phrases, and made some attempt to trace the historical development of these variations.

Professor Newcombe narrated his experiments on the sensitive curves made by roots in response to the streaming of water, and in response to contact with a foreign body. It was shown that about one-half of the thirty-three species of plants tested are sensitive to the water-current, and that of the four water-plants used, none is sensitive. So far as tested, all those plants responding to the water-current responded to the contact of a foreign body, and those not responding to one did not respond to the other. Hence it is supposed, though not demonstrated, that the response in both cases is response to one-sided pressure. A summary of these results may be found in SCIENCE, XIII. (1901), p. 250.

The third meeting came in January, 1901. Professor Gomberg detailed the experiments which led to his discovery of the trivalency of carbon. Accounts of this work may be found in *Jour. Amer. Chem. Soc.*, 22, 757; *Ber. d. d. Chem. Gesellsch.*, 33, 3150; *Amer. Chem. Jour.*, 25, 317. Dr. H. S. Jennings stated his results in studying the reactions of infusoria to external stimuli, illustrating his summary with experiments, made visible to all present by projection with a lantern. The researches of which Dr. Jennings gave an account have been published in full in various journals, and an abstract appeared in SCIENCE for January 11, 1901 (XIII., 74), in the report of the Zoological Journal Club of the University of Michigan.

The February meeting listened to papers by Dr. George Dock and Professor W. B. Pillsbury. Dr. Dock described the method of teaching internal medicine in the University. The limited time in the medical course makes it

difficult for undergraduates to do more in the way of research than to work out some original detail. In this work, they make extensive use of the laboratory method, and the effort is made to require students to think for themselves. The paper closed with the citation of subjects of investigation followed in the medical clinic. Professor Pillsbury presented a summary of a paper entitled 'Do the Sensations of Movement Originate in the Joints?' The narration of his experiments showed that a current through the ankle or elbow was as effective in reducing the sensitiveness of knee or elbow as currents through the joints in question. This fact, he stated, can only be explained if the sensory endings in the tendon or muscle are the seat of the sensation, and not the joints as is usually claimed.

In the March meeting Dr. Warthin and Dr. Hulett presented papers. Dr. Warthin spoke on 'A Contribution to the Normal Histology and Pathology of the Hemolymph Glands' (preliminary report). In this paper the occurrence of glands containing blood-sinuses instead of lymph-sinuses is for the first time shown to be constant in the human body. The distribution of these glands, their minute structure, their hemolytic function under normal conditions, etc., are described. Two types of these glands—splenolymph and marrowlymph glands—are found to occur. In a number of cases of fatal anemia, pathological changes were found in these glands, showing conclusively that they may become centers of red blood-cell formation.

Dr. Hulett presented a report of his measurements of 'The Relation Between Surface Energy and Solubility.' The theoretical relation between surface tension and solubility was discussed, and experimental data given to show that the solubility of a substance depends upon the curvature of the surface—*i. e.*, the finer the state of division the more soluble (*t* constant). The solubility of gypsum was increased 19 % by decreasing the size of the particles from 2μ to 0.3μ ; barium sulphate showed an increase of 100 % in solubility, and mercury oxide 300 % over that of the normally saturated solutions.

At the last meeting, held the 29th of May, Professor Lloyd read a paper bearing the title

'Some Unscientific Reflections upon Science.' The paper was vigorously discussed, some of those present thinking that the attitude of scientific men had been unfairly portrayed, while others supported Professor Lloyd. This paper is soon to appear in full in SCIENCE. At this meeting also, Professor E. D. Campbell detailed in a highly interesting manner his researches on the microscopical and chemical composition of steel. His paper gave a comparison of the heat of formation, and the action of nitric acid and of iodine on cementite, one of the constituents of high carbon steel, and on the pure carbide of iron isolated from pearlite. From these comparisons the author concludes that free cementite is not only not identical with the carbide of pearlite, as is usually assumed, but is probably not a carbide at all, but a solid solution of carbon in iron.

FREDERICK C. NEWCOMBE,
Secretary.

THE TEXAS ACADEMY OF SCIENCE.

DURING the half year ending with June, this organization held four meetings in the Chemical Lecture Room of the University of Texas. On January 18, Dr. William Morton Wheeler, professor of zoology in the University, lectured upon 'The Relation of Ants to other Living Organisms'; on March 23, Dr. William L. Bray, professor of botany, lectured on 'Texas Forests: their Present Condition and their Future Management'; and on April 5, Dr. William B. Phillips, the lately appointed director of University Mineral Survey, lectured on 'Texas Petroleum.' The lectures of Messrs. Wheeler and Bray were illustrated by a liberal use of lantern slides.

The program of the annual meeting, held on June 10, was as follows: 'Contributions of the Nineteenth Century to Education,' William S. Sutton, M.A., professor of the science and art of education in the University of Texas.

'Rice Irrigation in Texas,' Thos. U. Taylor, M.C.E., professor of applied mathematics in the University of Texas.

'Texas Railway Stock and Bond Law,' R. A. Thompson, C.E., expert engineer to the Texas Railroad Commission.

'Texas Minerals and Mineral Localities' (by

title), Frederic W. Simonds, Ph.D., professor of geology in the University of Texas.

'Notes on the Yellow Oxide of Mercury,' E. P. Schoch, M.A., and O. W. Wilcox, school of chemistry, University of Texas.

Professor Sutton's paper was a thoughtful exposition of the subject—'Contributions of the Nineteenth Century to Education'—though necessarily brief. The closing paragraph, in the form of a summary, was as follows: "In conclusion, let us consider for a moment the question, What is the significance of all these contributions which the last one hundred years have made to education? Upon what principle can be explained the accomplishment of a task so stupendous as to involve, first, the most radical changes with respect to the aim in education; second, the vast expansion of the culture-material to accomplish this aim; third, the discovery of scientific method in instruction; fourth, the provision for the professional training of teachers; fifth, the organization and partial development of gigantic systems of public instruction at public expense; sixth, the increase of number of the learned professions by recognizing the dignity of applied sciences; and lastly, the extension of the privileges of education to the child in the kindergarten, and to the parent in the home? There can be but one answer to this question—it is the spirit of real humanism, which is the distinctive characteristic of the nineteenth century, a spirit which through the reign of reason seeks to bring all men to a knowledge of the truth, and which has for its ultimate purpose the complete physical and spiritual enfranchisement of the human race."

Mr. Thompson in discussing 'The Texas Railway Stock and Bond Law,' called attention to the fact that Texas is the only State in which the issuance of railway stocks and bonds is controlled by the government, and also that it is the only one which has prescribed an absolute basis for the valuation of railway properties.

The Stock and Bond Law declares that the issuance and execution of all railway securities are 'special privileges' subject to the absolute control of the State; and that no indebtedness shall be authorized beyond the 'reasonable value of property' to be fixed by the Railroad Commission in accordance with actual cost.

Railways existing at the time of passage of the law were valued at the estimated cost of reproduction.

The causes that led up to the enactment of the law were discussed, and it was shown that the contention by investors in railway stocks and bonds, that they should be entitled to charge freight and passenger rates sufficient to earn a fair rate of interest on their holdings, and the support of the Courts in the matter, led the State to limit the issuance of such securities, and to absolutely prohibit the current practice of 'watering' stocks and bonds.

It was shown from the reports of the Railroad Commission that the average amount of stocks and bonds outstanding against the railways of Texas, under the effect of this and other laws, had been reduced from \$43,961 per mile in 1894 to \$36,926 per mile in 1900. As the Stock and Bond Law continues in effect this will be further reduced, thus permitting a larger per cent. of the net earnings to be used in the upbuilding of the roads and guaranteeing safer investments to the purchasers of railway securities. Notwithstanding the restrictions of the law, railway building in Texas is progressing at a rapid rate—building for purely speculative purposes is checked and legitimate construction promoted. In 1901 it is thought that Texas will easily lead the States of the Union in miles of new railway.

The following notes on the red oxide of mercury were presented by Messrs. Schoch and Wilcox:

"The yellow oxide of mercury has been carefully examined in the laboratory of the school of chemistry of the University of Texas, with a view to clearing up disputed points. By heating up to 200°C. and weighing the water evolved only 0.6% was obtained, which invalidates the statements of Walker and Schaffner that the substance is mercuric hydroxide—a statement made on the basis of results obtained by heating the substance in the open air and reporting the loss as water, and corroborates the work of Siewert. The substance is distinctly crystalline; its specific gravity is 10.6 as determined by Mr. J. M. Kühne, while that of the red oxide is 11."

Upon the report of Messrs. A. M. Ferguson

and John K. Prather, tellers, President Harper announced that the following persons had been duly elected officers of the Academy for the year 1901-1902: President, Professor James C. Nagle of the Agricultural and Mechanical College of Texas, College Station; Vice-President, Dr. Henry Winston Harper, of the University of Texas; Treasurer, Mr. R. A. Thompson, Engineer to the State Railroad Commission; Secretary, Dr. Frederic W. Simonds, of the University of Texas; Librarian, Dr. William L. Bray, of the University of Texas; Other Members of the Council, Hon. Arthur Lefevre, State Superintendent of Public Instruction, and Professors Taylor and Wheeler, of the University.

FREDERIC W. SIMONDS,
Secretary.

THE TORREY BOTANICAL CLUB.

At the meeting of the Club on May 24, 1901, the scientific program consisted of a paper by Dr. H. M. Richards on 'The Botanical Establishments at Buitenzorg and Tjibodas in Java,' illustrated by numerous photographs, including views of the entrance to the botanic garden and of species growing within, of large lianas a foot in diameter, of the nutmeg, jackfruit, etc., of a tapioca plantation, beautiful treefern groves with alsephilas 40 feet high, etc. Dr. Richards described his journey by train from Batavia 40 miles to Buitenzorg among the foothills of the western mountains. The Botanical Garden of Buitenzorg is at an elevation of over 900 feet, and therefore much cooler than the coast lowlands, the thermometer rarely going below 80° or above 90° F.; rain falls almost every day and almost uniformly through the year; the forenoon is bright and clear; the conditions for plant growth are very much as in a hothouse. A smoldering volcano rises on one side and an extinct one on the other, with a very variable river between.

The history of the Garden dates from Sir Stamford Raffles, British governor, who made a picturesque park about 1811 about his palace, of which the Garden shows some remnants. The *Rafflesia*, which perpetuates his name, is but occasionally to be seen, and although the Garden endeavors to maintain examples of

growth, none were to be had at the time of Dr. Richards' visit. Since the present directorship, about 1880, the Garden has been greatly stimulated. Dr. Lotze, formerly at the Johns Hopkins University, is now one of the staff there. The eight laboratory tables for foreign workers were well filled. Much valuable work has been done of immediate agricultural utility; it is here that the *Cinchona* was acclimated from South America to replace the coffee industry, the coffee plants having been destroyed by a fungus. Experiments toward finding a new rubber supply are in progress, and others to improve vanilla and cocaine production. The Malay workmen who fertilize the vanilla plant by hand prove very skilful. About 30 Europeans and 200 natives form the garden force. In the Botanical Garden proper the orders are not grown in exact sequence, but are grouped and marked off by letters; two specimens of each species are grown; one at least of these is labeled; if grown away from its congeners that fact is indicated by use of a red label. Many screw-pines which belong to the salt or brackish water of the coast grow well here in the garden soil. The palm collection is one of the largest in the world; notable features are its specimens of *Areca* and of *Livistona*. Down by a brook is a fine *Casuarina* collection, the Javanese species of which forms large forests on the upper hills resembling northern larch forests. The *Ficus* group is abundant and supplies the favorite shade tree for Javanese streets. Orchids hang especially from trees of the leguminous type, as *Amherstia*, *Cæsalpinia*, etc. These trees are very like candelabra in direction and so expose a reduced surface to the excess of light.

The mountain-garden at Tjibodas, at an elevation of about 4,500 feet, affords the necessary complement to the botanical garden proper. Dr. Richards found it cool enough after the afternoon rain to make a fire very welcome. Good potatoes are raised there, and on the journey up one passes paddy-fields and tea-plantations, including that from which came the Javanese villagers at the Chicago fair. A great jungle of 700 acres extends up to the mountain-top, through which the ascent was taken at 3 A. M. by torchlight, to get the sunrise view. Here tropical oaks develop

into dense balls, epiphyte ferns are in abundance, fallen trunks are covered with moss, and the path through the jungle chokes up so quickly that it has to be cut open often. The jungle is said to contain 1,500 species of trees. The Malays are very keen in perceiving distinctions, and recognize two species of oaks there which the botanists have not yet discriminated. On the heights the aspect becomes more European, *Viola*, *Ranunculus*, *Primula*, *Lonicera*, *Lobelia*, *Oxalis*, etc., appear, and Wallace explained this by supposing these northern forms were pushed south by a glacial climate and on the retreat of the ice they themselves retreated to the mountains.

EDWARD S. BURGESS,
Secretary.

THE ACADEMY OF SCIENCE OF ST. LOUIS.

At the meeting of the Academy of Science of St. Louis, on the evening of June 3, 22 persons present, the following subjects were presented:

A paper by Dr. Gellert Alleman, on 'The Action of Alcohol on Certain Isomeric Diazo Compounds,' and one by Dr. G. Hambach, entitled 'A Revision of the Blastoidæ,' were presented by title.

Mr. Wm. H. Roever, of Washington University, read a paper on 'The Effect of the Earth's Rotation upon Falling Bodies,' in which he showed that a body falling from a great height has a southward deviation in the northern hemisphere and a northward deviation in the southern hemisphere. The deviation is given by the formula—

$$\Delta = h \left[\frac{\left(1 + \frac{h}{R}\right)^3 K \sin \phi \cos \phi}{1 - \left(1 + \frac{h}{R}\right)^3 K \cos^2 \phi} - \frac{1}{\left(1 + \frac{h}{R}\right)} \cdot \frac{K \sin \phi \cos \phi}{1 - K \cos^2 \phi} \right],$$

in which h is the height through which the body falls, R the radius of the earth (assumed spherical), ϕ the latitude of the place of observation, K the numerical fraction $\frac{1}{289}$ and Δ the deviation. If h and R are given in feet, Δ is in feet.

For $h = 578$ feet and $\phi = 45^\circ$, $\Delta = .00133$ inch.

Mr. G. Pauls presented a number of specimens collected at Eureka, Mo. He exhibited a large number of galls on hickory, maple and oak leaves, commenting on the remarkable variety of the forms of galls made by the minute insects. He had bred a good many of these insects, and found that in successive years a good many different forms came from these galls.

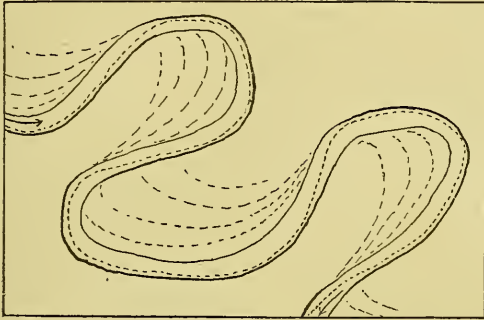
WILLIAM TRELEASE,
Recording Secretary.

CURRENT NOTES ON PHYSIOGEOGRAPHY.

NEW MAP OF THE MISSISSIPPI.

THE 'Preliminary Map of the Mississippi River from the mouth of the Ohio River to the head of the Passes,' published by the Mississippi River Commission (1881-1885, 32 sheets, one inch to a mile), is now to be supplemented by a new edition, of which 13 sheets are issued, bearing in red overprint the changes wrought by the river in about fifteen years. These new sheets are without question the most instructive exhibition of river work, quantitatively determined, yet published in this country; for a river of the first magnitude they have no rival in the world. They deserve to be widely known not only among engineers for whom they were primarily constructed, but among geographers and teachers to whom they convey much information. The general behavior of the meandering river may be inferred from the maps of the earlier edition, from which it appears that the meander system slowly moves down the valley, because the thread of fastest current, thrown toward the outer side of every curve, is therefore delivered to the down-valley side of every tangent or 'crossing' (so called because river boats must there cross the river obliquely in following the channel of greatest depth); and that the meander belt included between tangents drawn outside of the curves slowly widens as the curves increase in radius and arc until it here and there suddenly collapses when a curve is cut off. It may be noted in passing that it is for this reason that the abandoned curves—the ox-bow lakes—are frequently of larger radius than the average of the existing curves. The

down-valley shifting and the broadening of the meander belt are well shown by the pattern of the toe-taps of alluvium that are added, right and left, to the flood plain lobes as the meanders grow and shift, as in the accompanying figure.



All these systematic changes are directly shown by a comparison of the river banks in black and red on the new edition of the map; the wasting banks being systematically located on the outer and down-valley side of the channel, as indicated by heavy lines in the above diagram. Sheet 14 includes the remarkable serpentine meanders near Greenville, where the increase of radius and arc and the down-valley shifting are beautifully shown. Sheets 17, 18 and 19 include a number of curves in the neighborhood of Vicksburg, where the river has destroyed the old levees, thus necessitating the construction of new ones further back from the bank. The bends below Baton Rouge (sheet 25) exhibit relatively small change of position.

THE RIVER SPEY.

THE physiography of the Spey, a river flowing eastward from the Highlands of central Scotland to the North sea, is considered by Hinxman ('The River Spey,' *Scot. Geogr. Mag.*, XVII., 1901, 185-193). A number of the items presented are of interest, but the plan of the article does not imply a comprehensive view of the natural history of rivers. "The Spey valley for the greater part of its extent may * * * be regarded as the result of the slow erosion of the river, continued since early Paleozoic times"; this suggests altogether too great an antiquity; the incision of the Spey valley, and of all the existing valleys, glens and straths of Scotland, beneath the general level of the

Highland summits, is probably not older than Tertiary, and certainly not older than middle Mesozoic time. The valleys of "the river and its principal tributaries * * * belong to a very early period in the history of the earth. That they existed before the Old Red sandstone age" is known, because patches of that formation still remain in them here and there; a safer statement would be that an uneven land surface, presumably a region of hills and valleys, was buried by the Old Red, and that some of these ancient valleys have been re-excavated; but it is very improbable that the main and branch valleys of the Spey system are in any close degree coincident with any single ancient valley system. Indeed, much may be said in favor of the initiation of these and certain other Highland valleys on a land surface that was deformed by the tilting and faulting which disturbed the Old Red itself. No special consideration is given to the stage of development of the Spey in pre-glacial time, or to the amount of change produced by glacial action, destructive or constructive; but certain features of the existing river are presented. One is the diversion of a small upper part of river Feshie from the Dee system to the Spey; the diversion is ascribed to normal retrogressive erosion, but it is not shown that the capturing stream had any special advantage over the captured, and no account is taken of glacial action.* Reference is made to the temporary enlargement of the Spey by waters from Glen Spean, on the west, when the lower course of the Spean was obstructed by ice in the Glen Roy district; but that the Pattack and several other barbed headwaters of the present Spean were preglacial members of the Spey system is not considered. Special emphasis is given to the abnormal slope of the Spey; the upper course falls 327 feet in 14 miles, the middle course falls 215 feet in 40 miles; and the lower

* According to the Ordnance map, a gorge on the Feshie two miles southeast of Ruigh-fionntaigh would seem to mark the site of the divide between Spey and Dee before the diversion; and the diversion appears to have been associated with some glacial control. The gorge is not situated where it should be if the upper Feshie had been diverted by retrogressive erosion.

course falls 600 feet in 43 miles. The Feshie makes a fan across the flat middle section of the Spey valley. It is assumed that the Spey once had a normal slope, and it is suggested that a relatively recent uplift in its lower third flattened the middle course and steepened the lower course. Explanation is thus found for the action of the stream in aggrading its middle portion with drift and in cutting down its lower portion in bed rock; but no confirmation for the suggestion of recent uplift is looked for in the neighboring valleys; the success of the suggestion in explaining what it was invented to explain is taken as its verification, without looking for unexpected consequences.

THE RIES.

THE divide between the headwaters of the Main and Neckar on the northwest and the Danube on the southeast is in general determined by the crest of a rather pronounced cuesta of Jurassic limestone, part of which is known as the Swabian Alp. The escarpment of the cuesta, facing northwest, is usually well defined; the back slope, towards the Danube, is on the whole remarkably simple and systematic; but near the middle of its curved length there is a curious, roughly hexagonal depression, called the Ries, about 18 k. in diameter, rather flat floored and well enclosed by the hilly borders of the uplands, with Nordlingen as its chief town. This highly abnormal feature has been likened to a gigantic *maare*, or pit-crater; but although volcanic rocks are confusedly mixed with many others—decomposed granite, schists, mesozoic, tertiary and quaternary—in the floor of the depression, a detailed study by Gruber ('Das Ries, eine geographisch-volkswirtschaftliche Studie,' *Forsch deut. Landes u. Volkskunde*, XII., 1899, 193–291, map, 12 figs.), ascribe the basins to dislocations, similar to those by which various other depressions have been produced in central Germany. It is not clearly explained, however, in just what shares dislocation and denudation are responsible for the basin; no definite statement is made as to the form that the surface had when dislocation took place, as to the form that dislocation produced, or as to the work of denudation on the dislocated form. It is, therefore,

difficult to form a clear mental picture of the theoretical forms by which the observed forms are to be explained. In the second part of the essay, the people, settlements, occupations and products of the Ries are described.

W. M. DAVIS.

BOTANICAL NOTES.

'SAVE YOUR PUFF-BALLS.'

UNDER this title Mr. C. G. Lloyd, the well-known student of the higher fungi, has issued a circular asking botanists and others to save puff-balls of all kinds (excepting the large ones) for him. He intends to publish 'in the near future a detailed description of all the Gasteromycetes' and solicits specimens from every one who can help him. Due credit is promised for all specimens sent to him for this purpose. The monograph is to be profusely illustrated with photo reproductions of typical specimens of the species and also with micro-photographic enlargements of the spores and capillitium by Dr. Edward Thompson, an expert in this line of work.

In his directions to collectors Mr. Lloyd says: "For the purpose of study puff-balls must be ripe, that is, they must be full of dry dust. When young most kinds are white and when you cut them they appear like 'cottage cheese.' They are mostly good to eat in this condition, but not to study. The best time to gather them is just when they are getting ripe, just when the white has become moist and discolored and the spines are just drying up and beginning to flake off." * * * "Simply pick them up, handle them carefully so as not to mash them, and if they are just ripening and are moist, spread them out on the floor in a garret or where they will be out of the way and let them dry. Then pack them loosely in a little wooden box; don't squeeze or bruise them." "If your boxes are not full, pack in loosely a little cotton or tissue paper (cotton is better) to fill out. Do not wrap in paper or put in paper bags." Send the boxes, securely wrapped, by mail or express, to Mr. Lloyd at Court and Plum streets, Cincinnati, Ohio.

A NEW WORK ON TREES AND SHRUBS.

THE announcement is made by Messrs. Houghton, Mifflin & Co., of Boston, Mass., that

Professor Charles S. Sargent, author of 'The Silva of North America,' has under preparation a work to be known as 'Trees and Shrubs' and to consist of illustrations and brief descriptions of new and little-known trees and shrubs, chiefly from material obtained from the Arnold Arboretum. It will not be confined wholly to North American plants, but 'will include also the woody plants of other regions, especially those of the northern hemisphere, which may be expected to flourish in the gardens of the United States and Europe, and those of special commercial or economic interest and value.' It is to be published at irregular intervals, and each part will contain twenty-five plates. It is the hope of the publishers that one part will appear in the fall of 1901, and that at least two parts may be issued each year. From the specimen plates and pages of text it is evident that this is to be a work second only to the 'Silva' in importance and value to working botanists and horticulturists.

THE OAKS OF THE CONTINENTAL DIVIDE.

BOTANISTS who have puzzled over the little oak trees of the Pike's Peak region in Colorado will be interested in a paper by Dr. Rydberg in a *Bulletin of the New York Botanical Garden* (Vol. II., No. 6), in which he attempts to bring something like order out of the chaotic condition which has existed hitherto. After several seasons of field work in the Rocky Mountains, Dr. Rydberg finds that the Colorado oaks heretofore referred to *Quercus undulata* and *Q. gambelii* are more properly to be referred to ten or eleven species, three of which prove to have been undescribed. About Pike's Peak there are no less than six species, instead of the single species *Q. undulata*; these are *Q. utahensis*, *Q. leptophylla* (new), *Q. gunnisonii*, *Q. nitescens* (new), *Q. novo mexicana* and *Q. gambelii*. Dr. Rydberg found it necessary to extend his studies throughout the mountain region, and as a result he has very considerably enlarged the list of species for this portion of the continent. His descriptive list includes no less than twenty-nine names, of which the new species are: *Q. submollis* (Arizona), *Q. vreelandii* (Colorado to New Mexico), *Q. leptophylla* (Colorado), *Q. nitescens* (Colorado to Utah), *Q. eastwoodiæ* (Utah), *Q.*

havardi (Texas), *Q. pauciloba* (Arizona), *Q. wilcoxii* (Arizona to Utah and Nevada).

CHARLES E. BESSEY.

THE UNIVERSITY OF NEBRASKA.

CONFERRING OF DEGREES AT THE UNIVERSITY OF CHICAGO.

As we have already recorded, the University of Chicago conferred in connection with its decennial eleven honorary degrees. President Harper, in welcoming the men of science on whom the LL.D. degree was conferred, spoke as follows:

Edward Charles Pickering,

during twenty-five years Payne Professor of Astronomy and Director of the Astronomical Observatory of Harvard College, an observatory developed through your labors into an institution foremost in research on two continents; organizer in the United States of a system of laboratory teaching of great influence on education in physical science; student of optics; discoverer of variable stars and investigator in stellar photometry; originator of many astronomical applications of photography and spectroscopy, which have revealed the constitution of the stellar universe:—for these distinguished services, and especially for the last-named, by the authority of the Board of Trustees of the University of Chicago, upon nomination of the University Senate, I confer upon you the degree of Doctor of Laws of this University, with all rights and privileges appertaining thereunto.

Jacob Henry van't Hoff,

Professor of Physical Chemistry in the University of Berlin, investigator who has brought to bear upon chemical problems a keen and logical mind, endowed with speculative and imaginative powers of the highest order, founder of the theory explaining the space relations of atoms in molecules—a theory which is essential to a comprehension of the chemistry of organized and inorganized matter; master in the field of dynamic chemistry; investigator and brilliant discoverer in the domain of the modern theory of solutions, a theory which constitutes one of the greatest advances made by chemical science in the last quarter of a century:—for these splendid and fertile achievements, by the authority of the Board of Trustees of the University of Chicago, upon nomination of the University Senate, I confer upon you the degree of Doctor of Laws of this University, with all the rights and privileges appertaining thereunto.

Charles Doolittle Walcott,

Director of the United States Geological Survey, Superintendent of the National Museum, author of

numerous paleontological and geological contributions of eminent merit, notable among which are a series of monumental works on the Cambrian System of North America: for these distinguished contributions, and for signal ability displayed in the administration of the scientific and educational interests committed to your charge, by the authority of the Board of Trustees of the University of Chicago, upon the nomination of the University Senate, I confer upon you the degree of Doctor of Laws of this University, with all the rights and privileges appertaining thereunto.

Edmund Beecher Wilson,

Professor of Zoology in Columbia University, zoologist and worker in the field of biology, teacher and leader of many young investigators, writer of standard text-books in general biology and of numerous philosophical essays and classical memoirs on zoology; author of a masterpiece of research and presentation, 'The Cell in Development and Inheritance,' which embodies the writer's original contributions in embryology and cytology, as well as the results reached by other workers in these fields—for these eminent services in science, especially for the work last named, by the authority of the Board of Trustees of the University of Chicago, upon the nomination of the University Senate, I confer upon you the degree of Doctor of Laws of this University, with all the rights and privileges appertaining thereunto.

THE AMERICAN PHILOSOPHICAL SOCIETY.

THE American Philosophical Society, at its meeting on May 17, adopted the following resolution:

Whereas, The American Philosophical Society is and always has been a society of national scope, whose place of meeting was originally fixed at Philadelphia for reasons of convenience now less potent than formerly; and

Whereas, The growth and wide extent of our country and the multiplication of local societies tends to keep from our regular meetings those members who do not reside within a short distance of Philadelphia; and

Whereas, It is desirable that measures be taken to bring the distant members into more active participation in the work of the Society; therefore be it

Resolved, (1) That a committee of five be appointed by the President to consider the advisability and, if deemed advisable, to arrange for a general meeting at a time most convenient to all the members;

(2) That this meeting shall cover one or more days as may be considered advisable, and it is hoped

that the high scientific character and broad interest of the papers to be presented shall insure the attendance of a good proportion of distant members;

(3) That this committee shall have power to add to its number and to make all necessary arrangements to further the success of the proposed general meeting.

The committee appointed, consisting of Professors George F. Barker, Chairman, Edwin G. Conklin, Charles L. Doolittle, William B. Scott, William Powell Wilson, has enlarged its number, and has asked for suggestions which will tend to promote the success of the proposed general meeting. It is suggested that the meeting be held on the Friday and Saturday following Thanksgiving Day, on the Friday and Saturday following New Year's Day, or in Easter week.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

ADDITIONS AND CORRECTIONS TO THE PRELIMINARY ANNOUNCEMENT.

THE preliminary announcement of the Denver meeting of the Association has been mailed to all members, and it will undoubtedly have been noticed that the question of railroad rates has been left incomplete, except for the announcement of the Western Passenger Association, the statement being made that further arrangements will be announced in SCIENCE. The following arrangements have been made: *The Western Passenger Association*, covering the territory west of Chicago and St. Louis, has made a rate of one fare plus \$2 for the round trip, from all points in their territory to Denver, tickets to be sold July 10 to August 31, with final return limit of October 31.

The New England, Trunk Line, Central and Southeastern Passenger Associations, covering the territory east of Chicago and St. Louis, have made a rate of a fare and one-third for the round trip from all points in their territory to Denver, on the certificate plan, the conditions of which are as follows:

1st. Each person desiring to avail himself of the reduced rate must purchase a first-class ticket (either limited or unlimited) to the place of meeting, at the regular tariff rate and at the same time procure from the ticket agent a certificate of the standard form. If through ticket cannot be procured at the starting

point, the person should purchase to the most convenient point at which such ticket can be obtained and there repurchase through to the place of meeting, procuring a standard certificate from each agent from whom a ticket is purchased.

2d. *It is absolutely necessary that certificates be procured, indicating that the full fare has been paid for going passage and the route for which ticket or tickets for the return journey should be sold. No refund of fare can be expected because of failure to secure such certificates.*

3d. Tickets for the return journey will be sold at one-third the first-class tariff fare only to persons holding certificates of the standard form duly signed by the Permanent Secretary of the A. A. A. S., and signed by the special agent appointed for that purpose.

4th. No certificate will be honored that was procured more than three days (Sunday not included) before the meeting assembles (except that when meetings are held at distant points to which the authorized transit limit is more than three days, the authorized transit limit will govern), nor more than two days (Sunday not included) after the first day of the meeting. No certificate will be honored for return ticket unless presented during the time that the meeting is in session, or within three days (Sunday not included) after adjournment.

5th. Tickets for return journey will be limited to continuous passage on first train after purchase.

6th. Certificates will not be honored by conductors; they must be presented to ticket agents.

7th. Neither the certificates nor tickets furnished for this occasion are transferable, and if presented by any other person than the original purchaser, they will not be honored but will be forfeited.

Members desiring longer time than that allowed in connection with certificate reduction, viz., 3 days before the meeting assembles to 3 days after adjournment (Sunday not included) are advised to take advantage of the Colorado tourist fares or summer excursions, which, while costing a little more than the fare and one-third, are good from July 10 to October 31.

CORRECTION TO PROGRAM OF MONDAY AFTER-NOON, AUGUST 26.

(See page 26 of the preliminary announcement.)

Through some clerical or printer's blunder the vice-presidents elect are here announced to give their addresses at 3 o'clock at the high-school building. As a matter of fact, this is all

wrong. The vice-presidential addresses which will be given are those of four of the retiring vice-presidents, as follows:

Vice-President Brashear, before the Section of Mechanical Science and Engineering.

Vice-President Davenport, before the Section of Zoology.

Vice-President Butler, before the Section of Anthropology.

Vice-President Woodward, before the Section of Social and Economic Science.

It will probably be arranged so that two of these addresses will be given at 3 o'clock and two at 4 o'clock, in order to allow members interested to hear two addresses.

THROUGH PULLMAN SERVICE.

If a sufficient number of passengers can be guaranteed, arrangements can be made for through Pullman service, to connect at Chicago or St. Louis, so that members from different sections of the country can make the trip to Denver together. The Permanent Secretary therefore invites all members who plan to attend the meeting and who wish to take advantage of this through Pullman service to communicate with him at once, stating the name of the road over which they intend to travel and the date of their departure. If a sufficient number of replies are received, the arrangement will be made and members notified.

SCIENTIFIC NOTES AND NEWS.

PROFESSOR JAMES DEWAR, the eminent chemist, has been elected president of the British Association to follow Professor A. W. Rücker, and will preside at the Belfast meeting in 1902.

OXFORD UNIVERSITY has conferred its D.Sc. on Philip Lutley Sclater, M.A., F.R.S., secretary of the Zoological Society, London, and its D.C.L. on C. N. Dalton, C.B., comptroller-general of patents, designs and trade-marks.

DR. JOHN S. BILLINGS, director of the New York Public Library, has been elected president of the American Library Association.

M. MAUPAS has been elected a correspondent of the Paris Academy of Sciences in the

section of anatomy and physiology, replacing the late M. Marion.

The following have been appointed members of the visiting committee of the National Bureau of Standards: Dr. Ira Remsen, president, Johns Hopkins University; Professor Elihu Thomson, electrician, General Electric Company; Professor E. L. Nichols, professor of physics, Cornell University; Dr. Henry S. Pritchett, president, Massachusetts Institute of Technology; Mr. Albert Ladd Colby, metallurgical engineer, Bethlehem Steel Company, and secretary of the Association of American Steel Manufacturers. Professor E. B. Rosa, of Wesleyan University, has been appointed physicist.

DR. HENRY WOODWARD, F.R.S., keeper of the Department of Geology of the British Museum (Natural History), will retire in November, having some time since reached the age limit. It is expected that he will be succeeded by Dr. Arthur Smith Woodward, F.R.S., under whom the department would certainly be administered in accordance with the best scientific methods. Dr. Woodward's visit to this country last year is remembered with great pleasure by many American men of science.

PROFESSOR C. LE NEVE FOSTER, of the Royal School of Mines, London, has resigned the position of inspector of mines, which he has held for the past twenty-eight years.

WE regret to learn that Professor Rudolf Virchow has met with an accident, cutting his head by a fall, on June 13. His health has for some time past not been very good. Professor Virchow will celebrate his eightieth birthday on October 13.

PROFESSORS DAVID HILBERT (Göttingen), Georg Cantor (Halle) and Ulisse Dini (Pisa) have been elected foreign members of the London Mathematical Society.

J. W. LOWBER, PH.D., F.R.G.S., Austin, Texas, has been elected a fellow of the Royal Meteorological Society of London.

THE Belgian quinquennial jury of medical sciences has awarded its prize of the value of 5,000 francs to Professor Van Gehuchten of Louvain, for his researches on the brain and spinal cord.

PROFESSOR J. H. AMES, of the Johns Hopkins University, has accepted the position of associate editor of the *American Journal of Science* held by the late Professor H. A. Rowland.

DR. R. A. DALY has resigned his place as instructor of physiography at Harvard University to accept a position on the Geological Survey of Canada, where he will be attached to the party that is marking the international boundary on the Pacific slope. Mr. A. W. G. Wilson, who has just received the degree of Doctor of Philosophy in geology at Harvard, has also been appointed to the Canadian Survey for work in the country about Lake Nipigon.

GEORGE G. HEDGCOCK, B.Sc., 1899, and A.M., 1901, of the University of Nebraska, and sometime fellow in botany, has been appointed by the United States Department of Agriculture to investigate the diseases of the sugar beets of Nebraska and other western states.

PROFESSOR JOHN B. JOHNSON, dean of the College of Mechanics and Engineering of the University of Wisconsin, opened the discussion on present tendencies in technical and professional education at the twenty-ninth annual Convocation of the University of the State of New York, held at Albany last week.

AT a meeting of the Western Society of Engineers on June 26, Professor B. E. Fernow, of the New York State College of Forestry, delivered an address on 'The Relation of Forestry to Engineering.'

A COMMITTEE has been formed to erect in Bern a memorial to the great anatomist and physiologist Albrecht v. Haller, who was born in Bern in 1708 and died there in 1777.

DR. JOHN FISKE, the well-known lecturer and author, died on July 4 after a short illness caused by the excessive heat. Born in 1842, he graduated from Harvard University in 1863 and was for a time connected with the University as lecturer on philosophy and later as assistant librarian. Fiske did much by his books, lectures and articles to popularize the doctrine of evolution, especially on the lines laid down by Mr. Herbert Spencer. His 'Out-

lines of Cosmic Philosophy,' published in 1874, was followed by a long series of books, his contributions to history being in large measure influenced by his earlier work on evolution. Fiske enjoyed the personal friendship of Darwin, Huxley, Spencer and other great leaders, and the esteem of a large section of the general public.

PROFESSOR PETER GUTHRIE TAIT, who has held for the past forty years the chair of natural philosophy in Edinburgh University, died at Edinburgh on July 4. Born at Dalkeith in 1831, he attended Edinburgh University, and afterwards Cambridge University, where he was senior wrangler, first Smith's prizeman and fellow of Peterhouse. In 1854 he became professor of mathematics at Queen's College, Belfast, whence he removed to Edinburgh in 1860. He was the author of a long series of publications, both technical and popular in character. These include the 'Dynamics of a Particle,' 'Quaternions,' 'Thermodynamics,' and works on 'Heat,' 'Light' and 'The Properties of Matter.' His scientific papers were collected and published in 1898. In conjunction with Professor Balfour Stewart, he was the author of 'The Unseen Universe,' and, in cooperation with Lord Kelvin, prepared the well-known 'Natural Philosophy' of Thomson and Tait.

DR. THEODORE GREELY WHITE died in New York city on July 7, aged twenty-nine years. After having graduated from the School of Applied Sciences of Columbia University, he received the Ph.D. degree two years ago for work in geology. He was also assistant in the department of physics. Dr. White had made valuable contributions to geology and botany, and leaves a considerable amount of unpublished material. He was always active in good work, being last year one of the secretaries of the New York Academy of Sciences and acting editor of the publications of the academy.

THE small band of New Mexico naturalists has suffered a severe loss by the death of Mr. Francis J. Birtwell, of Albuquerque, who had spent two years investigating the ornithology of the territory, and who had in preparation an elaborate paper on the birds of New Mexico. Mr. Birtwell was married on May 24, and went

with his wife to study the birds of the Upper Pecos. On June 28, at Windsor's Ranch, 31 miles from Glorieta, he climbed a tall fir tree to obtain a bird's nest. Becoming dizzy, he signalled for help, and was being let down on a rope when by some means he jerked one arm out of the noose, and the rope tightened around his neck and strangled him before anyone could come to his assistance. Thus perished a man who was expected by those who knew his work to take a prominent place among American ornithologists. It is understood that his manuscript on the birds of New Mexico is in good order, and it is much to be hoped that the means will be found for its publication.

DR. JOHN CURWEN, a specialist in mental diseases, who for fifty years has been superintendent of hospitals for the insane at Harrisburg and Warren, Pa., died on July 2, aged eighty years.

MR. JOHN H. TEGMEYER, a well-known civil engineer, died at Baltimore on July 4, aged eighty years.

PROFESSOR LANGENBUCH, the eminent surgeon, director of the Lazarus Hospital, Berlin, died on June 9.

THE late Jacob S. Rogers, of Paterson, N. J., a locomotive builder, has bequeathed nearly his entire estate to the Metropolitan Museum of Art, New York City. The value of the bequest is estimated at from \$6,000,000 to \$8,000,000.

MR. ANDREW CARNEGIE has offered to give to the cities of San Francisco and Detroit \$750,000 for the establishment of public libraries.

THE Newberry Library, of Chicago, has acquired the philological library collected by the late Louis Lucien Buonaparte. It contains 15,000 volumes and is said to be the best philological library in the world.

IN connection with the census of India, a sum of at least £10,000 will be spent in collecting statistics relating to ethnology and anthropology.

A MAGNIFICENT specimen of the elephant seal (*Macrorhinus leoninus*) from the Macquarie Islands has lately been presented to the British Museum by the Hon. Walter Rothschild, one

of the trustees. The skin has been stuffed by Messrs. Gerard, who have imparted to the animal with its enormous fleshy nose a most lifelike, not to say human, appearance.

PLANS have been made to collect funds for a research scholarship at Trinity College, Dublin, in memory of the late Professor G. F. Fitzgerald.

AN anatomical museum fund, in memory of the late A. H. Hughes, who died in South Africa, has been established in connection with University College, Cardiff. Mrs. Hughes, the widow of Professor Hughes, has contributed £1,000 to this fund.

The deaths from the plague in Cape Colony to June 8 have numbered: Europeans, 58; colored persons, 164; Malays, 36; Indians, 9; Chinese, 0; natives, 59; total, 326. Only one case has occurred under naval and military control.

THE National Bureau of Standards was opened on July 1, with headquarters in the building of the Coast and Geodetic Survey. Plans are being prepared for the new building, for which Congress has made provision.

It is expected that the new Horticultural Building in Boston will be completed by the end of August, when there will be a special exhibition, arranged by Professor Charles S. Sargent, of the Arnold Arboretum.

THE observatory at Nice and its branch on Mt. Mourier has recently been visited by the board of control, consisting of MM. Gréard, Henri Poincaré, Barrot, Cornu, Lippmann, Loewy, Darboux, Mascart, Troost, Bischoffsheim.

THE Philippine Commission has established a government biological and chemical laboratory at Manila, which will have branch stations elsewhere. A superintendent will be appointed with a salary of \$4,000. A board of health has been established with a commissioner with a salary of \$6,000.

The Navy Department has purchased a tract of land surrounding the naval observatory, in order to protect the instruments. It was deemed advisable not to have any highways within 1,000 feet of the clock room, where the instruments are stationed, and a circle with a

radius of 1,000 feet was therefore drawn round the observatory. At the last session of Congress \$145,000 was appropriated to purchase the inclosed land, and of this sum \$122,000 has been expended for the purchase of about sixteen acres.

DR. C. W. ANDREWS, assistant in the Department of Geology, British Museum, Natural History, has been making collections in Egypt, which he has this month brought back with him to London.

THE expedition, planned by the South Dakota Geological Survey, into the Grand River region for this season has been postponed, because of smallpox in the Indian reservations where much of the work would have been done. It is hoped that next year circumstances will be more favorable.

THE Southeastern Union of Scientific Societies (England) held its sixth annual congress at Haslemere and Hindhead last month, under the presidency of Mr. G. A. Boulenger, F.R.S. The congress next year will be held at Canterbury, under the presidency of Dr. Jonathan Hutchinson, F.R.S.

WE learn from *Nature* that a committee has recently been appointed by the Institution of Civil Engineers, with the support of the Institutions of Mechanical Engineers and Naval Architects and of the Iron and Steel Institute, to consider the advisability of standardizing the various kinds of iron and steel sections, and, if found advisable, then to consider and report as to the steps which should be taken to carry such standardization into practice.

THE civil service commission reports that no applications have been received for the examination which was to have been held on July 6 for the position of laboratory assistant in physics at the national bureau of standards, as announced in this Journal several weeks ago. There are two vacancies to be filled as a result of this examination, one paying \$1,200 and the other \$1,400 a year. These openings are extremely desirable, as the work is largely research and the way is open for promotion.

THE civil service commission announces that it is desired to establish an eligible register

for the position of assistant physicist. It will not be necessary for applicants to appear at any place for examination. The examination will consist of the subjects mentioned below which will be weighted as follows :

Subjects.	Weights.
Education and training, with particular reference to the subjects of mathematics and chemistry	20
Experience in general laboratory manipulation, including glass-blowing, photography and assembling and making apparatus.....	10
Experience in advanced quantitative measurements, including determination of physical constants, comparison with standards, etc.....	20
Experience in original experimental research, particularly that relating to the physics of solutions and of finely divided solids. (In connection with this subject will be considered the various theses of published papers concerning investigations or experiments which the applicant has directed or assisted in).....	40
Training in mathematical physics. (This subject will include the consideration of theses of published papers on this line of work).....	10

From the eligibles resulting from this examination it is expected that certification will be made to the position of assistant physicist, Bureau of Soils, Department of Agriculture, at a salary of \$1,600 per annum, and to other similar vacancies as they may occur.

WE learn from the *Electrical World* that *L'Éclairage Électrique* is organizing a technical excursion to the United States to visit the Pan-American Exhibition in Buffalo, and to attend at the same place the convention in August of the American Society of Electrical Engineers. The party will leave Paris Aug. 3, arrive at New York Aug. 11, and leave for Philadelphia the same day. Aug. 13 will be spent in Washington, and the party will remain in New York from the 14 to the 18. The program from the 18 to the 26 coincides with that of the American Institute of Electrical Engineers. From Buffalo the party will go to Chicago, and from that city by way of the Lakes and the St. Lawrence River to Montreal and Quebec, returning to New York on Sept. 3, and sailing from the latter city Sept. 5.

CONCERNING the influence of chemical trans-

formation on weight, Lord Rayleigh writes to *Nature* as follows: Careful experiments by Heydweiller, published in the last number of *Drude's Annalen* (Vol. V., p. 394), lead their author to the conclusion that in certain cases chemical action is accompanied by a minute, but real, alteration of weight. The chemical actions here involved must be regarded as very mild ones, *e. g.*, the mere dissolution of cupric sulphate in water, or the substitution of iron for copper in that salt. The evidence for the reality of these changes, which amount to 0.2 or 0.3 mg., and are accordingly well within the powers of a good balance to demonstrate, will need careful scrutiny; but it may not be premature to consider what is involved in the acceptance of it. The first question which arises is: Does the *mass* change as well as the *weight*? The affirmative answer, although perhaps not absolutely inconsistent with any well-ascertained fact, will certainly be admitted with reluctance. The alternative—that mass and weight are not always in proportion—involves the conclusion, in contradiction to Newton, that the length of the seconds' pendulum at a given place depends upon the material of which the bob is composed. Newton's experiment was repeated by Bessel, who tried a number of metals, including gold, silver, lead, iron, zinc, as well as marble and quartz, and whose conclusion was that the length of the seconds' pendulum formed of these materials did not vary by one part in 60,000. At the present day it might be possible to improve even upon Bessel, or at any rate to include more diverse substances in the comparisons; but in any case the accuracy obtainable would fall much short of that realized in weighings. As regards Heydweiller's experiments themselves, there is one suggestion which I may make as to a possible source of error. Is the chemical action sufficiently in abeyance at the time of the first weighing? If there is copper sulphate in one branch of an inverted U and water in the other, the equilibrium can hardly be complete. The water all the time tends to distil over into the salt, and any such distillation must be attended by thermal effects which would interfere with the accuracy of the weighing.

UNIVERSITY AND EDUCATIONAL NEWS.

AFTER a long discussion of the report of the committee on 'A National University,' published above, the national council of education passed on July 9 the following resolution :

Resolved, That the report of the committee be received and the committee discharged ; and that while we express our appreciation of their labors we are not prepared to abandon the position taken by the National Educational Association in favor of a National University.

AT the Johns Hopkins University the following promotions have been made :

Henry F. Reid, Ph.D., now associate professor, to be professor of geological physics.

William J. A. Bliss, Ph.D., now associate, to be collegiate professor of physics.

Duncan S. Johnson, Ph.D., now associate, to be associate professor of botany.

Oliver L. Fassig, Ph.D., now instructor, to be associate in meteorology.

Charles R. Bardeen, M.D., now associate, to be associate professor of anatomy.

Thomas B. Fletcher, M.B., now associate, to be associate professor of medicine.

Walter Jones, Ph.D., now associate, to be associate professor of physiological chemistry.

Robert L. Randolph, M.D., now associate, to be associate professor of ophthalmology and otology.

Stewart Paton, M.D., now assistant in neurology, to be associate in psychiatry.

Percy M. Dawson, M.D., now instructor, to be associate in physiology.

Engene L. Opie, M.D., now instructor, to be associate in pathology.

Frank R. Smith, M.D., now instructor, to be associate in medicine.

Henry B. Jacobs, M.D., now instructor, to be associate in medicine.

Thomas McCrae, M.B., now instructor, to be associate in medicine.

Frank W. Lynch, M.D., now assistant, to be associate in obstetrics.

AT Washington University, St. Louis, Mr. Alexander S. Chessin, formerly associate professor of mathematics in the Johns Hopkins University, has been appointed professor of mathematics to succeed Professor Edmund A. Engler, now president of Worcester Polytechnic Institute. Alexander S. Langsdorf, graduate of Washington University, was appointed assistant professor of electrical engineering. It is announced that before the beginning of next

term, a professor of zoology and a professor of philosophy will be appointed.

JOSEPH MARSHALL FLINT, Ph.D. (Johns Hopkins), instructor in the University of Chicago, has been appointed to the newly established chair of anatomy in the University of California.

C. W. MARX, professor of mechanical engineering in the University of Missouri, has accepted the professorship of engineering in the University of Cincinnati.

DR. FREDERIC E. CLEMENTS, of the University of Nebraska, has been promoted from an instructorship to the adjunct professorship of botany. Dr. Clements is conducting a summer school of ecological botany in the Pike's Peak region in the Rocky Mountains of Colorado. About twenty students are registered for the work.


JOHN JAMES THORNER, B.Sc., 1897, and M.A., 1901, of the University of Nebraska, for several years teacher of science in the High School of Nebraska City, Nebr., and special botanical collector for the University of Nebraska for the present season, has been elected to the professorship of botany in the University of Arizona. He will assume his new duties on August 1, after which his address will be Tucson, Arizona.

MISS MINNIE A. STONER, dean of the Woman's Department and professor of domestic science in the Kansas State Agricultural College, has been elected professor of domestic science in the Ohio State University.


THE place left vacant in the State Normal School at Charleston, Ill., by the resignation of Dr. J. Paul Goode to accept the position of instructor of geography in the University of Pennsylvania, has been given to Mr. G. D. Hubbard, graduate of the University of Illinois and M.A., Harvard.

MR. W. V. B. VAN DYCK has resigned an instructorship in electrical science in Rutgers College, to engage in industrial work.

SIR MARTIN CONWAY, known to scientific men for his explorations in the Himalayas, in Spitzbergen and in the Andes, has been made professor of fine arts in Cambridge University.



JOSEPH LE CONTE, the most honored and beloved of American men of science, professor of geology and natural history in the University of California, the author of important contributions to geology, natural history, psychology and education, president in 1892 of the American Association for the Advancement of Science, president in 1896 of the Geological Society of America, one of the editors of this Journal, died in the Yosemite Valley, on July 6, at the age of eighty-eight years.



SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

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FRIDAY, JULY 19, 1901.

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A CENTURY OF CIVIL ENGINEERING.*

THE century which has just passed, the nineteenth of the Christian era, is distinguished from any of the preceding hundred-year periods in the world's history by the advances made in the cooperation of investigators in numerous branches of science in the formulation of doctrines regarding the nature and coordination of natural phenomena, which stand the test of experiment and calculation, thus leading to a nearer approximation to the understanding of the laws which govern such phenomena, and so to the development into a profession of the 'Art of directing the great sources of power in Nature for the use and convenience of Man,' which Art is entitled Civil Engineering. This definition is itself one of the most noteworthy products of the Nineteenth Century, and a study of the sequence of events and reasoning which led to its formulation is not without interest.

Ever since man became endowed with consciousness and the power of reasoning, he has been striving to solve the problems of the physical world around him in which he perceived matter in motion, which was evidenced to his senses by sight and touch, by sound and taste and smell, but which was devoid of sentience, so far as he could

* President's address before the American Society of Civil Engineers at the Annual Convention at Niagara Falls, N. Y., June 25, 1901. *Transactions Am. Soc. C. E.*, XLV., 599.

discover. He observed at once that by its different manifestations his physical comfort was materially affected, and it did not take long for him to learn that certain sequences of sensation, of one sort or another, followed certain manifestations occurring singly or in combination, and then that the order of many such manifestations could be controlled by him at will, while that of multitudes of others could not be so controlled at first, their methods and causes not being appreciable by his unassisted senses.

But until about three hundred years ago there does not seem to have been any systematic and well-directed effort to investigate the reasons why material changes occurred naturally, or how certain changes could be artificially produced with certainty.

To discover the sequence of natural events is first of all an empirical task: facts must be observed systematically, and recorded, and then their combinations reasoned upon. Hypotheses can then be formed as to the probable effects of slightly different collocations and sequences of events, and these subjected to experiment and computation. An hypothesis cannot be established as a scientific fact until it has been verified by observation and also proved to be in accordance with mathematical laws. Tennyson's apothegm, that 'knowledge comes, but wisdom lingers,' is profoundly true.

Now, up to the beginning of the seventeenth century of the Christian era, there had been no organized physical experimentation, on a comprehensive scale, and intelligent reasoning therefrom. The speculations as to the laws of nature which had been made from time to time had been purely efforts of the imagination, and were unsustained by either practical demonstration or analytical reasoning. Various hypotheses had been framed, on insufficient or incorrect premises, and some of them had been so near the truth as actually to delay

the progress of the truth, by the appearance of exactness in the reasoning from them, up to a certain point.

Really, the civil engineer had been practicing his art and directing the forces of nature for the use and convenience of man, but without any conception of what those forces were, or how they acted, or of why he did anything, or what the result of it would be, unless he had done the same thing before in the same way. He did not know that the earth moved, and he had no idea why or at what rate a stone fell to the earth, or water ran down hill. He had no measure of heat or light, and used no power but that which the muscles of an animal produced. And yet he had built the Pyramids, the Parthenon and the Pantheon; had constructed aqueducts, canals and sewers; had regulated and maintained the rivers of China for thousands of years; and had just been recognized, on account of his labors in protecting the lowlands of Holland and the shores of Italian rivers from the encroachments of the water, as holding a distinct rank among the workers of the world.

Of the application of the forces of nature to aiding his labors, he seems to have been ignorant, except by the use of a flowing stream to turn a wheel. The earliest recorded application of this mode of producing power in England was in 1582, when Peter Moryss, a Hollander, procured from the City of London a franchise for five hundred years for supplying water to the city by pumping from the Thames, using a wheel driven by the ebb and flow of the tide under London Bridge.

With the beginning of the seventeenth century, the world entered on a new era of science, theoretical and applied. The casual observation by a little child of the curious optical effect obtained by looking through two pieces of glass led to the invention of the telescope and the microscope, which

disclosed to man objects beyond the reach of his unassisted vision. The swinging of a hanging lamp suggested to a thoughtful man the idea of an unseen force, and Galileo, by experiment and reasoning, discovered the law of terrestrial gravitation and first grasped the idea of force as a mechanical agent.

Turning his newly invented telescope upon the heavens, he was the first man in the world to witness the actual motion of the planets and their satellites, and to prove that they and the earth revolved about the sun, as Pythagoras had imagined two thousand years before, Copernicus had asserted a hundred years before, and his own contemporary, Kepler, had reasoned from the imperfect data then possessed, and had actually formulated the laws of their motion in forms which the science of our day confirms exactly. He was the first to conceive the theory of transverse strains in solids, but the facility of experimentation with fluids diverted his attention from more rigid bodies, and the fundamental principles of hydraulic science were established by him and by his pupils and immediate successors in the fascinating studies he had introduced.

To Galileo also is due the invention of the thermometer, which enabled definite measurement to be made of the mysterious phenomenon of heat which his great contemporary philosopher in England, Lord Bacon, conceived to be 'an expansive undulatory motion in the particles of a body whereby they tend with some rapidity toward the circumference, and also a little upward.' But Bacon was two hundred years in advance of the physicists, and the century was occupied almost exclusively in the elucidation of the laws of gravitation as exemplified in the action of fluids. For the study of liquids and their action demonstrated that they were, under certain conditions of temperature, transformed into

invisible and elastic substances governed in general by the same laws, and also that there were all around other similar substances which could not be condensed into liquid inelastic form, but could be weighed by the barometer which Torricelli invented in 1643. And so the laws of gases came to be investigated and formulated by Mariotte, who, to aid him in his researches, invented the rain gauge in 1677, and measured the liquids condensed from the atmosphere. The value of the data thus obtained, to the hydraulic engineer, was appreciated by the French engineers at once, and ever since 1681 records of the rainfall have been kept continuously at Paris, and the practice has gradually extended over the whole world. But it is worthy of note that fifty years after the invention of the rain gauge, Belidor, in his magnificent treatise on Hydraulic Architecture (1728), the first compendium of engineering theory and practice, in treating of the sources of water supply for domestic use, did not mention the rain gauge or the amount of rainfall, but dwelt on the divining rod as the recognized means of discovering subterranean streams of water.

The close of this century saw the final establishment of the law of gravitation by Newton's proof of its governing the whole material universe. And any review of the progress made during the century toward the understanding of the laws of nature would be incomplete without allusion to the two great steps taken in it toward the facilitating of mathematical computations, the invention of logarithms at the beginning of the century and of the calculus at its close.

That heat produced dynamic effects had been recognized for ages. That it destroyed some solids, that it converted others into different forms possessing entirely different properties, that it caused the dissipation and disappearance of liquids, were facts

well established. That by its application to certain combinations of materials an explosive effect could be produced which overcame the force of gravity had been discovered three or four hundred years before when gunpowder was invented, but that a mechanical effect could be produced by the use of heat was not understood, and the nature of the phenomenon itself was not comprehended. It was looked upon by physicists as an 'element' or primary form of matter, and in 1690 Stahl conceived the idea of 'phlogiston,' an elementary substance, invisible and inappreciable by the senses, which entered into the composition of combustible substances, and which, by the process of combustion, was separated from them and passed off in the form of corpuscles which, striking the sensory nerves, were perceived as heat. Sir Isaac Newton espoused this phlogiston hypothesis and also conceived that light was the product of certain corpuscles which were perceived by the optical nerves. The discussion of these hypotheses occupied the attention of the philosophers for the whole of the eighteenth century, and, in the meantime, the physicists were busy experimenting on the methods of utilizing the vapor into which heat converted water. By degrees, the steam engine was developed into a practical machine, capable of doing work which before could only be accomplished by animal labor, and the engineer availed himself of it in the handling of materials. But although the chemists had been striving for centuries to learn the composition of matter and the means of transforming and combining its several natural conditions, they had not, at the beginning of the nineteenth century, learned how to produce either heat or light, except by the aboriginal method of striking flint and steel together. In the lack of knowledge of the properties of these phenomena and the fact that they could be utilized on a large scale, there was

no occasion for the devotion of any special class of men to their production and development. There were two other classes of phenomena which seemed as if they ought to be controlled by man, but the laws of which had so far eluded discovery—electricity and magnetism. So that, really, all that the civil engineer had to deal with was the force of gravity acting on such materials as the earth yielded him, in their natural state or as they could be modified by heat and manual labor.

But he had been making progress. In Italy, where the first application of science to construction had been made, the study of the laws of hydraulic science had been constantly pursued, and those laws applied to the regulation of the rivers; in France, ever ready to grasp new ideas and to pursue their application to practical results, the principles of hydraulics had been studied and applied to the construction of great canals, and to the supply of water to Paris, where, in 1671, water was pumped by a water wheel driven by the current of the Seine and distributed through cast-iron pipes. In England, Hugh Myddelton had supplied London with water, and, in 1638, Nicholas Vermuyden had been called in from Holland to protect the lands along the River Ouse from overflow, a task so well accomplished that his work stood for a hundred years, and only failed then from lack of proper maintenance, the English having by that time apparently concluded that, as Dr. Franklin wrote in 1772, 'rivers were unmanageable things,' and, inspired by the success of the public waterways of France, turned their attention to the construction of canals and the improvement of harbors. Many important works of this class were built in England during the last half of the eighteenth century. The men by whom these works were constructed were not educated men or men experienced in scientific research. They certainly were

men of great natural ability and good judgment, and capable of conceiving and executing great projects. One of the greatest of them, John Smeaton, who was the first Englishman to call himself a civil engineer, thus expressed his conception of the profession which he adorned :

“ Civil engineers are a self-created set of men whose profession owes its origin not to power or influence, but to the best of all protection, the encouragement of a great and powerful nation, a nation become so from the industry and steadiness of its manufacturing workmen and their superior knowledge in practical chemistry, mechanics, natural philosophy and other useful accomplishments.”

Smeaton was himself an investigator, but he is the only one of the civil engineers of Great Britain during the eighteenth century who strove to discover the laws which governed the operations of Nature.

The most eminent civil engineer in England in the year 1800 was Thomas Telford, who was born in 1757. Beginning life as a mason, he developed an extraordinary faculty of generalization, combined with an intimate acquaintance with the details of workmanship in all the methods of construction known in those days. In the building of canals, highways, harbors, bridges and docks he displayed great grasp of the subject of the improvement of transportation facilities, as then existing, and great boldness of design and ingenuity in construction.

But it must be borne in mind that at that time the canal was considered the only possible mode of increasing facilities of transportation and reducing cost, no motive power except animal force was known, the metals were but little used in construction, and a framed structure adapted to bear heavy loads was unknown. As ‘an eminent mathematician,’ quoted in the *Edinburgh Review* in 1805, remarked :

“ While we give ourselves infinite trouble to pursue investigations relating to the motions and masses of bodies which move at immeasurable distances from

our planet, we have never thought of determining the forces necessary to prevent the roofs of our houses from falling on our heads.”

It is related of Telford that when on one occasion he was consulted by a young man as to the advisability of his engaging in civil engineering, he said to him : “ I have made all the canals and all the roads and all the harbors. I don’t see what there is that you can expect to do.”

His ideas regarding the training of the civil engineer are given at some length in his Personal Memoirs prepared shortly before his death.

“ Youths of respectability and competent education who contemplate Civil Engineering as a profession, are seldom aware how far they ought to descend in order to found the basis for future elevation. Not only are the natural senses of seeing and feeling requisite in the examination of materials, but also the practiced eye, and the hand which has experience of the kind and qualities of stone, of lime, of iron, of timber, and even of earth, and of the effects of human ingenuity in applying and combining all these substances, is necessary for arriving at mastery in the profession. For how can a man give judicious directions unless he possesses personal knowledge of the details requisite to effect his ultimate purpose in the best and cheapest manner ?

“ It has happened to me more than once, when taking opportunities of being useful to a young man of merit, that I have experienced opposition in taking him from his books and his drawings and placing a mallet, chisel or trowel in his hand, till rendered confident by the solid knowledge which experience only can bestow, he was qualified to insist on the due performance of workmanship and to judge of merit in the lower as well as the higher departments of a profession in which no kind or degree of practical knowledge is superfluous.”

This is doubtless good, sound doctrine, but it does not betoken any very lofty conception of the aims and ends of the profession. But during the first quarter of the nineteenth century Telford stood at the head of the profession of civil engineering, and when, in 1820, the recently formed association of its practitioners for mutual advancement in science, which was termed the Institution of Civil Engineers, desired

a prominent leader, he was chosen its president, and held that office until his death in 1834. He does not appear to have contributed to the Institution any papers or discussions on engineering subjects.

Among the members of the Institution at that time was a man thirty years the junior of the president, who, like him, had risen from humble origin, and by his own exertions attained a high rank in the profession, and who, rather oddly, had the same forename, and a surname of two syllables, the initial and final letters of which and the vowel sounds of which were the same as Telford's. This similarity of name has led to some confusion and sometimes to the attributing to one of these men the sayings and doings of the other.

Thomas Tredgold, born in 1788, began life as a carpenter, but soon devoted himself to the study of engineering science and its practice in the office of the Chief Engineer of the Ordnance Bureau. He early recognized the deficiency of the knowledge then existing as to the nature and strength of the materials used in construction, and he studied, experimented and reasoned systematically, and published the results of his labors. His 'Treatise on Carpentry,' in 1820, was the first published attempt to determine scientifically and practically the data of resistance of beams to transverse flexure. During the next seven years he contributed to the *Transactions* of the Institution of Civil Engineers papers showing the mode of application of science to engineering problems, and he also published treatises on Warming and Ventilation, on Steam Navigation, on Railroads and Carriages, and on the Steam Engine. It was to him that the Institution turned when it wished to apply for a royal charter, in 1828, and requested him to prepare a definition of civil engineering.

As we look back upon the history of science, theoretical and applied, during the

first quarter of the nineteenth century, we can see how a new definition of the profession of civil engineering was needed at that date.

At the very beginning of the century there had occurred a marvelous revolution in the conception of the nature and operation of the laws governing matter and its motion. Lavoisier had revolutionized chemical science and Dalton had propounded a theory of atomic constitution of matter which has been sustained by observation and reason. All matter is composed of a few primal elements in an atomic or minutely subdivided form. These atoms have varying chemical affinity for each other, and, combining in certain proportions, form molecules of matter of various kinds. The study of these combinations has been the business of chemists for the last hundred years, and the laws of combination have been so successfully elucidated that many forms of matter which before were found only in a state of nature can now be artificially produced, and many other forms have been produced which are never found in nature and which are useful for purposes and under conditions where no natural product can be used to advantage. The impetus given to chemical research by the formulation of Dalton's theory was sufficient to establish the fact, early in the century, that chemical affinity was a source of power which could be directed by man intelligently and with prospect of advantage.

Just with the incoming of the century, too, came Rumford's demonstration of the fact that heat was not a material substance, but only a mode of motion. Almost simultaneously was propounded the theory of Thomas Young, that light, too, was not material, but was simply due to vibratory motion in an all-pervading medium to which he gave the name of the luminiferous ether.

It was in 1800, too, that Volta demon-

strated that an electric current could be artificially produced. How it could be controlled and applied to practical use did not yet appear, but a new direction had been given to the minds of those engaged in physical research.

As it became manifest that chemical affinity and heat and light could be controlled and directed and converted into Energy, as Young termed it, the men who had been trained in utilizing the force of gravity turned their attention to the development of these newly understood sources of power. Fitch and Fulton, with the aim of reducing the cost of water transportation, succeeded in applying the steam engine to the propulsion of boats, and Trevithick made successful application of steam propulsion to vehicles on land. Murdock had proved that illuminating gas could be produced and distributed to consumers. The civil engineers of the day had seized on all these inventions and discoveries, and in both Europe and America were designing and constructing works to render them useful to the greatest number of people.

Reviewing then what had been accomplished during the first quarter of the century, Tredgold could not but perceive that civil engineering was something broader and more comprehensive than the mere construction of harbors, breakwaters and canals, and he presented on January 4, 1828, in response to the request of the Institution, this ever-memorable definition of civil engineering :

" Civil Engineering is the art of directing the great sources of power in Nature for the use and convenience of man ; being that practical application of the most important principles of natural philosophy which has, in a considerable degree, realized the anticipations of Bacon, and changed the aspect and state of affairs in the whole world."

After a brief sketch of the objects of civil engineering, he added :

" The real extent to which it may be applied is

limited only by the progress of science ; its scope and utility will be increased with every discovery in philosophy, and its resources with every invention in mechanical or chemical art, since its bounds are unlimited, and equally so must be the researches of its professors."*

A more concise and comprehensive definition of a great truth can hardly be conceived. From a physical and intellectual standpoint, a nobler aim for the exercise of the mental powers cannot be imagined than the direction of the great sources of power in nature for the use and convenience of man. Psychology deals with mind alone, Physics considers the nature and the laws of matter, but Civil Engineering treats of the intelligent direction of the laws governing matter so as to produce effects which will reduce to a minimum the time and physical labor required to supply all the demands of the body of man and leave more opportunity for the exercise of the mental and spiritual faculties. Philosophy, Physics and Civil Engineering must work hand in hand. The philosopher must imagine, the physicist prove by experiment and mathematical computation, and the engineer apply to practice, the laws of matter. Each must keep himself informed of the progress made by the others and must aid them by suggestions as to the lines on which research needs to be carried forward. The civil engineer, in attempting to solve some problem of construction, finds that he needs a material which shall possess a certain quality which he cannot discover that any natural product possesses. He calls the chemist to his aid, and he, from a study of the combinations of existing forms of matter which most nearly approach the desired ideal, reasons that some special combination of elements will entirely fulfill the conditions, and he experiments to find whether such combination can be made. Sometimes he is successful in his first attempt and some-

* *Minutes of Proceedings*, Institution of Civil Engineers, Vol. XXVII., p. 181.

times not. But, whatever the result, he has added to his knowledge of the laws of combinations and has furnished to the philosopher fresh data for his generalizations, and to the engineer a new material for his use.

It not infrequently occurs that, from investigations made for a specific purpose, results are obtained of the greatest usefulness for an entirely different purpose. Thus, in 1855, when Henry Bessemer, inspired solely by that desire 'to kill something' which is alike the ruling passion of the rudest savage and the most highly civilized man, bent all his energies to the production of a metallic combination which should be able to resist the force of the highest explosive and so enable a cannon ball to be projected from a gun to a greater distance than ever before, he discovered a method of expelling all foreign substances from iron and then adding a minute quantity of another element, carbon, in such proportions that the original mass was materially changed in character and made more ductile, stronger and stiffer. The product was exactly what the railroad engineer wanted at that time for the bearing surface of his roadway, and the material which had been sought for destructive purposes became a most important factor in facilitating the transportation of men and goods with certainty and safety at high speeds.

As the knowledge of the nature of steel and the precise methods in which it can be manufactured have progressed, the engineer has gradually come to know just what he wants and how it can be produced, and, in his specifications, requires that the particular material of this class which he desires shall be of a certain chemical composition and also possess certain characteristics. The same is the case with almost every material which enters into the construction of engineering works of the present day. Matter in its original state is rarely used.

Its chemical condition must be transformed before the engineer can utilize it with any confidence. That almost any desired transformation can be effected was not realized until late in the century. Starting with the atom, the ultimate particle of matter so far comprehended by us, the chemist found that several different kinds of atoms could be identified, and that these would combine in certain ways according to laws which could be formulated. But in the application of these laws and the tabulation of the results gaps were found to exist which could not be filled without the supposition that other elements existed than those already known. The existence of such elemental substances was confirmed by the revelations of the spectrum analysis, and, later on, several of such elements have been actually identified by the use of the electric current in creating vibrations in the ether. The limit is probably not reached yet, but as each new element is discovered its affinities are sought by the chemist, its sensibility to various forms of vibratory motion are investigated by the dynamist, as we may term the physicist who is seeking the laws of either heat or light or electricity, and then it is the function of the civil engineer to study how it can best be applied to the use and convenience of man. For, ever since the beginning of the nineteenth century, the evidence has been cumulative that matter in motion accounts for all physical phenomena, that motion produces energy, that energy is never wasted, but is simply transformed, and that it manifests itself to the senses of man in various modes which are appreciable by the several organs of sense.

What our senses recognize as chemical affinity, heat, light and electricity, are simply conditions of matter induced by vibrations or quivers or waves or strains, whatever we may call them, of different kinds and at different velocities. Neither matter

nor motion can be originated by man, but, by a careful study of the sequence of events, control can be acquired of their modes of interaction, and natural phenomena can be artificially reproduced and other phenomena be produced. The intelligent application and direction of such means of control is the function of the civil engineer.

With the advance of science, the scope of civil engineering widened and advanced. The study of the action of forces induced analytical investigation of the means by which forces could be resisted and the best results obtained from proper distribution and arrangement of materials of different kinds. Steamships and locomotive engines were constructed by which the products of the earth and the manufactures of man, by machines and methods not before conceived, could be transported across the seas and overland by artificial highways and across bridges of previously unimagined span; and light and heat and electricity and water could be delivered in the apartment of every person to be used at will.

It was in the carrying out of the delivery of pure and wholesome water and the removal of its unused surplus that the civil engineer first was called on to deal with organic life. That minute organisms affected the comfort and the health of man had been recognized for hundreds of years. In the middle of the seventeenth century Leeuwenhoek, a Dutch maker of microscopes, discovered and described bacteria, and Nicholas Andry, a pathologist, ascribed to them the causation of disease. But later scientists discarded the idea, and it was not until 1831 that any real advances were made in the study of these microorganisms, and it is only within the last twelve years that it has become thoroughly recognized that the regulation of the growth of living organisms in air and water and sewage is necessary and practicable, and comes within the domain of civil engineering.

Indirectly, however, biological research has been one of the most important factors in the progress of engineering science, by calling the attention of students of physics to the fact that advance and not retrogression is one of the fundamental laws of nature. For the first half of the century, the old ideas of cosmogony, based on an hypothesis unsupported by proof, were prevalent everywhere. It was assumed that the world, in all its details, had been created perfect and had since been simply deteriorating and tending to a final dissolution. 'Change and decay, in all around I see,' was the dogma of the theologian, the philosopher and the scientist alike. While it had come to be recognized that the forms of inorganic matter could be changed by man, and that by the exercise of man's intelligence, certain characteristics of organic matter and the vital forces with which it was imbued could be modified and perpetuated, it was not considered possible that the superior intelligence which controlled everything could modify or transform such characteristics in any special form of matter.

But in 1859, Charles Darwin, after twenty years of study of the sequence of events in biological phenomena, demonstrated that there was an intelligence beyond that of man, which was constantly acting to change and modify the forms, the habits and the mode of life of animals and plants, and that such action resulted in the perpetuation of the fittest type of organism. The proof was irrefragable, and the effect of his wonderfully clear exposition of the processes by which his conclusions had been reached was marvelous in inducing a co-ordination of thought and a cooperation in methods of procedure in intelligent research in the investigation of all natural phenomena, whether relating to organic or inorganic matter.

In considering the means of directing the great sources of power, the psychological

element must not be forgotten. A mere intellectual application of the laws discovered by physical research is not enough to make a civil engineer. Breadth of view, the faculty of analyzing what has been done so as to discover how and why some enterprises have been successful and others have not, and the ability to forecast the future, are essential. These qualities are largely natural, but may be cultivated to a great extent by study and experience. That there has been a wonderful advance in this direction during the nineteenth century is shown by the great number of civil engineers who hold positions of prominence in the management and control of large enterprises which require the exercise of faculties which cannot be acquired in any other way than by experience in the designing, construction and management of engineering works.

A prominent factor in causing this advance in engineering science which has occurred simultaneously on the Continent of Europe, in Great Britain and in America, has been the collaboration of scientists. Early in the century it became evident that the multiplication of lines of research demanded a differentiation of the labor of their prosecution and a close cooperation of the workers in any special line, and various associations of specialists were formed to promote various branches of scientific research. By the middle of the century it had become apparent that civil engineering was not the prosecution of a specialty, but was the coordination and direction of the work of all specialties in science and its applications. And so in 1852, James Laurie and his associates, following the example of their English brethren, founded the American Society of Civil Engineers, the first and only national organization devoted to 'the professional improvement of its members, the encouragement of social inter-

course among men of practical science, the advancement of engineering in its several branches and the establishment of a central point of reference and union for its members.' To the privileges of its membership may be admitted not only every 'professional engineer,' but also 'any person who, by scientific acquirements or practical experience, has attained a position in his special pursuit qualifying him to cooperate with engineers in the advancement of professional knowledge and practice.' This meeting of that Society, which now has 2,500 names upon its rolls of membership, and owns a commodious society house with a reference library of some 40,000 titles, is sufficient proof of the wisdom of its founders.

Recognizing, then, that progress is a law of nature, the acceleration of progress is the aim of civil engineering. It strives to stimulate the results of the slow processes of nature, by causing the sources of power to act rapidly in any desired direction. Appreciating, too, the fact that there is constant progress, and that what now seems admirably adapted to our needs may in a short time require to be superseded by improved structures and processes, the tendency of the time is toward the production of works which will have a definite term of life, rather than toward the construction of everlasting monuments. We see that in the old nations, where the effort to build for eternity was made, time has outstripped the intent of the builders and what is antiquated is useless, and we see the same thing in our own streets to-day. The idea of building a monumental structure which will hand one's name down to future ages is a fascinating one, but it is simply a survival of the engineering of the Pharaohs.

The most thorough exemplar of the condition of civil engineering at the beginning of the twentieth century is the modern office-building in a great city. One hundred

years ago, the man of enterprise who resided fifty miles from a large city and wished to consult an engineer regarding a project for a new canal, arose before daylight, struck a spark from his flint and steel, which, falling on a scrap of tinder, was blown by him into flame and from that a tallow dip was lighted. In the same primitive manner the wood fire was kindled on the kitchen hearth and his breakfast was cooked in a pot and kettle suspended from the iron crane in the fireplace. Entering the cumbrous stage coach, hung on leather springs, which passed his door, he was driven over muddy roads, crossing the narrow streams on wooden trestle bridges and the navigable rivers on a ferry boat, the paddle wheels of which were turned by a mule on a treadmill. At last he was landed in the city, where he walked through dirty streets paved with cobble-stones until he reached his destination, a plain three-story brick building founded on sand, with a damp cellar and a cesspool in the back yard. Entering a dark hall, he climbed a wooden staircase and was ushered into a neat room, rag-carpeted, warmed by a wood fire on the open hearth and lighted by a sperm-oil lamp with one wick, for it was dark by this time. No wonder that before proceeding to business he was glad to take a good stiff noggin of New England rum.

To-day, his grandson, living at the old homestead, while comfortably eating his breakfast which has been cooked over a gas range, reads in his morning paper that the high dam of the irrigation reservoir in Arizona, in which he is interested, sprang a leak the day before, and he telegraphs to his engineer in the city that he will meet him at his office at noon. Then, striking a match, he lights the lamp of his automobile which is fed by petroleum brought 200 miles underground in pipes from the wells, rolls over macadamized roads to the railroad station, where he boards a luxuriously ap-

pointed train, by which he is carried above all highways, through tunnels, under rivers, or across them on long-span steel bridges, and in an hour is deposited in the heart of the city, where he has his choice of proceeding to his destination through clean and asphalt-paved streets in electric surface cars at 9 miles an hour, elevated steam cars at 12 miles an hour, or through well-lighted and ventilated tunnels at 15 miles an hour. Reaching the spot his grandfather had visited, he finds there a huge and highly decorated building, twenty or more stories high. Founded on the primeval rock, far below the surface of the natural ground, the superjacent strata of compressible material having been penetrated by caissons of sheet metal sunk by the use of air compressed by powerful pumps driven by steam or electricity generated at a power station half a mile or more away, and these caissons filled with a manufactured rock such as the ordinary processes of nature would require millions of years to produce, there is erected a cage of steel, the composition of which has been specified, and the form and mode of construction of which have been so computed that the force of the elements cannot overthrow the structure or even cause it to sway perceptibly. Towering above the courts of Law, the temples of Religion and the palaces of the Arts, the meshes of this mighty cage are filled with products of the earth, the mine and the forest, transformed so as to be strong and light and incombustible, and all interwoven with pipes and wires, each in its proper place and noted on the plans. In one set of these pipes there is pure water, which has been collected from a mountain area of igneous geological formation, depopulated and free from swamps, on which a record of the daily rainfall is kept, and in which impounding reservoirs have been constructed by masonry dams across its valleys. From these reservoirs the water,

after filtration through clean sand, is conveyed 30 or 40 miles through steel or masonry conduits to covered reservoirs, whence it is drawn as needed through cast-iron pipes to the building where it is to be used, and there distributed to all parts of it, chilled nearly to the freezing point through one system of pipes or heated nearly to the boiling point, through another system. Another set of pipes carries steam, which, passing through radiators, keeps the temperature of the air throughout the building at the proper standard for comfort. Sanitary conveniences are provided everywhere, and all wastes are consumed within the building by the surplus heat generated, leaving only ashes to be removed. Wires convey electric currents to all points, so that the occupant of a room, sitting at his desk, can by the touch of a button ventilate his apartment, illuminate it, call a messenger, be kept informed of every fluctuation in the markets, converse with anybody who is not 'busy' within 40 miles of where he sits, and if entirely 'up to date' can require his autograph and portrait to be reproduced before his eyes for identification. He dictates his correspondence and his memoranda, and 'takes his pen in hand' only to sign his name. He need not leave his seat except to consult the photograph hanging on his wall, which shows to him the latest condition of the mine, the railroad, the arid lands irrigated, the swamps reclaimed, the bridge in progress, the steamship, the water-works, the tunnel or the railroad, the dam, the filter or the sewage works, the town, the machine, the power plant or the manufacturing establishment in which he is most interested.

Entering the brilliantly lighted hallway of this building, the air of which is kept in circulation by the plunging up and down of half a dozen elevators, the visitor is lifted at a speed of 500 feet a minute, past floor after floor, crowded with the offices of finan-

ciars, managers and promoters of traffic and of trade, lawyers, chemists, contractors, manufacturers, to the headquarters of the controlling genius of the whole organism, the civil engineer. For he it is to whom all the members of this microcosm must apply for aid and advice in the successful operation of their respective occupations. It is not his to mechanically transform elements into matter, or matter into other forms, or to show how energy may be produced, but to direct the application of energy to the various forms of matter, original or produced, in such way as to bring about the most satisfactory results in the most speedy and economical manner.

He has grown with the growth of the nineteenth century, and is, so far as the relations between man and matter are concerned, its most striking product. And so, while the definition given in the 'American Edition of the Encyclopedia,' which appeared at the beginning of the century, that "civil engineers are a denomination which comprises an order or profession of persons highly respectable for their talents and scientific attainments and eminently useful under this appellation," is still true, it is hardly probable that the compiler of the Twentieth Century Encyclopedia will be content to let it stand without further explanation.

But the end is not yet; there are still many problems of nature unsolved. The experience of every day shows that there are sources of power not yet fully developed, and we cannot but say with the great poet:

"I doubt not through the ages one increasing purpose runs,
And the thoughts of men are widened with the
process of the suns." J. JAMES R. CROES.

*THE BRITISH NATIONAL ANTARCTIC
EXPEDITION.*

DR. GEORGE MURRAY, F.R.S., keeper of
the Department of Botany in the British

Museum, has been appointed director of the civilian staff of the British expedition, to fill the vacancy caused by the resignation of Professor J. W. Gregory. Dr. Murray will not, however, take part in the expedition, except in so far as he will proceed with the ship to Melbourne. He will edit the scientific results. A geologist is to be appointed to do the work in this direction that would have been carried on by Professor Gregory. The other members of the scientific staff are Dr. R. Koettlitz, Mr. Hodgson, Mr. E. A. Wilson, Mr. William Shackleton and Mr. R. Skelton. Full instructions to the commander and to the scientific director of the civilian scientific staff have been drawn up and are signed by Sir William Huggins, president of the Royal Society, and Sir Clements Markham, president of the Royal Geographical Society. They are as follows :

INSTRUCTIONS TO THE COMMANDER.

1. The Royal Society and the Royal Geographical Society, with the assistance of his Majesty's Government, have fitted out an expedition for scientific discovery and exploration in the Antarctic regions, and have entrusted you with the command.

2. The objects of the expedition are: (a) to determine, as far as possible, the nature, condition and extent of that portion of the South Polar lands which is included in the scope of your expedition ; and (b) to make a magnetic survey in the southern regions to the south of the 40th parallel, and to carry on meteorological, oceanographic, geological, biological and physical investigations and researches. Neither of these objects is to be sacrificed to the other.

3. The scientific work of the executive officers of the ship will be under your immediate control, and will include magnetic and meteorological observations, astronomical observations, surveying and charting, and sounding operations.

4. Associated with you, but under your command, there will be a civilian scientific staff, with a director at their head. A copy of his instructions accompanies these instructions to you.

5. In all questions connected with the scientific conduct of the expedition you will, as a matter of course, consider the director as your colleague, and on all these matters you will observe such consideration in respect to his wishes and suggestions as may be consistent with a due regard to the instructions under which you are acting, to the safe navigation of the ship, and to the comfort, health, discipline and efficiency of all under your command. Those friendly relations and unreserved communications should be maintained between you which will tend so materially to the success of an expedition from which so many important results are looked for.

6. As the scientific objects of the expedition are manifold, some of them will come under the immediate supervision of the director and his staff ; others will depend for their success on the joint cooperation of the naval and civil elements ; while some will demand the undivided attention of yourself and your officers. Upon the harmonious working and hearty cooperation of all must depend the result of the expedition as a whole.

7. The expedition will be supplied with a complete set of magnetic instruments, both for observations at sea and on shore. Instructions for their use have been drawn up by Captain Creak, R.N., and yourself and three of your officers have gone through a course of instruction at Deptford with Captain Creak and at Kew Observatory. The magnetic observatory on board the *Discovery* has been carefully constructed with a view to securing it from any proximity to steel or iron, and this has involved considerable expense and some sacrifice in other respects. We, therefore, impress upon

you that the greatest importance is attached to the series of magnetic observations to be taken under your superintendence, and we desire that you will spare no pains to ensure their accuracy and continuity. The base station for your magnetic work will be at Melbourne, or at Christchurch, in New Zealand. A secondary base station is to be established by you, if possible, in Victoria Land. You should endeavor to carry the magnetic survey from the Cape to your primary base station, south of the 40th parallel, and from the same station across the Pacific to the meridian of Greenwich. It is also desired that you should observe along the tracks of Ross, in order to ascertain the magnetic changes that have taken place in the interval between the two voyages.

8. Geographical discovery and scientific exploration by sea and land should be conducted in two quadrants of the four into which the Antarctic regions are divided for convenience of reference—namely, the Victoria and Ross Quadrants. It is desired that the extent of land should be ascertained by following the coast lines, that the depth and nature of the ice cap should be investigated, as well as the nature of the volcanic region, of the mountain ranges, and especially of any fossiliferous rocks.

9. A German expedition will start at the same time as the *Discovery*, and it is hoped that there will be cordial cooperation between the two expeditions as regards magnetic and meteorological observations, and in all other matters if opportunities offer for such cooperation. It is understood that the German expedition will establish an observatory on Kerguelen Island, and will then proceed to explore the Enderby Quadrant, probably shaping a course south between the 70° E. and 80° E. meridians, with the object of wintering on the western side of Victoria Land, whence exploring sledge parties will be sent inland. The

Government of the Argentine Republic has undertaken to establish a magnetic observatory on Staten Island.

10. You will see that the meteorological observations are regularly taken every two hours, and, also, in accordance with a suggestion from the Berlin committee, every day at Greenwich noon. It is very desirable that there should, if possible, be a series of meteorological observations to the south of the 74th parallel.

11. As regards magnetic work and meteorological observations generally, you will follow the program arranged between the German and British committees, with the terms of which you are acquainted.

12. Whenever it is possible, while at sea, deep-sea sounding should be taken with serial temperatures, and samples of sea water at various depths are to be obtained, for physical and chemical analysis. Dredging operations are to be carried on as frequently as possible, and all opportunities are to be taken for making biological and geological collections.

13. Instructions will be supplied for the various scientific observations; and the officers of the expedition will be furnished with a manual, prepared and edited by Dr. George Murray, on similar lines and with the same objects as the scientific manuals supplied to the Arctic expedition of 1875.

14. On leaving this country you are to proceed to Melbourne, or Lyttelton (Christchurch), New Zealand, touching at any port or ports on the way that you may consider it necessary or desirable to visit for supplies or repairs. Before leaving your base station you will fill up with live stock, coal, and other necessaries; and you will leave the port with three years' provisions on board, and fully supplied for wintering and for sledge travelling.

15. You are to proceed at once to the edge of the pack and to force your vessel through it to the open water to the south.

The pack is supposed to be closer in December than it has been found to be later in the season. But this is believed to depend rather on its position than on the time; and the great difference between a steamer and a sailing vessel perhaps makes up for any difference in the condition of the pack.

16. On reaching the south water you are at liberty to devote to exploration the earlier portion of the navigable season; but such exploration should, if possible, include an examination of the coast from Cape Johnson to Cape Crozier, with a view to finding a safe and suitable place for the operations of landing in the event of your deciding that the ship shall not winter in the ice.

The chief points of geographical interest are as follows:—To explore the Ice Barrier of Sir James Ross to its eastern extremity; to discover the land which was believed by Ross to flank the barrier to the eastward, or to ascertain that it does not exist; and generally to endeavor to solve the very important physical and geographical questions connected with this remarkable ice formation.

17. Owing to our very imperfect knowledge of the conditions which prevail in the Antarctic seas, we cannot pronounce definitely whether it will be necessary for the ship to make her way out of the ice before the winter sets in, or whether she should winter in the Antarctic regions. It is for you to decide on this important question after a careful examination of the local conditions.

18. If you should decide that the ship shall winter in the ice, the following instructions are to be observed:

a. Your efforts, as regards geographical exploration, should be directed, with the help of depots, to three objects—namely, an advance into the western mountains, an advance to the south, and the exploration of the volcanic region.

b. The director and his staff shall be allowed all facilities for the prosecution of their researches.

c. In carrying out *a* and *b* due regard is to be had to the safety and requirements of the expedition as a whole.

d. You have been provided by Sir Leopold McClintock and by Dr. Nansen with complete details respecting sledge work both by men and dogs, and you have yourself superintended every item of the preparations connected with food, clothing and equipment. You will be guided by the information and knowledge thus acquired.

e. Lieut. Armitage, R.N.R., who has been appointed second in command and navigator to the expedition, has had experience in the work of taking astronomical, magnetic and meteorological observations during three Polar winters. He has also acquired experience in sledge traveling and in the driving and management of dogs. You will, no doubt, find his knowledge and experience of great use.

f. Early in 1903 your ship should be free from the ice of the winter quarters, and you will devote to further exploration by sea so much of the navigable season as will certainly leave time for the ship to return to the north of the pack ice. Having recruited at your base station, you will then proceed with your magnetic survey across the Pacific and return to this country.

19. If, on the other hand, you should decide not to winter, you will bear in mind that it is most important to maintain scientific observations on land throughout the winter, and therefore if you are able, in consultation with the director, to find a suitable place for a landing party between Cape Johnson and Cape Crozier, and decide that such a party can be landed and left without undue risk, the following instructions will apply:

a. You will land a party under the command of such person as you may ap-

point. Such party shall include the director, the physicist, and one of the surgeons, and such other persons as you may consider desirable. But no person is to be left without his consent in writing, which you will be careful to obtain and preserve.

b. You will give every practicable assistance in establishing on land this party, which you will supply with all available requisites, including a dwelling hut, an observer's hut, three years' provisions, stores, fuel, sledges and dogs.

c. No landing party is to be established on any other part of the coast than that between Cape Johnson and Cape Crozier, as it is above all things essential that in case of accident the approximate position of the party should be known.

d. Before it is so late as to endanger the freedom of your ship, you will proceed north of the pack and carry out magnetic observations with sounding and dredging over as many degrees of longitude (and as far south) as possible, so long as the season and your coal permit, and then return to your base station, whence you will telegraph your arrival and await further instructions.

20. You are to do your best to let us have, and to leave where you can, statements of your intentions with regard to the places where you will deposit records, and the course you will adopt, as well as particulars of your arrangements for the possible need of retreat, so that in case of accident to the ship, or detention, we shall be able to use our best endeavors to carry out your wishes in this respect.

21. In an enterprise of this nature much must be left to the discretion and judgment of the commanding officer, and we fully confide in your combined energy and prudence for the successful issue of a voyage which will command the attention of all persons interested in navigation and science throughout the civilized world. At the

same time, we desire you constantly to bear in mind our anxiety for the health, comfort and safety of all entrusted to your care.

22. While employed on this service you are to take every opportunity of acquainting us with your progress and your requirements.

23. In the unfortunate event of any fatal accident happening to yourself or of your inability, from sickness or any other cause, to carry out these instructions, the command of the ship and of the expedition will devolve on Lieutenant Armitage, who is hereby directed to assume command and to execute such part of these instructions as have not been already carried out at the time of his assuming command. In the event of a similar accident to Lieutenant Armitage the command is to devolve on the executive officer next in seniority on the articles, and so on in succession.

24. All collections and all logs (except the official log), journals, charts, drawings, photographs, observations and scientific data will be the joint property of the two societies, to be disposed of as may be decided by them. Before the final return of the expedition you are to demand from the naval staff all such data, which are to be sealed up and delivered to the two presidents, or dealt with as they may direct. The director of the civilian scientific staff will be similarly responsible for the journals, collections, etc., of the officers under his control. You and the other members of the expedition will not be at liberty without our consent to make any communication to the press on matters relating to the affairs of the expedition, nor to publish independent narratives until six months after the issue of the official narrative. All communications are to be made to us, addressed to the care of the Secretary of the National Antarctic Expedition, London.

25. The *Discovery* is not one of his Maj-

esty's ships, but is registered under the Merchant Shipping Act, 1894, and is governed by it. Copies of this act will be supplied to you. You will see that the officers and crew sign the ship's articles as required by the act. The scientific staff will not sign articles, but are to be treated as cabin passengers. You must be careful not to take more than 12 persons as passengers.

26. The vessel has been covered by insurance, and, in the event of her sustaining any damage during the voyage, to recover the claim from the underwriters it will be necessary for you to call in the services of Lloyd's agent, or, in his absence, an independent surveyor, at the first port of call, in order that the damage may be surveyed before repairs are effected. His survey report, together with the accounts for repairs and supporting vouchers should be sent to us by first mail, together with a certified extract from the official log reporting the casualty.

In the event of damage occurring after you have left civilized regions precise particulars should be entered in the log, and the damage should be surveyed and repaired as soon as you return to a port where Lloyd's agent or other surveyor is available.

27. The *Discovery* is the first ship that has ever been built expressly for scientific purposes in these kingdoms. It is an honor to receive the command of her; but we are impressed with the difficulty of the enterprise which has been entrusted to you and with the serious character of your responsibilities. The expedition is an undertaking of national importance, and science cannot fail to benefit from the efforts of those engaged in it. You may rely upon our support on all occasions, and we feel assured that all on board the *Discovery* will do their utmost to further the objects of the expedition.

INSTRUCTIONS TO THE SCIENTIFIC DIRECTOR
OF THE CIVILIAN SCIENTIFIC STAFF.

1. The Royal Society and the Royal Geographical Society have approved your appointment as Director of the Civilian Scientific Staff of their Antarctic Expedition.

2. A copy of the instructions to the commander of the expedition accompanies these instructions, which are supplemental to them. You will see from the instructions to the commander what the objects of the expedition are, and your position relatively to them.

3. You will direct the scientific work of the gentlemen who have been appointed to assist you.

4. The names of the gentlemen associated with you are as follows:—(1) Mr. Hodgson (biologist); (2) Mr. Shackleton (physicist). The services of the two medical officers will be at your disposal for scientific work when not engaged on the work of their own department—namely, Dr. Koettlitz (botanist), and Dr. Wilson (zoologist).

5. You will note that the commander of the expedition has been instructed to communicate freely with you on all matters connected with the scientific objects of the expedition, and, as far as possible, to meet your views and wishes in connection with them. The societies feel assured that you will cooperate and act in concert with him, with a view, as far as possible, to secure the success of an enterprise which it is hoped will be attended with important results in the various branches of science which it is intended to investigate.

6. All collections, logs, journals, charts, drawings, photographs, observations and scientific data will be the joint property of the two societies, to be disposed of as may be decided by them. Before the final return of the expedition, you are to demand from the staff under your control all such data, which are to be sealed up and delivered to the two presidents, or dealt with as they

may direct. On the return of the expedition you will be expected to superintend the distribution of specimens to specialists approved of by the two councils or their representatives, and to edit the resulting reports. You will also be expected to contribute a report on the scientific results of the expedition for the official narrative. As it may be desirable during the progress of the voyage that some new scientific discovery should be at once made known in the interests of science, you will, in such a case, inform us of it by the earliest opportunity.

7. You and the other members of the expedition will not be at liberty, without our consent, to make any communication to the press on matters relating in any way to the affairs of the expedition, nor to publish independent narratives until six months after the issue of the official narrative. All communications are to be made to us, addressed to the care of the secretary of the National Antarctic Expedition, London.

8. Should any vacancies in the scientific staff occur after the expedition has sailed from England, you may, with the concurrence of the commander, make such arrangements as you think desirable to fill the same, should no one have been appointed from England.

9. You and the members of the scientific staff will be cabin passengers joining the expedition at your own risk, and neither the owners nor the captain are to be responsible for any accident or misfortune which may happen to you. You will obtain from each member a letter to this effect.

The instructions are signed by the Presidents of the Royal Society and the Royal Geographical Society.

TEACHING OF CHEMISTRY IN SCHOOLS—
1876, 1901.*

BEFORE comparing, or contrasting, the teaching of chemistry twenty-five years ago

* Read at the 25th anniversary of the American Chemical Society.

with that of to-day, it seems desirable to trace briefly the evolution of chemistry from a much earlier period. This will enable us to see at what part of the evolutionary line high-school chemistry had arrived when the American Chemical Society was founded, and where it now is.

In the alchemistic age the effort was to conceal, not reveal, facts. All the language is most obscure, and writers are pervaded with the idea that the wrath of God will rest upon them if they reveal the secrets of their laboratories. Basil Valentine says he fears he has spoken so plainly that he shall be doomed at the last great day; but the modern French writer Figuier facetiously remarks that all the adepts who have ever tried to decipher his language regard it as certain that he was one of the elect. There was no teaching, as there was no science. A little later, when an alchemist disclosed the philosopher's stone or the elixir it was to a few persons for large money considerations. If he made pretended transformations into gold in presence of spectators, the *methods* were kept secret.

With the advent of scientific chemistry, even among the phlogistics, secrecy became a lost art. Experiments began to be written about and talked of, but were not at first made in public. Books contained no illustrations. The question and answer method got into chemistry as in all other teaching. Jane Marcet's little book 'Conversations on Chemistry,' first published in London in 1806—which ran through 20 editions and was revised as late as 1855—set two generations to thinking of the marvelous revelations of nature. It consisted wholly of questions and answers, only the later editions being illustrated.

With the Lavoisierian chemistry—in fact, antedating it somewhat—came the demonstrative lecture method of teaching. As the professor—for this was a feature of colleges and medical schools only—performed his

experiments before the class, and called attention to the phenomena, which he explained either by phlogiston or according to the doctrine of Lavoisier, his hearers gained much. If there was still something of the alchemistic glamour, the subject could be studied afterwards in a suitable text-book. All in all, it was the most noteworthy advance in teaching that had taken place up to that time. As the question and answer method will never disappear from educational systems, so the best in the lecture method came to stay, and will always have its place. But it was far from being ideal, or final. During that period the man who could deliver the most faultless lecture was the best teacher.

But another step was to be taken, in which, in place of a passive observer, the student must prepare and set up his own apparatus, mix his chemicals, adapt the conditions, watch the phenomena and arrive at conclusions. This was a more radical revolution than even the lecture method, and it merits more than passing notice. Liebig is accredited as the inventor of the laboratory method as applied to chemistry. This method, transplanted in America by one of his pupils, Eben Horsford, who in 1848 was appointed professor of chemistry at the Lawrence Scientific School, Cambridge, Mass., gained a slow and struggling popularity. It was at the same institution and about the same time that Louis Agassiz began to employ the laboratory method in natural science. In 1850 Professor Cooke fitted up as a laboratory, mostly at his own expense, a basement room in University Hall at Harvard College, where a few selected students were admitted. There was no gas or running water. After seven years more, against great opposition, he succeeded in having laboratory work a requirement for Harvard students in chemistry. The first laboratory instruction in chemistry for *medical students* in this country

was in 1853 at the Harvard Medical School. It took another quarter of a century for the laboratory idea to permeate any but the larger colleges, and chemistry continued to be taught by the recitation method. One of the earliest, perhaps the first, secondary school to adopt the new idea was the Girls' High and Normal School of Boston, about 1865. It was followed by the Cambridge, Mass., High School in 1866, and the English High of Boston, in 1871. One of the early teachers says: "A chemical laboratory for pupils was a rarity; all foreigners and visitors to the city were brought to see it, and they opened their eyes in amazement at the strange sight." This was in 1870, and plans and photographs of this workshop for students were in demand from various parts of the United States.

But, generally speaking, the laboratory method, as regards high-schools, is a development of the past twenty-five years. A new era in chemistry teaching was dawning. It was greatly stimulated by the summer schools of science which sprang up in colleges all over the land. The first teachers' school of science was that of Louis Agassiz in natural history, held on the island of Penekese during the summer of 1869. In subsequent years this school, enlarged and broadened to include chemistry and other branches of learning, was held in Cambridge, Mass., the example of Harvard being followed by other institutions, and the laboratory idea was spread broadcast.

At first the workshop was usually put in the basement of the school building, and laboratory work was an extra subject, or voluntary exercise to be done after school hours by those sufficiently interested; hence very little was required. As the work grew and its value became apparent, note-taking was introduced. 'Observation' and 'conclusion' made up the notes, mostly mechanical, without much connection. After a time, this being found insufficient,

the teacher tried to put the student in the attitude of an investigator. He must describe the apparatus—which he has himself set up—the chemicals and how he has mixed them, the operations he has performed; must trace the phenomena and try to ascertain what the experiment shows, must test his products, and, so far as he is concerned, do real, original work. Finally he must write out in fairly good English all the above operations, observations and results. Later on, when he becomes somewhat familiar with the principles of the science, problems of a practical nature are given him to solve—to make given compounds, or to separate mixtures. This leads on to qualitative analysis, a brief course in which is quite generally taken now in the high-school, always following general chemistry and often put into a second-year course.

This accuracy of detail naturally led to two further developments: (1) A logical or scientific sequence of experiments. (2) Quantitative work—which is one of the latest phases of this method. In fact, quantitative work for beginners, who have not had thorough training in general, qualitative manipulations, is still a doubtful experiment—one which the colleges, technological and medical schools, are so far answering, for the most part, in the negative. Those in favor of the scheme in elementary work reason that it inculcates greater accuracy and skill in manipulation than mere qualitative work, gives the student an idea of research methods, and makes his work complete. The opponents claim that to a beginner the underlying facts and principles of science are of paramount importance, that the *qualitative* in evolution precedes the *quantitative*, and—since time is limited—research methods are better suited to such students as pursue the subject further. A well-known teacher writes: “The attempts to beat out methods theoret-

ically correct, the putting quantitative before qualitative and the ignoring of the great primal facts which lead easily into those parts of the subject which concern the great body of men and women, have a tendency to lessen the interest.”

The introduction of the laboratory method presented a new problem. When text-book work was the only feature, every chemistry hour was a reciting period. With the advent of the lecture table came a division of time between demonstration and recitation. The laboratory feature necessitated a further division, involving the question: How much time, relatively, ought to be given to laboratory, to lecture and to recitation? In the solution of this question there has been no unanimity, rather the greatest diversity, of result, each school with its peculiar environment making its own answer. In some instances the entire time is devoted to laboratory work, and in such cases the text-book is usually discarded. A new method always runs to extremes in individual cases. As a recent writer says: “Chemistry has suffered from the irresponsible wave of laboratory madness which has swept over the whole educational world. Laboratory work has been carried far beyond its limits, and things have been expected of it which it never did and never can do.” It seems safe to believe that the problem will finally resolve itself into a proper equating of the time ratio between text-book, lecture work and laboratory.

Another outgrowth of the last quarter is the conference, and reciprocal recitation—to coin an expression—in which the student becomes a questioner and the teacher recites and explains. The great value of this method—which may take up half or the whole of a recitation period—can be revealed only on trial. It shows what the teacher never knows before hand, *viz.*, the standpoint from which a pupil views a sub-

ject, and that, after all, is the case to be diagnosed. The opposite view that nothing should be told the student, but everything evolved, by a series of questions, from his brain—callow and ignorant of first principles though it be—is still advocated by a few in authority. It is the inductive method gone to seed.

Applied to chemistry teaching the inductive method, though in use earlier in some schools, was largely a growth of the decade beginning about 1885. The first text-books avowedly inductive began to appear. Like other good things, this Socratic, time-killing process was almost run into the ground by enthusiasts. Newth says: "In actual practice the *purely* inductive method of instruction breaks down. There is so much that the student is required to learn that life itself is not long enough, and certainly the limited time at the disposal of the student is all too short to admit of his going through the necessarily slow process of gaining this knowledge by his own investigation."

That part of induction which has the stamp of perpetuity consists in the teacher's quizzing the student while the latter is making an experiment. In this manner a world of thought and suggestiveness may be opened up to the imagination, and the method thus employed subserve a highly useful end.

In some schools the time allotted to chemistry is not more than it was 25 years ago, and certain laboratories blossomed into full maturity almost at the outset, but not so with the great majority. The chemical theory is taught more effectively now than then by the use of charts and blocks. Laws which cannot well be shown by experiment are illustrated by simple mechanical devices and diagrams, so that, instead of mere words, the pupil can get a clear mental picture of the given law. Many problems in practical chemistry are introduced and the bearing of equations, valence and stereo-

chemistry is studied as it was not 25 years ago. *Non multa, sed multum* is the watchword of the best teachers in chemistry, as in other branches. How much these improvements are due to the meetings and the *Journal of the American Chemical Society*, it is impossible to state. In the dissemination of chemical knowledge this magazine has been a great power. The history of important chemical discoveries, and something of biography are also taught in high-schools to-day. Instead of one text-book, students in the best schools have access to a large number of books and are encouraged to do outside reading in scientific periodicals.

What then have we found in high-schools as the result of our inquiry?

In 1876 a prevalent view that chemistry has little educational value.

In 1901 chemistry found in practically every high school curriculum.

In 1876 school committees very loath to expend anything for laboratories or equipment.

In 1901 the laboratory and lecture room among the first considerations in constructing a high-school building.

In 1876 practically no laboratories, the text-book recitation dominant, very few demonstrative lectures.

In 1901 chemical work mostly divided into lecture, laboratory and conference periods.

In 1876 no notes of work.

In 1901 notes containing description of apparatus, manipulation, chemicals, phenomena, inferences, reactions, couched in more or less correct English.

In 1876 deductive methods almost wholly.

In 1901 methods partly inductive, partly deductive.

In 1876 the student committing facts to memory.

In 1901 the student more or less an investigator.

In 1876 a smattering of general chemistry only.

In 1901 both general chemistry and qualitative analysis, with some quantitative work, to illustrate laws.

The object and aim of chemical study in the two periods may be illustrated by excerpts from the prefaces of two books. The one in 1876 says that the author "has sought to make a pleasant study which the pupil can master in a single term, so that all its truths may become to him household words. This work is designed for the instruction of youth, and for their sake clearness and simplicity have been preferred to recondite accuracy."

The 1901 author says: "The tendency of the present day is to make the student, from the very beginning, an *investigator*; to train and develop his faculties for observation; to make him find out facts and discover truths for himself; in other words, to make him *think* instead of merely committing to memory what others have thought."

What will be the next progressive movement in secondary-school chemistry? Already a few dim shadows are being cast which may materialize. In schools of the larger cities there is a growing demand for elective courses and elective studies in every department of learning. Elective *courses* are not a new idea, but should high-school pupils be allowed to choose *all their studies* throughout a three or four years' course, it would profoundly affect the scope of teaching and indirectly the methods. Another coming event is the reaching down of chemistry into the grammar grades. This has been successfully done in some few cities and towns. Should the grammar grades teach chemistry and the high-schools have elective studies, the higher grades of quantitative, volumetric, organic and theoretical chemistry may be forced into the high-school, and a minimized university result.

Another indication is that of cooperation. Chemistry teachers are beginning to

form associations for discussion of methods and aims. There is at present a wide diversity in methods of chemistry instruction. While these can never be wholly unified, nor is it desirable that they should be, owing to varied environments, yet discussions of methods, aims and results are most stimulating, and secondary schools may, in this respect, take a step in advance of colleges and universities. Magazines and periodicals for the discussion of what is latest and best in science-teaching mark also the new era, and are an indication in the same direction. The *Journal of the American Chemical Society*, whose 25th anniversary we celebrate to-day, may join hands with its infant sister, *School Science*, the youngest representative of scientific education.

From the twentieth century aspect of chemistry study, is it too much to say that it realizes more fully than perhaps any other single subject the ideal for combined manual, observational and intellectual training?

RUFUS P. WILLIAMS.

SCIENTIFIC BOOKS.

Public Water Supplies: Requirements, Resources, and the Construction of Works. By F. E. TURNEAURE and F. H. RUSSELL, professors in the University of Wisconsin. New York, John Wiley & Sons. 1901. Octavo. Pp. xiv + 746.

This volume has been prepared with particular reference to the needs of teachers and students in engineering colleges, and it is from this point of view that the following remarks are made: The field covered is a large one and in no other branch of engineering has there been a greater growth during the past twenty-five years. In particular the methods of purification of water have, by the aid of the sciences of chemistry and bacteriology, become so thoroughly understood that they are now of equal importance with the operations for storage and distribution.

Part I. of the volume, covering 197 pages, relates to the sources of supply, rainfall, flow of

streams, chemical and bacterial examinations, and the diseases caused by impure water. Part II., consisting of 549 pages, treats of hydraulics, works for the collection and storage of water, purification systems, and the methods of distribution by tanks, pipes and pumps. The space devoted to the different topics appears well proportioned to their relative importance, the subjects themselves are usually thoroughly treated and descriptions of the most modern practice are freely given.

The question of economy in engineering construction is a controlling one in all comparative designs, and this book is one of the few to bring it prominently to the notice of the student. The annual interest on the first cost, plus the annual cost of operation and maintenance, is to be made a minimum, and the general method of doing this is set forth clearly and satisfactorily. Even in cases where the general method is not of direct application, the economic arrangement of details is often discussed. Thus, the economic size of one sand filter bed is shown to depend upon the number of beds, and upon the cost of walls and bottom filling as compared with the cost of piping, valves and other appurtenances. Such discussions are a characteristic of modern engineering and their introduction into text-books should be welcomed, for economic construction is the corner stone of sound engineering practice.

The general subject of hydraulics is set forth only to a limited extent, as a full treatment could scarcely be given in a single chapter. The laws of flow of ground water are, however, fully presented and useful formulas developed, while the subject of water hammer is discussed in a novel manner. Reservoirs, dams, filtration systems, conduits and pipes, pumping machinery, and the distribution of water, are well and thoroughly treated, with numerous examples of constructed works. In short, it may safely be said that the book constitutes one of the very best treatises on water-supply engineering now before the American public.

At the end of each chapter, with the exception of the brief one on hydraulics, there is given a useful list of literature. Periodicals are cited in italics, while transactions and books

are in Roman type. Few engineering students will know what is meant by *Hyg. Rund., Cent. f. Bakt.*, and other similar abbreviations which should properly have been written out in full. The book seems, however, remarkably free from errors that are apt to occur in a first edition. The most serious ones noted are on page 213, where it is said that one U. S. gallon is 0.1605 cubic feet, and on page 216 where the word 'longitudinally' should have been 'transversely.' The book is well printed with the exception of the cuts, many of which properly deserve severe criticism.

The chapter on chemical and bacterial examinations of water appears to be the only one that is likely to prove unsatisfactory to engineering students. Bacteria are not defined and described in respect to size, form, color and functions, and the impression is given that all are specific germs of disease, while there is no hint as to the useful work performed by many species in transforming injurious decaying matter into harmless constituents. At the foot of page 123 a statement is made implying that bacteria in water are found in the suspended matter and not in solution. On page 125 it is said that a water rich in bacteria is not necessarily poor in quality. On the whole this discussion lacks that definiteness and logical method which is demanded by engineers. The chemical part of the chapter is better, but it is also lacking in definiteness, as no records of analyses are given and little is said which will enable a student or engineer to interpret the results of a water analysis.

The field of water supply on both the sanitary and construction side has become so vast that special treatises on the chemistry and bacteriology of water, filtration, reservoirs, standpipes and distribution plants are demanded by practicing engineers. For the student, however, such differentiation is neither feasible nor desirable, and this volume, with the exception above noted, presents such a satisfactory review of the theory and practice of the entire subject that it will undoubtedly prove of great service in technical education, and at the same time take high rank as a manual for young engineers.

MANSFIELD MERRIMAN.

LEHIGH UNIVERSITY.

Zoological Results based on Material from New Britain, New Guinea, Loyalty Islands and elsewhere, collected during the years 1865, 1896 and 1897, by Arthur Willey. Cambridge, Eng., the University Press. 4to. Part V. December, 1900. Pp. 531-690; pls. LIV.-LXXIV.

The fifth installment of Dr. Willey's 'Zoological Results' contains six papers, one of which deals with coelenterates, two with worms, two with crustaceans, and one with vertebrates. The first of these is by E. M. Pratt who describes the soft parts of the rare coral *Neohelia porcellana*. This species, which was previously known only from material obtained by the *Challenger*, belongs to the Oculinidæ, and as all its nearest relatives are fossils the importance of supplementing the earlier description of Moseley by a full account of its anatomy as given in the present paper is obvious.

The parasitic worms gathered by Dr. Willey were studied by A. E. Shipley who found that the collection contained seventeen species, nine of which were new. Two were trematodes and of these sufficient material was obtained of *Monostomum trigonocephalum* to enable Shipley to give a very full description of the anatomy of this form. Of the seven species of tapeworms six were new; two of minute size were taken from the intestine of a ray, one each from the digestive tract of a lizard, a snake, a fruit-eating pigeon and an albatross. Of the six species of round worms only one was new. Two specimens, however, were particularly interesting because of new light thrown on their geographical distribution. *Physaloptera obtusissima* had previously been recorded only from South American snakes, but apparently it also infests the native snakes of New Britain, and *P. retusa*, previously found only in Brazilian lizards, is now for the first time recorded from New Britain. A new species of *Gordius* and a new representative of the family Linguatulidæ are described.

The nemertines are reported upon by R. C. Punnett. Six of the twelve species collected were new. Five belong to the genus *Eupolia* whose headquarters seems to be the Malay archipelago. A new species, *Carinesta orientalis*, on the other hand, is the first Protonemertine

to be recorded from regions outside the Atlantic and Mediterranean.

The extensive collection of lower crustaceans contains, according to T. R. R. Stebbing, forty-six species, of which twenty-three are new. Eight of these represent new genera. Of special interest is *Panaietis incamerata*, a semi-parasitic copepod occurring in the pallial chamber of gastropods, and *Anchicaligus nautili*, a parasitic copepod infesting the mantle chamber of *Nautilus pompilius* and certain slimy portions of the shell of *N. macromphalus*.

The young of the robber crab, *Birgus latro*, have been made the subject of a short but interesting report by L. A. Borradaile. The adult robber crabs are land animals living some distance from the coast and, according to report, have been supposed to bring forth young resembling the parent. Thus it has been surmised that their development was without the larval metamorphosis usually characteristic of other crustaceans. Direct evidence of this has been wanting, for accurate observers have not heretofore happened on the crabs in the breeding season. Dr. Willey, however, reports the capture close to the sea of females with large masses of brown eggs attached to their abdominal appendages. An examination of this material showed that the young hatched as in allied species, in the zœa stage. When hatching begins the females presumably shake the young off in the water. The further development of *Birgus* is without doubt accompanied by a metamorphosis as in other hermit crabs.

G. A. Boulenger describes a new blind snake, *Typhlops willeyi*, from the island of Lifu. This is of interest since it is only the second species of land snake recorded from this island.

G. H. PARKER.

Ergebnisse der neueren Sporozoenforschung. M.

LÜHE. Jena, Gustav Fischer. Price, 2 M. 80.

Lühe's summary of the results of more recent investigations on Sporozoa is practically a revised reprint of his articles which recently appeared in the *Centralblatt für Bakteriologie, Parasitenkunde und Infektionskrankheiten*, Volumes XXVII. and XXVIII., and represents a summary of the zoological data contained in nu-

merous zoological and medical articles published in different languages and in different parts of the world.

First he gives a discussion of the general life cycle of the coccidia. This is followed by a classification of the coccidia. Chapter II. discusses the life cycle of the malaria plasmodium, while Chapter III. is given up to a general discussion of the more recent results in the other groups of Sporozoa. Taken as a whole, the material is well digested, and makes an excellent summary for any one who wishes to inform himself quickly regarding the most recent results in investigations concerning Sporozoa.

The work contains 35 illustrations, which add to a proper understanding of the text. One of the great difficulties in following the articles of the present day on the Sporozoa is the fact that so many different authors have considered it necessary or advisable to introduce so many new terms designating the different stages of development. If, for instance, we compare Ross's articles of 1898 with those of 1899 or 1900, we find different terms used for the same stage. Ray Lankester in 1900 uses still other terms; Harvey Gibson an entirely different terminology; while Grassi has repeatedly changed his technical terms. One almost needs a separate dictionary to-day to understand the literature on the Sporozoa. Lühe has in the main followed the terminology adopted by Schaudinn, 1899, and he gives a table by which it is possible to follow the terminology adopted by most of the other authors.

So far as the coccidia are concerned, Lühe's discussion compares quite favorably with the recent summary given by Rafael Blanchard in the *Société zoologique de France*, but it certainly is not superior to Blanchard's work in either style or presentation; in fact, it would be very difficult to improve on Blanchard's article. Lühe's discussion of the malaria parasite compares very favorably with the discussion recently published by Blanchard, Laveran and others in the French Academy of Medicine, but in addition to the abstract discussion of the life cycle of the parasite, he gives a general historical introduction to the subject, with a review of recent literature, and

makes an effort to establish the priority of certain discoveries. We are somewhat surprised to miss in this introduction all reference to the valuable contribution by Dr. King, of Washington, who was apparently the first author to give a scientific summary of the reasons in favor of the view of the transmission of malaria by mosquitoes.

Chapter III. assumes on the part of the reader a certain amount of knowledge of the groups discussed.

One point in connection with the work we can hardly leave unmentioned, and that is the antiquated method of citing literature. Each group has its own bibliography arranged alphabetically by authors. This results not only in unnecessary repetition, but also in confusion; for instance, Max Braun's treatise on animal parasites of man is No. 2 in the first bibliography, No. 12 in the second bibliography, and No. 2 in the third. The work would be greatly improved if the Harvard system of bibliography had been adopted.

C. W. STILES.

SCIENTIFIC JOURNALS AND ARTICLES.

THE May number of the *Bulletin of the American Mathematical Society* contains the following articles: 'Non-Oscillatory Linear Differential Equations of the Second Order,' by M. Bôcher; 'Concerning Real and Complex Continuous Groups,' by L. E. Dickson; 'On Holomorphisms and Primitive Roots,' by G. A. Miller; 'Reviews of Graf and Gubler's Bessel Functions II., by V. Snyder, and of Ricci's Theory of Surfaces,' by H. S. White; 'Notes'; 'New Publications.' The June number contains reports of the April meeting of the Society, by E. Kasner, and of the April meeting of the Chicago Section, by T. F. Holgate; 'The Value of a Certain Integral,' by F. Morley; 'On the Algebraic Potential Curves,' by E. Kasner; 'Review of Steinmetz's Alternating Current Phenomena,' by J. B. Whitehead, Jr.; and of de Tannenberg's Applications of the Calculus to Geometry, by L. P. Eisenhart; 'Notes'; 'New Publications.' The July number, concluding Volume 7 of the *Bulletin*, contains: 'Surfaces whose First and Second Fundamental Forms are the Second and First Respectively

of Another Surface,' by L. P. Eisenhart; 'On Groups Generated by Two Operators,' by G. A. Miller; 'A Curious Approximate Construction for π ,' by G. Peirce; Review of Manning's Non-Euclidean Geometry, by J. L. Coolidge, and of Bianchi's Differential Geometry, by J. K. Whittemore; 'Notes'; 'New Publications'; 'Tenth Annual List of Papers Read before the Society and Subsequently published'; and a sixteen-page Index of the Volume.

The Popular Science Monthly for July opens with an important article on 'The Transmission of Yellow Fever by Mosquitoes,' by George M. Sternberg, detailing the long and careful series of experiments which seem to clearly point out the mosquito as the active agent in the spreading of this disease. Incidentally it may be noted that no less than eighteen men voluntarily exposed themselves to the disease in order to test the theory of its diffusion. Under 'Climate and Carbonic Acid,' Bailey Willis discusses the evidence in favor of the theory that the glacial epochs have been caused by the absorption of carbonic dioxide from the atmosphere, permitting the radiation of heat and lowering the temperature of the earth's atmosphere. A translation is presented of the article on 'The Peopling of the Philippines,' by Rud. Virchow, and Havelock Ellis continues his 'Study of British Genius,' this instalment being devoted to pathology, from which it appears that there is a special connection between genius and gout. Edward L. Thorndike treats of 'The Intelligence of Monkeys,' deciding that they carry the animal method of learning beyond a point reached by any other of the lower animals. 'Cocaine Analgesia of the Spinal Cord' is discussed by Smith Ely Jelliffe, and Henry A. Pilsbry considers 'The Evidence of Snails on Changes of Land and Sea,' while Frank Waldo describes the work of 'The Blue Hill Meteorological Observatory,' which he considers the most successfully conducted meteorological observatory in America. The final article is on the organization and aims of 'The American Association for the Advancement of Science' apropos of its coming meeting in Denver. There is much in-

teresting reading to be found in 'The Progress of Science.'

IN *The American Naturalist* for June, W. M. Wheeler presents the first part of a paper on 'The Compound and Mixed Nests of American Ants.' Glover M. Allen describes 'The Louisiana Deer' as a subspecies under the name of *Odocoelus virginianus louisianæ*. It is a rather curious fact that the antlers of the type of the subspecies and of the two forms shown for comparison are all abnormal. R. W. Shufeldt gives an excellent paper 'On the Osteology and Systematic Position of the Screamers' (Palamedea: Chauna), in which their points of agreement and disagreement with the ducks and fowls are well shown. 'Normal Respiration and Intramolecular Respiration' are discussed by George J. Peirce, and Abram V. Mauck contributes an article 'On the Swarming and Variation in a Myriapod' (*Fontaria virginiensis*). The fifteenth instalment of the fine series of 'Synopsis of North American Invertebrates' is by Hubert L. Clark and is devoted to the Holothuriodea. 'Editorial Comment' and the customary reviews complete the number.

The Auk for July is mostly devoted to systematic papers: 'Bendire's Thrasher,' by Herbert Brown; 'Birds of the Black Hills,' by Merritt Cary; 'Unpublished Letters of William MacGillivray to John James Audubon,' by Ruthven Deane; 'The Resident Land Birds of Bermuda,' by Outram Bangs and Thomas S. Bradlee, containing descriptions of several new species; 'A New Ground Dove from Western Mexico,' by Outram Bangs; 'The Monterey Hermit Thrush,' by Joseph Grinnell; 'The Winter Birds of Pea Island, North Carolina,' by Louis B. Bishop, a list of 42 species, and 'A New Sharp-tailed Finch from North Carolina,' by Louis B. Bishop. The 'General Notes' and 'Reviews of Recent Literature' are very full.

SOCIETIES AND ACADEMIES.

PHYSICS AT THE AMERICAN ASSOCIATION.

THE officers of section B, Physics, Professor De Witt B. Brace, chairman, and Professor John Zeleny, secretary, have received the following titles of papers for presentation at the

joint meetings of Section B of the A. A. A. S. and the American Physical Society, to be held in Denver :

'Note on the Transmission of Radiation by Thin Films of Asphalt': Professor E. L. Nichols, Cornell University.

'The Visible and Infra-red Absorption Spectrum of Iodine in Solution': Professor E. L. Nichols and W. W. Coblenz, Ithaca, N. Y.

'Results of the Recent Magnetic Work of the U. S. Coast and Geodetic Survey': Dr. L. A. Bauer, Washington, D. C.

'The Physical Decomposition of the Earth's Permanent Magnetic Field': Dr. L. A. Bauer, Washington, D. C.

'Discharge of Electrification by Glowing Platinum and Velocity of the Ions': Professor E. Rutherford, McGill University, Montreal.

'The Absorption Spectrum of Colloid Ferric Hydrate Solutions': Professor B. E. Moore, University of Nebraska.

'Index of Refractions and Dispersion of Dilute Aqueous Solutions': Professor B. E. Moore, University of Nebraska.

'On the Calorimetric Properties of the Ferro-Magnetic Substances with Special Reference to Nickel-Steel': B. V. Hill, University of Berlin.

'Note on Strains in very Dilute Solutions of Gelatine': B. V. Hill, University of Berlin.

'On Electro-Striction': Professor Z. S. Shearer, Cornell University.

'The Distribution of Energy in the Spectrum of the Acetylene Flame': George W. Stewart, Ithaca, N. Y.

'The Visible Spectrum of the Incandescent Lamp at Various Temperatures': Ernest Blaker, Ithaca, N. Y.

'The Heat of Combustion of Acetylene': H. A. Rands, Ithaca, N. Y.

'The Radiant Efficiency of Vacuum Tubes': Edward E. Roberts, Ithaca, N. Y.

'The Fall of Temperature through a Wedge-shaped Wall of Glass': Albert Ball, Ithaca, N. Y.

'Notes on the Supposed Elongation of a Dielectric in an Electrostatic Field': Professor L. T. Moore, University of Cincinnati.

'On the Cavendish Experiment and the Law of Inverse Squares in Electrostatics': Professor S. J. Barnett, Stanford University.

'On Gauss's Flux Theorem': Professor S. J. Barnett, Stanford University.

'The Diminution of the Potential Difference between the Electrodes of a Vacuum Tube Produced by a Magnetic Field': Dr. John Almy, University of Nebraska.

'The Discharge Current from a Surface of large Curvature': Dr. John Almy, University of Nebraska.

'Experiments on a New Form of Standard High Electrical Resistance': H. C. Parker, Columbia University.

'Variation of Contact Resistance with Change of E.M.F.': H. C. Parker, Columbia University.

'On the Demagnetization of a Discharge in Iron when Electromagnetically Compensated': Zeno Crook, Lincoln, Nebraska.

'On the Forces produced on Adjacent Spherical Surfaces by the Flux of a Viscous Fluid': S. R. Cook, Lincoln, Nebraska.

'On the Determination of Dispersion by Means of Channeled Spectra with the Concave Grating': P. J. Antes, University of Nebraska.

'On the Faraday Effect during Hydrolysis of Ferric Chloride': F. G. Bates, University of Nebraska.

'The Absorption and Dispersion of Fuchsin': W. B. Cartmel, University of Nebraska.

'On Conditions controlling the Drop of Potential at the Electrodes in Vacuum Tube Discharge': Professor C. A. Skinner, University of Nebraska.

'The Influence of Temperature upon the Photoelectric Effect': Professor John Zeleny, University of Minnesota.

'On the Resolution of the Faraday 'Effect' in the Case of Liquids': Professor D. B. Brace, University of Nebraska.

'On the New Method of determining the Curve of Luminosity by Homogeneous Comparisons': Professor D. B. Brace, University of Nebraska.

SECTION OF BIOLOGY OF THE NEW YORK ACADEMY OF SCIENCES.

At a regular meeting of the Section held on May 13, Professor C. L. Bristol presiding, the following program was offered :

R. WEIL : 'A Contribution to the Problem of the Ear-Bones.'

A. G. MAYER : 'On the Variation of Snails of the genus *Partula* in the Valleys of Tahiti.'

O. S. STRONG : 'A Case of unilateral Atrophy of the Cerebellum.'

Dr. Weil's paper was a critical discussion of the theory of the ear-bones, as embodied in the recent articles of Kingsley and Gaupp. Two main contentions were considered : first, that the malleus and incus of mammalia were homologous with the quadrate and articular of lower forms, while the temporo-maxillary articulation is a new formation ; second, that the ossicles of mammalia cannot possibly have de-

scended from those of Sauropsida. The first contention is based upon the embryonic connection of malleus and incus with the Meckelian bar, upon the embryonic situation of the last anterior to the Eustachian tube, and upon the innervation of the muscle of the malleus by a branch of the trigeminus. Embryonically, however, the malleo-incudal complex, in addition to its continuity with the Meckelian bar, arises from the auditory capsule, which contributes to both malleus and incus, the stroma of the tympanic cavity, contributing to the manubrium mallei, and a membrane bone which forms the Fallopian process. Furthermore, as Gegenbaur points out, the continuity of malleus and incus, if they be the quadrate and articular, is itself in contradiction to the independent embryonic origin of these elements in the lower forms. The pre-trematic origin of the ossicles in the pig, as described by Kingsley, is contrasted with their post-trematic, or hyoidean, origin in lower forms. Dr. Weil stated that his studies of a full series of pig and opossum embryos did not enable him to decide whether the malleus, and still more, the incus, lay primarily in front or behind the tube. The bones cross the anlage of the tube in a transverse direction, lying above it; by the gradual absorption of the intervening stroma they come to occupy the cavity of the tympanum. Finally, the innervation of the tensor tympani muscle of the malleus by a branch from the otic ganglion of the trigeminus is taken to indicate the relation of the malleus to the mandibular arch. But lesions of the trigeminus at its root do not involve hearing, while the contrary is true of lesions of the facial. This fact would point to the origin of the above-mentioned nerve from the seventh nerve, and would make the malleus a part of the second arch. The second contention is supported, first by the difference in the embryonic relations of the bones to the Eustachian canal, an argument already considered, and second, by the differences in the relations of the chorda tympani nerve, which in Sauropsida crosses *above* the chain, and in mammalia *below* it. The speaker showed that the pathologists, from a comparison of a large number of lesions of the trigeminus and of the facial at the base of the brain, had demonstrated the exit of the

chorda tympani in man with the roots of the former. But since it leaves the brain in lower forms with the seventh, its relations to bony structures are evidently not sufficiently constant to constitute a criterion of homologies. From these facts, it would appear that the homology of malleus and incus with the quadrate and articular has not yet been demonstrated.

Dr. Mayer showed that the snails in question are subjected to conditions of isolation very similar to those affecting the Achatinellidæ of Oahu in the Hawaiian Islands, occurring in valleys which are separated by comparatively barren ridges. The farther apart the valleys, the less intimate is the relationship between their snails. Although geographical isolation is probably the chief factor in determining the establishment of definite varieties, yet the differing environmental conditions obtaining in each valley may exert considerable influence.

Dr. Strong presented a preliminary report, illustrated by lantern slides, upon a case of unilateral atrophy of the cerebellum in a child which lived to the age of three years and four months. The principal external anomalies noted were the following: The left hemisphere of the cerebellum was almost entirely absent; the right olive was wanting and the transverse pontile fibers on the left side were deficient; the left half of the pons protruded more than the right; the right crus cerebri was much narrower than the left; the left restiform body was smaller than the right, and the superior cerebellar peduncle of the left side was deficient; the posterior corpora quadrigemina were asymmetrical, while the left anterior corpus quadrigeminum was apparently lacking; the median line of the fourth ventricle was curved with its convexity toward the left, and such structures of the medulla as the clava, cuneus, ala cinerea, and eminentia teres were located or extended further cephalad on the left side than on the right. Preliminary transverse sections cut at various levels through the medulla, pons, isthmus and posterior corpus quadrigeminum showed the following points: only small parts of the right olive and the left corpus restiforme were present, and there was a corresponding deficiency of the cerebello-olivary fibers; the transverse pontile

fibers on the left side were reduced, but the nuclei pontia were larger on the left side; the longitudinal pontile fibers were deficient on the right, as shown by the smaller crus cerebri of this side; the left lemniscus was the smaller, and the left superior cerebellar peduncle was reduced. Other deficiencies were noted, which, however, require further study. Full discussion of the case was postponed, as the research is as yet uncompleted.

HENRY E. CRAMPTON,
Secretary.

DISCUSSION AND CORRESPONDENCE.

THE WASHINGTON MEMORIAL INSTITUTION.

TO THE EDITOR OF SCIENCE:

A curious incongruity appears in the plan for the Washington Memorial Institution as outlined in the report on 'A National University' in the current number of SCIENCE, as well as elsewhere. The first paragraph in the platform of the new institution provides that 'it will be independent of government support or control' (p. 51). Yet the seventh paragraph assumes that the institution will depend on the governmental departments (including the Smithsonian Institution, the Library of Congress, etc.) for its facilities, or in other words for the essential part of its support; and it also provides that 'students working in government laboratories or collections will be subject to the rules and regulations there prevailing,' *i. e.*, will be under governmental control. It should be pointed out that this unfortunate incongruity is much more glaring in statement than in thought; the projectors of the enterprise merely desired to emphasize the independence of the prospective institution from direct federal appropriation. Nevertheless, the incongruity has given rise to criticism in various influential quarters; it would seem, indeed, to have been one of the factors leading to the rejection of the report made by the committee of the National Educational Association.

As a matter of fact, the publications hitherto made concerning the Washington Memorial Institution have been of preliminary character, and have emanated from committees and individuals rather than from the Institution. Accordingly, criticism might well be withheld

pending the issue of official statements by the Institution itself.

W J MCGEE.

WASHINGTON, D. C.,

July 13, 1901.

ROYAL SOCIETY OF CANADA. SUPPLEMENTARY NOTE.

IN the account given of the twentieth meeting of the Royal Society of Canada held in May, 1901, and published in the June 28 issue of SCIENCE, the writer inadvertently omitted to mention Professor T. Wesley Mills's paper presented to Section IV. (geological and biological sciences). The title of the paper was: 'The Anatomy and Physiology of the Brain of the Bird.' It was a continuation of a former one presented to the Society two years ago. The author outlined his plan of investigation which was somewhat extensive and which, for its execution, would require much time yet. He showed that the anatomical results would probably modify the views of conduction in the nervous centers until recently prevailing, and that the entire subject would require reconsideration in view of his own and other researches in various directions. The effects of ablation of portions of the brain on the psychic condition of birds were traced in brief outline with their general implications. This part of the subject had already been worked out by the author pretty fully, but was also being continued at the present time. Remarks were made by Professor R. Ramsay Wright, of Toronto University, by Professor E. E. Prince, Commissioner of Fisheries for Canada, Dr. F. Slater Jackson, and Dr. A. M. Mackay.

H. M. AMI.

OTTAWA, July 9, 1901.

A HORNED LIZARD AT A HIGH ALTITUDE.

ON June 30, at the head of John's Cañon, Las Vegas Range, N. M., I was somewhat surprised to find a horned lizard in the uppermost part of the Canadian Zone, above 10,000 feet (the aneroid indicated 10,500, but is not quite reliable at that altitude). The species is *Phrynosoma hernandes* (Girard), and the specimen is dark gray, beneath white mottled with gray. The top of the range is Hudsonian, and no lizards are found there.

T. D. A. COCKERELL.

E. LAS VEGAS, N. M.,

July 2, 1901.

SHORTER ARTICLES.

THE GEOLOGIC DISTRIBUTION OF *POLLICIPES*
AND *SCALPELLUM*.

IN a valuable memoir on the 'Hudson River beds near Albany and their taxonomic equivalents,' published as Bulletin of the New York State Museum, No. 42, April, 1901, Dr. Rudolph Ruedemann describes a number of variously shaped valves found in the Upper and Lower Utica Shale of Green Island and Mechanicsville, N. Y. (p. 573, pl. ii.). These he believes to 'find their homologues in parts of the capitula of the pedunculate cirriped genera *Scalpellum* and *Pollicipes*, notably of the latter. On this account the various valves have been united under the caption *Pollicipes siluricus*, in full consciousness of the enormous gap existing between the appearance of this Lower Siluric type and the next Upper Triassic (Rhaetic) representatives of these genera.' Confirmation of Dr. Ruedemann's ascription may be derived from the fact that 'the enormous gap' does not exist. Early in 1892 Dr. C. W. S. Aurivillius* published the descriptions of *Pollicipes signatus* from bed *e* (= Lower Ludlow), *P. validus* from bed *c* (= Wenlock Shale), *Scalpellum sulcatum*, *S. varium*, *S. granulatum*, *S. strobiloides*, *S. procerum*, *S. cylindricum*, and *S. fragile*, all from bed *c*, of the island of Gotland. The species of *Scalpellum* are founded on peduncles, *Pollicipes validus* is represented by a broken scutum only, but *P. signatus* is based on an almost perfect specimen. The occurrence of more than one species of both these genera in the Silurian lends significance to the diversity of form presented by Dr. Ruedemann's specimens. The ornament on his Fig. 18 most nearly resembles that of *P. signatus*, while the rostrum, Fig. 22, is also not unlike that species. Figures 16, 17, 19 may belong to more than one other species, while 24 (with which presumably 25 is to be associated) may belong to a *Scalpellum*, as Dr. Ruedemann seems to hint. In the circumstances it is specially regrettable that Dr. Ruedemann has selected no one of these specimens as the holotype of *Pollicipes siluricus*. If he does not do so soon, confusion is pretty certain to arise.

* Bihang Sveska Vet.-Akad. Handl., XVIII., Afd. IV., No. 3.

Figures 13, 14, 15, are referred to *Turrilepas* (?) *filosus* n. sp. A recent examination of the plates of that genus suggests to me that the note of interrogation is fully justified.

Aurivillius considered that *Pollicipes signatus* showed a closer approach to the Balanidæ than any other of the Lepadidæ, but he too, in ignorance of the Devonian *Protobalanus* Whitf., discoursed needlessly about the gap in the distribution. Now that the range of the Lepadidæ has been extended to the Ordovician, we may look confidently for further discoveries. We may also hope that the time has now come when even the text-books may awake to the fact that the genera *Pollicipes* and *Scalpellum* existed in Palæozoic times. It was pointed out in your own columns a year ago (Vol. XI., p. 984), and in other reviews before that. But perhaps the reviewer and the author reviewed are the only readers of a review.

My apology for insisting on this is not merely that both Dr. Aurivillius and Professor Lindström, who supplied him with the material, have unhappily passed away, but that I had the good fortune to be the discoverer of the beautiful specimen of *Pollicipes signatus*, when developing a specimen of *Gissocrinus verrucosus* from the *Pterygotus* bed of Wisby Waterfall in May, 1891. The very fragile specimen was subsequently licked into shape (no metaphor is intended) by Mr. G. Liljevall, to whom the excellent drawing of it is due. F. A. BATHER.

LONDON, June 5, 1901.

QUOTATIONS.

THE SALARIES OF SCIENTIFIC MEN IN THE
EMPLOYMENT OF THE GOVERNMENT.

WITHIN the past few years our Government has come to fully recognize the wisdom of utilizing in every way possible the results of modern science, particularly in the conduct of its internal affairs. The amount appropriated by the late Congress for scientific purposes was somewhere in the neighborhood of \$9,000,000—a larger sum than is devoted by any other Government to like purposes. Yet the liberal and enlightened policy evinced by legislation of this sort has been accompanied by a short-sightedness—not to use a less complimentary term—hard to account for in a legislative body made up largely

of business men. The head of the Division of Forestry, for example, with \$187,520 at his disposal, receives a salary of \$2,500. If a thoroughly competent man has been secured for this important position at this ridiculously low figure the Government is, indeed, to be congratulated. As soon, however, as he shall have established a reputation he will very probably be 'lifted' by some more generous Government. This actually happened last year in the case of an officer of the Department of Agriculture who received \$1,800 a year. He now holds a like position in Japan at a salary of \$7,000.

If in spite of this Congressional niggardliness many very capable men be now engaged in governmental scientific work, this result has been brought about more by good luck than by good management, and the broad truth is not thereby affected that in every business, whether private or public, the higher salary appeals to the higher order of talent, with its consequence of greater efficiency in the work done. At the late session of Congress an unsuccessful effort was made to rectify this mistaken policy. It is to be hoped that another session of Congress will not pass without a further and a successful effort to readjust the salaries of all government scientists, and to fix them at figures which will at least bear a comparison with those paid for similar work by many private firms and corporations.—*Philadelphia Record*.

Two important government positions at Washington are going begging because there are no applicants for them. The reason is simple: they can be filled only by men of technical skill and scientific training, and the salaries attached to them are \$1,200 and \$1,400 a year, respectively. The politicians who fixed these low salaries for high-class work knew that the incumbents would be worthless for political manœvering, and hence did not care to 'waste' much money on them. It is a rule that holds good all through the scientific side of government work.—*Philadelphia Ledger*.

THE NATIONAL UNIVERSITY PROJECT.

THE action taken at Detroit by the National Educational Association on the subject of the

projected national university leaves that matter in a peculiar but not a necessarily disappointing status. A committee of the Association had investigated the general project of utilizing, for higher university education, the facilities afforded by the governmental establishment and appurtenances at this capital. It reported in favor of the plan recently proposed by the George Washington Memorial Association and the Washington Academy of Sciences for the creation of an establishment to be known as the Washington Memorial Institution, to direct the energies of students desiring to avail themselves of the educational facilities here, without endowing a specific educational organization. The association declined to adopt this view and passed resolutions declaring its unwillingness to abandon its favorite project of establishing a distinct national university in this city.

Thus it appears that the issue at Detroit is between two plans to accomplish the same purpose. There is no division on the score of the desirability of utilizing the exceptional educational advantages of the capital city. All the educators agree that here lie chances for higher education which are not to be found elsewhere and which could not be duplicated with any expenditure. The majority of the delegates to the convention believe, as have many leaders of pedagogic thought in the past, and as did George Washington in the beginning, that the best way to make use of this plant is by direct means to create a university which shall stand for the national progress and prestige. Others contend that this is impracticable, and that the most promising method is to respect the existing educational establishments as sufficient in themselves and to create a supplement for the special use of those who desire a post-graduate course afforded only by the governmental facilities here.

The capital desires nothing more than that the fullest possible use be made of its exceptional opportunities for education. It hopes to see George Washington's ideal realized in some form as early as possible. It will aid to the extent of its ability any promising project to this end. It will safeguard the interests of any educational creation here, whatever its form or name. It

hopes that the discussion of the particular method whereby his object is to be attained will arouse the interest of every educator in America, and will create a determined purpose to accomplish something definite without further delay.—The *Boston Transcript*.

A NEW MAMMALIAN GENUS.

PROFESSOR E. RAY LANKESTER writes from the Natural History Museum, under the date of June 17, to the *London Times*, as follows :

I have this afternoon received and unpacked the case shipped at Mombasa on April 19, containing the skin and two skulls of the remarkable new giraffe-like animal obtained from the Semliki forest by Sir Harry Johnston, and sent by him to me for preservation in the Natural History Department of the British Museum. I write without loss of time to say that the specimens have arrived in perfect safety and they fully and completely bear out Sir Harry Johnston's statements and inferences.

The animal is a giraffe-like creature devoid of horns, with relatively short neck and with color stripes on the limbs, but nowhere showing spots or areolæ like those of the giraffe. Sir Harry Johnston was amply justified in assimilating the animal to the extinct *Helladotherium*, but after an examination of the skulls I am of opinion that the 'Okapi' (the native name by which the new animal is known) cannot be referred to the genus of the *Helladotherium*, but must be placed in a new genus.

I must say that, although the horny hoofs are not present, yet the double bony supports of the hoofs are preserved with the skin, and leave no doubt, even without reference to the accompanying skulls, that the animal which bore the skin was not a horse-like creature, but one with cloven hoofs.

P. S.—The 'five-horned giraffe' recently reported as having been discovered by Sir Harry Johnston is (I am told by Dr. Forsyth Major) due to a misunderstanding of a French translation of Sir Harry Johnston's description of the Okapi as 'une girafe sans cornes' (grafe à cinq cornes).

Harry Johnston has written as follows: Perhaps I may be allowed to correct a slight misapprehension that has arisen owing to a postscript attached to my friend Professor Ray Lankester's letter in *The Times* of June 18. It has been thought by the authorities of the British Museum that the telegram of a press agency from east Africa announcing that my expedition had recently discovered a giraffe with five horns was a misleading variant of the account sent some months ago as to the other discovery made by us in the summer of 1900 of the existence in the forests bordering the Semliki River of a giraffe-like animal, without horns, which has just been named 'Ocapia' by Professor Ray Lankester. Quite independently of this interesting discovery, the credit of which, it must not be forgotten, has to be shared by Mr. Karl Ericsson, of the Congo Free State, who furnished me with a complete specimen, my expedition has been the means of discovering a species or variety of giraffe, which, in the male, possesses five horn cores, instead of the two or three found in other known species of giraffe. Specimens of the five-horned giraffe were shot by Mr. Doggett and myself about five weeks ago in the country lying to the east of Mount Elgon in the northeastern part of the Uganda Protectorate. Of these specimens, two are males and two females. The female has only three horns, while both the male specimens exhibit five horn cores.

In coloration it is my opinion that this species of giraffe differs from those already known. I have in my possession now drawings and photographs confirming these statements, and the four specimens (bones of the head and neck and skins) are on their way to England for presentation to the Natural History Museum.

Until these specimens are in the hands of competent authorities it is rather premature to discuss the worth of the discovery, or the question of its substantiating the existence of a hitherto unknown giraffe.

Perhaps I may be allowed to add that the fact that a month ago my expedition was still travelling through a very wild part of the Uganda Protectorate, and was passing through enormous herds of wild game, recalling the

In connection with the above letter, Sir

best days of Gordon Cumming, is indirect evidence of the rapid extension of the Uganda railway and of the remarkable facilities which it affords for travelling in a short space of time to and from London and the heart of Africa.

*THE NEW BUREAU OF FORESTRY.**

ON the first of July the Division of Forestry and three other scientific divisions of the U. S. Department of Agriculture were advanced to bureaus. This was provided for by the last session of Congress, which appropriated for the expenses of the Bureau of Forestry during its first year \$185,440. The appropriation for the Division of Forestry during the year just ended was \$88,520. For the year 1898-99 it was \$28,520.

These figures show how rapidly the forest work of the Government has expanded of late, and also how well it has commended itself to Congress. There was a time when the practical value of the scientific investigations carried on by the Government was not fully understood, and farmers were inclined to think that the money spent on experiment stations and chemical laboratories was of little benefit to them. Now the case is very different. The improvements in agriculture due to the work of the Department have increased the value of the farm products of the country by many millions of dollars annually. As this kind of work has proved its practical utility, Congress has shown itself generous toward it. The readiness with which Congress has increased the appropriations for the Division of Forestry is the best evidence that forestry has proved its importance from a business standpoint.

The change from a division to a bureau, and the larger appropriation, will make possible both an improved office organization and more extended field work. The bureau will be provided with a much larger office force and will be organized in three divisions. But field work, not office work, is what the bureau exists for. This work has been going on during the last year from Maine to California and from Georgia to Washington. It includes the study of forest conditions and forest problems all over the country, the giving of advice to owners of

forest lands, and the supervising of conservative lumbering operations which illustrate forest management on business principles. This work can now be greatly extended. Private owners of some three million acres have applied for this advice, which in every case requires personal examination, and about 177,000 acres have been put under management. This land is in many tracts, large and small, and is owned by individuals, clubs and corporations. Several State governments have also asked the aid of the bureau. But the greatest demand is that of the Department of the Interior of the National Government, which has asked for working plans for all the forest reserves, with the enormous total area of about 47,000,000 acres.

The Bureau of Forestry is made up of the Division of Forest Management, the Division of Forest Investigation, and the Division of Records. Each of these continues, with enlarged facilities, work which was in progress under the old Division of Forestry.

The Division of Forest Management is in charge of Mr. Overton W. Price, the former superintendent of working plans. When the owner (private or public) of woodland wishes to consider the possibilities of his property if handled as a constant source of timber supply, the tract must be examined by an expert to ascertain the condition of the standing timber, the prospects of reproduction, the facilities for marketing, the best method of harvesting the present crop so as to secure the largest present and future yield, and the likelihood of success under management. A preliminary report is then made. If the owner decides on management, a working plan follows. This involves a careful study of the rate of growth of the different kinds of marketable timber, the computation of the proper interval between cuttings and of the amount of timber to be harvested, and, if desired, the recommendation of the necessary regulations to enable the work to go on under contract. All this falls to the Division of Forest Management.

The Division of Forest Investigation, under the charge of Mr. Geo. B. Sudworth, makes studies of trees—of their rates of growth, distribution, reproduction and habits—and investigates all the forest problems connected

* Press bulletin.

with fires, lumbering, grazing, tree-planting, stream flow and erosion.

The Chief of the Division of Records is Mr. Otto J. J. Luebker. It takes charge of all office and routine matters, and also has custody of the library of literature bearing on forestry, and of a unique collection of photographs, which is continually being added to, illustrating forest conditions all over the United States.

The result of the work of the Division has been to turn practical forestry in the United States from a doubtful experiment into an assured success. Special studies of some of the most important trees, commercially, have been made, from which can be calculated their probable future yield. Cheap methods of harvesting the present lumber crop without injuring the productivity of the forest have been put in operation. Such concerns as the Great Northern Paper Company and the Deering Harvester Company have been led to undertake conservative management of their forest properties. Meanwhile, the work of tree-planting, particularly in the almost treeless Western States of the plains, has been furthered; the relation of the forest to the volume of streams, erosion, evaporation and irrigation have been studied; matters connected with irrigation and water supply have been investigated; hopeful progress has been made in the direction of regulating grazing in the Western reserves in a manner fair both to the important interests of cattle and sheep owners and to those who look to the reserves as a source of continuous supply of wood and water; and studies of forest fires were conducted with a view of reducing the great yearly loss from this source, a loss which has been estimated at \$50,000,000.

Field work is to go on this summer in 17 States. There are in all 179 persons engaged in the work of the Bureau. Of this number 81 are student assistants—young men, largely college students, who expect to enter forestry as a profession, and who serve during the summer on small pay for the sake of the experience gained.

SCIENTIFIC NOTES AND NEWS.

PROFESSOR RUDOLF VIRCHOW has been appointed a Knight, with the right to vote, of the

Prussian Order 'Pour le Mérite' for Science and Art.

TRINITY COLLEGE has conferred the honorary degree of M.S. on Mr. John H. Sage, secretary of the American Ornithologists' Union.

CAPTAIN SCOTT and the other officers and the members of the scientific staff of the British National Antarctic Expedition were entertained at a farewell dinner by the Savage Club, on July 6.

THE annual dinner of the Royal Institute of Public Health will take place on July 24, in London, when the Harben Gold Medal of the Institute will be conferred on Professor R. Koch, of Berlin. Lord Lister, Lord Strathcona, Professor Brouardel and other guests will be present.

F. W. DYSON, chief astronomer at the Greenwich Observatory, arrived at San Francisco on June 8, after having observed the total eclipse of the sun in Sumatra. He visited the Lick Observatory on the ninth, and intends to inspect other American observatories before his return to England.

DR. THEO. GILL, after having attended the ninth jubilee of Glasgow University as a representative of the Smithsonian Institution and the National Academy of Sciences, is at present on the continent, where he will visit scientific institutions, including the Zoological Station at Naples.

PROFESSOR WILLIAM OSLER, of the Johns Hopkins University, and Dr. Edward G. Janeway, of the University and Bellevue Hospital Medical College, are among the delegates who will attend the Congress of Tuberculosis to be held in London next week.

MR. F. H. NEWELL, in charge of the hydrographic work of the U. S. Geological Survey, and Mr. Gifford Pinchot, chief of the Bureau of Forestry, left Washington on July 11 for the West, having in view, among other things, the investigation of the forests and water supply of eastern Oregon. Mr. H. Gannett, of the U. S. Geological Survey, is already in Oregon inspecting the work of the various parties surveying the forests.

THE Secretary of Agriculture has recently

made a reconnoissance of a portion of the area of a proposed Appalachian forest reserve designed for the protection of forests and the preservation of the water resources and soils of the Appalachian region. He was accompanied by Messrs. Gifford Pinchot, chief of the newly created Bureau of Forestry; F. H. Newell, chief of the Hydrographic Division of the U. S. Geological Survey; W. J. McGee, of the Bureau of American Ethnology, and J. A. Holmes, state geologist of North Carolina.

PROFESSOR O. P. PHILLIPS, of the Southern California University, is in the Pueblo region, under the auspices of the Bureau of American Ethnology, for the purpose of obtaining motion-pictures illustrating the industries, ceremonies and domestic customs of the Pueblo peoples.

DR. FRANZ BOAS, of Columbia University, received on July 1 an honorary appointment as philologist in the Bureau of American Ethnology; and under an arrangement completed just before his departure for Europe, Messrs H. H. St. Clair and W. A. Jones have taken the field and commenced the collection of several Indian languages.

As we have already stated Dr. Paul C. Freer, professor of chemistry in the University of Michigan, has received a year's leave of absence to go to the Philippines. We are now informed that he will there organize the laboratories recently established by the civil government.

DR. W. W. FORD, of McGill University, will undertake researches on some subject connected with preventable diseases under the auspices of the trustees of the Rockefeller Institution for Medical Research. He will spend the next six months at the Pasteur Institute at Paris, returning to McGill University, when the new laboratories are completed, to work under Professor Adami.

SIR ROBERT BALL, professor of astronomy at Cambridge University, will lecture in the United States during the autumn, under the auspice of Major Pond.

SIR HENRY ROSCOE, the eminent chemist, has been reelected vice-chancellor of the University of London.

SIR A. R. BINNIE has resigned the position of chief engineer to the London County Council. Under his direction many important public works, such as the Blackwell Tunnel, were carried out.

PROFESSOR A. JACOBI, New York City, has sent a notice, calling attention to the fund being collected in honor of Rudolf Virchow's eightieth birthday, to which we have already referred. The fund is to be added to that collected ten years ago, its income being used for furthering biological, anthropological and medical research. Professor Virchow will celebrate his birthday on October 13, and contributions should be in Professor Jacobi's hands not later than the first of September.

DR. ROBERT MAYER, eminent for his announcement of the law of the conservation of energy, was born at Heilbron in 1814 and practised medicine in that city until his death in 1878. The Berlin branch of the German Association of Engineers has recently placed a memorial tablet on the house in which he lived.

A BUST of Dr. Armauer Hansen, the discoverer of the bacillus of leprosy, will be unveiled with appropriate rites in the Lungegaards-Hospital at Bergen on August 10.

DR. WILLIAM H. HARKNESS, known for his contributions to entomology and botany, died in San Francisco on May 10.

WILLIS H. BARRIS, D.D., corresponding secretary and curator of the Davenport Academy of Sciences died last month in his eightieth year. Dr. Barris was professor in a theological school of the Protestant Episcopal church and was at the same time much interested in science, having published in the *Proceedings* of the Davenport Academy of Sciences' numerous papers on geology and paleontology. He was a trustee of the Academy from the time of its foundation, and was elected president in 1876, and for many years acted as curator and corresponding secretary.

PROFESSOR JOHANNES LAMP, one of the scientific members of the expedition which is demarcating the boundary between German East Africa and the Congo State in the neighborhood of Lake Kivu, died on June 21 of sun-

stroke. He was for some time employed at the Geodetic Institute in Berlin, and was afterwards appointed to the observatory at Kiel, and held a professorship at the university of that city.

DR. AXEL ERICSSON, the Swedish explorer, died in the interior of Africa on May 31.

It is this week reported that Mr. Andrew Carnegie has offered to give \$100,000 for a library building at Leadville, Colo.; \$35,000 for Alameda, Cal., and \$75,000 for Coatbridge, Scotland.

MR. T. G. YOUNG has bequeathed £3,000 to the Technical College, Glasgow, for the purpose of establishing exhibitions in connection with the chemical laboratory.

AN institute for the official examination and analysis of new drugs and remedies is to be established in connection with the Imperial Board of Health in Berlin.

THE newly established Health Board for the Philippines will shortly begin to work in cooperation with the army surgeons throughout the archipelago in studying the relation of mosquitoes to malaria.

THE library of the late Dr. Felix Birch-Hirschfeld, professor of pathological anatomy in the University of Leipzig, has been purchased by the Cornell University Medical College. It contains about 5,000 volumes, and cost about \$10,000.

THE Worshipful Company of Goldsmiths has purchased for £10,000 the library of economic literature collected by Professor H. S. Foxwell. This was done just in time to prevent the removal of the library to the United States.

MR. GEORGE GRANT MCCURDY, of Yale University, secretary of Section H, Anthropology, of the American Association, has sent to members the following notice:

The Fiftieth Meeting of the American Association for the Advancement of Science will be held in Denver, Colorado, August 24-31, 1901. Dr. J. Walter Fewkes, of the Bureau of American Ethnology, will preside over the Section of Anthropology.

You are cordially invited to attend and to contribute papers upon subjects connected with your field of research.

In order that a preliminary sectional program may be distributed in advance of the meeting, titles of communications should be sent to the secretary as soon as possible. Abstracts of papers or the papers themselves may be sent later at the convenience of the authors, who are reminded that no title will appear on the final program until the paper either in full or in abstract has been passed upon by the Sectional Committee.

Excursions to points in the southwest, of special interest to anthropologists, are being planned.

THE president of the Davenport Academy of Sciences, Mrs. M. L. D. Putnam, requests us to extend an invitation in the name of the Academy to the members of the American Association to visit its museum and archeological collections in going to, or returning from, Denver. Davenport, Ia., is on the Chicago, Rock Island and Pacific Railway on the direct route to Denver.

THE International Association for the Advancement of Science, Arts, and Education will hold its second meeting at Glasgow, in the University and in the Exhibition, from July 29 to September 27. One of the most important functions of the meeting will again be, as at Paris last year, to study and interpret the matters of scientific, geographic and other interest afforded by the exhibition by means of lectures and conferences, with demonstrations and visits under skilled guidance.

It appears from the London medical journals that the Congress of Tuberculosis which will open in London on July 22 will be of considerable importance. Over 1,200 applications for membership have already been received, and it is expected that more than 2,000 members will be in attendance. The sum of about \$25,000 has already been collected for the expenses of the meeting. The program includes addresses by Professors Koch, Brouardel and Macfadyean.

THE American Philological Association held its thirty-third annual meeting at Harvard University last week with a full program. The meeting will be held next year at Union College, Schenectady, N. Y., under the presidency of Professor Andrew F. West, of Princeton University.

A CIVIL service examination will be held on

August 20 for the position of chief taxidermist in the U. S. National Museum at a salary of \$125 a month. The subjects and weights are :

Practical questions.....	25
Practical tests.....	50
Experience.....	25

The practical tests will comprise the submission of photographs or other illustrations of large animals or groups of animals which have been prepared by the competitor. Applicants should submit as complete and perfect representations of their work as they can secure. Applicants will be required to make sworn statements that the photographs or other illustrations submitted by them are taken from work which they executed. The position to be filled is an unusually responsible one and involves on the part of the appointee a rare combination of qualifications. He should not only have mechanical ability to execute first-class taxidermic work, but should possess the qualifications of an artist and some knowledge of the life history of animals. Applicants should have considerable experience in the preparation of large mammals, animals of the size of the grizzly bear or larger.

THE University of California has established a marine laboratory at San Pedro, as part of its proposed biological survey of the waters along the California coast.

THE new pathological institute of the London Hospital was opened by Sir Henry Roscoe, F.R.S., vice-chancellor of the University of London, July 10.

MR. JOHN LEWIS CHILDS, of New York, has purchased a large collection of birds' eggs and nests made by Mr. H. C. Parker, of Ridley Park. The collection is said to be very complete, including a specimen of the great auk's egg and other rare sorts.

MR. ABRAHAM E. SMITH, consul at Victoria, writes to the Department of State that a surveying party has located the landing site of the British Pacific telegraph cable (which is to connect the Dominion of Canada with the Australian Confederation) on Kelp Bay, near Banfield Creek, 7 miles from the entrance to Barclay Sound, and something over 100 miles from

Victoria. The location is described as admirably adapted for the purpose—a good harbor, 12 fathoms of water close to the shore, so that vessels of 10,000 tons can find safe anchorage. The harbor is landlocked, and has a bottom of ooze that it is said will furnish good protection for the wire. Work has already begun in England on the cable. It is to be 5,834.5 miles in length, the longest yet constructed, and will be transported and laid in one ship, which is now being specially built for the purpose. The cable will run from Vancouver Island to Fanning Island, a distance of 3,337 miles, before a landing is effected ; thence to the Fiji Islands thence to Norfolk Island, and thence to Queensland. The first instalment of cable, including the sections from Queensland to Norfolk, Fiji and Fanning Islands, is expected to leave England in January, 1902. The second and longest portion is to leave in August, 1902, come direct to Vancouver Island, and be laid from Barclay Sound to Fanning Island. According to the contract, the whole cable is to be laid and working by January 1, 1903. Unforeseen disaster excepted, those engaged in the work believe this great enterprise, which will cost \$10,000,000, will be completed at the date promised.

UNIVERSITY AND EDUCATIONAL NEWS.

GENERAL A. C. BARNES, of Brooklyn, has undertaken to build and equip an astronomical observatory for Cornell University.

THE will of the late Signor Villeneuve of Montreal, leaves \$25,000 to Laval University.

THE sum of about £100,000 has been subscribed toward converting University College, Liverpool, into Liverpool University.

MR. CHAMBERLAIN has asked the city of Birmingham for a contribution towards the maintenance of the new engineering buildings of the University. It appears that Nottingham contributes £7,380 a year to Nottingham College, that Sheffield gives nearly £6,000 a year to Firth College, that Leeds gives £1,500 a year to the Yorkshire College, that Manchester gives £1,100 a year, and that Liverpool gives £1,800 a year to University College, and has in addition given land worth £30,000.

As we recorded last week the National Council of Education did not adopt the report of its committee on a national university. The National Educational Association passed the following resolution, offered by President R. H. Jesse, of the State University of Missouri :

Resolved, That this Association hereby reaffirms its former declaration in favor of the establishment by the National Government of a national university devoted not to collegiate but to true university work.

THE Berkeley correspondent of the New York *Evening Post* reports that the summer session of the University opened with a registration of 720 ; but as some schools have not yet closed, whose teachers are to join the attendance later, the total attendance is certain to pass 800. To this body of students sixty-eight courses are offered by forty-two instructors. Last year there were 433 students and twenty-five instructors, the latter giving thirty-five courses. In 1899 there were 161 students.

THE chair of geology and natural history in the University of California, held by the late Professor Joseph Le Conte, will, it is understood, be divided, Professor Andrew C. Lawson being placed in charge of the geology and associate Professor William E. Ritter in charge of the department of zoology.

THE professorship of astronomy in the University of Missouri, which has been vacant since the resignation of Professor Milton Updegraff, to accept appointment in the United States Naval Observatory at Washington, has been filled by the selection of Dr. Frank H. Seares, of California, now studying in Paris. Dr. Seares is a graduate of the University of California.

PROFESSOR WILLIAM ESTY, of the University of Illinois, has been appointed assistant professor of electrical engineering in Lehigh University.

DR. E. C. LUNN, of the University of Chicago, has been appointed instructor in mathematics and astronomy in Wesleyan University.

PROFESSOR JAMES P. C. SOUTHALL, M.A. (Virginia), of Hobart College, New York, has been appointed associate professor of physics at the Alabama Polytechnic Institute, at Auburn,

filling the vacancy caused by the resignation of Professor H. H. Kyser. Professor Southall was for three years instructor in mathematics and physics at the University of Virginia. He has been professor of physics at the Miller Institute, in Virginia, for five years, fellow and associate in physics at the Johns Hopkins University, and for two years professor of physics at Hobart College, New York.

THE usual twenty fellowships have been awarded at the Johns Hopkins University, including the following in science :

Arthur Byron Coble, of Lykens, Pa., A.B., Pennsylvania College, 1897. Mathematics.

Rheinart Parker Cowles, of Los Angeles, Cal., A.B., Stanford University, 1899. Zoology.

Charles Fowler Lindsay, of Halifax, N. S., A.B., Dalhousie University, 1899. Chemistry.

Robert Edward Loving, of Wilmington, Va., A.B., Richmond College, 1896. Physics.

Benjamin LeRoy Miller, of Oskaloosa, Ia., A.B., University of Kansas, 1897. Geology.

Louis Alexander Parsons, of Burlington, Ia., A.B., Iowa State University, 1895. Physics.

Dorothy M. Reed, of Leyden, N. Y., B.L., Smith College, 1895, M.D., Johns Hopkins University, 1900. Pathology.

Daniel Naylor Shoemaker, of Fair Haven, O., S.B., Earlham College, 1894. Zoology.

William Stone Weedon, of Baltimore, S.B., Maryland Agricultural College, 1894. Chemistry.

THE following appointments to fellowships and scholarships in physics have been made in the University of Nebraska :

Fellows : W. B. Cortmel, Case School, Cleveland ; F. T. Bates, University of Kansas. Scholars : L. B. Tuckerman, Adelbert College, Cleveland ; I. Summers, University of Missouri ; S. Williams, Iowa College, Grinnell.

DR. ISAMBARD OWEN has been elected principal of Cardiff College in succession to the late Viriamus Jones.

THE Council of University College, Liverpool, has elected Edgar Walford Marchant, D.Sc., senior demonstrator at Finsbury Technical College (London), to the lectureship in electro-technics vacated by Mr. Alfred Hay's appointment to a professorship at Cooper's Hill.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

EDITORIAL COMMITTEE: S. NEWCOMB, Mathematics; R. S. WOODWARD, Mechanics; E. C. PICKERING, Astronomy; T. C. MENDENHALL, Physics; R. H. THURSTON, Engineering; IRA REMSEN, Chemistry; CHARLES D. WALCOTT, Geology; W. M. DAVIS, Physiography; HENRY F. OSBORN, Paleontology; W. K. BROOKS, C. HART MERRIAM, Zoology; S. H. SCUDDER, Entomology; C. E. BESSEY, N. L. BRITTON, Botany; C. S. MINOT, Embryology, Histology; H. P. BOWDITCH, Physiology; J. S. BILLINGS, Hygiene; WILLIAM H. WELCH, Pathology; J. McKEEN CATTELL, Psychology; J. W. POWELL, Anthropology.

FRIDAY, JULY 26, 1901.

THE CULTURAL VALUE OF ENGINEERING EDUCATION.*

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At the very outset of this discussion is encountered a great difficulty. What is culture? The writer has been asking this of his friends. An answer has been sought for in the printed page where is recorded the best thought of the best minds. Great thoughts and lofty ideals have been disclosed, but nowhere has been found a satisfactory definition, a phrase or paragraph that succinctly and clearly sets forth the heart of the matter.

People often recognize, appreciate and reverence its possession without being able to fully analyze and set down its elements. There is something subtle and emotional about it that eludes a close pursuit.

The reason for this perhaps lies in its essential individual quality, in its being the result of a personal life, developed, it is true, on lines similar to those used in other lives, yet including something that pertains exclusively to the human unit that is different from all other units.

Nevertheless, there seem to be certain fundamental qualities which must be possessed before a man can be classed with cultured people, qualities which are only acquired after a considerable experience in

*Address of the President of the Society for the Promotion of Engineering Education, Buffalo meeting, June 29, 1901.

life, but which are influenced greatly by the years of student training and therefore fit subjects for discussion here. Far be it from the purpose of this paper to attempt a definition of culture or a setting forth of its elements in any completeness; rather the emphasizing of some things that relate to it, especially with reference to the education of young engineers.

First: The man of culture must be a thinking and reflecting being. There must be not only the ability, but the habit; and this is no easy thing to acquire. Modern American life is full of hurry, full of affairs that demand instant attention, and one matter follows another with rapid succession. We get news from Pekin to-day, from Havana to-morrow and from the Philippines within a few hours. We build railways, erect bridges and fill large orders for locomotives for foreign shipment in such short space of time as to astonish the world. Men seek short cuts to fortune. In the popular opinion, the men who act quickly, the men of decision, are those who succeed. But there is a danger here. For, back of the action, behind the sharp decision, must lie a mature judgment, and how else is this to be formed except as a result of deliberate reflection. However quickly one may reach a conclusion, its correctness or faultiness will depend not on intuition, but on the degree of true comprehension. The decisive act which is also right rests on a process of thinking and judging that has been long fostered, until it has become a habit, until there are established certain standards by which things are to be measured.

The early steps of this training are necessarily slow, and we, as teachers of engineers, must recognize this and not yield to the temptation to crowd our students over too much ground on the one hand, or, on the other, to lead them through short cuts across country by empirical paths that may give

them ease and quickness of travel, but little or no reason why the path is chosen. Let them go the long road. I do not by any means wish our teaching to be non-practical—rather more practical in the best sense; but first, last and all the time, let students be trained to do their own thinking and to form their own judgments; to test the statements of others by the workings of their own mental processes.

Second: There is another element of culture that comes in here, an ethical one, that of forming right judgments. Men may have the appearance of culture without its true spirit, which is essentially honest. This is especially important, as culture seeks to make a man's life satisfactory to himself when measured by his own conscience, as well as successful in the field of affairs. So his standards must be based on sound principles of right and wrong; and it is only when these are so placed that his life becomes one of freedom, freedom from the bondage that wrong thinking and acting always bring. A class room is no place to preach a sermon, but there can be there imparted a respect for truth and perfect honesty. A teacher's attitude should always be open and frank, that of a sincere seeker after truth. He should never dodge an honest question, and be ever ready to say 'I do not know' if he does not. There is an incalculable power that 'makes for righteousness' and the happiness of the after life of the student in the true teacher's conduct of even such a material subject as mechanics.

Back behind the subject with its subdivisions, its formulæ and rules, lies something larger, a sort of spiritual quality that binds it to all other subjects, to the universe as a whole, and makes it a part of the truth of God's realm. The student that gets hold of this significance learns much more than facility in the manipulations of processes or the application of principles. He gets some-

thing that makes his life richer and better and his mastery of the subject more complete.

Third : There can be no true culture for a man that does not work, that does not put his cultivated powers to some useful service : and here there must be such degree of mastery over the chosen profession or business as will result in a special skill and dexterity—a doing of some one thing better than others can do it. A man expresses himself through his work, and whether he will or no, he thus discloses to all who know him his own peculiar qualities. It is this intensity of application, this concentration of purpose and directness of aim, that gets the world's work done. Here in early years the engineering student has the advantage of the student in arts. Study for knowledge's sake may be stimulating to the few, but for the many there is needed the goal of a special calling to secure the close application that results in ability to concentrate one's energy to the attainment of a certain end. But here again comes a danger, that of too early, or over, specialization, and the following of short cuts to professional life that are advocated by some who, in the eyes of the world as well as in their own, have been eminently successful as specialists. Whether these can be called men of culture of the highest attainments is another matter. The extreme specialist may be supreme in his own line of details, but may fail when there comes up a question involving the relation of his specialty to other things. Even within his own domain, his conclusions will be modified by his general knowledge and experience. All one-sided people, whether they be linguists or naturalists, poets or merchants, preachers or engineers, are quite liable to the forming of erroneous judgments. To the few geniuses, whose capacities and powers seem to be abnormally developed, though of limited scope, much is forgiven ; but for

the average man of the day there is demanded an ability to form good and wise conclusions.

Fourth : In order to form those that are appropriate and correct there is needed, then, breadth of view—a quality that has been expressed by the word poise. A man of poise, of even balance, will see things in their right relations and due proportions ; he will weigh matters, giving to each component part its just degree of importance. He will the better understand the motives that underlie other men's actions and the more readily use them to suit his own purpose. He will be more apt to rightly interpret the new movements in the world of thought or action and can seize opportunity for a personal advantage or a larger sphere of service before others see that there is such.

This demands a considerable range of knowledge. Not the close mastery of many lines in all their details, but a fair degree of familiarity with their general phenomena and principles ; and there is scarcely any field that will not contribute something to the result. It is admitted at once that the average man is of limited capacity and unable to grasp a comprehension of all knowledge that may influence his life and work ; what is pleaded for is such degree of breadth as may be needed to make one of great efficiency in his chosen profession and of most value to himself, not only in a financial way, but also in the sense of gaining a joyful recognition of the worth of developing all the powers that one has.

The value of mathematics and the physical sciences with their applications to technical things needs no discussion here, for these are the engineer's tools ; but it is a fair question whether, in our desire to graduate students that can be early useful, we do not place too much stress on technical things to the exclusion of others that give greater breadth of training. We must

not forget that we are educating men for a life; that we must look forward to the time when these young people will be fifty years old, and at the period of their maximum productiveness as workers and of maximum value in society and as citizens.

Engineers have to deal with other things besides materials and physical laws; they must manage men and matters of finance. If they are to rightly influence those whose capital they are employed to expend, they must be able to meet them socially and intellectually, to discuss intelligently matters outside the pale of strictly professional life. Evidence of professional ability and skill is of course first demanded, but breadth of culture creates an added confidence in the wisdom of the conclusions reached and the advice given.

Heretofore much of our engineering work has been concerned with the opening and developing of new country or new business and industrial enterprises. So engineers have found their work away from contact with men. But engineering practice is changing, as conditions become older and more settled, and more and more practitioners find their work in communities and busy centers of trade where they are constantly thrown into close contact with strong and cultured men. Present engineering courses do little to prepare a man for this thorough instruction concerning human nature and human relations. Something of history, economics and sociology should be included.

Fifth: It is not sufficient to form correct judgments only; there must be added a skilful and effective presentation of them in well chosen and fitting English. The ability to do this involves more than training in the writing of compositions, themes, forensics and reports. The cultured man should have a taste for reading the best that has been written in his mother tongue, and for several reasons: The great

thoughts of great minds are stimulating and broadening to his own mind; he thereby absorbs a knowledge of words and their shades of meaning; he gains an appreciation of style and insensibly better knows how to form his own; and, not least by any means, he makes of his books friends that are life-long, that cheer and console him under all happenings, adding much to his internal resources for happiness.

The time given to English in our courses is not enough to train students properly in its use and at the same time open the doors to our best literature. It may be said that all this English work should be done in the preparatory school, and it is probably true that the character and quality of the high-school English is better to-day than it has been heretofore. Yet it seems to me that engineering students should have some training of a college grade along the line of literature.

Sixth: To the writer's mind, there is another element of culture that should enter into an engineer's training, viz., an appreciation for beauty. As he has said at another time* the engineer is a designer, and it is important that he should embody his design in artistic form if he is to fulfil his whole mission and please and gratify others by the perfection of his work. The engineering student devotes a good share of his time to the drawing-board, and much can be done here toward the cultivation of this quality by an instructor who possesses it, without lessening at all the amount or force of the technical exercises for which the process is primarily used. There should be, however, something further by way of giving instruction in elementary aesthetics and by opening the students' eyes to what is beautiful in nature.

Seventh: The possession of agreeable manners and tact is another evidence of

* *Proceedings* of the American Association for the Advancement of Science, Vol. 45.

culture. Not merely the conventional bearing of polite society, though this has its value. This alone is but a husk which must cover the real kernel, refined and gentle feeling; and such feeling is the result of moral and intellectual convictions. Manners, then, are not to be taught from a text or by lecture; they rather follow as a consequence from the whole course of training and are crude or refined, just as the character of the instruction makes them. The teacher's personality has very much to do with this matter. If he is of coarse grain, of domineering or selfish disposition, his influence will not tend toward the production of true gentlemen.

And now for the real question—does engineering education tend to produce culture? According to old standards, when men limited culture chiefly to a knowledge of language, literature and philosophy, the reply would be in the negative. However, standards are not the thing itself, only methods of measurement; moreover, standards change. Science has modified and is still changing the ideas of culture that men hold, and this evolution makes it all the more difficult to find a common ground upon which all can stand when considering things concerning it. This much is clear, however, that no one existing course of educational training has a monopoly of cultural methods; nor will the completion of any college course necessarily secure its attainment because of its personal quality. Further, culture is the result of a life, and the most that can be expected of a college course is to open the students' eyes to its real worth, to start them rightly with certain leanings and aptitudes, and furnish them with the means of a continuous growth toward its maturity.

It is maintained that an engineering course can tend in this direction, and that in some of our best colleges, under the instruction of people themselves cultured,

it does so tend to-day. Our best engineering courses are stiffer and more exacting both as to time and effort than those in the college of arts, and the resulting acquisition of mental power and the ability to focus it proportionately greater.

The fixed course with its correlated parts and the certain definite end to be strived for are advantageous. The training is a continuous testing and trying of the truth of knowledge, and teaches the student to ask 'why' and to reflect. He gains respect for nature's laws, and learns that his professional success will depend on his ability to work in harmony with her. He gathers a fair degree of knowledge of himself, his strong points as well as his limitations. He acquires a habit of thought and action that leads to further growth. He learns how to adapt means to an end, and within what limits of precision to work that it may be reached with economy. In short, he becomes a trained and educated man, cultured to a certain degree, but with limitations; just as the arts student who has specialized to a like degree in language and literature, with little of science training, becomes cultured, but also with limitations. Let the latter retain his A.B. On the other hand, let it be recognized that the engineering B.S. stands for culture as well, of equal worth and value, though of different kind.

As between the two specialists, I think the advantage lies with the engineering graduate as being on the whole, better equipped for a life of useful service and one that will possess the greater capacity for further development.

As one looks forward ten or twenty years and attempts from present tendencies to forecast the work and social standing of engineers, he must see that the profession will be doing a larger work and exerting a greater influence.

Further, that an engineering training will be more and more recognized as the one best

fitted to lead to positions of an executive nature in connection with industrial enterprises, and in the administration of public works. Everywhere will be demanded expert skill, sound judgment and broad views, primarily because these will be found to be economical. The entire class of men that a recent writer has called 'mattoids,' the ill-trained, narrow and egoistic, will be pushed out because their service is costly.

There are two tendencies in the present-day engineering education that are, in my judgment, opposed to the desirable result. First, a tendency to crowd too much of the foundation work back upon the preparatory school, already overloaded. This Society's Committee on Entrance Requirements has advocated a standard which is high enough. Second, the allowing of technical subjects to crowd the fundamental general ones from the college course, in a vain attempt to do what from the very nature of the case cannot be done, make an engineer by college study. The result of this in some institutions is further seen in too early a differentiation between the various engineering courses; so that, for instance, the civil student knows nothing of applied electricity and the electrical student nothing of surveying, while neither has a chance to acquire a taste for literature.

The whole problem is an involved and complicated one, but there is a way out that must be found if the engineer is to fill the important place that awaits him. One part of the solution will be probably found in a refining of the methods of instruction, so that better results may be reached in the same time. In the end, however, the writer thinks that there must come a deeper sense that after all life is long, that it should be taken with more of deliberation, and that it is the end that is important, rather than the beginning. The feverish rush and haste to be earning must be re-

placed by a recognition of the real necessity for a full rounded-out preparation if the largest and best service is to be given. Then the student will be glad to spend the one or two extra years in college that may be demanded. The wise student now will do this without its being required.

The Chief Justice of my own State has said, "The spirit of an age is that which makes finally for the happiness of the race. I have absolutely no fear as to the final end of things, nor as to the steps and incidents of evolutionary development. The aspirations, the great universal possessions of a people, can never move them to other ends than their happiness and good. The spirit of this age is commercial enterprise and conquest, and as to it I have an unspeakable conviction that it will, as the spirits of other ages have done, work itself into forms and institutions of beauty and eternal worth to men."

It is largely through the engineer that this is to be done. The finest result requires the most skilful labor; the noblest workman demands the most fitting training.

Herein lies our responsibility!

FRANK O. MARVIN.

UNIVERSITY OF KANSAS.

PHYSICAL CHEMISTRY.*

As I am to deliver in the course of the next few days a series of lectures upon some parts of physical chemistry in their details, I should like to use this educational conference as an occasion for presenting an introduction to my lectures.

I add at once that one of our best modern historians, Ladenburg, in his 'Development of Chemistry in the Last Twenty Years,' sustains that the more and more prominent position of physical chemistry characterizes the development of our whole chemical

* An address given at the decennial celebration at the University of Chicago, published in the *University Record*.

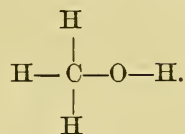
science during the last twenty years. Let me briefly trace how this physical chemistry has grown, and what it is at present. Allow me in doing this to rely partly on personal observations.

When, as a student of the Bonn University, I studied chemistry first, about thirty years ago, under the guidance of one of the most famous men, Kekulé, chemical science had, according to our master, come to a dead point.

The existence of atoms, though an indirect chemical conclusion, seemed to have been well established, corroborated as it was by the conception of molecules—a conception which rested merely on physical grounds. The details about the mutual relation in which these atoms stood in the molecule either were already known, or in the case of complicated or new compounds a knowledge of them was but a question of time. Thus H_3COH was used to represent the mutual relations of the atoms in the molecule of a simple compound, methyl alcohol; that is to say, it was known that three atoms of hydrogen are held in some unknown way by the atom of carbon, the fourth hydrogen atom is held by the atom of oxygen, and this in turn again by the carbon atom. Yet all such formulas were merely schemes in the mind, or diagrams on paper, and chemistry was looking out for a kind of Newton who might tell us the laws which hold together these atoms in their constellations, the molecules.

You know as well as I that up to the present time this Newton has never come. Yet, only a few years after Kekulé's disappointing prophecy (which, by-the-by, a teacher should never express before his pupils) stereochemistry awoke, and is now a fully developed and well-founded branch of chemistry. By stereochemistry so much at least was attained that, admitting the existence of atoms, we now know to a large extent, not only the mutual *relations*, but

also the mutual *positions*, which these atoms occupy in the molecule. H_3COH becomes



That is, the three atoms of hydrogen and the atom of oxygen were found to be arranged in space around the carbon atom in such a way as to occupy the four corners of a tetrahedron, in the center of which the carbon atom lies.

But there we stood, and still stand, since more than twenty-five years, still ignorant of the laws to which their relative position is subordinated, though a recent attempt seems to me hopeful.

Nevertheless, research went on in a way which had very little to do with that architecture constructed by the mind whose building stones are atoms. So, fifteen years after Kekulé's discouraging prophecy, a second child of hope awoke, and this was physical chemistry. It did not appear at once—a scientific branch hardly ever does—it developed as a plant unseen in the shadow, till it felt the sun, and then grew up to be a giant tree.

Some, as Duhem, even say that physical chemistry is a third fundamental science, entitled to be placed between physics and chemistry. Others, like Winkler and Ladenburg, say that, to begin with, we might allow it a prominent place in chemistry and substitute for the division into the two branches, organic and inorganic, a division into three. It will be of interest to add that the University of Göttingen has recently organized the chemical department on this principle. But, apart from all principle of division, which in the end is always arbitrary, because our whole science, like nature, which it reflects, is only one thing, though rather large, we ask: What has physical chemistry achieved?

There are two ways along which a reply to such a question can be given. I might trace in outline the general conclusions, and might speak to you of the laws of chemical change, of reaction velocity, of electro-chemical processes, but I should not be able to do much without the use of a rather complicated formula, which the character of this introduction excludes.

The second way is of a special nature, and I will venture on it, to trace on what lines physical chemistry wrought out its conclusions and what success it met with. The particulars will apply to one of the best known and farthest reaching achievements, to the investigations on osmotic pressure.

Let me begin with that particular attraction for water which we find in some substances very familiar to us, say in ordinary burnt lime. If the lime is kept in a well-filled flask or bottle, which is not hermetically sealed, water from the surrounding air will be attracted by the lime. This will augment the volume of the lime, and the flask or bottle will eventually give away; a tremendous force is thus developed, too large, perhaps, to be exactly measured.

But, on a smaller scale, we may follow up quantitatively the analogous process with sugar, for instance, in a dilute solution, say a 1-per-cent. solution. This will attract water also, as may be shown by filling with the solution a flask, porous, but permeable for water only, and by placing this flask, when well sealed, in water. Then water will enter it till, if the flask holds, a pressure of two-thirds of an atmosphere is attained, as was measured by Pfeffer.

We may generalize and say every solution has the tendency to diffuse into the solvent as if it were attracted by the solvent, and this tendency will produce a pressure if the diffusion is prevented by a membrane. This pressure, for more than

a century studied as osmotic pressure, has a well-defined amount; it was known to vary with concentration, with temperature, and with the nature of the substance dissolved, etc., and this was all we knew about it until the way in which physical chemistry worked was applied to it. The result was so transparent that every student may now calculate readily for any dilute solution what its osmotic pressure is; for all may be summed up in this one expression:

$$P = 0.08 CT,$$

with P , the osmotic pressure in atmospheres, T , the absolute temperatures, C , the concentration or number of gram molecules of dissolved substance in one liter of the solution. The above value of the pressure for a 1-per-cent. sugar solution is, at once, got at by this formula. Let me only insist on the different way in which physical chemistry works as compared with stereochemistry. Physical chemistry does not seek the solution of problems by trying to reveal the constitution of matter, but it works out between measurable things relations to which the calculus may be applied.

This is not all. Looking upon the tremendous work which atomic chemistry has achieved, one must acknowledge that in research relatively little up to the present has proved of value as to what most interests us, the problem of life. Quite the opposite can be maintained with the lines followed up in physical chemistry; and even ten years ago, I used an occasion like this at Utrecht to point out the large part which this osmotic pressure, the laws of which physical chemistry revealed, plays in physiology.

I could indicate the result of many a physiological investigation, pointing to the fact that osmotic pressure is a fundamental factor in the most different vital functions in plant and animal existence. According to de Vries, it regulates the growth of the

plant; according to Daudres it regulates the functions of the blood; according to Mussart it regulates some functions of the human eye as well as the life of the most deadly infectious poisons, like the typhus bacilli.

Since then literature on the same subject has appeared which might fill a new and most interesting volume, in which the most startling fact up to the present would be the fact realized here by that splendid discovery of Professor Loeb, that the act of fertilization in lower organisms, as sea urchins, may be substituted by a given increase in the osmotic pressure of the surrounding medium.

And I may well quote in conclusion his summary that: "At no time since the period immediately following the discovery of the law of conservation of energy has the outlook for the progress of physiology appeared brighter than at present, this largely being due to the application of physical chemistry to the problems of life."

J. H. VAN'T HOFF.

PSYCHOLOGY AND THE MEDICAL SCHOOL.

IT requires only a minimum amount of consideration for a person thoughtful of the matter to recognize that in the most essential meaning of the proposition, psychology is the most fundamental of all the sciences: psychology discusses the mental processes whereby all perceptible nature is perceived. As long as men continually and of necessity study each other, subject and object alike in modes of consciousness, that body of related facts and principles concerning mind will remain basal, and, consciously or unconsciously, universal. Chemistry, for example, treating of the composition of matter, arrives at its analyses only through mental processes which it is the business of psychology to explain and to facilitate. Astronomy tells us of the planets and the stars, but the astronomer who is

consciously or unconsciously nothing of a psychologist may readily deceive not alone himself, but the scientific public, as has happened more than once. To the psychologist no longer 'seeing is believing,' as the ancient adage runs, for the nature of man unfolds itself apace and shows fold within fold undreamed.

Yet on other grounds than these, which are theoretical and philosophic, lies the interest of the science of psychology to all who have the opportunity to intelligently learn its principles—men and women value it and usually become more or less absorbed in it because it describes themselves, and, ever more successfully, attempts to explain what is and must ever be the most regarded of subjects to every agent, namely himself, as individual and as social unit. The biologic egotism implanted deep in every soul sees to it inevitably that all one's life, whatever the social status or the life-pursuit, that soul shall study continually itself, with however apparent indirectness or however elaborate the social system of real or hypocritical altruism may be. Indeed, altruism has nothing to do with the deeper aspects of the interest in question, this interest being beneath all altruism, in the organic mechanism. The degenerate criminal and the flower of ethical manhood play alike on the same fragile instrument, one miserably and the other with far better harmony; this instrument is consciousness and the changes that it manifests are constant in one only thing—it is I, I, I, the type, the sum. It is chiefly on this account that psychology is an interesting science.

But besides being the basal and an eminently interesting science, psychology is a sound science, 'new' but soundly scientific, a thoroughly self-reliant and deep-set department of systematized human knowledge. In substance older than Thales, known as methodical since Aristotle, yet

every century has added alike to its mass and to its dignity as a science, every year of late has better shown its interpenetrating relations with other topics of learning and dug its foundations ever deeper into the rock-based ground of human knowledge. From one point of view the science is sometimes at a relative disadvantage because it merges in its upper rarefied air with metaphysics and 'divine philosophy,' so that some have left it in their eagerness to loiter on the paths less fixed, less final; let us hope their wings will bear them there. It is as if the astronomer should become a dreamer wandering among his stars, hoping thus best to make out the almanac or to satisfy the yearning curiosity animating all men on the humble earth. In psychology as in astronomy it is the workers who count most, men and women to whom a sphygmograph or a chronoscope is an instrument as dignified as the pen which writes without experimental mediation the reasoned imaginings of the seer.

But there is a class of persons who harm the fame and progress of psychology among the mass of average men, and the injury these do is devoid of any sort of recompense. These are the irresponsible multitude who know little or nothing of science and who have no desire to know, quite, nay more than, satisfied if in one or the other of a host of shiny masks they can fleece a willing public either of their dollars or their sense, succeeding ordinarily in abstracting both at once. These are the 'mental healers,' the 'metaphysicians,' the 'Christian scientists,' the 'psychologists,' the astrologers, the palmists, the 'mediums,' and their ilk, all of whom more or less of the public consider in some way or other allied with the science of psychology. Mysticism of this grade is for the scientific student an absorbingly interesting topic of research, leading him meanwhile to wonder and to pray—wonder at the shal-

low deeps of the human mind, pray for the day to hasten when education shall be for all men, share and share alike, each according to his needs and his ability. Psychology bears the brunt, necessarily, of many a false system and falser creed whose names any who reads the signs along the pavement may learn full easily, the list above containing some of those most known. But the science of psychology looks on with serenity, complacently expressed with the consciousness that phenomena like these are part of its own subject-matter, to analyze and to explain. It is the public who are fooled and who wish to be, and them in turn, as the loci of ever-recurring phenomena, psychology studies and characterizes. Deplorable indeed is the ignorance of the mass of men, even in America, concerning this science. To many the name means psychical research, to others some phase of mental healing, to others something, which, chiefly because spelled p-s-y-c-h instead of s-i-c-h, can never come within their knowledge, to others, finally, nothing whatever for they never heard the word.

But even among the educated, too often the notion of this science is such that it is not valued at its proper worth, because its *practicality* is too little understood. Here is suggested one of the future duties of the psychologist—it is time that he demonstrated to the world, the great world as well as to the lesser world of letters, that psychology is properly a very practical science, thoroughly useful to the average man. It is on this basis alone that it is worthy of life. A science seemingly should not be classed with belles-lettres or with pure philosophy, as the means of satisfaction of man's eagerness for abstract knowledge or for an understanding of the æsthetics of existence. These things may in one sense be more than science, but they are at the same time in a different sphere and incomparable. The

progress of the race depends not on the products of pure reason ; did it so depend Plato and Kant would be more than names to the millions of our countrymen, and this splendid Greek of so long ago would be the world's idol in the place of the men who have *done* things and who *do*. Men at large desire science rather than philosophy, for to them rightly the sciences mean progress in living ever better and more easily. Utility is and must remain the unchanging standard by which a science, like all other things in the last resort, is measured. This fact many psychologists apparently have overlooked, so brief at present has been the time since their science freed itself, by working out the outlines of its proper sphere, from the conservatism of philosophy. Right well and exceedingly is psychology fitted by its subject-matter to demonstrate and then to enlarge its human usefulness. By necessity of the 'struggle for existence' (so inevitably often emphasized in every sociological discussion), all men are psychologists and not less so that only one in a million thinks of himself as such. Somewhat in proportion to his practical success as a psychologist, consciously or unconsciously, in proportion, that is, to his knowledge of his fellow-men and of himself, does a man or woman succeed in life. It means more than anything else this wisdom in human nature. The schoolboy knows his teacher more or less well as he recites to him or seeks to win his favor ; the candidate for the doctorate very likely has studied the faculty only less than his research, and at the time when each word counts he uses well his information. The merchant studies the man from whom he buys his stock, and doubtless still more carefully the 'market,' which is only a convenient term for the balance of the hour between merchandise and men's desire therefor. The business man depends even more largely on his knowledge of human nature in his dealings

with a public which is always more or less suggestible. The actor studies humanity that he may imitate it, the conjurer that he may deceive it. The judge in court is pre-eminently a practical psychologist, the policeman less so, while the value of the jury system and the virtue of a particular juror often depends directly on the jury's rightly weighing the human probabilities of motive and of action. Such values are practical and real.

But more than others, if possible, 'professional men' should be good, that is, practical, psychologists. They should understand completely the psychophysical nature of men and women to be successful. The clergyman must preach the Gospel, but he must preach it both in the spirit of the times and in the spirit of his hearers—not preaching hell-fire when the advancing rationality has put hell-fire forever out and named it cruelty ; not preaching sermons two hours long when men in general might fairly be satisfied with half-an-hour. So too the lawyer (and in a perhaps even larger degree) must be a psychologist, whether he knows it or not, if he is to please his client and enlarge his practice. He must know well the relative value in a particular man of feeling and of cognition, must value rightly his client's strength of will and perhaps his cleverness under cross-examination. In every phase almost of the lawyer's professional life his knowledge of himself and of man in general forms his chief stock-in-trade. The lawyer's success largely depends on his acquaintance with man's mind and how it works—his science above all is the 'science of the soul.'

To medicine, the third of those pursuits long classed as professions, we now turn to see how, in a more immediate way than has so far been considered, psychology is naturally related to it. Like other men, the physician is of course a practical psychologist so far as his native instincts lead him

to become so. For reasons, however, which will be pointed out below, the medical man needs a more exact and systematic knowledge of the relations of the human mind than the hereditary common wisdom of the race provides him with, while at the same time his opportunities for acquiring this knowledge at present are either entirely lacking or quite impracticable for the average practitioner. It is a fact that the men who, for the public benefit, require the largest amount of insight into mind and its relations with body, have had thus far the least convenience for acquiring it. This condition is probably a relic of that same ancient fallacy so very frequently encountered everywhere, that material objects (here the tissues of the body) are more real and more important than things which are immaterial, ideas and emotions and the determinations of the will. Yet most old men and women would tell you that these latter things had influenced their lives far more than matter of any sort whatever. For every person maimed by a material accident a dozen are maimed by some one's will or emotion or idea.

The physician needs some direct acquaintance with the science of psychology, because, in part, he is properly the self-elected teacher of the public, and to every teacher, of whatever sort, psychology is by reason of its nature necessary foundation-knowledge; to argue otherwise is sophistry, convincing to none. The average physician, that is to say, most physicians, are not teachers of the public in hygiene, physiology and general prophylaxis to half the measure that they might be, some from inability, some from thoughtlessness, some from 'inertia,' some possibly from indisposition so to do. But this duty of the medical man is a privilege and its compensations out of proportion to its costs. Herein lies the general affection for the old-time family doctor, the most contented and best re-

quited of his profession, the friend and confidant rather than the hireling of his neighbors. Practical psychologist that he was, when he entered a house, patient and household at once felt better even though death were near.

In ways, however, more immediate to his cases than in this position as medical educator to the public does the physician need to know the principles of modern psychology in a broad meaning of the term. He requires it because always in his practice he is concerned with living and social organisms who invariably are compounded of *both* body and mind. As regards the wholly obvious necessity of acquaintance with the normal mind for the many medical graduates who pay chief attention to mental and to nervous diseases, much might be said, although little will be, here. Even these, alienist and neurologist (although usually versed more or less, late or soon, in the substance of empirical psychology, while some are competent and even distinguished psychologists), even specialists in the mind, have at present no adequate opportunity to learn the substance of the science in a thorough systematic way. Many of our distinguished alienists have enjoyed a general college education and some have been led by the psychology learned meanwhile to 'specialize,' when their medical degree was acquired, in the diseases of the mind. But these educational privileges are relatively infrequent and with our present system of college education must remain so some time, most medical schools being not yet, by probably many years, post-graduate institutions. Yet insanity appears, by reliable statistics, to be on the increase; and to meet the certain demand for the care and proper treatment of these patients, a larger proportion of all medical graduates will, by economic principles, devote their attention to this most important branch of therapeutic science.

To meet the necessities of this class of practitioners alone the establishment in the medical schools of courses in normal medical psychology is urgently demanded. To graduate a psychiatrist without this knowledge is like pretending to qualify a general practitioner without teaching him physiology. Exceedingly few of the graduates, eager to get at actual cases, and the best of them soon enough crowded for time, will or can take up the long-drawn unadapted psychological courses in the universities and colleges, nor, did they desire to do so, would funds be often at their disposal, the debts of the young doctor being often, as it is, quite sufficiently appalling to the young man anxious then to earn as fast as possible. For the sake of these men alone, then, courses in medical psychology should be provided where alone they will be studied with the splendidly productive medical-student eagerness and attention.

The education given, or rather sold, to the medical student seems in general, however, too grossly materialistic, too somatic. He learns but one side of this two-sided story; from the first year to the fourth, from the dissecting room to the gynecological or otological clinic, the routine student sees and hears of muscles and bones, and viscera, sense-organs, nerves and vital fluids, but little, unaccountably little, of that other aspect of men and women which to these very men and women is their life, while these other, these organs, are but needful instruments of that life's attainment. And their point of view, it need not be said, is also that of philosophy; shift it, and illogical confusion follows. The layman cares little or nothing for his stomach's condition so long as it gives him no pain and takes good care of what his will and his appetite lead him to supply to it. The woman in search of a happy family life thinks seldom of her reproductive mechanism so long as it gives her healthy children whom she can love.

There is something besides cell-built tissue for the gynecologist in charge of an operative case to consider when of two women, alike in vigor, who undergo identical ovariectomies, for example, one goes in three weeks from the hospital a new woman, cheerful, capable and happy, while the other becomes an hysteric wreck never perhaps to equal her former self in happiness or in health. As every surgeon knows, such differences are met continually and they puzzle him. Why is it that present medical education takes no account of the principles underlying phenomena like this? So far as the student is concerned, the course, four years or three years long, quite ignores in general the emotional and temperamental factors which in one way or another, directly or indirectly, less or more, enter into almost every chronic case and into many of the acute cases which the general practitioner is called upon to treat. Instead of striving to teach the student what conditions underlie mental habits and idiosyncrasies, medical instructors are now content practically to ignore them, regardless of possible great benefits to come from their study as psychological data. Too often is the medical man the most materialistic-minded member of a community, when his view should be much deeper, into the controlling forces of life. This is the natural outcome when in a long medical course no part of the individual is presented to the student except what he can feel with his hands or see through the microscope. Yet how commonplace is the assertion that the man, the real man or woman, is not his or her body, but the will, affections, habits, character, of the individual, while (what is more immediate to our argument) these same aspects of consciousness are often the direct molders or destroyers of disease and, as one side of an inseparable psychophysical organism, have more control or influence over the functions purely somatic

than the average practitioner of medicine appreciates. Not mind controlling body nor body controlling mind, but both together always sensitive to the stimuli of a common environment combined into the actual individual.

The conventionalized and systematized knowledge of conditions thus important in treating disease is a portion of psychology. Crude indeed are its names and its conceptions as crystallized in names compared with the empirical reality, but it is of necessity that they are crude and only representative or symbolic that a science may be constructed and discussed. A new medical psychology adapted to its special usefulness would very soon develop a terminology of its own, fitted to the case. The term temperament, for example, vague and little really explained by general psychology, would, as a subject in medical psychology and in the minds of physicians, soon take to itself more explicit meaning, adapted to its use. By this natural process of specialization of sense medical psychology would suffer relatively little from that variation in meaning among different writers, from which general psychology (from the abstract nature of its matter) suffers much misunderstanding within itself. By thus fixing the meaning of certain terms, and that probably in more or less direct relation with concomitant somatic conditions, medical science would do a distinct service to empirical and physiological psychology, and more substantially than any dictionary could do it.

A normal medical psychology, to be at once scientific and comprehensive of the field, would very likely set out with a relatively brief exposition of genetic and of empirical psychology, discussing thus in certain and uninvolved terms the classification of mental processes under cognition, feeling and will in the ordinary elementary way. The more physiological in nature the treat-

ment of this portion of the subject, the better would the medical student connect it with his knowledge of the body gained earlier in his course. With these principles of the science as a basis and point of departure into allied branches of science, the topics more immediately practical to the physician might be taken up in a series as much unified logically as possible. In this, the immediately practical portion of the work, the field would naturally and necessarily spread out somewhat so that it would be important to enter briefly at times into anthropology (anthropometry especially, perhaps), criminology and certain departments of biology, notably that regarding the heredity of mental traits. Still, obviously, the greater part of the discussions would lie strictly within the domain of psychology as it is empirically studied to-day, using for its own purposes, as it does, the products of many different varieties of scientific research.

The topics of medical and surgical importance which such a course might examine into with benefit and interest are very many, as any medical man will recognize. They are subjects such as those below are examples of, placed here almost at random so far as order is concerned, namely, temperament, mood, idiosyncrasy, pleasure, pain, emotion, anæsthesia, hypochondriasis, dynamogeny, will power, sleep, subconsciousness, habit, sexual, racial and epochal differences, suggestibility, hallucinations and other scarcely abnormal phenomena of the sense-organs and their neural centers. To mention only suggestibility, the habits and sexual psychology out of this list will perhaps be sufficient to show how important a course treating of such topics might be made by a competent man. Continually is suggestive therapeutics taking a larger share in the treatment of certain chiefly psychical diseases, and to explain its nature, uses and limitations is to equip every physician

better than now he is equipped. Again, who could exaggerate the importance of the habits in causing misery and in curing it? And lastly, in these days sex is taking ever more rapidly its proper place in the science of 'things as they are,' monstrous often to the layman, and properly, but to the physician natural and preeminently important. A widely related discussion of such topics as these, it seems to the present writer, would furnish to a medical student of the necessary mental development, facts and relations as important for his professional purpose as most of those which are at present taught him. Such a course would do much to supply the lack of knowledge of man's dual nature, which, as has been sufficiently suggested, usually obtains in the average physician. This would be its chief value in a medical curriculum, but not its only one. It would also supply that needful amount of psychology which would allow the usual courses in psychiatry and neurology to be better appreciated and more completely understood, especially of course as concerns those conditions, such as hysteria, neurasthenia, paranoia, dementia paralytica and the rest in which a purely 'mental' aspect is often or always prominent. It would help to make such conditions really understandable so far as their description at least is concerned, whereas at present, the ideal disturbances, notably in paranoia (very commonly met with), are far beyond the understanding of the medical student, for lack of acquaintance with the theory of normal ideation. It would make such conditions seem like scientific problems pressing for his solution rather than like mere arbitrary sets of ill-understood events which he must learn by rote and the memory of which, when occasion offers, he must mechanically apply.

In form such a subject might easily be comprehended in a course of weekly lec-

tures during the former half of the fourth year of the medical curriculum, either elective or required. It need involve of course no laboratory work, nor would this be fitting, sufficient demonstrations being used to illustrate certain points and to increase still more the students' interest.

It is not difficult to understand why something of this sort has not already been introduced, instruction which would impart the suitable product of the progress in these directions in the last few years. The progressive spirit of the various medical faculties has been employed of late, for the most part, in establishing departments of bacteriology, pathology and experimental physiology, and in enlarging various modes of clinical experience. These have now in all schools of the first class become flourishing departments, demonstrating well their importance. Thus other fields have naturally been neglected in these new years of the sciences of the bacteria. It seems time now that the growing energy of the medical schools should look around more widely and realize, with practical benefit, that if emotions cause at times disease as well as the bacteria, so it is equally important that the conditions of the one should be taught the student as well and as certainly as those of the other. Not at once as a universal means of progress will this enlarged and more scientific mode of viewing every patient be shown the student of the medical sciences, but assuredly it will come, and in some form not wholly unlike that which has here been all too rudely sketched and for reasons similar to those here pointed out. Such a course by a psychologist of wide interests and information among branches of learning of allied aims, a medical man if possible, would seem to be worthy at least of trial in every medical school whose avowed purpose it is to provide its graduates with a knowledge of men as they are, and not

alone to furnish them with the science of one-sided and therefore false somatology.

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TUFTS COLLEGE MEDICAL SCHOOL.

*THE BOTANICAL WORK COMMITTEE.**

A BLUE-BOOK (205) of 247 pages has been issued containing the report of the committee on botanical work and collections at the British Museum and at Kew. The Committee was appointed by the Treasury on February 1, 1900, 'to consider the present arrangements under which botanical work is done and collections maintained by the Trustees of the British Museum, and under the First Commissioner of Works at Kew respectively; and to report what changes (if any) in those arrangements are necessary or desirable in order to avoid duplication of work and collections at the two institutions.' The chairman of the committee was Sir Michael Foster, M.P., and the other members were Lord Avebury and Mr. F. D. Godman, representing the Trustees of the British Museum, Mr. S. E. Spring Rice, C.B., Mr. H. A. D. Seymour, C.B., Professor I. B. Balfour, Queen's botanist for Scotland, Mr. F. Darwin, reader in botany in the University of Cambridge, and Sir John Kirk. Mr. B. D. Jackson, secretary of the Linnean Society, was afterwards appointed secretary to the committee. The report opens by pointing out the essential differences between the Botanical Department of the British Museum and the Royal Botanic Gardens at Kew.

The former is a collection of such objects as can be placed in a museum, and is not concerned with the applications of botany; whereas the latter, besides constituting a public garden, is an organization which gives assistance to the government on questions involving botanic science in all parts of the Empire. Both possess herbaria with

libraries attached; and the two herbaria, though each possessing some special features, are to a very large extent duplicates of one another. This duplication of specimens entails, of course, a duplication not only of housing room, but of scientific work and of the scientific staff; and the existence of this waste is a strong *prima facie* argument against the maintenance of the collections in their present form. The report observes that the question of amalgamating the two collections has been considered by committees again and again, and after considering the arguments urged on both sides, the Committee, with the exception of Lord Avebury, pronounce in favor of their union. Their report discusses at length the possible methods of union, the relative convenience of Kew and the British Museum as sites, and the question of constituting a special advisory board, on which the Trustees of the British Museum should be adequately represented, in the event of the removal of the greater part of the British Museum collections to Kew. The recommendations on these points are summed up as follows:

(1) That the whole of the botanic collections at the British Museum now administered by the Keeper of the Department of Botany under the Trustees, with the exception of the collections exhibited to the public, be transferred to the Royal Botanic Gardens, Kew, and placed in the charge of the First Commissioner of his Majesty's Works and Public Buildings under conditions indicated below, adequate accommodation being there provided for them. (2) That a board, on which the Trustees of the British Museum, the Royal Society, and certain departments of his Majesty's government should be directly represented, be established in order to advise on all questions of a scientific nature arising out of the administration of the gardens, the powers and duties of the

*From the London *Times*.

board, its relations to the First Commissioner and to the Director, as well as the position of the latter and the functions of the gardens, being defined by Minute of the Lords Commissioners of his Majesty's Treasury. (3) That the illustrative botanic collections now publicly exhibited at the British Museum be maintained, and, so far as it is possible and expedient, enlarged and developed with the view of increasing popular interest and imparting popular instruction in the phenomena of the vegetable world, and be placed under the charge of an officer of adequate scientific attainments, responsible to the Director of the Natural History Departments. (4) That upon the transference of the botanic collections from the British Museum to the Royal Botanic Gardens such arrangements be made both in respect to the accommodation of the collections and the staff administering them that they shall fully serve the purposes which they have hitherto served. (5) That the botanic collections consisting of fossil plants, now in the charge of the Keeper of the Department of Geology in the British Museum, be maintained for the present under the same conditions as heretofore. We desire to express our warm appreciation of the valuable services which have been rendered to us by the secretary, B. Daydon Jackson, Esq., secretary of Linnean Society. Not only has he performed his duties as secretary with great zeal and ability, but also throughout the inquiry we have repeatedly derived great assistance from his very intimate acquaintance with the botanic collections under our consideration, as well as from his wide knowledge of botanic science and literature.

This report is not signed by Lord Avebury, who cannot concur in recommending a removal of the British Museum herbarium to Kew, for the following reasons:

It seems, no doubt, at first sight, an an-

omalous arrangement that there should be two national herbaria; first, on account of the expense; and, secondly, because botanists in some cases have to consult two collections instead of one. But the evidence shows that the saving of annual expense through the suggested fusion would be small, and that the initial outlay for building, cabinets, etc., would be heavy. The alleged inconvenience seems to me to be exaggerated and affects only a few of those engaged in systematic botany who are thus obliged to consult two herbaria instead of one: while, on the other hand, to those engaged in other departments of botany, the existence of the two herbaria is an advantage. I deprecate the proposals contained in the majority report for the following reasons: (1) The British Museum is the greatest museum in the world, and is justly the pride of the nation. To dismember it, by depriving it of so integral a part as the Botanical Department, would be destructive of its unique character as a fully representative museum, and specially of a natural history museum; would be vehemently opposed by many, if not most, British botanists, and, as it seems to me, would be a great injury to science. (2) To London and country botanists the British Museum is much more accessible than Kew. (3) The plan proposed would separate the fossil from the recent plants. (4) It would involve the creation of a new board. If, on the other hand, Kew Gardens and the British Museum were brought into closer relations, as recommended in the report which I have signed in conjunction with Mr. Seymour, several advantages would result; for instance, the officers of the Museum would have access to the living plants; while those of Kew Gardens would have access to the British Museum library and the collection of fossil plants.

Lord Avebury and Mr. Seymour also ob-

ject to the constituting of an advisory board. They say :

If we were starting *de novo* it seems obvious that the whole of the national biological collections in and near the metropolis would be placed under one management. The Trustees of the British Museum are established by statute, and are partly selected and partly *ex-officio* members, more than one-third being high Ministers of State. Those to whom the active duties of management and superintendence are entrusted possess special knowledge in the various subjects illustrated by the collections, and they appear to us to be more fitted both by their experience and their position in the scientific and cultured world to be the governing body of the amalgamated botanic collections at Kew than any other that can be built up in their place. If those collections form part of the British Museum, the Director at Kew would become an officer of the Trustees in the same manner as is the Director of the Museum at South Kensington. It is true that in the report it is stated, 'Were Kew placed under the Trustees of the British Museum, unless their control were a merely nominal one, a thing in itself most undesirable, the demands of the Colonial, India and Foreign Offices on the resources of Kew would be subject to the control of the Trustees, a situation fraught with difficulties and dangers.' This assertion does not appear to us convincing. No example is quoted of these difficulties, the dangers are not indicated. It is far from clear why one controlling authority is more likely to produce them than a lay authority and a scientific authority with an advisory board interposed as a buffer between them. * * * We feel that the introduction of a new board such as is proposed is at least as likely to produce friction and difficulties as the present authorities, and will tend to weaken responsibility, and on this account,

as well as because we do not attach much reality to the 'difficulties and dangers' which would arise from the substitution of the control of the Trustees of the British Museum for the present control, we dissent from the second recommendation of this report.

THE FUNCTION OF THE STATE UNIVERSITY.

WHEREVER in this paper the word university occurs, it means State university; wherever the word college is used, it means a private or denominational institution. Let me describe the function of the State university as it appears to me.

I. It should be *within* :

- a. Non-partisan, but patriotic to the State and to the Nation ;
- b. Non-sectarian, but religious ;
- c. Free as to tuition in all departments, academic and professional ;
- d. Every inch a university.

a. While the obligation named first binds every institution of learning in our country, it binds the State universities in a peculiar degree. Their foundations are federal land grants. The funds for their maintenance come from their respective commonwealths. In the highest and broadest sense they should be nurseries of patriotism, but they should shun partisan politics as they shun death.

b. Non-sectarian, but religious.

The State universities have not yet realized their opportunity for developing in students a life that is religious and yet not sectarian. Freedom from denominationalism is apt to be construed as license to subordinate unduly religion in education. No good reason appears why the universities should not each maintain one professor at least to lecture upon sacred literature, natural religion and practical morals, and to serve as chaplain of the students. If, unfortunately, the law or Constitution forbids such teaching at public expense, an appeal should be made for an endowment

by private benefactions. What a blessing for a long time has Dr. Peabody been to Harvard. Such a man ought to be at every seat of higher learning.

Moreover, why should not a large State university maintain a department of theology, without which it is not complete and which does not belong necessarily to any denomination. In Germany, in spite of an established church, theology is non-sectarian. Men of all creeds go there for training. Why should not our American State universities show that ethics, religion and even theology of the highest and best type may be divorced entirely from denominationalism?

c. Free as to tuition in all departments, academic and professional.

This proposition ought to be established by the mere statement that in every commonwealth the university is the head of public instruction, which is free up to the higher learning and ought to be free there also. The reasoning that people have indulged in as to free tuition is very curious. In early times the doctrine was preached that schools should be maintained at public expense, but should be limited to the elements of learning—reading, writing, arithmetic, geography and United States history. A little learning the public might give the individual, but no more. After strenuous opposition, this doctrine was established in New England, in the Middle States, in the West, and finally in the South. Then came the second step forward, in which in many places high-schools were smuggled in. In Kansas City, for example, the first high school, now one of the best in America, was for years maintained surreptitiously. Later the people throughout the union came to the belief that a chance at secondary education also, without charge for tuition, was due from the commonwealth to every soul on its soil; but it was still argued gener-

ally that college or university training should be paid for by the individual. Not long ago, some Western States reached the third stage of progressive belief that free instruction should be given through the college of liberal arts, but that professional training should be paid for. In the process of evolution, however, the fourth era is near at hand, in which it will be recognized, I think, that the discrimination between academic and professional instruction is wholly specious. If it be granted that the State owes to every soul on its soil a chance at free instruction through the college of liberal arts, by what legerdemain of logic can it be denied in medicine or engineering? In these so-called professional courses perhaps half the studies are academic, and the other half are applications of the academic. Is it reasonable for the State to teach a man freely physics, chemistry, mechanics, drawing and mathematics, but refuse to teach him freely their applications to engineering? Should one learn at public expense, such academic subjects as physics, chemistry, neurology, embryology, anatomy, histology, physiology, physiological chemistry and bacteriology, but learn at personal expense their applications to medicine? All such reasoning is to my mind artificial. It is said that law, medicine and engineering are gainful pursuits, and, therefore, the beneficiaries should pay for training in them. The argument is not worth refuting, but, if it were, it might be pointed out that bachelor of arts is a gainful degree. Moreover, academic graduates are not more useful to the people than are lawyers, physicians, pharmacists, dentists, engineers, etc., of superior quality. As soon as you admit that the commonwealth must furnish its people free instruction in any degree you are compelled to admit that it must furnish free instruction in every degree and in every useful form. But the same argu-

ment, it is said, might be advanced for free clothing or board or books. To my mind this does not follow at all, but if any man will demonstrate that they should be furnished in any stage of education, it would be easy to prove that they should be furnished in every stage thereof and in every useful form.

It is questionable whether, in view of the superb training at Harvard, Massachusetts is bound to found a free university, but in my opinion she is bound to give her citizens that desire it and are prepared to receive it free instruction in some accessible university of high rank. Whether free tuition should be extended by one State to citizens of another is a question that I will not now discuss. Those who, like the writer, exalt the Nation above the State will favor it.

In closing this division of my subject let me say with emphasis that free tuition in any department without high standards of admission and of graduation is akin to crime.

d. Every inch a university.

There is danger that through eagerness to take in new territory, to swell enrollments, and to provide instruction for special classes, some of our universities may forget that to deserve richly their titles is the highest obligation they owe to the people. Policies of expansion and adaptation are sometimes commendable and occasionally are forced upon us by circumstances, but they take money and subtract from the energy due to higher teaching. Never should they be allowed for a moment to obscure the main purpose, which is to be from circumference to center a great university. Particularly objectionable is the tendency too often exhibited to swell enrollments by adding professional schools in the nearest metropolis. These *morganatic* unions rarely bear good fruit. A university is much more than a college or an aggregation of them. Its great work is graduate and pro-

fessional studies based upon an academic degree. To attain this end is far harder when the work is not concentrated on one campus.

II. The university *without* should care for the State and should serve as a buttress to a National University.

It has been preached strenuously that the State should care for its university but scarcely has the idea been broached that the university should care for the State. It is possible to do this in a variety of ways, in material, in social, in political and in spiritual things. The possibilities in spiritual things have been discussed in the second paragraph of this paper. What can a great seat of learning do for the public good in other directions?

a. Through the College of Agriculture, or in conjunction with it and other public agencies, it should look after the material welfare of the people.

The loftiest learning should not scorn to help men in their material interests. If in its laboratories a dietary can be discovered whereby the fattening of swine is made cheaper to swineherds, the university should promulgate that dietary. The Babcock Milk Test, discovered at the University of Wisconsin, has been a blessing to dairymen in all the world, and almost as beneficial to another class of husbandmen has been the discovery in the University of Missouri of a method of inoculating cattle against Texas fever, whereby the mortality in blooded animals carried south has been reduced from ninety to less than eight per cent. Our colleges of agriculture have devised better dietaries for domestic animals than the wit of medicine has yet invented for growing children.

Expeditions have been sent out by our universities to measure accurately remote water power and to survey routes for transmitting it electrically to railway stations; to measure beds of coal and test their ther-

modynamic values; to measure beds of cement and quarries of stone and try their quality; to collect flora, fauna, rocks and minerals; and for other useful purposes. The results, carefully tabulated, have been widely distributed. Diseases of animals and plants have been held firmly in check. What has been done shows what may be done for things material by the scientific skill of universities. But what has been accomplished has been mainly along the paths prescribed by the United States, in the Hatch Act, establishing Agricultural Experiment Stations. Except under federal leadership, our universities have not done very much, I fear, for the material welfare of the people, when one considers the immense possibilities.

b. In collaboration with State boards, bureaus and commissions, the university should look after social and economic conditions.

How many States can point with pride to their penal institutions—their jails, penitentiaries, reformatories, almshouses, tenement houses and asylums? Yet the university of each commonwealth perhaps maintains a chair of sociology. On the campus are students from every county. In their summer vacations they could visit every reformatory and eleemosynary institution, reporting accurately its condition. A judicious publication of the results, with a statement of fundamental principles, would lead often to radical reforms in the treatment of the criminal and defective classes.

No State is without municipal problems and few can boast of a rational system of taxation. Why should not the department of economics take up these subjects? If the professors understand what scientific taxation is, why can they not apply it wisely to prevailing conditions? The wisest teaching of political economy in municipal problems should be spread broadcast. The

Federal Government maintains in every commonwealth an Experiment Station to find out what is wise in agriculture and to disseminate among the people the knowledge gathered. The departments of sociology and political economy ought to be experiment stations after their kind in the full meaning of the Federal Government, and the university should not begrudge the cost of publishing and distributing among the people whatever information may be necessary to enable them to adjust wisely their systems of taxation, to solve municipal problems, and to improve the condition of their penal institutions, reformatories, asylums, almshouses, tenement houses, etc. It is the function of a university to investigate, to teach and to publish.

A painstaking study of the State laws, in the light of the broadest learning and in comparison with other codes, if embodied in timely publications and spread broadcast, would not be without good results anywhere. The achievements of David Dudley Field in this direction are well known.

The early history and archeology of every State is an inviting field for investigation, while the editing of early local writers of the better sort might well employ some of the literary skill of the faculty. A *spicelegium* in some cases it might be, but in every case it would be valuable.

The departments of chemistry, sanitary engineering and medicine find a wide field of usefulness in things pertaining to public health: pure foods and drugs, pure water, good sewers, the ventilation of buildings and so on. In this broad direction it is possible by scientific work and by helpful publications to diminish sensibly the rate of sickness and of death.

c. In cooperation with boards of education and the State Superintendent the university should build up the schools below it.

The writer has talked on this subject so often that he feels inclined now to dismiss it hastily. Elementary schools cannot be brought to efficiency, unless there be high-schools to lead them, and high-schools cannot become ideal without the help of a university. The whole system of public education from the kindergarten to the graduate department, and through it, should be strongly knit together. This principle is accepted universally, the chief discussion being about instrumentalities. My own experience causes me to place high value upon examiners of schools appointed by the university. The examiner should be an instructor or assistant professor of pedagogy, and should lecture sometimes on the campus. In large States it might prove convenient to have an examiner for town high-schools, another for rural schools, and a third for elementary schools. The examiners should all be extension teachers of practical pedagogy. Their function is not so much to examine as to build up. If the university will pay for the cost of this service, the money will come back two-fold. As an example of what may be done by an institution for the schools below it, let me point to the University of the State of New York. Few universities could engage in all its manifold work, but according to our means we should adopt its best methods. Traveling libraries and galleries and extension lecturers as well as examiners of schools are educationally important means of grace.

Moreover, the university is not without obligation to the private and denominational colleges which, chartered by the State and protected by its laws, teach a large percentage of the educable youth. It is a blunder of the first magnitude to assume towards these colleges an attitude of hostility. One of the best things that we have tried in Missouri is the College Union, consisting of the University, and of every other

respectable institution of higher learning. At the meetings, held at each institution in succession, we discuss common problems, talk of common troubles, and help one another to the common end—the uplifting of the people. In spite of provoking opposition occasionally from the churches, any university should be held largely responsible if bad feeling continues between the denominational colleges and itself. Stepping grandly over small animosities, it should remember that, while officially it is the head of public instruction alone, in a broader sense it should be the loving helpful head of all sound education in the commonwealth.

The State university should serve as a buttress to a National University.

Education will not be complete in these United States until we have at Washington a national university with State institutions as its buttresses. Some day our education will conform to our system of government. I for one would not be willing to see institutions of any class enjoying privileges in the national university that are denied to other institutions of equal or superior grade, but close affiliation between the State and nation seems inevitable in education also.

In conclusion let me answer some possible objections to the positions taken in this paper as to the outward obligations.

Should the university invade the provinces of the boards, bureaus, and commissions—the Geological Survey, the Natural History Survey, the Health officers, the Tax Commission, the Superintendent of Public Instruction, and the College of Agriculture and the School of Mines, if, unfortunately, these stand on separate foundations? If the interests of the State are adequately served by others, the university might let well enough alone. Under no condition should it officiously invade the territory of any officer or organization appointed by

the State. But ninety-nine per cent. of the difficulty will disappear if only the university will do the work admirably and let others take the credit. If the purpose be to promote public welfare why should one care who gets the praise? In every instance, hitherto, in the writer's experience, the scientific, philanthropic and statistical departments of the State and the nation have been eager for cooperation, wherever the university has demonstrated ability to do work superbly, and in most cases they have supplied the money. Besides, it is one thing to appoint commissions and quite another to induce them to fulfill strenuously the purposes for which they were appointed. Many a yawning gap of deficiency in public officials may be quietly bridged by the patriotism and skill of the university, which should be the eye of the people, searching in every direction for opportunities to serve their welfare.

Will not the discussion of social and civil questions embroil the university in partisan politics? The most important problems of sociology and politics are not often embodied in State platforms, which usually consist of the national structure with a few more planks lauding one party and vilifying the other.

Do you ask where the money for all this is to come from? False to the core is the idea that the resources of a university are solely for instruction on its campus. The administration has no right to wait always on needed investigations for special appropriations from the Legislature. It should rather assume that in part the income must be consecrated, as need arises, to promoting the public good wherever it can be reached by scientific skill. Ultimately no use of money will pay better, even as an investment of capital. At last, we are not required to do more than our resources permit. It is the spirit that maketh alive. The important thing is for the university to

construe its functions liberally and to choose intelligently what can be done now and what should be postponed. Time as well as money is necessary for perfect performance of its whole function.

In conclusion, let me say that the State University, founded by the Federal Government and supported by a mill tax upon the property of a great commonwealth, with broad outlook and intense devotion to the welfare of the people, can be made the best institution yet devised by the wit of man for the promotion of human progress. University mottoes are sometimes inspiring, but the one that appeals to the writer most is from Cicero, *De Legibus*—'Salus Populi Suprema Lex.' The welfare (*salus*), construed broadly, is coextensive with public interests, which, beginning in the soil of earth and rising through human society, mount upwards finally to the Kingdom of Heaven.

R. H. JESSE.

SCIENTIFIC BOOKS.

Le système métrique des poids et mesures. Par G. BIGOURDAN. Paris, Gauthier-Villars. 1901.

A hundred years have passed since the inauguration of one of the most important reforms yet undertaken by civilized man, considered as to its far-reaching effects upon social, economic and scientific interests and conditions. Although the establishment of a universal and uniform system of weights and measures among all enlightened nations is not yet an accomplished fact, that most desirable end is so nearly reached that no reasonable person can for a moment entertain a doubt as to the final result. Only two great nations, constituting the English-speaking people of the world, still hold out against the irresistible movement in favor of uniformity of standards and they are both wavering very decidedly, preparatory to the inevitable yielding which the most thoughtful of their people are endeavoring to hasten. During the last decade in both England and America popular interest in the subject of

metrological reform has been unprecedentedly great and there is a general conviction that abandonment of the antiquated, inconvenient and unscientific systems of measure now in use must soon become an absolute necessity.

Under these conditions the excellent treatise of M. Bigourdan is a most timely and welcome contribution to available literature relating to the history of the origin and the gradual propagation of the metric system of weights and measures. In its preparation the author has had the advantage of convenient reference to original papers, state, scientific and personal, and in his résumé of the very important operations of the last quarter of a century, as embodied in the work of the International Bureau of Weights and Measures, he has been able to avail himself of the thorough knowledge of Messrs. Benoit and Guillaume, the two distinguished experts of that bureau.

The book begins with a brief discussion of the chaotic state of all matters relating to standards of measure during a few centuries preceding the coming of the metric system, in which little is said of anything outside of France. At a very early period in the history of metrology attempts were made to establish natural standards—that is, to refer ordinary standards of measure to something in nature fixed and unchangeable. It was not until 1670, however, that a really rational and scientific scheme was proposed by Gabriel Mouton, vicar of the Church of St. Paul in Lyons.

A few years earlier than this it had been proposed to refer the standard of length to the pendulum making a single vibration in one second or in some fraction of a second. Perhaps this suggestion came first from Sir Christopher Wren, and it was made about 1670–73 by Picard and by Huyghens. Mouton's system was *in principle* the metric system of to-day; he proposed to refer the standard of length to an arc of the terrestrial meridian; his multiples and submultiples of the unit were decimal, and he also proposed for convenience of reproduction a reference to the seconds pendulum. It is interesting to note that when Picard proposed the seconds pendulum as a standard of length in 1671, he expressed a suspicion that such a pendulum must be somewhat shorter

near the equator than near the pole, although it was only in that same year that Richer went to South America to make a series of astronomical observations, during which this fact was actually proved.

During the next hundred years many suggestions looking to a reformation of standards were made in France and many projects drawn up to bring about a unification of weights and measures throughout the nation, but it was not until one was presented by Talleyrand, about 1789, that the real movement set in. In this project he advocates the use of the pendulum as a standard of length, and with evident appreciation of the importance of the matter with which he is dealing, he suggests a reference of the subject to a joint international commission, to be composed of an equal number of members of the French Academy of Sciences and of Fellows of the Royal Society of London. At about the same time an active agitation in favor of metrological reform began in England and also in the United States, its chief exponent in our own country being Thomas Jefferson. Unhappily neither of these movements came to much, for reasons that cannot here be gone into. The history of the creation of the metric system and its adoption by the French Government, which followed within a few years after Talleyrand's project was submitted, is pretty well known to those interested in this phase of the subject, and the details of it constitute the larger part of the volume under review.

The whole subject was in the beginning referred to a Commission which, with those that were subsequently appointed, fortunately included such men as Laplace, Lagrange, Borda, Mongé, Condorcet, Lavoisier, Delambre, Coulomb, Cassini and others, constituting a most brilliant array of Frenchmen most eminent in science.

Consideration was given to three 'natural' standards to which the unit of length might be referred: The length of a pendulum beating seconds, the quarter of the terrestrial equator and the quarter of the terrestrial meridian. The pendulum was rejected, principally because its use involved the elements time and force, both foreign to length; the equator was rejected because of the difficulty of measuring it, climatic

and other conditions rendering it relatively somewhat inaccessible; and the quarter of a terrestrial meridian was finally adopted. It is pleasing to note that throughout the discussion which led to this result, the influential members of the Commission, as well as many others not members, stood out against the use of any unit of length or mass already in use in France, as it was recognized that such use would be an obstacle to the introduction of the system among the people of other nations. An interesting episode of the initiative of the arc measurement was a controversy over the use of a sector in the determination of latitude or the newly invented repeating circle of Borda. Indeed it seems not unlikely that 'a desire to make the reputation of the circle of Borda' had some influence in the choice of the new standard as against the seconds pendulum. Delambre proposed to Borda to employ both sector and circle, but the latter dryly intimated that it was desired to ascertain if the sectors were good, and the matter was not pressed.

When the Commission was received by the King, Louis XVI., after its recommendations had been approved and before the formal beginning of its operations, his majesty, speaking to each one in turn of the special duties that had been assigned to him, asked Cassini (the fourth eminent astronomer bearing that name), to whom had been assigned the triangulation and measurement of latitudes, how it was that he was going to remeasure an arc of the meridian that his father and grandfather had already done before him. Did he hope to do better than they? To which Cassini replied that he would not so flatter himself, if he had not a great advantage over them in the fact that while the instruments which they used in measuring angles gave results correct to within fifteen seconds, that invented by Borda would enable him to reach a precision of one second.

M. Bigourdan's volume contains much detailed information relating to the work of the Commissions, with many interesting and important citations from original documents. The fundamental legislation by which the system was founded is fully discussed, the opposition to it is fairly presented, and the subsequent legislation and discussion leading to its final

adoption by the nation as a whole receive satisfactory treatment. There is a chapter on the propagation of the system among foreign nations which leads up to the appointment of an international metric commission about 1870, and to the establishment of the International Bureau of Weights and Measures about 1875. The splendid work of the latter during the twenty-five years of its activity is treated in some detail and forms a fitting close to a most useful and interesting contribution to the history of metrology.

T. C. MENDENHALL.

A Treatise on Electromagnetic Phenomena and on the Compass and its Deviations Aboard Ship, Mathematical, Theoretical and Practical. By Commander T. A. LYONS, U. S. Navy. John Wiley & Sons.

The first volume of this treatise, the only one yet published, deals with electromagnetic phenomena, or radiation in all its protean forms. If the reader wants information about sun-spots or auroræ, about Crookes's fourth state of matter or Bjerknæs's imitations of magnetic fields by pulsating discs, about the work of Hertz or the genesis and action of Röntgen rays, he will find it in this introductory volume. However many and however diverse the subjects discussed, they are all treated from the point of view of the wave-theory. Commander Lyons seems to hold a brief for the ether whose existence he seeks to remove from the condition of a working hypothesis and whose properties he tries very hard to define. This is indeed a difficult task; for he tells us, on page 9, that "the mathematician attributes to the ether properties necessary to the formation of equations expressing its energy; the physicist ascribes to it qualities essential to the explanation of facts; the electrician meets conditions that require further hypotheses; still others do not accept fully any one of these conceptions; and some even reject the ether altogether."

So conscious is the author of the paramount importance in physics and philosophical speculation of the medium which fills intermolecular as well as interstellar space, that he dwells with great insistence upon the experimental evidence which there is for its existence. He is so eager

to beget in the mind of the reader the strong etheric conviction of his own, that he does not hesitate to recall and repeat where such repetition seems to him necessary. It must be admitted that he has made out a very commendable case for the medium as well as for its magnetic, electric and luminous properties.

The book reads easily. The style is not severely didactic; it is clear, sometimes diffuse and occasionally rhetorical. Here and there we meet similes and metaphors that occasion surprise, partly by their unexpectedness and partly by their novelty or boldness. Thus we are told that when electromagnetic waves reach the more tenuous strata of our atmosphere, they illumine them, and as a consequence "we have those brilliant auroras that cap the magnetic poles like huge candle-extinguishers" (!) (p. 20). Again, "magnetic storms have overspread the continents of Europe and America at the same time, when every needle was affected as with a kind of frenzy—oscillating together, as if some gigantic Briareus reached out his hundred arms, and with a finger on every one moved them regularly or wildly as the mood was upon him" (p. 6). On page 41 we find 'a mote of ether' and on page 62 we are confronted with 'a jungle of electromagnetic manifestations.'

The following passage, which occurs on page 197, is quite Tyndallian:

From ships of war cruising in every sea; from merchant vessels plying between the ports of the world; from observatories equipped with delicate instruments in various countries; from expeditions afloat and ashore specially fitted out for the purpose; and from numerous other private and public sources of many kinds—have been gathered, during long years, a multitude of observations of the magnetic elements; collated, classified and stripped of all discernible errors, they afford, when plotted on charts of the globe, an excellent insight into its magnetic condition.

We can hardly, however, bring ourselves to define the dyne as 'the unit of measure of magnetic intensity' (page 434), for we have hitherto accepted it as the unit of force. On the same page we read that "the weight of a body is the product of its mass by the force of gravity; the mass is everywhere a constant but hazy (!) factor, while gravity varies slightly

from place to place, but is always accurately known. This being understood, the weight of a body will be spoken of as representing it." Adopting a word from this sentence, we cannot but qualify the above statement as somewhat 'hazy.' What we do know, and know clearly, is that the weight of a lump of matter depends conjointly on its mass and on the intensity of gravity, so that we can write

$$w = \lambda mg.$$

By a suitable choice of units, we can make $\lambda = 1$, and then we have

$$w = mg.$$

After stating that the mass of a body is constant, the writer might have said, in so many words, that its weight depends upon its position with respect to the center of the earth, and thence concluded that the important property of a body, both scientifically and commercially, is not its weight but its mass.

Ampère's theory of magnets is found on page 490 to be 'more rational than the theory of magnetized particles.' We should like to believe it, and consequently regret that the author did not give a few reasons in support of this opinion. The origin of the Ampèrian currents is no better known than that of the magnetization of the molecules in Weber's molecular theory, while the maintenance of the currents implies the further difficulty of a resistanceless circuit.

The author is very chary in the use which he makes of proper names. Doppler, it is true, gets credit on page 320 for his 'principle,' and Lissajous on page 52 for his 'figures.' Why not Lenz for his 'law' (page 410) and Zeeman for his 'effect' (page 503)? Peter the Pilgrim (Peregrinus) is mentioned *cum laude*, but Gilbert is passed *sub silentio*! Yet it was Gilbert, the philosopher of Colchester, who first explained the behavior of the compass and the dipping needle by his grand discovery that the earth itself is a huge magnet: *Magnus magnes ipse est globus terrestris* are his words. Surely Commander Lyons has read *De Magnete* either in the original Latin or in Mr. Mottelay's translation; so that his neglect of Gilbert's transcendent merits is hard to explain.

The magnetical discoveries of Columbus are

clearly stated on page 206, where is ascribed to him the first explicit record of a change in the variation (declination). "While Columbus," writes the author, "may not hence be said to have discovered the variation, he must be credited with having been the first to make it known, as well as the first to discover a line of no-variation." The author might have added that this agonic line lay a little to the west of the island of Fayal, one of the Azores; and he might also have informed the reader that the variation of the compass was not generally accepted as a fact until the middle of the sixteenth century—Gilbert's time—being supposed to be due to the mechanical defects of the compass itself.

The explanation of the earth-couple acting on the compass needle, given on page 383, is rather involved. The matter would be greatly simplified by discussing the usual expression, viz., $Hm \sin \theta$ deduced from a diagram on page 295. We notice that the author here resolves H at right angles to the length of the magnet, still the force acting at each end of the needle parallel to the magnetic meridian is not H but Hm ; and the arm of the couple is $l \sin \theta$ so that the twisting moment is $Hml \sin \theta$.

It is necessary, when studying the distribution of free magnetism in a bar magnet, by the method given on page 181, to point out that the bar must be so placed that the axis of the compass-needle when at rest will lie in the magnetic meridian, with its north-seeking pole pointing magnetic north.

We are told on page 152 that a small magnetized bar will place itself equatorially when suspended between the poles of a horse-shoe magnet of nearly equal strength. This surely is a *lapsus calami*, for the bar will set, not equatorially, but axially.

A very important feature of this treatise is to be found in the diagrams and illustrations distributed throughout every one of its twelve chapters. Many of them are original, and are excellent efforts at representing graphically some difficult points in what we may term the physics of the ether. Teachers and students alike will find them very useful.

The author's object in the first part of his treatise is to give such information about the

principal phenomena of magnetism and correlated subjects as will prepare the way for an intelligent grasp of the matter to be discussed in the second volume; and in this he has well succeeded. The work is full of up-to-date information set forth in a clear and frequently impressive manner. It makes one eager for the appearance of the concluding volume, which will treat of such practical matters as the compass, the ship considered as a magnet, swinging the ship, compensation of the deviations and the mathematical theory of these deviations.

Part I. extends to 556 pages and contains 368 figures, the whole put forth in the publisher's well-known excellent style.

M. F. O'REILLY.

Animal Life: a First Book of Zoology. By DAVID STARR JORDAN and VERNON L. KELLOGG. New York, D. Appleton & Co. 12mo. Pp. 329; frontispiece and 180 plates and figures in the text. Cloth, \$1.20.

This handy, beautifully printed and illustrated book is a distinct attempt to introduce to the reader the subject of zoology from the standpoint of the life of the animal rather than from the purely systematic or comparative anatomy side. It is a book to read and enjoy in the fields and woods or at home rather than a manual to study in the laboratory. Its scope is well stated in the general headings of its sixteen chapters: (I.) The Life of the Simplest Animals; (II.) The Life of the Slightly Complex Animals; (III.) The Multiplication of Animals and Sex; (IV.) Function and Structure; (V.) The Life Cycle; (VI.) The Primary Conditions of Animal Life; (VII.) The Crowd of Animals and the Struggle for Existence; (VIII.) Adaptations; (IX.) Animal Communities and Social Life; (X.) Commensalism and Symbiosis; (XI.) Parasitism and Degeneration; (XII.) Protective Resemblances and Mimicry; (XIII.) The Special Senses; (XIV.) Instinct and Reason; (XV.) Homes and Domestic Habits; (XVI.) Geographical Distribution of Animals. Following the text proper are a table of the systematic position of the animals mentioned, a glossary and finally an excellent index.

In the subject matter of the volume one can-

not help feeling the advantage of a combined authorship, the senior author being primarily a student of vertebrate, and the junior author of invertebrate, life. This has insured a fairly balanced discussion of the phases of animal life in the two great divisions.

While, as stated above, this book is upon the life of the animal world rather than upon the anatomy, it is to be remarked that wherever the life processes are illuminated by the structure or development, these are freely introduced according to the guiding principle laid down by the authors: "Function and structure are always associated in nature and should always be associated in our study of nature."

It is gratifying to read such a book as this from cover to cover and find it free from vagaries. The authors, from personal knowledge and from the rich stores of the knowledge of others, have selected with great skill the facts illustrating each chapter, and have impressed these facts by excellent pictures, many of which are of their own production. In the discussion of the various topics, beyond the mere statement of facts, one constantly feels the certain hand of a master, a hand trained by personal knowledge and reflection and not dependent on the opinion of others. The book is very free from infelicities of expression and also from what seem to the reviewer doubtful statements. If two of the few observed might be mentioned, it is with the hope that future editions will modify the statements concerning the plate of embryos taken from Haeckel (p. 86), and also the statement on p. 107, that bones are not really living, etc. Taken in their setting these and a few other doubtful statements are true in spirit, but not quite in the letter. They can easily be made to conform with the vast majority of illustrations and be true both in spirit and in letter.

As a conclusion of this review a quotation from the chapter on geographical distribution will give an idea of the spirit and method of the authors:

"In California numerous anomalies [in distribution] have been noted, as the occurrence of Tahoe trout in Feather River, and in the Blue Lakes of Amador, which are on the other side of the main crest of the Sierra Nevada

from Lake Tahoe, and the occurrence of the Whitney golden trout in Lone Pine Creek. In each case naturalists have found the man who actually carried the species across the divide. If this matter had been investigated a generation later, these cases would have been unexplainable anomalies in geographical distribution. Real causes are almost always simple when they are once known" (p. 288).

S. H. G.

GENERAL.

M. OCTAVE DOIN, Paris, has begun the publication of an elaborate 'Bibliothèque internationale de psychologie expérimentale.' The subject-matter of psychology has been divided among fifty volumes, each of which is being prepared by a different author. France is, of course, fully represented, though the absence of certain names might be unexpected to those unacquainted with the personal conditions. Italy and Russia are well represented and there is one volume from England, 'Metaphysics,' by Mr. G. F. Stout, of Oxford; and two from America, 'Judgment and Knowledge,' by Professor J. Mark Baldwin, of Princeton University, and 'Movement,' by Dr. R. S. Woodworth, of University and Bellevue Hospital Medical College. It is somewhat curious that the name of no German should appear on the list. The volumes, which will be on the average 300 to 400 pages in length, will be sold at the uniform price of 4 fr. Together they will form one of the most important encyclopedias that has been published in any science.

THE Syndics of the Cambridge University Press have undertaken the publication of the first part of the 'Index Animalium' to the preparation of which Mr. C. Davies Sherborn has devoted so many years. The object of the Index is to provide zoologists with a complete list of all generic and specific names given by authors to animals both recent and fossil since January 1, 1758, the date of the 10th edition of Linnæus' 'Systema Naturæ.' With each name will be given an exact date and a reference intelligible to the layman as well as to the specialist. The British Association appointed a special committee to watch over the incep-

tion and progress of the work, the preparation of which was undertaken in 1890. Financial support has been given by the British Association, the Royal Society and the Zoological Society, while the authorities of the British Museum have afforded continual assistance. The work will be to the student of animal life what the 'Index Kewensis' is to the botanist, and indeed far more, as the last-named work refers only to Phanerogams, whereas the 'Index Animalium' will include all groups of animals and both recent and fossil forms. The portion of the work already completed and in the press covers the period from 1758-1800 and consists of 61,600 entries.

THE Society of German Engineers, in Berlin, has undertaken the preparation of an international technical dictionary to be published in English, French and German.

SCIENTIFIC JOURNALS AND ARTICLES.

The *Journal of the Boston Society of Medical Sciences* completes its fifth volume with the double number for May 23 and June 4, the index to the volume being issued with this number. From a small 16mo the *Journal* has grown to a volume of over 500 pages, although it shows at the same time the modern tendency towards specialization by containing more bacteriological and pathological papers than formerly. There is, however, much of general interest as well as important contributions to our knowledge of anatomy and physiology.

The *Plant World* for June contains 'Botanizing in Bermuda,' by Marshall A. Howe; 'Suggestions for the Study of the Hawthorns,' by W. W. Ashe, which notes that in place of ten species formerly recognized we know that at least 120 species occur on the Atlantic coast; 'Cuban Uses of the Royal Palm,' by William Palmer, and 'Botanizing in and around a Lake,' by E. L. Morris, besides briefer articles, notes and reviews. The supplement devoted to 'The Families of Flowering Plants,' by C. L. Pollard, treats of the Mimosaceæ, Cæsalpiniaceæ, and the Pæpilionaceæ. The number is well illustrated.

SOCIETIES AND ACADEMIES.

ONONDAGA ACADEMY OF SCIENCE.

At the June meeting Mr. Chas. G. Rogers presented a series of observations made during March, April and May, on the dates of arrival of birds on their spring migration, the blue-bird being first seen on March 15, and the robin appearing three days later.

Mr. Geo. D. Lynch read a paper on 'Hawks,' in which he described the food, and the nesting and defensive habits of Cooper's hawk, the sparrow hawk and the red-shouldered hawk, illustrating his remarks with specimens of skins and eggs of each of the three species.

Principal John D. Wilson read a paper embracing his observations on a family of blue-birds. He constructed a box in the shape of a prism about six inches square and fifteen inches deep, two opposite sides stopping about two inches short of the top, thus forming two entrances, protected from rain by a projecting roof. A narrow shelf was placed just beneath each entrance. Sparrows seemed unable to utilize the box for nesting purposes and so left it alone. They gathered about, however, when the young birds began to appear at the entrances, but were soon driven away by the parent birds. After the young were hatched they seemed to be fed solely by the mother, who invariably entered and left the nest by the opening on the south side. The male entered either opening indifferently, never brought food, and usually brought out excreta from the nest. Mr. Lynch spoke of similar observations on a robin's nest. The young birds were fed entirely on caterpillars, while the parent birds ate freely of cherries, monopolizing one tree, and even brushing their wings against the head of any person attempting to climb the tree.

Mr. Horace W. Britcher spoke briefly of the habits of some of the forms of life inhabiting a small springtime pond in which a form of the fairy shrimp (*Branchippus gellidus* Hay?) occurs. The pond is usually dry from July to November. Larval *Branchippus* appear in February, and eggs are deposited during late April and early May, the water becoming so warm by the middle of May that the *Branchippus* are rapidly killed. A year ago eggs were collected and an attempt

made during the summer, and again during the winter, to hatch them in aquaria, but without success.

H. W. BRITCHER,
Secretary.

DISCUSSION AND CORRESPONDENCE.

THE LARYNX AS AN INSTRUMENT OF MUSIC.

It is with considerable hesitation that I venture to enter into a discussion that has arisen in this Journal under the above title. It is so likely to become a discussion of terms that may be defined by different writers in different ways that it is, perhaps, a question whether a prolonged discussion of the subject is desirable. In spite of this fact, however, I take the liberty of expressing an opinion to which I have been brought by the past several years of observations upon the larynx. Of course, we may call that part of the larynx which vibrates a 'cushion,' a 'reed,' a 'membranous reed,' a 'cord,' a 'membranous cord' or other names, and still find much justification in each case. It seems to me that if we wish to discuss the question as to the class of instruments to which this belongs, we must judge it by two series of facts: first, what elements control the pitch of the fundamental tone produced; second, what is the quality of the tone produced. If we examine the larynx with these points in view, we find, in the first place, that the pitch of the tone produced is controlled by three mechanisms: first, one for increasing tension; second, one for decreasing the length; third, one for lightening the weight of the vibrating part. These three factors are those used for controlling the pitch of a string. If we examine the quality of the tone produced we find that the fundamental and over-tones form a series whose rates of vibration are to each other in the order of the natural numbers, 1, 2, 3, 4; etc., this quality of tone is the quality produced by a string and not the quality produced by a reed or membrane, in both of which the quality is much more complex and contains many intermediate over-tones. It seems to me, in view of these considerations, that we refer to this vibrating part as a 'cord' quite properly. It will be admitted, undoubtedly, by all that the tilting of the cricoid cartilage on the thyroid cartilage in-

creases the tension on the vocal cords, and in so doing raises and tends to control their pitch. The arytenoid cartilages when brought together bring out the edges of the vocal cord from the side of the tube, and by their rotation may decrease the free length of the vocal cords, as is clearly shown by photographs that have been taken of the larynx when producing tones of different pitches. In Fig. 1 we have a section

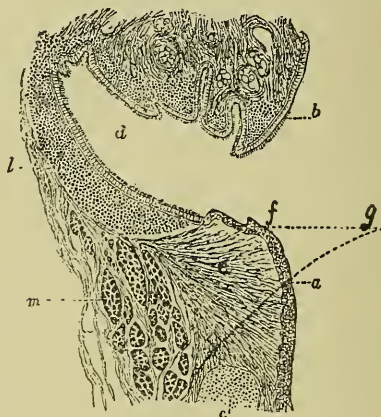


FIG. 1.

through the vocal cord and its immediate surroundings. It is shown in the relaxed position against the wall of the tube. The dotted line between *a...g...f* shows, approximately, the position and form of the cord in action. In Fig. 2 is shown, diagrammatically, a cross-section

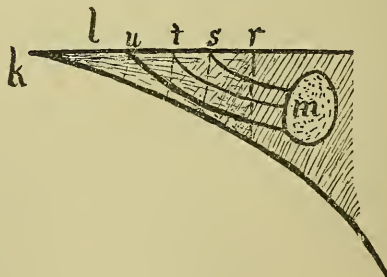


FIG. 2.

tion of the vocal cord, the point extension at *k* being rather exaggerated. *m* is the vocal muscle extending from the inside front of the thyroid to the outer side of the arytenoid, and passing through the back of the vocal cord. This muscle serves to rotate the arytenoid, and

thus shorten the vibrating portion of the cord ; at the same time certain fibers from this muscle extend outward into the cord toward *s*, *t*, *u*, etc. The action of these fibers, when the vocal muscle is contracted, tends to hold rigid more and more of the cord, allowing less and less of the extreme edge to vibrate. This action lessens the weight of the vibrating part of the cord.

Other minor facts tend to confirm the belief that the action is essentially that of a cord. For example, the extreme edge, as indicated at *k*, is of a different material from the rest of the cord and the whole structure of the cord is entirely different from that of the lips, or from what could be properly defined as a cushion. In observations upon the vocal cords when producing a tone it is very often easy to recognize certain secondary nodal points in the cord. If a little mucus happens to be upon the vocal cord at the time of producing a continued tone, the mucus collects at the secondary nodal points, just as sand upon a vibrating plate, and is easily apparent as a white spot upon the edge of the cord.

Of course, in those cases where the larynx has been removed and an artificial voice apparatus has been introduced, the source of sound has been a reed, but this has been simply from a mechanical difficulty of introducing a vibrating string which should have the proper range. The reed is extremely simple mechanically and answers the purpose quite satisfactorily. But this offers no argument in support of the belief that we are dealing with a reed instrument in the human voice. It is true that Helmholtz and others have referred to the larynx as a reed instrument, but it is curious to note that after this reference has been made, Helmholtz continues in the most elaborate way to treat the quality of the sound produced by the human voice as if it had been produced by a vibrating string, discussing the pitches and intensities of the over-tones of a string and never referring to other over-tones of a reed or a membrane.

It is claimed that the vibrations of the air in the mouth cavity are 'free vibrations' and not 'forced' ones and that these free vibrations in the mouth cavity are excited by the impulses from the larynx formed by the explosive open-

ings between the vocal cords. In this connection Professor Scripture, in his contribution from the Yale Psychological Laboratory, describes an experiment of making a key whistle by blowing in its end a stream of air, which has been rendered intermittent by artificial vocal cords. No one denies for a moment that impulses or a succession of impulses may set up the natural vibrations of a resonance cavity, but it must also be borne in mind that a continuous stream of air under the same circumstances will produce a more forcible result just in proportion as the energy in the continuous stream is greater than in the interrupted stream. Thus, we know that a continuous current will cause a key to whistle, and there is no mechanical reason why an interrupted current should not produce a similar result while the puffs last. Applying this to the mouth cavity as related to speech, we have a natural vibration set up in the case of a whisper by the continuous current of air rushing through these cavities. Interruptions in this current will not increase the intensity of the natural vibrations of the air in the cavities. We have precisely an analogous case if we simply blow through a clarinet or cornet or flute without establishing the primal source of sound by the vibration of the reed, the lip, or the air jet.

It seems to me that, fundamentally, there can be no difference between a vowel as sung and that same vowel as spoken. Of course, the duration of the vowel sound may be very short, but during that period it must have its perfectly definite quality in order to be recognized, and it seems incorrect to assume one set of determining factors in case of a spoken vowel and another set in the case of the vowel as sung. The problems involved in this discussion, overlapping the subjects of anatomy, physiology and mechanics, are naturally very troublesome, and it is readily to be expected that the physicist is perhaps inclined to lay too much stress upon the mechanics of air vibrations. But on the other hand, the physiologist and the students of phonetics have in too many cases brushed aside serious mechanical obstacles with a non-chalance that is scarcely justified by the facts. In those cases where the synthesis of the vowel

sounds has been most satisfactory they have been made up of the fundamental and *string* over-tones and not by the combination of the pitch tone with a 'characteristic pitch' having no harmonic relations between the two. In the case of spoken vowels it seems to me of fundamental importance that the individual should speak upon a known pitch, otherwise the case is hopelessly confused by a constantly changing fundamental. In a great many of the investigations involving the so-called characteristic pitch of the different vocal sounds, it seems uncertain as to whether or not this so-called 'characteristic pitch' may not be more directly due to some inherent rate in the apparatus itself, rather than in the sound which it is supposed to record impartially. In this connection it must be borne in mind that the widest possible variations in tone quality are still recognized as the same vowel spoken by different individuals under different conditions. This discussion has wandered from the musical instrument to the articulator. In music the vowel is everything, the consonant usually inconspicuous; in speech the vowel is secondary and the consonants all-important.

WILLIAM HALLOCK.

PHYSICAL LABORATORY,

COLUMBIA UNIVERSITY, June, 1901.

'IS LARVÆ CONTAGIOUS?'

THE following cross interrogatories were prepared by the district attorney of a county in a western State for a deposition.

What is larvæ? What does larvæ come from? Is larvæ injurious to fruit trees? Is it contagious?

What is pupæ? Describe it fully? Is it injurious to fruit trees? Is it contagious?

It seems to me that the questions furnish an answer to the frequent question in the scientific laboratory, 'Will this ever be of any use to me?' If such knowledge furnish nothing else to a man, it would prevent him from making such questions as these.

H. S. GAUS.

CURRENT NOTES ON PHYSIOGRAPHY.

GLACIAL CORRIES IN THE BIGHORN MOUNTAINS.

THE glaciated district near Cloud Peak, Bighorn Mountains, at altitudes above 10,000 feet,

contains over forty corries or cirques of more or less pronounced form, as mapped and described by Matthes ('Glacial Sculpture of the Bighorn Mountains, Wyoming,' 21st Ann. Rep. U. S. Geol. Surv., 1900, pt. II., 167-190). A contour map shows the summit of the range in general with rounded forms free from sharp peaks and precipitous cliffs. The valleys on the slopes below 10,000 are usually broadly open; but on ascending towards the stream sources, the valley walls steepen on either side of a broad floor where rock basins hold many little lakes, and at or near the valley head the walls close in a great cliffed amphitheater. Highland streams cascade down from shallow hanging valleys into the deep cirques. It is concluded that these peculiar forms are here, as elsewhere, to be regarded as glacial modifications of preexistent valleys that once had more ordinary form. In a few cases, the widening and headward recession of the valley walls have resulted in the consumption of the rounded uplands of the mountains so far that only a narrow, sharp, serrate wall remains; this is well seen around Cloud Peak, thus giving support to Richter's views regarding the importance of glacial action in producing sharp peaks and arrêtes in the Alps. In a single remarkable example, an east-sloping valley (No. 20) receives the drainage of the uppermost mile of a southwest-sloping valley (No. 18) in such a way as to suggest very strongly the glacial capture of the latter by the former; and this is made the more probable when it is noted that the capturing valley has a distinctly stronger slope than the captured. If it be admitted that glacial erosion has made significant changes in the valley forms—and this does not seem to be open to dispute—the present pattern of drainage in these two valleys could not have existed in preglacial time.

It is a curious commentary on the education of our topographers that articles of the kind here referred to should be so rare.

THE NORTH GERMAN LOWLAND.

THE accounts of the North German lowland as a region of glacial topography by Berendt, Wahnschaffe, Keilhack and others are supplemented to an extraordinary degree of detail by

the folio sheets of the geological map (1:25,000) of Prussia and the Thuringian states, with explanatory texts. Several sheets of the area north of Berlin may be cited. In the neighborhood of Oderberg (46th Lieferung), the Oder turns sharply from the ancient westward waterway along the glacial margin past the site of Hamburg to the North Sea, into its present northward course past the site of Stettin to the Baltic. Hereabouts are several looped moraines with uneven hills and hollows, holding many pools and ponds; the loops are nicely marked by boulder belts, which have long furnished material for road-making. Outside of the morainic loops (southwest), stretch outwashed sand plains, the barren 'upper sands,' with deep-lying ground water. Inside of the moraines come the rolling uplands of the ground moraine, with a fertile soil. Overlaid sands and silts are common here, the deposits of ice-margin lakes held in the loops during glacial retreat; the outlets of the lakes are frequently found in trenches through the morainic hills. Some of the larger existing lakes of the district remain in shallow basins, roughly central to the morainic loops.

South of the outwashed sand plains, the broad channel of the ancient waterway (the Thorn-Eberwalder channel, the northern of the three chief ice-margin waterways) is strewn with the 'valley sands.' Once as smooth as the bed of a large river may be, these sands are now trenched and terraced to moderate depths west of Oderberg, where they are traversed only by small streams; but they are largely swept away southeast of Oderberg, where the ice-margin river sank to a lower level when the northern outlet past Stettin was opened. A new, broad channel was eroded at the lower level, with great sweeping curves appropriate to the course of a large river; the channel bed now remains as a marshy alluvial plain on which the diminished Oder wanders. One of the great curves of the channel rounds a spur of drift uplands by Oderberg; the 'new Oder' is led through the narrow neck of the spur by an artificial canal, while the 'old Oder' still straggles around the spur.

Where the ancient waterway departed somewhat from the moraines, a low upland slopes

southward to it from the morainic loops and their sand plains. The upland here is a gently rolling drift plain, traversed now and again by the sandy beds of larger or smaller streams that for a time came out from the ice on the north. A striking example of this kind is found near Kyritz (Lieferung, northwest of Berlin). The sandy stream bed was probably washed by sprawling currents in many braided channels, which acted partly as an aggrading agent, for the bed is hardly incised beneath the rolling drift plain. Later a narrow trench was cut through it, as if the ice-water had for a brief interval been changed from a turbid sand-bearing stream to a clear stream (perhaps the outflow of an ice-margin lake); the trench is now floored with peat, or occupied by long shallow lakes, as if it were barred here and there with unwashed alluvium.

The casual traveller often describes the north German lowlands as a 'flat and uninteresting country.' It is as meaningless to him as a cuneiform inscription would be; yet how significant its delicate details become when interpreted! To American students, the elaborate treatment of this remarkable field foreshadows what may in time be provided for us concerning the Illinois and other glacial lobes, whose general features only have now been sketched.

W. M. DAVIS.

MUSEUM REPORTS.

THE 'Annual Report of the Director' of the Carnegie Museum for the year ending March 31, 1901, was issued a short time ago, as well as the report on the 'Prize Essay Contest.' From the report we learn of the rapid progress of the institution particularly in the field of vertebrate paleontology, the explorations conducted last year by Mr. J. B. Hatcher having resulted in the acquisition of nearly 200 boxes of specimens, some of the more notable of which were described a short time ago in SCIENCE. As Mr. Hatcher again began field work in April, the present year will doubtless see other important accessions of fossils.

In zoology the announcement is made that the Museum has acquired a specimen of the almost extinct *Rhinoceros simus*, only four other ex-

amples of which are in existence. It is also announced that the Museum last year purchased the Ulke collection of Coleoptera. Among other illustrations the report contains a fine view of a remarkable lot of 'cannon-ball' concretions in Laramie sandstone.

It is announced that no less than 843 scholars participated in the Prize Essay Contest, the subject being 'An Afternoon at the Carnegie Museum.' The successful essay is printed in full and the names and addresses of the other contestants are given.

THE Annual Report of the President of the American Museum of Natural History for the year 1900 is also at hand. The most evident progress has been made in arranging the extensive anthropological collections of the Museum, and the new West Hall, devoted to the American Indian and Eskimo, was opened on November 1, 1900.

No less than seven expeditions were sent out during the year to conduct ethnological and archeological researches, including one to Siberia and another to the vicinity of Lake Titicaca. This extended work was made possible through the liberality of friends of the Museum.

The Department of Vertebrate Paleontology, which completed its first decade in May of this year, comprises in its collections 8,534 specimens of fossil mammals and about 4,000 of reptiles. The most important accessions during 1900 were a complete skeleton of the herbivorous dinosaur, *Thespesius*, and one of a carnivorous dinosaur, several partial skeletons of horses from Texas, and a skull of elephant.

The attendance during the year was 523,522, an increase of a little more than 65,000 over the previous year. It is announced that the income from the endowment fund is now \$20,280, and while this is gratifying it is to be wished that it were ten times as great. For the first time in many years the report contains no illustrations, but this is more than compensated for by the publication of the *Museum Journal*, which chronicles the current progress of the institution.

F. A. L.

THE AMERICAN CHEMICAL SOCIETY.*

THE Twenty-Fourth General Meeting of the American Chemical Society will be held in the High-School building, on the block bounded by Nineteenth, Stout, Twentieth and California Streets, Denver, Colorado, Monday and Tuesday, August 26 and 27, 1901.

The same arrangements as heretofore will prevail between Section C of the American Association for the Advancement of Science and the American Chemical Society. Monday and Tuesday of the Association week will be devoted mainly to the sessions of the American Chemical Society, and the remainder of the week to those of Section C. A few minutes will be given to Section C for organization on Monday morning, and in the afternoon the American Chemical Society will adjourn in time to afford the opportunity of listening to the address of the Vice-President of Section C.

The first session of the Society will convene on Monday morning, August 26, immediately after the organization of Section C of the A. A. S., probably at about 11.30 A. M.

The afternoon session will be called to order at 1.30 P. M., and will be adjourned in time to listen to the address of Vice-President Long before Section C.

At the close of Vice-President Long's address, a meeting of the Council and Directors of the American Chemical Society will be held at some convenient place to be announced.

The hour for the morning and afternoon sessions of the Society on Tuesday will be announced on the program. Other arrangements for the meeting will also appear in the official program, or be announced at the sessions of the Society.

Hotel headquarters for the meeting will be at the Brown Palace Hotel, Seventeenth and Tremont Streets. Rates: American plan, \$3.00 to \$5.00 per day; European plan, \$1.50 up. This hotel is within five minutes' walk of the Denver High School Building, and is reached from the Union Depot by the Seventeenth Street electric car line.

The following is a list of other hotels and boarding houses easily accessible to the Denver High School:

* Announcement of the secretary.

The Albany, 17th and Stout Streets. American plan, \$2.00 to \$4.00; European plan, \$1.00 to \$2.00 per day.

The New St. James, Curtis Street, between 15th and 16th Streets. American plan, \$2.00 to \$3.50; European plan, \$1.00 to \$2.50 per day.

The Oxford, 17th and Wazee Streets, one block from Union Depot. European plan only, \$1.00 to \$2.00 per day.

The Windsor, 18th and Larimer Streets. American plan, \$2.00 to \$3.50; European plan, \$1.00 to \$2.00 per day.

American House, 16th and Blake Streets. American plan, \$2.00 per day.

Hotel Metropole, opposite Brown Palace Hotel. American plan, \$2.50 to \$5.00 and up; European plan, \$1.00 to \$3.00 per day and up.

Hotel Albert, 17th and Welton Streets. European plan, \$1.00 to \$1.50 per day.

The Belvoir, 737 East 16th Avenue. Room and board, \$1.50 to \$2.00 per day.

The Bonaventure, 18th and Glenarm Streets. European plan only, 75 cents to \$1.50 per day.

The Broadway Hotel, Broadway and Cheyenne Street. American plan, \$1.50 to \$2.00 per day.

The Drexel, 433 17th Street. European plan, 75 cents to \$2.00 per day; \$4.00 to \$8.00 per week.

Douglas Place, 1439 California Street. Room and board, \$1.50 per day; \$7.00 per week and up.

The Grant, 1922 Grant Avenue. Room and board, \$1.25 per day; \$8.00 per week.

The Holland, 17th Street and Pennsylvania Avenue. Room and board, \$1.50 to \$2.00 per day.

The Princeton, 2137 Stout Street. Room and board, \$5.00 to \$7.00 per week.

The Vallejo, 1420 Logan Avenue. Room and board, \$2.00 to \$4.00 per day.

The Vaille, 208 17th Street. European plan, \$1.00 to \$2.00 per day.

Warren Hotel, 17th and Larimer Streets. Rooms, 75 cents to \$2.00 per day.

Young Women's Christian Association, 18th Street and Sherman Avenue. Ladies only.

Reservations for accommodations should be made as early as possible, by direct corres-

pondence with the hotels and boarding houses. The Local Committee on Hotels and Boarding Houses will also be glad to give information on this subject. Address communications to Arthur Williams, Local Secretary, P. O. Box 1504.

The Western Passenger Association, covering the territory west of Chicago and St. Louis, has made a rate of one fare plus \$2.00 for the round trip, in their territory, to Denver, Colorado Springs and Pueblo. The tickets may be bought from July 10 to August 31, and are good for return up to October 31. At this rate the fare from Chicago to Denver and return will be \$31.50. The Pullman fare is \$6.00 extra each way. Rates from points east of Chicago will be announced later in the columns of SCIENCE.

It is probable that there will be, however, a choice of the following terms:

1. A rate of one and one-third fare on the certificate plan for the round trip from starting-point to Denver and return.

2. Full fare from starting-point to Chicago and return, and the above rate of \$31.50 from Chicago to Denver and return.

3. Regular season rates for Colorado tours.

Which of these terms will be the most advantageous must be ascertained by inquiry at the various local ticket offices.

The Pullman rates from New York to Chicago will be \$5.00 extra each way, and those from other points can be ascertained upon inquiry at the various local offices.

If rates are obtained on the certificate plan, the name 'American Association for the Advancement of Science' should appear on the certificate, as all arrangements of this kind are made by that body and not by the American Chemical Society.

Various visits and excursions will be arranged by the Local Committee of the A. A. S. and the Local Committee of the American Chemical Society. These will probably include visits to the smelting and reduction works in the vicinity of Denver, and other places of special interest to chemists.

Members who have papers to present at the meeting are requested to mail to the Secretary, in the enclosed envelope, as soon as possible, name of author, title of paper, and estimated

time for reading the same. It is also earnestly requested that *all members of the Society fill out and return the enclosed slip at once*, whether they expect to attend the meeting or not, being careful to give the name and address as they should stand on the official roll of the Society, which is now being revised for the annual directory.

Manuscripts and abstracts of papers may be sent to the Secretary, Albert C. Hale, addressed to Jewett, Greene Co., N. Y., till August 15; after that date they should be addressed to him at the Brown Palace Hotel, Denver, Colorado.

Many of the members responded with praiseworthy interest and zeal in the effort to increase the membership of the Society to 2,000 before the date of the 25th anniversary meeting last April. The time, however, was not sufficient in which to attain the desired result, but it has been suggested that a sufficient effort now on the part of every member of the Society would enable us to raise the roll of membership to 2,000 before the presentation of the Secretary's annual report in December. *Will you not give your personal attention to this matter*, and see that the enclosed blank is properly filled out with the name and qualifications of some eligible chemist, not now upon our roll, whom you will nominate for membership, returning the blank to the Secretary at your earliest convenience? Additional blanks may be obtained from the Secretary at any time, or will be forwarded by him to any chemists whose names are furnished him for that purpose.

ALBERT C. HALE,

Secretary of the American Chemical Society.

July, 1901.

RAILWAY TIME TABLES BETWEEN THE EAST AND DENVER.

At the request of the permanent secretary of the American Association, Dr. L. O. Howard, we publish time tables of some of the railways between the East and Denver. We hope to give subsequently further details.

PENNSYLVANIA RAILROAD COMPANY.

Leave New York.	Leave Philadelphia.	Leave Baltimore.	Leave Washington.	Arrive Chicago.
7:55 a. m.	10:25 a. m.			7:45 a. m.
	8:40 "	8:50 a. m.	7:50 a. m.	7:45 "
1:55 p. m.	4:30 p. m.	4:35 p. m.	3:30 p. m.	2:50 p. m.
5:55 "	8:50 "	9:00 "	7:45 "	8:45 "

Leave Chicago.	Arrive Denver.	
10:00 a. m.	11:30 p. m.	C. & N. W.
11:30 p. m.	7:30 a. m.	"
4:00 "	(same station.) 6:30 p. m.	Burlington.
11:00 p. m.	7:10 a. m.	"

Via St. Louis.

Leave New York.	Leave Philadelphia.	Leave Baltimore.	Leave Washington.	Arrive St. Louis.
9:55 a. m.	12:20 p. m.	12 noon.	10:50 a. m.	12:56 p. m.
1:55 p. m.	4:30 p. m.	4:35 p. m.	3:30 p. m.	6:40 "
5:55 "	8:25 "	8:30 "	7:15 "	9:40 "

Leave St. Louis.	Arrive Denver.	
2:05 p. m.	6:15 p. m.	Burlington.
9:01 "	7:10 a. m.	"
10:10 "	12:05 p. m.	Mo. Pacific.
10:10 "	7:30 a. m.	C. & A.

BALTIMORE AND OHIO RAILROAD COMPANY.

This route is either *via* Chicago or St. Louis, thence over any of the several connecting lines between those points and Denver.

For instance:

Leave New York	1:30 p. m.	Monday.
" Philadelphia	4:20 "	"
" Baltimore	7:00 "	"
" Washington	8:05 "	"
Arrive Chicago	9:00 "	Tuesday.
Leave Chicago	10:00 "	"

Via C. R. I. & Pacific Ry.

Arrive Denver	7:45 a. m.	Thursday.
	or	
Leave New York	4:30 a. m.	Monday.
" Philadelphia	7:00 "	"
" Baltimore	9:40 "	"
" Washington	10:50 "	"
Arrive Chicago	9:00 "	Tuesday.
Leave Chicago	10:00 "	"

Via C. & N. W. Ry. and U. P. System.

Arrive Denver	1:45 p. m.	Wednesday.
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Similar connections can be made *via* St. Louis.

Passengers reaching Chicago from the East before 1 p. m., can use the 'Rocky Mountain Limited,' which leaves Chicago daily at that hour, reaching Denver the following afternoon at 4:45.

THE SOUTHERN RAILWAY.

Leave New York	12:10 a. m.	4:25 p. m.
" Philadelphia	7:20 "	6:55 "
" Baltimore	9:34 "	9:16 "
" Washington	11:15 "	10:45 "
" Atlanta	6:00 "	4:15 "
" Birmingham	12:45 p. m.	10:20 "
" Memphis	8:25 "	10:25 a. m.
Arrive Kansas City	9:45 a. m.	7:10 "
Leave Kansas City	6:40 p. m.	10:40 "
Arrive Denver	11:10 a. m.	6:00 "

SCIENTIFIC NOTES AND NEWS.

AT the meeting of the Senate of London University on July 11, Professor A. W. Rücker, professor of physics in the Royal College of Science and secretary of the Royal Society, was elected principal of the University.

AT the first congregation of the University of Birmingham, on July 6, the degree of Master of Science was presented to the following officers of the University: Dr. Oliver Lodge, principal; Robert S. Heath, vice-principal and professor of mathematics; Bertram C. A. Windle, dean of the faculty of medicine and professor of anatomy; John H. Poynting, dean of the faculty of science and professor of physics; Thomas Bridge (zoology), Charles Lapworth (geology), William Hillhouse (botany), Percy F. Frankland (chemistry), Frederick W. Bursall (engineering), Adrian J. Brown (brewing), Bostock Hill (public health), Gilbert Barling (surgery), Bennett May (surgery), Alfred H. Carter (medicine), Robert Saundby (medicine), Edward Malins (midwifery), Priestly Smith (ophthalmology), Arthur Foxwell (therapeutics), Robert F. C. Leith (pathology), James T. J. Morrison (forensic medicine), Edmond W. W. Carlier (physiology), John W. Taylor (gynecology).

SECRETARY of Agriculture Wilson, Mr. E. Henry Stevens, of the House Committee on Agriculture, and Professor Milton T. Whitney, chief of the division of soils of the Department of Agriculture, made last week a trip through Connecticut and western Massachusetts, seeking facts and information relative to the growing of tobacco under cloth in those sections.

UNDER the auspices of the New York Botanical Garden, Professor Lucien M. Underwood, of Columbia University, has visited Porto Rico, and Dr. M. A. Howe, assistant curator of the museum, has explored the coasts of Nova Scotia, Newfoundland and New Brunswick.

SURGEON KINYOUN, recently of San Francisco, and now in charge of the Marine Hospital at Detroit, has been detailed to visit Japan and China to inspect the work of the marine hospital service with special reference to the plague.

DR. FESHENKO, of the University of St.

Petersburg, has been sent by the Imperial Geographical Society to the Pamir, and is at present at Tashkent making geological, botanical and zoological researches.

DR. E. J. LEDERLE, chief chemist of the Health Department of New York City, sailed on July 18 for Europe, where he will inspect the municipal laboratories of Europe, including Paris, Brussels, Cologne, Berlin, London, Glasgow, Edinburgh and Dublin.

MESSRS. DARTON, Hatcher and Fraas have completed the special study of the Titanotherium Beds in South Dakota for the U. S. Geological Survey. The work was greatly impeded by exceptionally rainy weather. Mr. Darton will report upon the results which will subsequently be used in the monograph on 'The Titanotheres' by Professor Osborn.

PROFESSOR LESTER F. WARD, of the U. S. Geological Survey, has recently made a two months' trip in the Triassic of Arizona, studying the geology and collecting fossil plants. A small but valuable collection of fossil vertebrates was made at the same time for the U. S. National Museum.

PROFESSOR STEWART CULIN, curator of the Pennsylvania University Museum, has returned to Philadelphia, after a visit to Cuba in search of traces and relics of the aboriginal Indian tribes.

THE American astronomers who went to Sumatra to observe the eclipse of the sun in May arrived at San Francisco on the *Indiana* on July 16. The members of the party include Professor E. E. Barnard, Professor A. N. Skinner, Commander U. S. N.; Professor W. S. Eichelberger, U. S. N.; F. B. Littell and H. D. Curtis.

REUTER'S AGENCY telegraphs from St. Petersburg that Baron Toll, the leader of the Russian Arctic expedition, has sent to the Academy of Sciences the following despatch from Yeniseisk, dated April 16: "Safely arrived in the Gulf of Taimyr, where I am wintering. We have erected a station for meteorological observations in the neighborhood of Archer Harbor. Mathiessen has explored the Nordenskiöld Islands, traveling in sledges. Kolomeizeff has been sent to the mouth of the Yenisei with

orders to establish a coaling station. I myself shall traverse the Cheliuskin Peninsula with Koltshak. Matthiessen has been appointed commander of the *Sarja*. All are well."

PROFESSOR ERNST HAECKEL has consented to give a course of lectures on paleontology in London.

DR. TRACY F. HAZEN, recently fellow in botany at Columbia University, has been appointed director of the Fairbanks Museum of Natural Science at St. Johnsbury, Vt.

MR. E. G. HASTINGS, who has held the position of assistant bacteriologist at the University of Wisconsin Experiment Station, has been granted leave of absence for a year's study in Europe. His position will be filled in the interim by Mr. John F. Nicholson.

A STATUE of Chevreul was unveiled on July 11 in the Paris Museum of Natural History.

DR. JAMES MARVIN died at his home at Lawrence, Kansas, July 10 last, aged 81 years. Dr. Marvin was educated at Alfred Academy (now Alfred University) and Allegheny College, in both of which institutions he was subsequently a teacher. For a number of years he was superintendent of schools at Warren, Ohio, from which place he went to Allegheny College as professor of mathematics and astronomy. In 1874 he was called to the chancellorship of the University of Kansas, doing much during his ten years' service to build up that institution. Later he became the first principal of Haskell Institute, one of the leading government schools for Indians, and laid the foundations for what has since become a great school. His public service closed with a six years' term as pastor of a Methodist church at Lawrence. For several years he had been an invalid, slowly declining under the action of paralysis.

THE death of H. W. Harkness, which we announced last week, will be a serious loss to science in San Francisco. Born eighty years ago in Massachusetts, he went to California in 1849, and, having amassed a considerable fortune by the practise of medicine, retired in 1869 and devoted himself chiefly to scientific interests. He was from 1887-1896 president of the California Academy of Sciences. He was the author of numerous contributions to

botany, chiefly on the cryptogams. He presented his collections, containing 10,000 specimens, to the Academy of Sciences.

MISS EVA M. REED, indexer in the library of the Missouri Botanical Garden at St. Louis, was instantly killed by a train while walking on the tracks near Louisiana, Missouri, on July 7. The body was interred at St. Louis. Miss Reed had been connected with the Botanical Garden for about seven years, going to that institution from the University of Wisconsin. She was deeply interested in botanical pursuits, giving attention to the mosses, as well as to the winter characters of trees, a subject on which she had written for publication. Not long ago she began working on plant ecology, under the direction of the botanical department of the University of Chicago, and it was in the prosecution of investigation in the field that she met her death.

SIR CUTHBERT EDGAR PEEK, who maintained at Rowsdon an astronomical and meteorological observatory, died on July 5, at the age of forty-six years. He went to Queensland on the last transit-of-Venus expedition, and made numerous contributions to astronomy and meteorology. He was an active supporter of scientific work, being a member of the council of the Royal Geographical Society and of the Royal Meteorological Society and honorary secretary of the Anthropological Society.

THE death is announced of Miss Eleaonor A. Ormerod, known for her contributions to economic entomology, on which subject she had published a number of works. She was recently given the LL.D. degree by the University of Edinburgh, where she had been examiner in agricultural entomology.

THE death is also announced of Dr. Gino Ciaccio, professor of comparative anatomy at the University of Bologna, and of James Hamblin Smith, of Gonville and Caius College, Cambridge, a famous coach of the University and the author of several works on elementary mathematics.

THE New York City Municipal Civil Service Commission will hold on July 31 an examination for the position of assistant bacteriologist with a salary of \$1,200.

It is stated in *Nature* that the London Institution of Mining and Metallurgy will award twenty-five guineas each for the best papers on the comparative merits of circular and rectangular shafts for mines of great depth.

THE Association of Military Surgeons proposes as a subject of its Enno Sander prize for 1901-1902 'The Most Practicable Organization for the Medical Department of the United States Army in Active Service.' The prize is a gold medal and \$100. The essays must be submitted before the end of February, 1902. Further particulars may be obtained from the secretary, James Evelyn Pilcher, Carlisle, Pa.

THE physiological laboratory given to the University of Edinburgh by Mrs. Cox in memory of her father, the late Professor John Hughes Bennett, was dedicated on July 20, an address being made by Sir J. Burdon Sanderson.

THE Board of Supervisors of San Francisco adopted a resolution on July 15 accepting the offer of Mr. Carnegie to give to this city \$750,000 for the establishment of a central and branch libraries. The concluding sections of the resolutions read as follows:

Be it resolved, That the gift of Andrew Carnegie be and the same is hereby accepted, and that the thanks of the Board of Supervisors of the city and county of San Francisco be and are hereby extended to him. And be it further

Resolved, That the example set by Mr. Carnegie in distributing his vast private fortune to great public purposes, and at the same time inducing municipal cooperation in channels which might otherwise be neglected, should serve as an example to other citizens and meet the approval and encouragement of all.

BARON IWASAKI has purchased the library of the late Professor Max Müller, containing 13,000 volumes, for presentation to the University of Tokyo.

AIDED by a special fund presented by a friend of the American Museum, Professor Osborn has sent out two expeditions especially in search of fossil horses—one to Texas and one to eastern Colorado. Word has just been received at the museum that the very first discovery made by the Texas party included a deposit of skulls of the three-toed horse, *Protohippus*, associated

with parts of the limbs, feet and backbone. This is one of the stages especially desired in the long series leading up to the modern horse. The skulls are reported to be the best that have thus far been found, and this discovery is an auspicious opening to this special series of explorations. *Protohippus* belongs to the Pliocene, and is believed to be the immediate ancestor of the true horse.

THE New York Zoological Park has just received from the Galapagos Islands via San Francisco, five very large giant tortoises, representing three species, *Testudo microphyes*, *vicina* and *elephantopus*. The largest is a very old specimen measuring, in straight lines, 42 inches in length, 30½ in width, and in height 20 inches. Its weight is 310 pounds. Three other specimens weigh respectively 156, 129 and 118 pounds. These five specimens represent the pick of a lot of 13 collected in the Galapagos group last winter by Capt. William Johnson, of San Francisco.

THE *Bulletin* of the New York Botanical Garden states that the first instalment of the Vignier Herbarium, the purchase of which was arranged by Dr. Britton while in Europe last fall, has lately been received. This portion of Mr. Vignier's herbarium contains the Schaffner Mexican collection numbering about 4,500 specimens, many of them duplicated, and thus valuable for future exchanges, and that part of a general collection consisting of cryptogams, and the flowering plants from the *Ranunculaceæ* to the *Leguminosæ*, according to the DeCandollean system, numbering 10,877 specimens. This important accession was made by means of funds provided by Mr. Andrew Carnegie.

THE Paris correspondent of the *London Times* writes under date July 2: I went yesterday to Vesinet, a pretty little village between Paris and St. Germain, where I witnessed some most interesting experiments in wireless telegraphy by Colonel Eugene de Pilsoudski, an engineer of the Russian army. His system depends in no way upon the air for transmission of the current. The earth itself is his conductor. He established his apparatus in two villas about one kilometer apart. The messages were transmitted clearly, rapidly,

and without the slightest hitch. The current passes from the transmitter to an underground plate, and then to a box containing the isolating elements of pitch and petroleum, whence it is carried to the receiver at a distance and read off by a Morse apparatus, which in turn reproduces the communications transmitted back to the starting-point. The realization within a limited space of the theory of wireless tellurian telegraphy is therefore complete. A demonstration of the feasibility of the system is shortly to be made between Paris and Compiègne, and immediately afterwards between Paris and Brussels. Of course the radius of action depends upon the power of the electrodes, but Colonel de Pilsoudski declares that messages can traverse not only mountains and streams, but more easily still the sea.

AN exposition will be held at Osaka in Japan from March 1 to July 31, 1903. The articles to be exhibited include agricultural, horticultural, forestry and water products; mining, industrial, and mechanical exhibits; and those pertaining to education, science, sanitation, economy and the fine arts. The articles shall be those collected, produced or manufactured by the subjects of the Empire, or by foreigners residing in Japan. The cost of the exposition is to be paid by the imperial treasury, except the expense of exhibiting, which will be borne by the exhibitors.

UNIVERSITY AND EDUCATIONAL NEWS.

THE New York *Evening Post* states that Mrs. Mary Austin Carroll, of Boston, has just made a gift to the University of Virginia, by which the institution will receive during the remainder of her life an annual income of about \$11,000. Mrs. Carroll's father, the late Arthur W. Austin, at his death twenty years ago left his estate of \$400,000 in trust for the benefit of his daughter during her life, and at her death to go to the institution founded by Thomas Jefferson. Mrs. Carroll, sharing her father's love for the University, has just arranged to give for the rest of her life all her income except \$5,000 a year, which she reserves for her own support.

THE first meeting of the Trustees of the Carnegie Educational Fund was held in Edinburgh

on July 15. Lord Elgin, who presided, read a letter from Mr. Carnegie announcing that he had signed a deed placing \$10,000,000 at the disposal of the trustees.

THE last general Assembly of Connecticut passed a bill giving an appropriation of \$3,000 per annum to the Agricultural Experiment Station at New Haven for insect work and requiring that the station appoint a State entomologist and pay his salary. Mr. W. E. Britton was appointed to that office by the Board of Control at its meeting, June 10. The law also requires that all nurseries in the State be inspected once each year and that all nursery stock shipped into the State shall bear on each bale or package a certificate of inspection.

THE position of Austin teaching fellow in histology and embryology at the Harvard Medical School is vacant. The value of the fellowship is \$500, the appointment being annual. The holder is expected to give about one-third of his time to teaching in the laboratory and the remainder wholly to an original research, which must be approved by the professor in charge. In the prosecution of the research the large resources of the laboratory may be utilized. Applications should be accompanied by a statement of previous experience and work, and should be addressed to Dr. Charles S. Minot, Harvard Medical School, Boston, Mass.

DR. F. L. STEVENS, who has just returned from a year of study at Bonn, Halle and Naples in the capacity of travelling fellow of the University of Chicago, has been elected instructor in biology, in full charge of the department, in the College of Agriculture and Mechanic Arts, Raleigh, N. C.

N. E. GILBERT, A.B. (Wesleyan, 1895), Ph.D. (Johns Hopkins, 1901), has been appointed instructor in physics at Lehigh University.

FREDERICK H. SAFFORD, Ph.D. (Harvard), has resigned from the mathematical staff of the University of Cincinnati.

AT Birmingham University, Dr. A. H. R. Buller has been appointed lecturer in botany and Dr. R. C. Farmer demonstrator in chemistry.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

EDITORIAL COMMITTEE : S. NEWCOMB, Mathematics ; R. S. WOODWARD, Mechanics ; E. C. PICKERING, Astronomy ; T. C. MENDENHALL, Physics ; R. H. THURSTON, Engineering ; IRA REMSEN, Chemistry ; CHARLES D. WALCOTT, Geology ; W. M. DAVIS, Physiography ; HENRY F. OSBORN, Paleontology ; W. K. BROOKS, C. HART MERRIAM, Zoology ; S. H. SCUDDER, Entomology ; C. E. BESSEY, N. L. BRITTON, Botany ; C. S. MINOT, Embryology, Histology ; H. P. BOWDITCH, Physiology ; J. S. BILLINGS, Hygiene ; WILLIAM H. WELCH, Pathology ; J. MCKEEN CATTELL, Psychology ; J. W. POWELL, Anthropology.

FRIDAY, AUGUST 2, 1901.

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DOCTORATES CONFERRED BY AMERICAN UNIVERSITIES.

THE following table, compiled from official sources, gives details in regard to the conferring of the degree of Doctor of Philosophy during the past academic year :

	Humanities.	Sciences.	Total for 1901.	1900.	1899.	1898.
Yale.....	21	18	39	26	30	34
Chicago.....	20	16	36	37	24	36
Johns Hopkins..	11	19	30	33	38	33
Harvard	14	15	29	36	24	26
Columbia	12	13	25	21	33	22
Pennsylvania..	13	12	25	9	20	24
Cornell	8	13	21	19	7	19
Virginia	4	4	8	2	2	0
Clark.....	0	7	7	9	5	13
New York.....	5	1	6	7	9	5
Wisconsin	2	3	5	5	7	5
Columbian.....	2	1	3	5	0	1
Michigan.....	3	0	3	5	4	7
Princeton	3	0	3	3	3	0
Brown	1	1	2	3	3	1
Minnesota	2	0	2	3	2	1
California	0	2	2	2	3	1
Stanford	1	1	2	2	0	2
Bryn Mawr.....	0	2	2	1	3	3
Vanderbilt.	0	1	1	3	0	0
Nebraska.....	0	1	1	1	1	2
Washington.....	0	1	1	0	2	0
Tulane.....	0	0	0	1	0	0
Colorado.....	0	0	0	0	1	0
Kansas.....	0	0	0	0	1	0
Missouri.....	0	0	0	0	1	0
Syracuse.....	0	0	0	0	1	0
Total.....	122	131	253	233	224	234

The table shows that the degree was conferred on 253 candidates, an increase of 20

as compared with 1900, of 29 as compared with 1899, and of 19 as compared with 1898. This probably represents the largest number of degrees conferred during any year since the development of our university system. The degree was conferred in the sciences in nine more cases than in the humanities, a gain for the sciences as compared with preceding years. In 1898 there was an excess of 24 degrees in the humanities; in 1899 of six degrees in the sciences, and in 1890 of seven degrees in the humanities. There appears to be consequently a relative increase in the number of those who pursue advanced studies in science. We have in previous years called attention to the fact that the division of the subjects into sciences and humanities is somewhat artificial. Those that have been allotted to the exact and natural sciences are shown in the accompanying table. Of the 253 degrees, three were doctors of science, one each being given by Cornell, New York and Vanderbilt. In view of the rareness with which this degree is conferred and the desirability of using it for an honorary degree, it seems evident that it should no longer be used as a practical equivalent for the Ph.D. The Ph.D. degree, we are glad to note, was not given *causa honoris* by any university from which reports have been received. It will be noticed that the universities are divided into two fairly distinct classes. Seven—namely, Chicago, Columbia, Cornell, Harvard, Johns Hopkins, Pennsylvania and Yale—have almost invariably given between 20 and 40 degrees each year, whereas none of the other universities reaches an average of 10. This year, for example, the seven universities mentioned gave 205 degrees as compared with 48 degrees by the twenty other universities on the list. We may doubtless, however, expect a rapid increase in the number of degrees given by the State universities of the Middle and Western States.

Harvard and Yale have this year given as many degrees in the sciences as in the humanities, whereas in previous years the humanities have predominated, as the sciences have at Johns Hopkins and Cornell. There was a relative excess in the number of degrees in chemistry at Johns Hopkins; in physics at Cornell and Johns Hopkins; in mathematics at Yale; in zoology at Chicago; in psychology at Clark, Yale and Harvard, and in geology at Johns Hopkins and Harvard.

The number of doctorates in the sciences last year and in the three preceding years is as follows:

	1901.	1900.	1899.	1898.
Chemistry	28	26	32	27
Physics.....	23	15	7	11
Mathematics.....	18	11	13	11
Zoology.....	15	11	11	12
Psychology.....	13	9	15	18
Geology.....	10	5	5	6
Botany.....	8	12	11	11
Astronomy.....	5	4	2	3
Sociology.....	3	3	5	—
Education.....	2	8	5	—
Physiology.....	1	4	1	4
Anthropology.....	1	2	0	2
Paleontology.....	1	2	4	0
Anatomy.....	1	—	—	—
Bacteriology.....	1	1	1	0
Engineering.....	1	—	—	—
Mineralogy.....	0	0	2	0
Meteorology.....	0	0	1	0
Total.....	131	113	115	105

The names on whom the degrees were conferred and the titles of their theses are as follows:

JOHNS HOPKINS UNIVERSITY.

1898. Robert Montgomery Bird: The Action of Ammonia and of Alcohols and Alcoholates on the Chlorides of Orthosulphobenzoic Acid.
1899. Jay Allan Bonsteel: The Soils of St. Mary's County, Md., showing the Relationships of the Geology to the Soils.
1900. Lyman James Briggs: On the Absorption of Water Vapor, Carbon Dioxide and certain Substances in Aqueous Solution by Finely Divided Quartz.
1901. Benjamin Palmer Caldwell: On the State of Equilibrium of Certain Double Iodides, Cyanides, Nitrates and Sulphates in Aqueous Solution.

Victor John Chambers : A Further Investigation of the Action of Phenols and Alcohols on the Chlorides of Paranitroorthosulphobenzoic Acid.

William Chambers Coker : Observations on the Gametophyte and Embryo of *Taxodium Distichum*.

Winterton Conway Curtis : Life History, Normal Fission and Reproductive Organs of *Planaria Maculata*.

James McDowell Douglas : The Dissociation of certain Acids, Bases and Salts at different Temperatures.

Joseph Christie Whitney Frazer : I. On Relations between the Color and the Composition and Constitution of the Alkali Salts of Nitrophenols. II. Comparison of the Metasulphaminebenzoic Acids made by Different Methods.

Norman Everett Gilbert : Some Experiments upon the Relations between Ether, Matter and Electricity.

Gilbert Logan Houser : The Neurones and Supporting Elements of the Brain of a Selachian.

Norton Adams Kent : Notes on the Zeeman Effect. George Curtis Martin : The Miocene Gastropod Fauna of Maryland.

Francis LeJau Parker, Jr. : A Study of the Preparation of Permanganic Acid by Electrolysis.

Harold Pender : On the Magnetic Effect of Electrical Convection.

Israel Euclid Rabinovitch : The Foundation of the Euclidean Geometry, as viewed from the Standpoint of Kinematics.

George Burr Richardson : A Study of the Red Beds of the Black Hills of South Dakota and Wyoming.

Ward Weaver Simmons : A Further Study of the so-called infusible Diamide of Parasulphobenzoic Acid.

Charles Carroll Schenck : Some Properties of the Electric Spark and its Spectrum.

YALE UNIVERSITY.

Katherine Jeannette Bush : Descriptions of three New Genera and sixteen New Species belonging to the Tribes Sabellides and Serpulides.

Charles Montague Cooke, Jr. : The Hawaiian Hepaticae of the Tribe Trigonatheae.

Walter Wells Davis : Researches in Cross Education.

Edgar Selah Downs : The Induced Alternating Current Discharge studied with reference to its Spectrum and especially the Ultra-Violet Spectrum.

Arthur Sullivan Gale : On a Particular Class of Algebraic Minimum Curves and Surfaces.

Laurence Ilsley Hewes : Some Properties of Path-Curves of Continuous Projective Groups.

Treat Baldwin Johnson : Researches on Amidines and Imidoesters.

J. E. Wallace Wallin : Researches in the Rhythm of Speech.

Stuart Weller : Studies of the Paleozoic Faunas of the Interior Continental Basin of North America, Two Volumes.

Joshua Larson : A Computation of the Orbit of Σ 3062.

Edwin Hoyt Lockwood : Atmospheric Stability as affected by Water Vapor.

Ishiro Miyake : Researches in Rhythmic Action.

John Treadwell Norton, Jr. : The use of Sodium Thiosulphate in Analysis.

Charles Adams Peters : Oxalic Acid and the Oxalates in Analysis.

Chauncey Brewster Rice : An Experimental Study of the Wehnelt Interrupter.

Edward Christian Schneider : The Excretion of Kynurenic Acid.

Edwin Bidwell Wilson : The Decomposition of the General Collineation in Space into three Skew Reflections.

Ruth Goulding Wood : Non-Euclidean Displacements and Symmetry Transformations.

UNIVERSITY OF CHICAGO.

Charles Joseph Bushnell : The Development of the Corporation in England in Relation to the Sentiment of Antagonism.

John Gaylord Coulter : A Contribution to the Life History of *Sium*.

Elliot Rowland Downing : The Spermatogenesis in Hydra.

Minnie Marie Enteman : Coloration of *Polistes* (the Common Paper Wasp).

William Findlay : The Sylow Subgroups of the Symmetric Group on K Letters.

John Morris Gillette : The Culture Agencies of a Typical Manufacturing Group, South Chicago.

Ralph Stayner Lillie : Excretory Organs of *Arenicola Cristata*.

Anne Moore : The Effect of Electrolytes on Rigor Mortis.

Virgil Everett McCaskill : The Metamerism of *Hirudo Medicinalis*.

Ralph Harper McKee : The *Isourea* Ethers.

James Bertram Overton : Parthogenesis in *Thalictrum purpurascens*.

John McClellan Prather : The Skeleton of *Salax* Microdon.

Fritz Reichmann : Capacities at Small Distances.

Samuel Bower Sinclair : The Possibility of a Science of Education.

Ernest Brown Skinner : On Ternary Monomial Substitution—Groups of Finite Order with Determinant ± 1 .

Helen Bradford Thompson : Psychological Norms.

HARVARD UNIVERSITY.

- Charles Hamlin Ayres, Jr. : Measurements of the Internal Resistance of Galvanic Cells.
- Maurice Alphens Bigelow : The Early Development of Lepas, A Study of Cell-Lineage and Germ-Layers.
- Charles William McGowan Black : The Parametric Representation of the Neighborhood of a Singular Point of an Analytic Surface.
- George Ashley Campbell : On Loaded Lines in Telephonic Transmisson.
- Clarence Augustus Chant : The 'Skin'-effect in Electric Oscillators ; with a Method of determining Wave-Lengths.
- Thomas Harvey Haines : The Temporal Relations of Mental Processes : An Experimental Study of Objective and Subjective Simultaneity.
- Robert William Hall : The Development of the Mesonephros and the Müllerian Ducts in the Amphibia.
- Charles Nelson Haskins : On the Invariants of Quadratic Differential Forms.
- George William Heimrod : The Silver Voltmeter.
- Edwin Bissell Holt : The Motor Element in Vision.
- Ernest Howe : The Pre-Cambrian Intrusive Rocks of the Animas Canyon, Colorado.
- Benjamin Shores Merigold : A Revision of the Atomic Weight of Uranium.
- Raymond Herbert Stetson : Rhythm and Rhyme.
- Reuben Myron Strong : The Development of Color in the Definitive Feather.
- Alfred William Gunning Wilson : Physical Geology of Central Ontario.

COLUMBIA UNIVERSITY.

- Grace Andrews : The Primitive Double Minimal Surface of the Seventh Class and its Conjugate.
- Frederick Mark Becket : Electrolysis of Fused Salts.
- Walter Richard Crane : Investigations on Magnetic Fluids with reference to Magnetic Ore Concentration.
- Bergen² Davis : On a Newly Discovered Phenomenon Produced by Stationary Sound Waves.
- Alfred² Newton Richards : A Chemical Study of Yellow Elastic Connective Tissue.
- Arthur Cleveland Hall : Civilization and Crime.
- Edward Frank Kern : The Quantitative Determination and Separation of Uranium.
- Alfred [Louis] Kroeber : Decorative Symbolium of the Arapahoe.
- George² W. A. Lucky : The Professional Training of Secondary Teachers in the United States.
- Joseph Warren Miller, Jr. : Elastic Properties of Helical Springs.

Herbert Raymond Moody : Reaction at the Temperature of the Electric Arc.

Francis Bertody Sumner : Kupfer's Vesicle and its Relation to Gastrulation and Concrecence.

Clark Wissler : The Correlation of Mental and Physical Tests.

CORNELL UNIVERSITY.

- William Suddards Franklin : Poynting's Theorem.
- Ernest Blaker : A Spectrophotometric Comparison of the Relative Intensity of Light from Carbon at Different Temperatures.
- Judson Freeman Clark : On the Toxic Action of Certain Salts of Mercury and Copper.
- Benton Dales : Contributions to the Chemistry of the Rare Earths of the Yttrium Group.
- Margaret Clay Ferguson : The Development of the Pollen Tube and the Division of the Generative Nucleus in Certain Species of Pines.
- William Benjamin Fite : On Metabelian Groups.
- Henry Waldo Kuhn : On Imprimitive Substitution Groups.
- Charles Philo Matthews : On Certain Improved Photometric Apparatus and Results therewith obtained.
- Wilton Marks Munson : The Horticultural Status of the Genus Vaccinium.
- Rolla Roy Ramsey : The Effect of Gravity and Pressure on Electrolysis.
- John Sandford Shearer : Some Effects of High Elective Tension on Dielectrics.
- Carrie Ransom Squire : A Genetic Study of Rhythm.
- George Walter Stewart : Distribution of Energy in the Spectrums of Acetylene.

UNIVERSITY OF PENNSYLVANIA.

- Gilbert Hillhouse Boggs : I. The Separation of Vanadic Acid from Metals by means of Hydrochloric Acid Gas. II. The Occurrence of Molybdenum in the Mineral Endlichite.
- Henry Shoemaker Conard : Water Lilies : a Monograph on the Genus Nymphaea.
- Burton Scott Easton : Substitutions and Substitution Groups.
- William Clarence Ebaugh : On the Atomic Weight of Arsenic.
- Henry Brown Evans : The Right Ascensions of One Hundred and Eighty Latitude Stars.
- Alice Macmichael Jefferson : Aromatic Bases as Precipitants for Rare Earth Metals.
- John Raymond Murlin : The Digestive System of the Land Isopods, with special reference to the Morphology of Absorption and Secretion.
- Marie Louise Nichols : The Spermatogenesis of

Oniscus asellus with especial reference to the History of the Chromatin.

Jonathan Taylor Rorer : A Definitive Determination of the Orbit of Comet 1898 χ —Brooks.

Thomas Maynard Taylor : I. The Atomic Weight of Tungsten. II. On the Ammonium Tungstates.

Caroline Burling Thompson : *Zygeupolia Litoralis* : A New Herteronemertean.

Roxana Hayward Vivian : The Poles of a Right Line with Respect to a Curve of Order n .

CLARK UNIVERSITY.

Clemence J. France : Psychology of Gambling.

Samuel B. Haslett : A Plan and Rationale of Sunday School Work.

James Edmund Ives : Contributions to the Study of the Induction Coil.

Herbert G. Keppel : The Cubic 3-spread Ruled with Planes in 4-fold space.

Melanchthon F. Libby : Influence of the Idea of *Æsthetic* Proportion on the Ethics of Shaftesbury.

Charles H. Sears : Studies in Rhythm.

John N. Van der Vries : On the Multiple Points of Twisted Curves.

UNIVERSITY OF VIRGINIA.

Dr. Wm. A. Lambeth : Geology of the Monticello Area.

C. J. Moore : On the Products of Interaction between the Aliphatic Amines with certain Metallic Salts.

Herbert R. Morgan : The Orbit of Enceladus.

L. D. Skeen : Bacterial Flora of Charlottesville Reservoir Water.

UNIVERSITY OF WISCONSIN.

Charles Kenneth Leith : Rock Cleavage.

Charlotte Elvira Pengra : On Functions connected with Special Riemann Surfaces, in Particular those for which $p=3, 4$ and 5 .

Herman Schlundt : On the Dielectric Constants of Pure Solvents.

UNIVERSITY OF CALIFORNIA.

Russell Tracy Crawford : Determination of the Constant of Refraction from Observations made with the Repsold Meridian Circle of the Lick Observatory.

Frank Elmore Ross : Differential Equations Belonging to a Ternary Linearoid Group.

BRYN MAWE COLLEGE.

Mary Bidwell Breed : The Polybasic Acids of Mesitylene.

Elizabeth Rebecca Laird : The Absorption Spectrum of Chlorine.

BROWN UNIVERSITY.

Leonard Worcester Willians : The Anatomy of the Common Squid.

COLUMBIAN UNIVERSITY.

William Mather Lamson : Iron and Steel Domes.

LELAND STANFORD JUNIOR UNIVERSITY.

John Flesher Newson : A Geologic and Topographic Section across Southern Indiana, from the Ohio River at Hanover to the Wabash River at Vincennes, with a discussion of the General Distribution and Character of the Knobstone Group in the State of Indiana.

VANDERBILT UNIVERSITY.

Warren Henry Hollinshead : Some Points in Analytical Chemistry.

UNIVERSITY OF NEBRASKA.

Wilbur Clinton Knight : The Artesian Basins, Oil Fields and Mining Districts in Wyoming.

NEW YORK UNIVERSITY.

John A. Mandel : Glycuronic or Glucuronic Acid.

WASHINGTON UNIVERSITY.

Herbert J. Webber : Spermatogenesis and Fecundation of *Zamia*.

A BASIS OF SCIENTIFIC THOUGHT.*

LÉMERY in his *Cours de Chimie* (1675) was the first to separate that branch of science termed chemistry into organic and inorganic. The latter embraced those bodies found in the mineral world and those produced by means of such substances. Berzelius, recognizing that organic bodies contained carbon, maintained that they came about through the influence of a particular force—*vis vitalis*. In 1828, however, Wöhler synthetically prepared, from strictly inorganic materials in the laboratory, urea, the eventual product of animal metabolism. This discovery was followed by the synthesis of numerous other bodies hitherto thought to be possible of preparation only through the mysterious life-force.

Although the fundamental laws underlying these divisions of chemistry are the same, yet for pedagogic convenience this classification is adhered to by many; oth-

* Read at the April meeting of the N. C. Section of the American Chemical Society.

ers even diversify at greater length and we have physical chemistry, technological, analytical, agricultural and physiological chemistry. Chemical laws prevail and are the same, it matters not how one classifies his facts.

By mathematics through ages we have sought expression, whether by definite exact numbers, equations or indeterminates. It is the language of physics, making possible the expression of the invention of means for measuring force and calculating its effect upon matter. Joule, Helmholtz, Robert Mayer and Maxwell in their refined discoveries in mechanics touched chemistry, for the explanations of the phenomena of dissociation, solution, vapor pressure, osmotic pressure, etc., as developed by Arrhenius, Van't Hoff and Nernst, and taught by Ostwald, could never have gained currency save through the invention of a mode of quantitative expression by the former *savants*. J. B. Richter over a hundred years ago said that chemistry was a branch of mathematics. In fact, recently Lord Kelvin said 'Nothing can be clearly understood until we can express it in figures.'

It has only been within the past three-tenths of the present century that the barriers between physics and chemistry have been completely removed. This came about through the necessity of applying more closely certain laws of physics for the explanation of chemical facts, as, for example, electrolytic conductivity, heat of reaction and so on, and reciprocally by conversion of chemical force into electrical energy, heat, phosphorescent light, etc., and measuring the same. Mathematics has served as the medium of quantitatively determining these changes—in short, physical chemistry.

Geology may be termed the chemistry and physics of the earth's crust, more particularly applied to the inanimate portion of the world, although full cognizance is

taken of alterations of the shell by animals. Latterly geology and biology, the chemistry and physics of animal life, may be said to merge. Only recently chemistry and biology have been more firmly welded into a unit by the interesting work of Bredig and Müller von Berneck on 'Inorganic Ferments,' in which was demonstrated that certain life processes, hitherto regarded as possible only through the intervention of bacilli, could be carried out by means of an active chemical. This step is far in advance of even Büchner's enzyme fermentation. Attention has been called by the sensational press to the incomplete, but fruitful and promising, researches of Loeb and E. B. Wilson on parthenogenesis or chemical fertilization.

Cognizant of the persistent outcropping of favorable evidence for Darwin's evolution, we observe a unity of purpose in animal growth. Astronomy is the chemistry and physics of celestial bodies, and our knowledge of them is based upon observations dependent upon mathematical considerations. By the term mathematics here used of course must be meant simply a method by which the senses judge.

Accepting, therefore, the articulated relation among the various utilitarian divisions of science, we may develop our theme along the lines of those teachings of which we feel best qualified to write, namely, physics and chemistry, and regard all science as these two differently applied, either as to method of application, or class to which we would direct the application. We are perfectly aware of valid arguments that may be put forward strenuously against such a conception, yet feel that we shall be reduced to the study of a unity, as we must eventually express our knowledge of all science, qualitative and quantitative, mathematically.

Despite this unifying tendency to which we would call attention, chemists persist in discovering new elements, as argon, helium,

neon, krypton, radium, polonium, etc., and seem to have *facts* in direct opposition to our ideas. Over a century ago the same Richter noted resemblances of what chemists now term elements. Lavoisier by chemical and physical means proved the law of conservation of matter. Then Dalton ascribed weights to these elements composing matter, from which came our satisfactory atomic theory. None of these, as well as Joule's masterful proof of the conservation of energy, was possible without a medium of expression, namely mathematics, whereby the necessary comparison of weights and other measurements could be made. The triads of Döbereiner and Dumas, and Newlands' octaves foreshadowed a periodicity in atomic properties as later clearly and definitely set forth by Mendeléeff and Lothar Meyer. This periodic law, so long accepted, has had shadows cast upon its universality by the failure of scientists so far to satisfactorily arrange the new elements noted (and several old ones) in accord with it. Naturally we lend ourselves to the thought that this is due to our insufficient knowledge of these novel and striking members of the chemical family.

Prout may not have been so far wrong in conception when he asserted that all the elements were compounded of hydrogen, then known to have the lowest of all atomic weights. Stas's classical researches and re-determinations of the atomic weights and Morley's accurate proof of the mass relations of hydrogen and oxygen prevent absolutely the acceptance of the fact of the statement, but the germ of thought bears fruit. The idea is still prevalent, and Crookes has termed that initial, universal substance of which all else is composed, *protyle*. In fact, J. J. Thomson has only recently, in very wonderful researches on electric discharges in gases, been able ingeniously to demonstrate, by mathematical interpretation of the experimental results, that the atom is

made up of a number of smaller bodies, which he terms *corpuscles*.

Thus we are brought almost face to face with the most ancient alchemical teachings. Within recent years, Hartley, thoroughly orthodox, has written that "one element in a group differs in its properties from another not because it consists of another kind of matter, but because the quantity of matter in an atom is different." While we are not inclined to give over-serious consideration to Fittica's recent assertion that he has actually transmuted phosphorus into arsenic under one set of conditions and into antimony under another, doubtless later transmutation will become an experimental fact; not that all our base metal will be converted into a precious one, but we shall secure more refined methods and further decompose our present elements; or the increased number of elements, yearly augmented, shall give us a more perfect periodicity, demonstrating the relationship of the elements and their unity without requiring the actual experimental proof. The speculative hylozoists may thus have foretold events.

We have other experimental evidence pointing in the direction indicated. Some of our chemistries, not so long ago, dogmatically taught that hydrogen was the lightest known gas and impossible of liquefaction; or if it could be solidified, it would be metallic in character. Dewar, Olzewsky and Wroblewsky have secured that gas as a limpid liquid by intense refrigeration in vacuum-jacketed apparatus. And but recently the first named in classical researches reduced the temperature of liquid hydrogen to within eighteen degrees of the absolute zero (-255° C.) and obtained white, crystalline, solid hydrogen. These researches with extreme cold and Moissan working at from three to four thousand degrees give us the widest ranges of temperature. The latter has already secured many elements hitherto regarded as non-volatile in a gas-

eous condition. Like Dewar's work at the low temperatures, it appears that a refinement of skill will secure all elements in a gaseous condition. Thus all matter, that is, elemental, may exist in the three physical states.

In the domain of physics, observation of the marvelous effects of the Röntgen rays, Becquerel rays, the characteristic property of certain old and some recently discovered elements, as barium, thorium, radium and polonium, show new things undreamt of. We cannot say that these discoveries, praise-deserving and wonder-creating as they are, will give us final proof of the truth of our premise as put forth, yet they do point in that direction.

All forms of energy are interchangeable, hence we have but one force, whether it exhibit itself as heat, electrical energy, chemical force, or what not. These new rays, active and specific in their demonstration, are but altered forms of the *one* force. Why not therefore a *one matter*? Having reached that point we may con within reason Ostwald's dictum, that all is force, there is no such thing as matter. We may well conclude by repeating the query of the elder Büchner, that *aberwitzig* youth: "Is it a duty to believe things that can not be proven?"

CHARLES BASKERVILLE.

FORMATIVE MUSEUM PERIOD.*

SCIENTIFIC activity developed more slowly and was less encouraged in New York in the earlier years of this century than in its neighboring rivals Boston and Philadelphia. The expression of a mercantile, or more harshly described as that of a money-making city was early acquired, and baffled or obscured the spirit of scientific research. In a measure this suggestion, applied to the miscellaneous avenues of enterprise and the accumulation of wealth, was sensibly deceptive. It would be quite impossible to

stifle the incentives to the study of nature in a population of nearly one million people, and the limited consideration given to physical, chemical and geological science in the colleges, high-schools and seminaries, which aroused unflinching increased interest in the objects of nature, led to their collection, and stimulated local societies in their study and record.

An examination of the decade immediately prior to the establishment of the American Museum of Natural History, and by implication a reference to the conditions somewhat earlier, show us the formative stages shaping public needs for its appearance and public appreciation of its value.

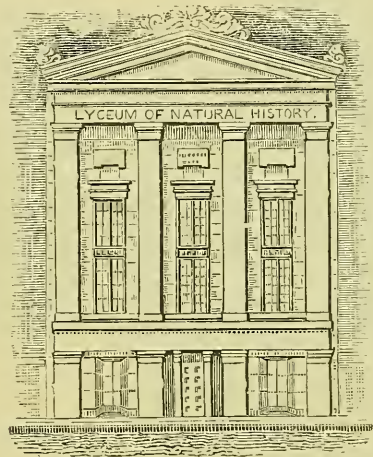
Philanthropic and social designs, historical research, theological learning, medical study and literary invention were significant in the more intellectual life of New York City from 1830 to the date of the foundation of the Museum in 1870; the active participation in education of three colleges, a normal school for women, two medical schools, and numerous lesser centers of learning, including the invaluable services of the Cooper Institute with two seminaries devoted to religious instruction, were distinctive evidence that New York was not oblivious to the claim of knowledge.* But science in its purer forms and especially the study of nature in its animal and vegetable life, received scant recognition in the curricula of instruction. Two societies, the New York Academy of Sciences, later (1876) the Lyceum of Natural History, and the Torrey Botanical Club (1870), were the guardians and shrines of the scientific life of the city, and collected in a compact coterie the separated enthusiasts

* Columbia University (King's College) dates from the last century (1754); the New York University was opened 1831; the College of the City of New York (Free Academy) in 1849; The Normal College in 1855; Union Theological Seminary in 1836; General in 1817.

in the study of nature. The Lyceum was in a precarious condition for many years, and, at least until 1836, led a shifting, and in some respects shiftless, life. In the latter year it occupied its own building at 563 Broadway, and here the elder Stillman began a series of lectures on geology, seven in all, which produced a moderate sensation in the controversies of the day. A museum was a part of the appropriate features of the society and these were increased by donations to such an extent that Mr. J. H. Redfield, a competent judge, alludes to them as 'large,' a term certainly of variable significance in the mouth of a collector. The exact nature and contents of these collections can be determined from the chapter on collections in Professor Fairchild's 'History.' In view of the many local features now introduced in the halls of the Museum and as a means of determining the advance made in the expectations and ambitions of a Museum, a glance at these collections is instructive. As early as 1817, Messrs. Torrey, Rafinesque and Knevels were made a committee 'to travel and explore the natural history and productions of the neighboring countries'; with them in this work were associated Drs. Mitchill and Townsend. Bones of a mastodon were found in Orange Co., later were added a right whale and a swordfish, from the Atlantic, while specimens of the Wallkill carp and pike, and 'white wild sheep' from the Rocky Mountains, formed the nuclei of an increasing cabinet. 'Measures for completing a catalogue of the vegetables growing within 100 miles of the city' were early instituted, a device now variously illustrated in the collections of plants, buds and insects made to-day. Minerals were added, and repeated additions of snakes and fishes, fossils, skeletons, plants and shells gave it a local reputation and naturally engendered some self-congratulation amongst its members. But

when we learn that it was all accommodated in sixty-two boxes, the reader, familiar with existing needs, is recommended to realize how ideas and ideals advance.

It is not incumbent upon a historian of the American Museum to dwell upon the struggles of the Lyceum, but it would be an error in precision not to indicate the influence this and similar or affiliated movements had in determining its inception, and especially pointing out the critical relations in 1865 of the Lyceum to the projected



The Lyceum Building, No. 563 Broadway.*

American Museum. The Lyceum increased in its membership and the papers read at its meetings by Jno. J. Audubon, De Witt Clinton, James E. DeKay, Jno. LeCompte, Samuel L. Mitchill, Jno. Torrey, Asa Gray, G. Troost, Thos. Bland, James D. Dana, Theodore Gill, Gen. L. Lawrence, Jno. H. Redfield, Temple Prime, Alexander Agassiz, W. A. Dall, J. S. Newberry, William Stimpson, Benj. N. Martin, Augustus R. Grote, while listened to by a small audience, were contributions to the development of scientific feeling in New York. Dr. Jno. C. Jay, whose collections in conchology formed the nucleus of the present cabinet

* This and other illustrations to this article are published by the courtesy of Professor H. L. Fairchild.

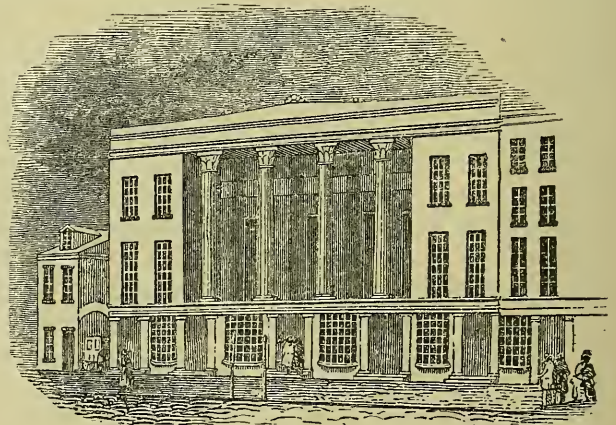
of shells in the American Museum, as his library was the foundation of its present



University Medical College, Fourteenth St.

library, was one of the most enthusiastic and sedulous advocates of its interests while in its financial necessities the Lyceum leaned rather too heavily on his generous sympathy. Amongst the friends and officers of the New York Lyceum from 1860 to 1869 were names afterwards identified with the opening and even the later years of the American Museum. Amongst these were William A. Haines, Robert L. Stuart, George M. Lawrence, J. Carson Brevoort, D. Jackson Steward. These gentlemen were in several instances themselves collectors and possessed libraries and cabinets of commanding interest. They became interested in 1865 in a movement to secure moneys for the furtherance of the object of

the Lyceum with a possible reference to a permanent home and a hall for its collections. Quoting from Professor Fairchild's 'History of the New York Academy of Sciences' (p. 49) we learn that "the circular letter explaining the plan had affixed to it the names of the active members of that time, which were these: William A. Haines, Robert L. Stuart, George N. Lawrence, J. Carson Brevoort, H. D. Van Nostrand, Chas. A. Jay, Dr. John W. Greene, D. Jackson Steward, Charles M. Wheatley, Temple Prime, with Livingston Satterlee as Chairman." This effort was unsuccessful and the disappointed hopes of its authors were later revived and the cooperation of the more influential embodied in the creation of the American Museum of Natural History. All expectation of securing in the rehabilitation of the Lyceum a permanent museum was destroyed, when, on May 21, 1866, the Medical College building, in which the collections of the Lyceum were placed, was burned. The collections were not insured and only its valuable library escaped de-

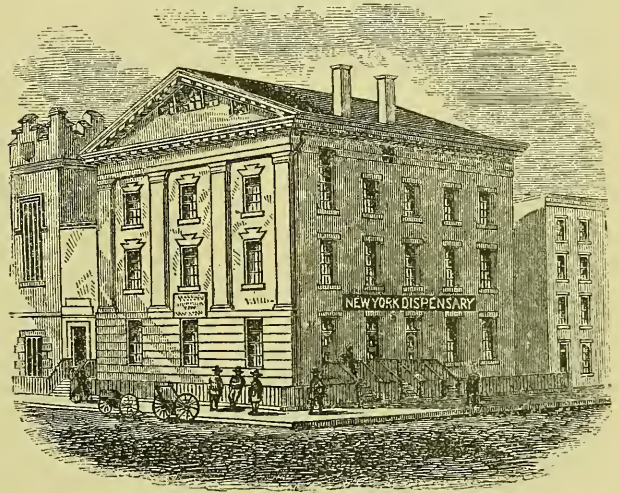


Stuyvesant Institute, University Medical College.

struction. For years before this the Lyceum had been engaged in a despairing

struggle to perpetuate itself and secure an autonomous existence. It had become after the foreclosure of its own building the guest of the University, moving from the Stuyvesant Institute on Broadway to the Medical College upon the site of the present Tammany Hall. With the disappearance of its collections, and the abrupt termination of plans of its growth into a substitute for a museum, its formative relations to the American Museum ceased. Its scientific work continued, and the spirit of research it fostered helped the objects of the Museum. Such addresses as that of Dr. Barnard at its Semi-Centennial on 'The relation of science to the advancement of civilization and the expediency of a public provision for the support and encouragement of scientific inquiry' were directly stimulating to the project of a museum, at that moment ready to take place. Besides the slender and perhaps almost imperceptible influence of the Lyceum in creating a demand for a great museum, a small measure of regard can be bestowed upon the effect, on the public-spirited citizens at least, of the Brooklyn Institute, which during all these years from 1845 onward had been engaged in the study of science, in developing scientific discussion, scientific education, and in stimulating the acquirement of scientific collections. A few details of the history of this institution can hardly be disregarded in any exhaustive sketch of the scientific tendencies then surrounding or immanent in New York City. The Brooklyn Institute originated in the Brooklyn Apprentices' Library Association in 1825. It expanded rapidly. Lectures under its auspices were amongst the first public expositions of natural science near New York. In 1843 it assumed the pres-

ent name and function of the Brooklyn Institute, and was really an important factor in the educational life of Brooklyn. Here Agassiz, Dana, Gray, Henry, Morse, Mitchell, Torrey, Guyot and Cooke brought the treasures of their learning and thought during the conspicuously brilliant period of its activity from 1843 to 1867. Mr. Augustus Graham endowed it, and while for some time the interests of history and the claim of religion somewhat disabled the efforts of its scientific members, collections were made, notably that of coleoptera of Harvey

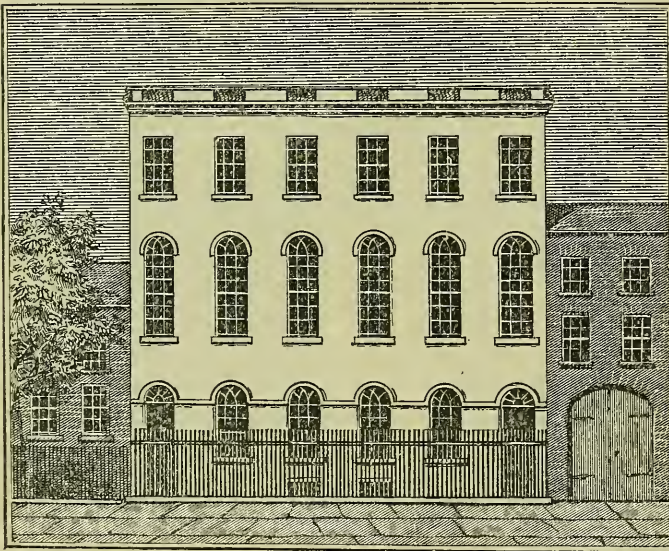


New York Dispensary, White and Centre Streets.

G. Rich, and the interests of science through its remarkable educational work advanced. It served its useful purpose in preparing the ground, in cultivating public feeling for the erection and support of a great museum. A stream of influence, not very perceptible, perhaps, but of some importance as the years drew near to 1876, emanated from the School of Mines in Columbia College (1864), where from the exertions of Professor J. S. Newberry the study of botany and zoology was more technically pursued than anywhere else in New York, and from which groups of young students

in geology and mineralogy were annually issuing.

Apart from the gradually educated demands amongst the studious classes, the public-spirited citizens of New York were intelligently sensitive to the reputation of the city, and when they recalled the museums of foreign cities whose collections and arrangements had challenged their admiration, they regretted that New York was yet without its own museum. In the United States it was behind other cities.



College of Physicians and Surgeons, Barclay St.

The Academy of Natural Sciences, founded in Philadelphia in 1812, possessed some collections with which were associated the names of Morton, Conrad, Nuttall, Audubon, Lucian Charles Bonaparte, Harlan, Rafinesque and others, and had created a provisional museum. Thomas Say, the distinguished conchologist, was its first curator, and through the generosity of William Maclure, the geologist, a building was opened in 1840 to the public, abundantly stored with the objects of nature, later succeeded by the structure at Nineteenth and

Race avenues; at Washington, the Smithsonian Institution, embracing the aims of the National Institute, was provided with a museum, apologetic, perchance, to the taste of an exacting critic, but still a dignified place for public instruction. Boston, from the exertions of the members of its Society of Natural History, had dedicated its museum on the 2d of June, 1864, when Professors Wyman and Wm. B. Rogers, with Mayor Lincoln, gave distinction to the ceremony. In Cambridge, as early as 1860,

rapid progress had been made on the new Museum of Comparative Zoology through the enthusiasm of Agassiz, whose definite relations to the creation of the American Museum of Natural History are presented later in this history. Chicago had created a museum under the auspices of Major Robert Kennicutt and later through the stimulus of Stimpson, and although it was damaged by fire in June, 1866, it still survived, and furnished, long prior to the erection of the great Field Museum, entertainment and information to the public.

There had been indeed in New York, outside of the immediate limits and influence of the Lyceum, efforts at museum installation. But they were industrial or historical or artistic and but slightly regarded the natural sciences. It must be remembered that the impulse which finally resulted in the Museum of Natural History was twofold, and enclosed the divergent tendencies towards nature and art, for the American and Metropolitan museums were simultaneous creations.

These preliminary efforts to give a mu-

seum to New York are significant in this connection. Perhaps the first museum in which a regard for scientific arrangement was shown in New York was that described in a rare and old pamphlet printed in 1804 entitled, 'Catalogue of the Natural Productions and Curiosities which Compose the Collections of the Cabinet of Natural History, opened for Public Exhibition at No. 33 William St., New York.*' This catalogue, apparently prepared by a Delacoste, in an introduction of four pages states that "there is scarce a city or town of any importance in Europe that is not possessed of a cabinet of that kind; but in the United States of America, the variety of whose productions and their dissimilarity from those of the Old World offer ample field for the researches of the naturalist, there is scarcely a collection deserving the name, except the one in Philadelphia belonging to Wm. Peale, whose indefatigable researches and laudable exertion to promote the knowledge of natural history entitle him to the gratitude of every friend of science." This collection was exhibited as the 'Delacoste Cabinet of Natural History,' at Federal Hall and apparently at No. 80 Greenwich Street. The collections, according to the examination instituted by Mr. Avery, appear to have been gathered on the coast of Guyana in South America, presumably by this Delacoste, and were made up of 'Quadrupeds, Birds, Fishes, Insects, Reptiles and Natural Productions of Cayenne.' The information is further elicited from the pages that "this above collection, which was originally put up for a Cabinet in St. Petersburg, would be sold here, if any purchaser should offer, and in case of the contrary will be forwarded next

spring to its first destination." Delacoste inaugurated the plan of subscriptions now familiar under a different form to his successors, and we find amongst his subscribers the names of leading New York people of that early day, as the Clintons, Hamiltons, Depeysters, Hosacks, Livingstons, Pringles, Seymours, Rutherfords, VanDykes, etc. Amongst these is the name of Jerome Bonaparte. Delacoste wished to make his establishment "permanent in New York, to augment his collections in proportion to the encouragement which he will receive, * * * and binds himself, if enabled by an adequate support, to travel through the whole continent of North America for the purpose of securing a skeleton of that anonymous animal called the mastodon." The subscriptions ranged from \$3.00 to \$1.00.

Before this in 1790 the Tammany Society 'established a museum for the purpose of collecting and preserving everything relating to the history of the country.' (Manual of the Common Council of New York, 1865, D. T. Valentine.) This museum was subsequently relinquished to Gardiner Baker, whose expenditure of time and money upon it had been considerable. After the death of Baker it was sold to W. J. Waldron, and finally was merged in the Scudder Museum, of which it formed the foundation, in Chatham Street. This embryonic effort was called the American Museum.

John Scudder, the predecessor of Barnum and Peale, established a pay museum of some merit in 1810. It was praised in very mellifluous English by a contemporary who rejoices that "it continues daily to improve, by extensive and valuable additions of the *works of nature* and artificial curiosities, from all parts of the world. Its immense collections are well arranged and beautifully displayed in four spacious saloons, each 100 feet in length; in addition

*We were indebted to the kindness of S. D. Avery, Esq., for the privilege of inspecting this interesting pamphlet, a notice of which was first printed in the *New York Times*, *Saturday Review*, July 1, 1899.

to which another department has recently been added of still larger dimension." This museum was on the ground now occupied by the St. Paul Building, opposite St. Paul's Church, Broadway. Fitz Green Halleck describes it as :

"Once the almshouse, now a school of wisdom,
Sacred to Scudder's shells and Dr. Griscom."

Peale's Museum and Gallery of Fine Arts stood on Broadway opposite to City Hall Park. It was founded in 1825. It is impossible to withhold at least a partial quota-

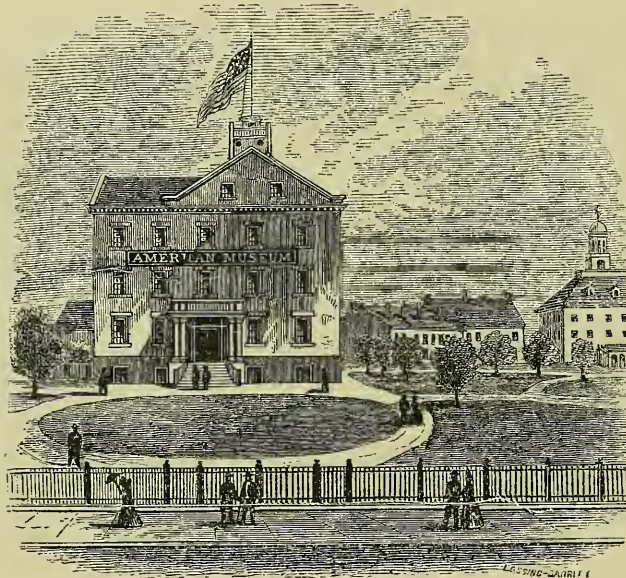
style in which the articles are mounted, render it one of the most interesting places of public amusement in the country. The 2d is a large and valuable collection of paintings, by eminent artists, amongst which may be particularly mentioned a portrait of Napoleon by Le Fevre ; a Magdalen by Le Brun, together with portraits of at least 150 celebrated citizens and foreigners. The 3d contains a very superior Cosmorana, several wax figures of good workmanship, fossil shells, minerals and miscellaneous curiosities."

As early as 1801 botany at least achieved in New York a notable recognition. It was then that Dr. David Hosack purchased the Elgin domain and created there a botanical garden. This property of twenty acres was between 5th and 6th avenues on 47th and 51st streets. Here, to quote the elegant Dr. Francis, "were associated in appropriate soil, exposed to the native elements or protected by the conservatory and hothouse, examples of vegetable life, and of variety of development—a collection that might have captivated a Linnæus or a Jussieu : and here indeed a Michaux and a Barton, a Mitchill, a Doughty, a Pursh, a Wilson or a Le Comte

often repaired to solve the doubts of the cryptogamist or to confirm the nuptial theory of Valliant."

This effort of Dr. Hosack's was a natural, though distant, precursor of a scientific museum.

Associated with Gardiner Baker in the organization of the American Museum was John Pintard, who laid the foundation of the N. Y. Historical Society. This institution gathered strength rapidly, as might have been expected, and its museum of his-



New York Institution. 'The Old Almshouse.' Western end facing Broadway.

tion depicting its attractions as given by the veracious Disturnell.* "It contains four spacious apartments, which are arranged in the following order : The 1st contains *specimens of natural history in all its branches*, and for beauty of arrangement, and the exquisite

* 'New York as it is in 1837 containing a general description of the City of New York, list of officers, public institutions, and other useful information. Including the public officers, etc., of the city of Brooklyn, accompanied by a correct map—published by J. Disturnell, 1837.'

torical treasures increased and expanded, and led a migratory life of more than 50 years, in which it wandered successively from the old City Hall, in Wall Street, to the Government House, in Bowling Green, to the N. Y. Institution, to the Remsen Building, on Broadway, to the Stuyvesant Institute, to the N. Y. University, until finally, in 1857, they rested permanently in the present home of the society at Eleventh Street and Second Avenue (History of N. Y. City, Benson J. Lossing). This society's collections assumed at this latter date the character of a museum in a popular sense, for at this time it secured the possession of Dr. Abbott's collection of Egyptian antiquities.

As early as 1854 Dr. Abbott's collection of Egyptian antiquities was brought to this country by its distinguished owner and an effort made to secure for it an appropriate home in America. Dr. Abbott, during a residence of more than twenty years in Egypt, where he had served as a physician in the army of Mehemet Ali during the Syrian war, had spared no pains and apparently little expense in the accumulation of a museum of Egyptian antiquities. The reception of his project was disappointing and hardly creditable to New York, where the collection it was expected would receive a proper reception. It did not, however, undergo the misfortune of being lost to the city. Several friends of Dr. Abbott and many gentlemen of influence and means, amongst whom was Peter Cooper, secured for it at least temporary security and it was placed in an apartment in the then New Institution, now the Cooper Union Hall, in Astor Place. The amount required was \$60,000. The editor of *Harper's Magazine* urged its purchase on the grounds that it 'would be the nucleus of a generous and extensive historical, scientific and artistic museum, which would give New York an elevated rank as a real, and

not a pretended and assumed, metropolis among the great cities of the world.' Such opinions, prevalent in the prints of the time, show how widely emphasized was the need of a great museum for the city. The Historical Society subsequently became the possessor of an immense art collection, numbering 1,000 examples of paintings and sculpture.

The project of a permanent crystal palace is familiar perhaps to the older men of our day, and the history of that elusive scheme, from the day when it opened as a World's Fair to its extraordinary half-ludicrous climax as a stock company, and a faint reflex of Sydenham Palace, under Barnum's direction, a well-remembered chapter in the events of half a century ago. In May, 1853, the approaching completion of the Crystal Palace was hailed by the New York public and by the large expectant population of its suburbs with delight and pride. It was at first a World's Fair, and in the sketches of the time we meet expressions of interest in which are mingled quite indiscriminately delight over its completion, and pleasure at the prospect of the Franconi hippodrome and a stupendous tower for panoramic views. The Crystal Palace was a wonderfully attractive building. It was modeled after the Crystal Palace of London, but was a really more admirable architectural work. It occupied the ground now known as Bryant Park, and covered five acres of ground. Its roof was supported on iron columns and the spaces between them were closed in by glass. It was a marvelous creation of Moorish and Byzantine composition. The annual fairs of the American Institute were held here, and it was perhaps the first seriously and generously conceived effort at the work and mission of a museum. It was known as the New York's Industrial Exhibition, and while it largely partook of the ephemeral bizarre and commercial character of a fair, it enlarged the

mind of the public by a display of both nature and art, and was a logical excitant of those desires in the scientific and artistic spirit of New York that led finally to the establishment of our art and scientific museums. During the season of the World's Fair the art and the products of Denmark, France, England, Germany, Belgium, Holland, were here superbly housed, and the illuminating effect upon our people cannot be overestimated. Its mention is essential for an appreciation of the conditions preliminary and formative to the erection of the present Museum of Natural History.

Those various enterprises and events so briefly epitomized would not of themselves have provided exactly the sort of stimulus required to bring to a procreant stage the undefined wishes of the leading citizens of New York for a great museum. This stimulus was provided, however. It arose from two separated centers of scientific activity, the organization of a Natural History Survey of New York State, and the persuasive influences emanating from Louis Agassiz at Cambridge.

Zoology in New York State received an early recognition in the labor of Samuel L. Mitchill, who in 1813 commenced an account of the fishes of the State, which, however, when published became a local review of the fishes near New York City. Contributions to the ornithology of the State were frequent, apart from the general works of Wilson, Bonaparte, Audubon, Cooper and DeKay, and William Cooper; Bachman, Le Conte, Barnes, Jay, Bailey, added fresh studies in herpetology, mammalogy, conchology and microscopy. As early as 1799 Mitchill had collected facts relative to the mineralogy of New York State, and he was succeeded by less-known names, until T. Romeyn Beck published in 1813 a more valuable review of this subject. The interest in the natural productions grew, and public attention and public funds became

gradually involved in the examination. Stephen Van Rensselaer in 1820 authorized Amos Eaton and T. Romeyn Beck to make a survey of the county of Albany. This was later extended to Rensselaer County, and over the line of the Erie Canal, the latter exploration producing Eaton's famous geological nomenclature and scheme of New York geology. The realization amongst public officers that the time was ripe for a thoroughly organized survey was more and more strengthened. In 1835, upon the motion of Charles P. Clich, a representative from New York, the Assembly of this State passed a resolution directing the Secretary of State, John A. Dix, to report upon the most expedient plan for a complete geological and natural-history survey of the State. Secretary Dix made the report, and on the 15th of April, 1836, this great survey was sanctioned by the Legislature, its maintenance provided for, and James E. DeKay, John Torrey, Lewis C. Beck, William W. Mather, Ebenezer Simmons, Timothy A. Conrad, Lardner Vanuxem and later James Hall were organized into a scientific directorship of its interests. The immediate result of this survey was the erection of a museum in Albany, and a new conception given throughout its publications to the importance of natural science. In 1869, the year immediately preceding the foundation of the museum, the survey had been in operation some thirty years, and Professor James Hall had gathered together a private collection of remarkable dimensions, representing the paleontological history of the State. A lesson, if exhibited instructively to the public, in geological events was here concealed, and only the facilities and purposes of a great museum could properly present it. The entire range of facts embodied in the reports of the survey and those of the New York State Cabinet had sensibly deepened the growing impression and expectancy that a great city must

assume the responsibilities of such an institution. This collection of Professor Hall's was for sale and its possession would be of inestimable value to a new institution.

The second and presumptively more effective influence shaping the thought of our citizens in this direction was the enthusiasm over the work and lectures of the great Swiss naturalist, Louis Agassiz. Agassiz's own success in securing the cooperation of the Massachusetts State Legislature to create the Museum of Comparative Zoology at Cambridge was a pioneer effort along lines followed quite closely by the American Museum of Natural History. It was indeed upon the inauguration of the Museum of Comparative Zoology that the second group, as Marcou has observed, of Agassiz's pupils, was formed, a group that disseminated over the entire United States a new love for natural science, and formed in themselves a radiant center of genius and industry.

Louis Agassiz, the Swiss naturalist who had declined the flattering and profitable offers of the French government to fill a position of superintendence over the Museum of Natural History or Jardin des Plantes in Paris, also the chair of paleontology in the State University of Switzerland, had established himself in the affections of America. His lectures were revelations, and the public of New York, as of almost every other great city, had been awakened to a new sense of appreciation of the study of nature. A series of distinguished men had imbibed from his contagious enthusiasm for nature, and had elevated the fame and established the permanence of American science; amongst these were Allen, Scudder, Verrill, Putnam, St. John, Morse, Emerton, Hyatt, Shaler, Ordway, Stimpson, Niles, Lyman, Clark, Mills, Packard, Dall, Mann, Uhler.

Agassiz's association with Bache, Gray, Morton, Leidy, Baird, Wyman, Pourtales,

Lesquereaux, Rogers, Conrad, Guyot, Marcou, in the higher scientific circles of America, and his intimacy with Emerson, Whittier, Longfellow, Felton, Lowell, Holmes, Binney, Hoar, Ticknor, Howe, Sumner, in the social regency of Boston, had created for him a personal preeminence quite unique in the United States. Certainly Agassiz's relations with all his pupils had not been invariably honorable to himself, but even the famous 'Salem Secession' with its resulting publication of *The American Naturalist* only served to give a wider prominence to his peculiar and fascinating enthusiasm.

And in 1860 Agassiz's long-cherished scheme of founding a great museum materialized in a conspicuous inauguration of the building of the Museum of Comparative Zoology in Cambridge. The Governor and his staff and a great concourse of people, with the faculty of Harvard College, were present, and the event, dwarfed indeed by the imminence of a terrible conflict, distinctly foreshadowed the development and expansion of the museum idea in the large cities of the Union.

Amongst those early engaged in the duties of this museum was Albert S. Bickmore, a young man then, who, in a succeeding year, entered the service, and being detailed to duty near the seashore, seized the occasion to revive his studies of sea-life by making a collection of the coast shells of North Carolina. Professor Bickmore had noted with interest Agassiz's supple combination of tact, eloquence and personal charm in securing the effective alliance of the Commonwealth of Massachusetts, and his adaptability to the methods of private importunity. Through these combined agencies the Legislature of Massachusetts had granted \$100,000, the citizens of Boston raised \$71,000, Mr. Francis C. Gray left \$50,000, and a sentiment of generous appreciation for the purposes of the museum had

been created. Agassiz's success in this way was remarkable. He obtained under the most discouraging circumstances, even in the darkness of the war, large sums of money from the Legislature of Massachusetts, and his appeal to individuals was always irresistible.

It seems pertinent, in view of the analogous relations of the New York museum to the Legislature of the State and private benefactors, to quote Marcou's expressive description of Agassiz's methods. Agassiz's biographer writes: "The amount of scientific diplomacy he made use of is something astounding; for instance, he would detail with great clearness the working of the institution, and make it clear that the museum is an element of education even in the most elementary school of commonwealth, and that in the future generations there would not be a child who would not have the opportunity of understanding the scheme of creation as thoroughly as he understood his multiplication table. He had the tact to adapt his explanations and his description of the absolute poverty of the institution to the listener and his official position in the State. Then, after weeks of such preparatory work at the State House, came the annual visit of the whole legislative body, with the Governor at its head, to the museum. Everything was in readiness for the reception when the six or ten street cars, filled with legislators, arrived at the University grounds. Agassiz conducted them at once into the various exhibition halls, showing the treasures of each and briefly describing the departments. Afterwards in the lecture room, in an informal conversation, he detailed the methods and needs of the institution. He always succeeded in winning to his side farmers, tradesmen and politicians. After such a visit the Legislature always voted a new appropriation of public money; it was only necessary for the President of the Sen-

ate and the Speaker of the House to make speeches in its favor, and the resolution would easily pass the three readings without further debate."

Celebrated collections of the Old World, constant accessions from the new, were pouring into the museum at Cambridge. In 1869 Professor Agassiz reported that though the income of the British Museum and the Jardin des Plantes was more than ten times that of the Museum of Comparative Zoology, yet the last "in certain departments, such as corals and fishes, was superior to both, and that in activity of research and publication it yields to neither, while the increase of its collections since its existence, and the prominence it has attained among the museums, are such as no like establishment has reached in the same time and with the same means."

It was with anxious eyes that the naturalists of New York and those citizens of the great metropolis that were devoted to the advancement of its intellectual interests noted this rapid progress. The formative period closed, and the crystallization of an idea, so definitely recognized, quickly succeeded in those years, which included the incorporation of the American Museum of Natural History.

L. P. GRATACAP.

AMERICAN MUSEUM
OF NATURAL HISTORY.

SCIENTIFIC BOOKS.

Publications of the Japanese Earthquake Investigation Committee. Nos. 5 and 6. Tokyo. 1901.

These two volumes are continuations of the series of publications in foreign languages of the investigations of the Imperial Japanese Seismological Committee, the earlier numbers of which received a somewhat extended notice in the columns of this journal some time ago. They are written by Dr. Omori, a member of the Committee in immediate charge of the investigations, and they contain horizontal pen-

dulum observations of earthquakes during 1898 and 1899, together with a detailed description of the horizontal pendulum seismographs used and some discussion of the results.

In the 'compound,' or park, at Hongo, Tokyo, in which the buildings of the Japanese Imperial University are located, there has been erected an 'earthquake-proof' house in which two of the large horizontal pendulums are placed. They are of rather unusual dimensions, the vertical distance from the point of suspension to the point of support being nearly three meters. The pendulum is excellently planned for stability and convenience of adjustment, and is capable of a vibration period of as long as three minutes, being, therefore, extremely sensitive. When adjusted to a period of two minutes it will show an index displacement of about 1 mm. for a change of level of about one two-hundredth of a second. Two of these seismographs, exactly alike, are mounted, one to give the N. and S. component of the disturbance and the other E. and W. component. They are designed, of course, for the registration of very feeble but often long-continued disturbances whose seismic origin is remote from the point of observation. Concerning the transmission of such disturbances many extremely interesting observations have been made, only a few of the most important of which can be referred to here.

Broadly speaking, the motion of an earthquake may be divided into three successive stages, which are always more or less well defined; the *preliminary tremor*, consisting usually of vibrations of small amplitude and short period; the *principal portion*, the active and often destructive part of the earthquake, during which the amplitude is much greater and the period usually longer; the *end portion*, which is the feeble, small amplitude finishing of the disturbance. The first of these is again usually quite sharply divided into two stages, which may be designated as the first preliminary tremor and the second preliminary tremor, and the *principal portion* is also made up of three tolerably distinct phases, of which the last, designated as the *quick-period phase*, is of the greatest importance in the present discussion.

Several seismologists have already pointed

out the fact that the duration of the *preliminary tremor* of an earthquake increases with the distance of the seismic center from the place of observation, and this proposition is not only confirmed by Dr. Omori's observations, but from them and some others he has been able to deduce an equation which represents the relation between duration and distance with astonishing closeness. Sometimes the total duration of these disturbances, due to distant earthquakes, is as long as four hours, but the equation here given is based upon first preliminary tremors varying in duration from five minutes to eleven minutes. It is as follows:

$$x = 17.1y - 1360$$

in which x is distance in kilometres (on the surface of the earth along the arc of a great circle passing through the two points) and y is the duration of the *first preliminary tremor* in seconds. This equation is based on long-distance observations of several earthquakes, three of which, occurring respectively in Alaska, Smyrna and Japan were observed in Japan, while others originating in Japan were observed in Potsdam and Italy. The agreement of the calculated values of x with the actual values is shown in the following table:

Earthquake.	Actual Distance.	Calculated Distance.
Alaska,	6,100	6,500
Smyrna,	4,800	4,560
Java,	9,200	9,240
Japan,	8,999	8,840
Japan,	9,580	9,540

Perhaps the most interesting subject discussed in these volumes is the transmission velocities of the various phases of an earthquake disturbance. Dr. Omori has given much attention to this important question, considering it in considerable detail in the light of his own and other recent observations. It has long been known that all seismic waves did not travel with the same velocity, and it was long ago suspected that different phases of the same disturbance might be transmitted at very different speeds. During the past few years the development of 'long-distance seismology,' as it may be called, has added greatly to our knowledge of velocity of transmission, and at the same time it has materially increased the difficulties by which the subject is surrounded.

Dr. Omori has compared the time of the arrival of the beginning of three of the phases mentioned above, namely the *first preliminary tremor*, the *second preliminary tremor*, and the *quick-period* phase of the *principal portion*, and he has assumed, as he is quite justified in doing, that they originated simultaneously at the seismic origin. He has compared the velocities of transmission of these three phases between Italy and Japan, in ten earthquakes, with results which agree among themselves in the most remarkable way.

The means are, for the *first preliminary*, 12.8 km. per second; the *second preliminary*, 7.2 km. per second, and for *quick period* of the principal portion 3.3 km. per second. The latter quantity, it will be observed, is what is usually thought of in speaking of the velocity of an earthquake wave.

Now no known rock has a modulus of elasticity high enough to transmit a wave, of either compression or distortion, with the speed of the *first preliminary tremor* as shown above, and it seems impossible to avoid the conclusion that this disturbance must be transmitted along some shorter path within the earth's crust, while the *principal portion* undoubtedly travels along the earth's surface. This question is greatly complicated, however, by the fact that the duration of the *first preliminary* at a given observation station is very nearly simply proportional to the *surface* distance from the origin of the disturbance.

It is impossible to close even so brief a notice as this must be, without again congratulating Dr. Omori and his colleagues of the Earthquake Commission upon the splendid way in which they are making use of the rare opportunities which they enjoy for seismological study. The indirect results of this study, especially as they are related to the general subject of terrestrial physics, promise to be of the greatest importance, and the Japanese seismologists may well feel assured that they are practically in control of a field worthy of their highest efforts.

The general form and style of these publications is so excellent that it may be worth while to call attention to the existence of a few blemishes, doubtless due to careless proof-reading. One is tempted to especially mention one of

these, which is the frequent appearance of *Alasca* or *Alaskan*, in which form alone, indeed, is found the name of the territory, or whatever it may really be, known to us who own it as Alaska.

T. C. MENDENHALL.

Beitrag zur Systematik und Genealogie der Reptilien. By MAX FÜRBRINGER. Abdruck aus der *Jenaische Zeitschrift für Naturwissenschaft*, XXXIX. Bd. (N. F. XXVII.). Jena, Verlag von Gustav Fischer. 1900. Pp. 1-91.

The paper to which the attention of all who are interested in the class of reptiles is here called is only a portion of an extensive memoir, a summing up of the results of studies detailed in the twenty-seventh volume of the *Jenaische Zeitschrift* and occupying over four hundred pages of that journal. In view of the author's important contributions to zoological literature, especially of his great work on the morphology of birds, anything that he may have to say on the kindred group of reptiles must attract attention.

The author first discusses the position of the most primitive Reptilia and the origin of the Sauropsida (I.); then a survey is made of the systematic and genealogical relationships of the various orders (II.); and finally, these are grouped into subclasses, and their genealogical relation to the other Tetrapoda is treated (III.).

I. Of the living reptiles the Lacertilia and the Rhynchocephalia are regarded as the most primitive; of the latter a single representative exists; of the Lacertilia about 1,600. Contrary to what is generally held, the author does not regard *Sphenodon* as the most primitive reptile, although it possesses many primitive features. A just appraisal of all its characters places it lower than the highest Lacertilia, but higher than the lowest representatives of the latter. The author contends that in the primitive reptiles the quadrate bone was movable (streptostylic), and that its fixed (monostylic) condition is the result of secondary modifications. Some of the earlier Rhynchocephalia, as *Patteohatteria*, were probably the lowest of known reptiles. Notwithstanding their differences, the Lacertilia and the Rhynchocephalia had a common ancestor.

As to the origin of the Sauropoda, Fürbringer holds that they sprang from amphibian ancestors whose quadrate was streptostylic.

II. The author regards the lizards and snakes as constituting two distinct orders. The snakes are not further considered. The Lacertilia are divided into five suborders, viz., Lacertilia vera, Varano-Dolichosauria, Mosasauria, Amphibænia, and Chamæleontia. Among the true Lacertilia, the Geckos are the lowest of living reptiles. In many characters the Varanidæ stand apart from other Lacertilia. The Mosasaurs are regarded as Lacertilia which at an early period branched off from perhaps near the ancestors of the Varanidæ, and became pelagic. The author finds in the Chamæleontia numerous points of resemblance with the Lacertilia vera, especially with the Uroplatidæ. They are hence placed closer to the lizards than in the system of Boulenger, but farther removed from them than in the system of Cope.

As regards the Ichthyopterygia, Fürbringer holds that they possess close relationships with the Rhynchocephalia, but are widely removed from the Sauropterygia. The Chelonia are not thought to be related to the Theromorpha, but rather to the Sauropterygia. The special phylogeny of the Chelonia is veiled in darkness. The Trionychidæ are considered to be the lowest in rank of living tortoises, the Pleurodira the highest. The isolated position in which *Dermochelys* has been placed by some writers is not accepted. The small group of Mesosauria of the Permian and Lower Triassic find their relationships with the Sauropterygia, Chelonia and Theromorpha; nevertheless they display many peculiarities.

The Theromorpha appear in the Permian and lower Triassic in great numbers and in varied forms; but with the Triassic they disappear. Many of them became highly specialized, attained considerable size, and developed, to a remarkable degree, stoutness of body and of its component parts. Their relationships are held to be with the Rhynchocephalia, but not close. They have no affinities with the Chelonia. In connection with this group the author discusses the origin of the Mammalia. His conclusion is that they have sprung from no group of reptiles, but directly from the Batrachia.

The Crocodilia are held to be the highest of living reptiles. They have distant connections with the Lacertilia and the Rhynchocephalia; closer ties with the Dinosaurs. The extinct groups Parasuchia and Pseudosuchia are to be retained close to the crocodiles.

In rank the Dinosauria stand above the Crocodilia, with which group they show many affinities. Two characters possessed by the higher forms lift the Dinosauria above the Crocodilia, the upright mode of progression and the development of cavities in the bones. The Dinosaurs are accepted as a single order, to be divided into two or three suborders.

The Pterosauria are estimated to be the highest in rank of all known Reptilia. They are specially related to the crocodiles and the Dinosaurs. Any close relationship to the birds is rejected.

III. Finally, the various orders are grouped by our author into subclasses. The first contains the Lacertilia, Ophidia, Rhynchocephalia and Ichthyopterygia; and for his subclass Haeckel's name Tocosauria is appropriated. The second subclass is constituted by the Theromorpha. A third subclass is formed of the Mesosauria, Sauropterygia and Chelonia; and to this the name Synaptosauria is applied. The Crocodilia, Dinosaurs and Pterosauria make up the subclass of Archosauria.

O. P. HAY.

AMERICAN MUSEUM NATURAL HISTORY,
NEW YORK, July 4, 1901.

Alleghany County, Maryland. By WM. B. CLARK, State Geologist. Md. Geol. Surv., Baltimore, Md. 1900.

This royal octavo volume of 323 pages, accompanied by a folio of 6 pages containing topographic, geologic and soil maps of the county on a scale of one mile to the inch, is the first of a series of descriptive reports by counties to be published by the Maryland Survey. Not only the geology, mineral resources and physiography are described, but also the soils, climate, hydrography, magnetic declination, forests, flora and fauna. In addition to its general scientific value, it is of unusual interest to the county, presenting invaluable data for the farmer and manufacturer, and furnishing a

most excellent means of education and instruction to the inhabitants by interesting them in the local phenomena and the history of the mountains and the rocks forming them.

The physiography is by Cleveland Abbe, Jr., and the geology by Cleophas C. O'Hara. The county is in the western part of the State, embracing parts of the Allegheny Plateau and the Great Appalachian Valley. The rocks exposed in the plateau district are of Carboniferous and possibly Permian age and have been folded into a flat northeast-southwest syncline. The upturned resistant Pottsville conglomerate forms the eastern edge of the plateau in a straight even-crested ridge, and the interior of the plateau is composed of the softer overlying rocks protected in the syncline to the west. The Ridge district, embracing that part of the county in the Great Appalachian Valley, is composed of Silurian and Devonian rocks folded into numerous open parallel northeast-southwest folds, generally with steeper dips to the northwest, but not overturned or overthrust. Erosion has produced long parallel sharp-crested ridges separated by narrow valleys.

The remains of two physiographic plains have been recognized in the topography. The older, called the Schooley Plain, is preserved only in the crests of the higher ridges. The younger, called the Shenandoah Plain, is represented by the tops of low ridges and knolls between 900 and 1,100 feet elevation along the margins of the larger streams. This latter plain consisted of broad valleys between high ridges which were not reduced during that cycle of erosion. Two terraces of recent date were observed in the stream gorges, marking temporary halts in the downward cutting of the streams. Some very interesting stream adjustments are described. The geologic history of the region is also interestingly presented.

Among the mineral resources mentioned, the more important are coal, fireclay, cement rock and iron ore. Excellent steam coal has been mined in the county for many years, and the district is known as the Cumberland-Georges Creek Basin. Several important beds are mined and are distributed vertically through the Pottsville and Coal Measures. The Big

Vein or 14-foot Vein occurs in the upper part of the series, and is noted for its great size, purity and fine steam quality. The report on the economic products is by Wm. B. Clark, C. C. O'Hara, R. B. Rowe and H. Ries.

The soils of the county are represented on the geological map, the subdivisions corresponding to the divisions of the underlying rocks, but a separate legend giving the descriptions of the soils. Mechanical and chemical analyses of the various soils are given in tabular form and their value for agriculture is discussed. Clarence W. Dorsey is the author.

The hydrography and the remaining subjects presented in the report, as well as the soils, were surveyed in cooperation with branches of the U. S. Government and the reports are presented by members of the government corps.

The volume is handsomely printed and illustrated with half-tone cuts in the same excellent manner as in former publications of the Survey. The atlas accompanying the report is a high-grade lithographic production. The topographic map is that prepared by the U. S. Geological Survey in cooperation with the State. The colors and patterns used on the geologic maps are the same as those used by the U. S. Government and the results obtained are very pleasing. The publication by counties, however, makes it necessary to dissect the maps awkwardly and print them on three sheets, and makes the folio of unhandy size.

GEORGE W. STOSE.

WASHINGTON, D.C.

SCIENTIFIC JOURNALS AND ARTICLES.

THE *American Geologist* for May contains a biographical sketch of Elkanah Billings with portrait by Henry M. Ami. Dr. J. B. Woodworth contributes an article on 'Cross-Banding of Strata by Current Action.' He describes micaceous bedding in the glacial sand near Lake Walden and attributes its formation to the vertical movements of the water about the crest of a current mark. This is followed by 'A Historical Outline of the Geological and Agricultural Survey of the State of Mississippi,' by E. W. Hilgard. This is followed by 'Reviews of Recent Geological Literature' and 'Scientific News.' The June number contains the follow-

ing articles: 'The Ontario Coast Between Fairhaven and Sodias Bays,' by J. O. Martin. Some peculiar features of the landscape due to the rapid erosion of the glacial drumlins along the shore line are described. 'Eighth Session of the International Congress of Geologists, Paris, 1900,' is written up by Persifer Frazer. 'Two New Genera and Some New Species of Fossils from the Upper Paleozoic Rocks of Missouri,' by R. R. Rowley. Mr. Rowley describes two new genera of blastoids and proposes the names *Lophoblastus* and *Carpenteroblastus*, following which he describes two new species of the first, one of the second, and fourteen of the other genera of fossils from the same region. The article is accompanied by a plate. 'Ore Formation by Surface Decomposition,' is discussed by C. R. Keyes, in which he concludes "that with the exception of possibly a few isolated unimportant instances ore concentration does not generally take place through surface decomposition of rock masses, in areas such as the Ozark lead and zinc region." 'Gold and Other Minerals in Iowa,' by Samuel Calvin. The author undertakes to destroy the fallacious ideas that gold, gas or oil exist in paying quantities in Iowa. He also exposes the fallacy that any so-called geologist with a drilling outfit is to be trusted in his predictions to a public-spirited community.

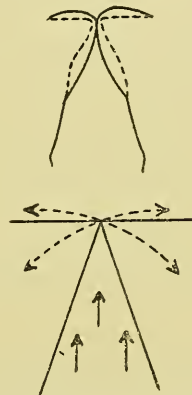
DISCUSSION AND CORRESPONDENCE.

THE LARYNX AS A MUSICAL INSTRUMENT.

THE wide prevalence of the mistaken notion that the vocal cords vibrate in the axial direction of the larynx makes it desirable to point out that observations by the laryngostroboscope—a combination of a laryngoscope and an adjustable intermittent source of illumination—have proved to the contrary for the male chest register. With this method it is possible to follow a vibration slowly through its phases. This has been done by Musehold, who reports that in singing in the chest register the cords touch along their whole length; that in loud tones the edges have a slightly rounded form, especially in the middle, indicating strong contact in the middle and weaker contact at the ends of the glottis; that in weaker tones the

line of contact appears even and thin while the top of the cord becomes flatter; that the edges of the cords move out sidewise and not in the axial direction of the larynx. Two of Musehold's diagrams are reproduced here. The upper one shows the bunching of the cord edges due to the firm contact; the lower one is an indication of the way the air pressure in the trachea presses the cords apart.

In connection with the remarks of Professor Le Conte on a previous occasion, it is interesting to note that with the same method Musehold was able to observe the lips of a performer on a horn, with the result of seeing that the lips vibrate as cushions and not in the direction of the axis of the horn.



In Professor Hallock's interesting communication in the last number of *SCIENCE*, the microscopic section of one of the cords is correctly given, but the diagram of the supposed way in which the muscle turns into a thin sheet is certainly incorrect. It is hardly the place here to give a summary of the facts in regard to the action of the vocal cords and the nature of the vowels in speech and song; I have stated in a previous communication that the proof is clear and complete that a vowel both in speech and song is not essentially a fundamental from the cords with a series of overtones reinforced by the vocal cavities. I may, perhaps, be pardoned for saying that I have given a digest of the many investigations on this and related subjects in a work on experimental phonetics now in press.

E. W. SCRIPTURE.

YALE UNIVERSITY,
July 26, 1901.

SHORTER ARTICLES.

THE ORIGIN OF TRAVERTINE FALLS AND REEFS.

In a recently published article, Professor Davis, in speaking of certain travertine cascades and reefs, says: "We could not find any satisfactory explanation for the growth of these travertine reefs,"* and he refers to an occurrence of falls over travertine reefs in Central America as if such deposits were unusual.

In the limestone regions of East Tennessee travertine cascades are common. A creek that enters the Frenchbroad river a mile and a half above Dandridge, Jefferson county, has a series of travertine falls where the stream emerges from the hills upon the bottom lands of the river. The narrow valley of the stream is in places completely floored over with travertine. Similar deposits occur in the town of Dandridge, especially near the ferry over the Frenchbroad, where a small stream pitches over the edge of the bluff. At many of the falls the deposit has grown outward until the water pours over belled protrusions of the travertine. It is worthy of note in that particular region that springs whose waters are equally charged with lime deposit no travertine where they flow quietly into the river.

In the vicinity of Stanford University, California, some of the streams descending from the calcareous areas of the Coast Range are heavily charged with lime and deposit travertine wherever the waters are thrown into spray. Like most mountain streams they descend by a series of terraces, or steps, represented by quiet stretches having little cascades at their up-stream and down-stream ends. These cascades are made of rocks, frequently water-worn boulders, and in every instance the boulders at the cascades are covered with more or less travertine, while similar boulders along the quiet stretches and especially in the deeper waters are without the travertine.

The waters of Congress Springs, in Santa Clara County, California, are highly charged with carbon dioxide and carry much lime in

solution. The water is now conducted through open wooden troughs to storage tanks, and wherever the troughs are so steep that the water is rippled the travertine is rapidly deposited and has to be removed from time to time in order to prevent the complete filling up of the troughs. The old stream bed along which this Congress Spring water formerly ran is covered with travertine wherever the water was rippled. At one place along this old channel there is a bank of travertine eight or ten feet high.

These phenomena are to be seen at many other places in the foothills around the sides of the Santa Clara Valley.

At Santa Cruz, California, a stream flowing out of a hilly limestone region, where it emerges from the hills, has deposited a bed of travertine that is probably fifty feet or more in thickness and covers an area of several acres.

Perhaps the most remarkable deposits of the kind are those along the western coast of Palestine and the southern coast of Asia Minor, where the streams pass over regions of limestone. They are frequently spoken of in works upon that region.*

Whether these deposits are all made in the same way or by a single process is doubtful. In the case of the highly carbonated waters of Congress Springs it seems most probable that the deposition of the lime is due chiefly to the escape of the carbon dioxide when the water is exposed to the air by rippling or spraying. In the cases of streams that run for some distances in open channels before giving up their lime it may be that the deposition is due, at least in part, to the increase of the temperature of the water and the loss of carbon dioxide. But inasmuch as the travertine is formed most abundantly at the falls, it appears that the spraying of the water is an effective agency in the escape of the gas. It is well known also that certain aquatic plants help precipitate lime from water by the absorption of carbon dioxide. An interesting case of the kind is mentioned by Clarke,† and other papers have lately been pub-

* 'Karamania, or a Brief Description of the South Coast of Asia Minor,' etc., by Francis Beaufort, 2d ed., London, 1818.

† *Bull. New York State Mus.*, VII., 195-98.

* 'An Excursion into Bosnia, Hercegovina and Dalmatia,' by W. M. Davis, Geological Society, Phila., III., 42-44.

lished by C. A. Davis* and by Blatchley and Ashley.†

My observations upon the growth of stream deposits of travertine in Tennessee and California led me to the following conclusions:

1. The deposits grow more rapidly in the summer and at low-water stages.

2. The channels become locally choked up with travertine and the streams are compelled to shift from side to side.

3. The thin horizontal beds of travertine are formed in the shallow waters immediately above the falls.

4. Although the larger streams appear to be eroding and do erode at high stages and at certain parts of their courses, the process on the whole is constructive.

5. The travertine tends to form a series of terraces along the streams depositing it.

J. C. BRANNER.

STANFORD UNIVERSITY, July 4, 1901.

PSEUDOSCOPIC VISION WITHOUT A PSEUDOSCOPE.‡

A METHOD of securing an illusion of binocular vision wholly without instrumental aid occurred to me recently, which is interesting in connection with the study of pseudoscopic vision. It is fully as startling as any of the results obtained with the lenticular pseudoscope, which I described in SCIENCE (about Nov., 1899), and, requiring the aid of no optical instrument, is very much more impressive. A lead pencil is held point up an inch or two in front of a wire window screen, with a sky background. If the eyes are converged upon the pencil point, the wire gauze becomes somewhat blurred and of course doubled. Inasmuch, however, as the gauze has a regularly recurring pattern the two images can be united, and a little effort enables one to accommodate for distinct vision of the united images of the mesh. To accommodate for a greater distance than the point upon which

the eyes are converged requires practice, but the trick is very much easier in this case than in the case of viewing stereoscopic pictures without a stereoscope. As soon as accommodation is secured the mesh becomes perfectly sharp, and appears to lie nearly in the plane of the pencil point, which still appears single and fairly sharp. If now the pencil is moved away from the eyes, which are to be kept fixed on the screen, the point *passes through the mesh* and appears double, the distance between the two images increasing until the point touches the screen.

If now the pencil be removed it will be found that the sharp image of the combined images of the gauze persist, even though the eyes be moved nearer to or farther away from the screen. Move the eyes up to within six or eight inches of the plane in which the screen appears to lie and try to touch it with the finger. *It is not there.* The finger falls upon empty space, the screen being, in reality, a couple of inches further off. This is by all means the most startling illusion that I have ever seen, for we apparently see something occupying a perfectly definite position in space before our eyes, and yet if we attempt to put our finger on it, we find that there is nothing there.

It is best to begin by holding the pencil an inch or less in front of the screen. As the eyes become accustomed to the unusual accommodation the distance can be increased. The greater the distance, the greater the illusion, of course. I have succeeded in bringing up the apparent plane of the mesh five or six inches, but this requires as great a control over the eyes as is necessary in viewing stereoscopic views without an instrument.

R. W. WOOD.

THE BOTANIST'S JOURNEY TO THE DENVER MEETING OF THE A. A. A. S.

FOR the observing botanist (and what kind of a botanist is he who is not observing?) the journey to the Denver meeting of the American Association for the Advancement of Science will be of the greatest interest. Leaving the originally wooded country some distance east

* *Jour. of Geology*, Sept.-Oct., 1900, VIII., 485-503.

† 'The Lakes of Northern Indiana and their Associated Marl Deposits,' by Blatchley and Ashley, 25th Ann. Rep. State Geologist of Ind., pp. 43-51.

‡ Since writing this note I have learned that a similar illusion is described in Le Conte's 'Sight.' It may however be new to some.

of Chicago, he enters the level prairies of Illinois, originally treeless except along the water-courses, and passes from these to the rolling prairies of Iowa, whose undulating surface was wanting in woody vegetation except in the broad valleys which border the streams. Now, as in Illinois, all over the landscape are lines and clumps of vigorous trees, all the result of man's work. What was once a treeless view is now as freely dotted over with trees as in the case of many a landscape in the originally wooded portions of the eastern United States. Crossing the Missouri River he soon enters the region of the Great Plains, with an elevation of 1,200 feet above the sea at the eastern border, rising rapidly across Nebraska to 2,000, 3,000 and 4,000 feet above the sea. If he follows the broad valley of the Platte River from Omaha to Denver, he will receive the impression that the Plains are 'as level as a house floor,' since he sees only the flat alluvial plain worn by the great river, and is ignorant of the fact that on each side are hills and valleys stretching away for hundreds of miles, the hills treeless as in the prairies, and the valleys with groves of trees along the margins of the streams. If he is fortunate enough to choose a route which crosses the hills and valleys of the Plains instead of following a single valley, he will see for himself this relation of the trees to the general surface of the country, and he may even see evidence of the westward march of the trees, where the fires no longer check their growth. With the increase in elevation the fringes of trees along the streams grow narrower and narrower, until at last they disappear altogether on the high plains at the foot of the mountains, 4,500 feet or more above the sea. This is the land of the 'sage brush,' 'dagger weed,' 'buffalo grass,' 'bunch grass' and 'cactus.' It is not a desert, and yet is as uninviting as one—until man runs little streams of water over it, when as if by magic it is transformed into a garden of flowers and fruits, or a farm of golden wheat and purple alfalfa. What water is to the plant is nowhere better shown than on these high Colorado plains, a mile above the sea. Then, still beyond, are the mountains, with a vegetation entirely unlike that of the plains at their base. Pines, spruces, firs,

cedars are all of different species from those of the east, and not many of the deciduous trees are of species which are common along our Atlantic border. For the botanist who sees this flora for the first time it will be a novel experience to find that he can name scarcely a plant that he sees, whether herb, shrub or tree. He will need his collecting case and plant press, as it will be impossible for him to resist the desire to make specimens of the many interesting plants he finds at every turn.

THE SAND HILLS OF NEBRASKA.

THE interesting region known as the Sand Hills of Nebraska may be visited by the botanists who attend the Denver meeting in August. They occupy an area of from 15,000 to 20,000 square miles in central and northern Nebraska, having a width of from 100 to 200 miles. The prevailing contour of the surface is irregular, consisting of rounded, swelling hills with gentle depressions between them, or elongated ridges with steep sides, enclosing deep valleys. These hills consist of sand or gravel, and when the surface vegetation is removed the sand is driven by the winds, and forms moving dunes. To a very large extent the surface configuration is such that the water which falls in the rains is not drained off in streams, but disappears in the porous soil or evaporates from the surface. Here and there are streams which find their way through the valleys and hills, and where these streams are of considerable size they have worn deep canyons. Such streams are always fed by many springs which burst out from the sides of the canyons, and doubtless in this way the water which falls upon the areas which have no surface drainage finds its exit.

The vegetation in the Sand Hills consists almost entirely of grasses and sedges intermingled with deep-rooted perennial herbaceous or woody plants. The perennial herbaceous plants are coarse, strong-growing species, and the woody plants are to a very large extent of low stature and with large, widely-spreading roots. Among these shrubs are the sand cherry (*Prunus besseyi*), shoe string (*Amorpha canescens*), one or more species of prairie clover (*Kuhnistera*), one or two species of wild roses (*Rosa arkansana* and *Rosa woodsii*), New Jersey tea (*Ceanothus ovatus*),

etc. In the wet valleys occur wild plums (*Prunus americana*), and the dwarf wild cherry (*Prunus demissa*), the former a shrub or small tree, and the latter an upright little-branched shrub, both usually forming close thickets.

The trees are almost entirely confined to the narrow belts which border the streams in the canyons. Where the canyons are deep these forest belts are entirely hidden as one glances over the undulating surface of the plain. In the eastern part of the Sand Hill region the forest belts are wider, but in passing westward they are narrower, the trees are lower, and eventually they are mere straggling shrubs, finally disappearing altogether. The species are to a large extent those found in the eastern portion of the State, there being but few cases in which the Rocky Mountain trees have taken possession of such protected areas. They are the white elm, occasionally the red elm, the box elder, red ash in small numbers, green ash in larger numbers, sometimes the hackberry, with the common cottonwood and several species of willows, and occasional hawthorns, with here and there the remnants of groves of bull pine (*Pinus scopulorum*).

THE GRASSY COVERING OF THE GREAT PLAINS.

THOSE who visit the Great Plains for the first time are usually interested in the grassy covering, which is the most marked feature of the vegetation of the region. This covering is mostly composed of a mixture of several species, there being few places where a single species occupies the ground to the complete exclusion of all others. In the eastern portion of the region the grassy plants (including sedges) number about 130 species, in the central portion (the Sand Hills) there are 170 species, while in the western portion (the Foot Hills) there are about 110 species. The eastern visitor will notice with interest the 'buffalo grass' (*Bulbilis dactyloides*) in well-marked patches, the different species of 'grama' (*Bouteloua oligotachya*, *B. hirsuta*, and *B. curtipendula*) scattered over the surface, the 'wheat grasses' (*Agropyron pseudorepens* and other species) usually mingled with species of *Bouteloua*, the 'bunch grasses' (*Andropogon scoparius*, *A. furcatus* and *A. hallii*) scattered in bunches over the

surface, the 'needle grasses' (*Stipa spartea*, *S. comata* and *S. viridula*) scattered in bunches over the surface, with other species known in general as 'prairie grasses' (species of *Koeleria*, *Eatonia*, *Sporobolus*, etc.). Should he go into the Sand Hills he would find the 'blowout grasses' (*Muhlenbergia pungens*, *Eragrostis trichodes*, *Oryzopsis cuspidata* and *Redfieldia flexuosa*) in or on the margins of the naked sand pits blown out of the hillsides. In the Foot Hills he would find great areas covered almost exclusively with the yellowish-brown foliage of the little sedge (*Carex filifolia*) known throughout the region under the names 'nigger wool,' 'nigger root,' or 'black root,' highly esteemed by the stockmen for its nutritious qualities, and whose tough and durable black roots form a persistent sod much used by the settlers in the construction of their 'sod houses.'

TREES OF THE RYDBERG COTTONWOOD.

It may be of interest to some of the botanists who will visit the Rocky Mountains this summer to know that they can see many fine specimens of the 'Rydberg cottonwood' (*Populus acuminata*) in the town of Colorado Springs. They have been planted along the streets and avenues mingled with trees of the common cottonwood (*Populus deltoides*). Especially fine trees may be seen along the east side of Cascade avenue. Botanists will remember that in 1893 this tree was first described by Dr. Rydberg in the *Bulletin of the Torrey Botanical Club* (February, 1893) from material collected in the canyons of the Wildcat Mountains of Western Nebraska. Since the publication of the species it has been found to extend from the Black Hills southward to Southern Colorado, New Mexico and Arizona. In the plantings along the streets of Colorado Springs this species was not distinguished from the common cottonwood. The two trees may, however, be very easily distinguished by the shape and particular contour of the leaves, which are rhomboid-lanceolate with serrulate margins in the new species, in contrast to the broadly deltoid-ovate leaves of the common species with their incurved-dentate margins.

CHARLES E. BESSEY.

THE UNIVERSITY OF NEBRASKA.

THE AMERICAN FORESTRY ASSOCIATION.

THE principal summer meeting of the American Forestry Association for 1901 will be held at Denver, Colorado, Tuesday, Wednesday and Thursday, August 27-29, in affiliation with the American Association for the Advancement of Science, as we learn from the *Forester*, the official journal of the Association.

There will be two sessions daily, at 10 a. m. and 2:30 p. m., which will be held in the Denver High School building, and, in addition, an open evening meeting, in the Central Presbyterian Church, Wednesday, August 28, at 8 p. m. At the latter meeting there will be short addresses by Hon. Thomas M. Patterson, Hon. Thomas F. Walsh, Hon. Platt Rogers, and others, followed by an illustrated lecture by Mr. Gifford Pinchot, Forester of the United States Department of Agriculture, entitled 'The Government and the Forest Reserves.' This meeting will be a distinctively Western one, and its proceedings of special interest to all concerned with the forest problems before the Western States—fires, grazing, relation of forests to water supply, etc.

The address of welcome at the opening session, Tuesday, August 27, 10:30 a. m., will be delivered by Hon. Thomas M. Patterson, United States Senate. It is expected that the President of the Association, Hon. James Wilson, Secretary of Agriculture, will attend the meeting, and preside at one or more sessions.

A partial list of speakers at the meeting, and their subjects, follows:

Mr. A. L. Fellows, Denver, Col., 'The Hydrography of Colorado'; Mr. Geo. B. Sudworth, Chief of Division of Forest Investigation, Bureau of Forestry, Washington, D. C., 'Forests and their Relation to Agriculture and Manufacturing Industries'; Mr. S. J. Holsinger, Phoenix, Arizona, 'The Boundary Line between the Forest and the Desert'; Professor R. H. Forbes, Tucson, Arizona, 'The Open Range and the Irrigation Farmer'; Mr. R. L. Fulton, Reno, Nevada, 'The Reclamation of the Arid Region'; Mr. William L. Hall, Superintendent of Tree Planting, Bureau of Forestry, Washington, D. C., 'Progress in Tree Planting'; Professor A. J. McClatchie, Phoenix, Arizona, 'The Eucalypts as American Forest

Trees'; Mr. T. P. Lukens, Pasadena, California, 'The Reforestation of Watersheds'; Professor L. H. Pammel, Ames, Iowa, 'Some Phases of the Growth of the Cultivated Trees in Iowa'; Mr. F. H. Newell, Hydrographer, U. S. Geological Survey, Washington, D. C., 'Forests as Reservoirs'; Mr. Gifford Pinchot, Forester, Washington D. C., 'Grazing in the Forest Reserves.' Other speakers are: Professor William R. Dudley, Stanford University, California; Mr. William H. Knight, Los Angeles, California; Mr. George H. Maxwell, Chicago; Edward M. Griffith, Bureau of Forestry, Washington, D. C.

*THE AMERICAN ASSOCIATION FOR THE
ADVANCEMENT OF SCIENCE.*

FOR the benefit of members who will attend the Denver meeting of the Association beginning on August 24, we reproduce the arrangements made with the railways:

The Western Passenger Association, covering the territory west of Chicago and St. Louis, has made a rate of one fare plus \$2 for the round trip, from all points in their territory to Denver, tickets to be sold July 10 to August 31, with final return limit of October 31.

The New England, Trunk Line, Central and Southeastern Passenger Associations, covering the territory east of Chicago and St. Louis, have made a rate of a fare and one-third for the round trip from all points in their territory to Denver, on the certificate plan, the conditions of which are as follows:

1. Each person desiring to avail himself of the reduced rate must purchase a first class ticket (either limited or unlimited) to the place of meeting, at the regular tariff rate and at the same time procure from the ticket agent a certificate of the standard form. If through ticket cannot be procured at the starting point, the person should purchase to the most convenient point at which such ticket can be obtained and there repurchase through to the place of meeting, *procuring a standard certificate from each agent from whom a ticket is purchased.*

2. *It is absolutely necessary that certificates be procured, indicating that the full fare has been paid for going passage and the route for which*

ticket or tickets for the return journey should be sold. No refund of fare can be expected because of failure to secure such certificates.

3. Tickets for the return journey will be sold at one-third the first-class tariff fare only to persons holding certificates of the standard form duly signed by the Permanent Secretary of the A. A. S., and signed by the special agent appointed for that purpose.

4. No certificate will be honored that was procured more than three days (Sunday not included) before the meeting assembles (except that when meetings are held at distant points to which the authorized transit limit is more than three days, the authorized transit limit will govern), nor more than two days (Sunday not included) after the first day of the meeting. No certificate will be honored for return ticket unless presented during the time that the meeting is in session, or within three days (Sunday not included) after adjournment.

5. Tickets for return journey will be limited to continuous passage on first train after purchase.

6. Certificates will not be honored by conductors; they must be presented to ticket agents.

7. Neither the certificates nor tickets furnished for this occasion are transferable, and if presented by any other person than the original purchaser, they will not be honored but will be forfeited.

Members desiring longer time than that allowed in connection with certificate reduction, viz., 3 days before the meeting assembles to 3 days after adjournment (Sunday not included), are advised to take advantage of the Colorado tourist fares or summer excursions, which, while costing a little more than the fare and one third, are good from July 10 to October 31.

If a sufficient number of passengers can be guaranteed, arrangements can be made for through Pullman service, to connect at Chicago or St. Louis, so that members from different sections of the country can make the trip to Denver together. The Permanent Secretary therefore invites all members who plan to attend the meeting and who wish to take advantage of this through Pullman service to

communicate with him at once, stating the name of the road over which they intend to travel and the date of their departure. If a sufficient number of replies are received, the arrangement will be made and members notified.

SCIENTIFIC NOTES AND NEWS.

THE Smithsonian Institution, having provisionally undertaken to represent the 'International Catalogue of Scientific Literature' in the United States, begs to bring this fact to the attention of men of science in the United States, and to request them to furnish the Institution with copies of all their writings which appear in separate form. It is intended to index all original scientific matter published since January 1, 1901.

THE position of State Geologist of New Jersey, vacant by the resignation of Mr. John P. Smock, has been offered to Professor I. C. Russell, of the University of Michigan. Professor Russell agreed to accept the office a year hence, and the board of managers has not yet decided whether to wait. In the meanwhile Dr. H. B. Kümmel is acting geologist.

PROFESSOR H. C. BEELER has been appointed state geologist of Wyoming.

PROFESSOR GEORGE E. HALE, director of the Yerkes Observatory, has been elected a foreign member of the Società degli Spettroscopisti Italiani.

THE Paris Academy of Sciences has elected M. Maupas, of Algiers, a corresponding member in the section of anatomy and zoology.

WE learn from *Nature* that Professor A. W. Rücker will resign the secretaryship of the Royal Society in consequence of his appointment as principal of the University of London.

PROFESSOR PASQUALE VILLERI has been elected president of the Reale Accademia dei Lincei, of Rome.

PROFESSOR E. B. POULTON, of Oxford University, will give one of the lectures at the Fifth International Congress of Zoology which meets next week at Berlin. His subject is 'Mimicry and Natural Selection.'

PROFESSOR WILLIAM B. SCOTT, of Princeton University, has arrived in La Plata, Argentina,

on his way to Patagonia where he will continue the paleontological studies that have been carried forward by several Princeton expeditions.

PROFESSOR OSBORN, accompanied by Professor Eberhard Fraas, of Stuttgart, has recently made a tour of the chief typical Jurassic exposures of Colorado, Utah and Wyoming, especially the beds of Cañon City, Green River, Como and the Black Hills. This is preliminary to a careful survey of these beds, which will be made for the monograph upon the Sauropoda. Valuable geological studies of the Jurassic have recently been published by Knight, Logan and especially by Loomis. Professor Fraas is very familiar with the Jurassic of Europe, having personally studied all the Jurassic exposures, and as a result of this trip he will undertake a careful correlation of the American and European Jurassic horizons which will be published by the American Museum. Messrs. Wieland and Loomis are also independently studying the Jurassic sections in the Black Hills region.

PRESIDENT DAVID STARR JORDAN has returned from the expedition to the Hawaiian Islands, sent by the U. S. Fish Commission.

DR. THEODORE GILL, of the Smithsonian Institution, has just returned from a European trip during which he enjoyed opportunities of examining ichthyological and other collections in various museums, and thus of materially advancing his comparative studies.

DR. HENRY S. PRITCHETT, superintendent of awards at the Pan-American Exposition, has announced as jurors in the department of electrical exhibits: Carl Hering, chairman; F. B. Crocker, A. V. Abbott, D. C. Jackson, W. S. Franklin, W. S. Barstow, W. E. Goldsborough, A. E. Kennelly, Henry S. Carhart and William L. Puffer.

CHIEF OFFICER HANS RUSSEK, of the Baltimore and Hamburg liner *Batavia*, has been appointed captain of the German Antarctic expedition.

SIR NORMAN LOCKYER, having reached the age of sixty-five years, will at the end of the present year give up his duties as professor of astronomical physics in the Royal College of Science, London.

JUDGE ADDISON G. BROWN, of the United States District Court for the Southern District of New York, having served twenty years and having reached the age of 72 years, has resigned. Judge Brown is known among scientific men as a botanist. He was long president of the Torrey Botanical Club, and cooperated with Professor N. L. Britton in the publication of the illustrated 'Flora of the Northern United States and Canada.'

MEMBERS of the Indiana Forest Board, established at the recent session of the Legislature, have been appointed by Governor Durbin as follows: Professor William H. Freeman, of Wabash, secretary of the board; Professor Stanley S. Coulter, Purdue University, Lafayette; Finlay P. Carson, Michigan City, representing the Indiana Retail Lumber Dealers' Association; John Cochrane, Indianapolis, representing practical woodworkers; Albert Lieber, Indianapolis, representing the Indiana Forestry Association.

THE Executive Committee of the National Physical Laboratory of Great Britain have made the following appointments: *Superintendent of the Engineering Department*: T. E. Stanton, D.Sc., Victoria; *Assistants in the Physics Department*: J. A. Harker, D.Sc., Victoria; A. Campbell, B.A., Cambridge; H. C. H. Carpenter, M.A., Oxon., Ph.D., Leipzig; *Junior Assistants*: B. F. E. Keeling, B.A., Cambridge; F. E. Smith, Royal College of Science. It is expected that one or two more junior assistants will be appointed shortly. The *London Times* states that the alterations to Bushey-house and the new buildings for the engineering laboratory are well advanced, and it is hoped to begin work early in October. Of the staff, Dr. Stanton, after serving an apprenticeship with an engineering firm in the Midlands, has had a distinguished career at Manchester and Liverpool, and is now professor of engineering at University College, Bristol. His paper on 'Surface Condensers,' published in the *Philosophical Transactions*, is well known to engineers. Dr. Harker and Mr. Campbell have both done work of real value in thermometry and electric measurements; while Dr. Carpenter, who will have charge of the chem-

cal researches, after a successful course at Oxford, has gained further experience at Leipzig under Ostwald, and more recently at Owens College. Mr. Keeling obtained a double first in natural science and mechanical science respectively at Cambridge; while Mr. Smith was the most distinguished student of his year at South Kensington, and for two years has been one of Professor Rucker's assistants.

DR. CHARLES T. MOHR, the well-known botanist, died at Asheville, N. C., on July 17. He had been a resident of Mobile, Ala., for a number of years, but about a year ago moved to Asheville, N. C.

THE western press announces the death of Dr. Joshua Miller, of Arizona. Dr. Miller was an enthusiastic student of the archeology of the Territory, and was instrumental in creating the Arizona Antiquarian Association, of which he was made president; he was also instrumental in securing the enactment of a law for the protection of the antiquities of the territory from ruthless destruction.

GEORGE K. LAWTON, of the U. S. Naval Observatory, died at Washington on July 25.

THE death is announced of Felix Joseph Henri Lacaze-Duthiers, the eminent French naturalist. Born in 1821, he began the study of medicine, but soon turned to zoology, and was appointed professor at Lille at the age of thirty-three years. In 1865 he became professor of zoology at the Paris Museum of Natural History, and three years later he was appointed to a similar position in the faculty of sciences. He was elected a member of the Academy of Sciences in 1871. In 1875 he established a zoological laboratory on the coast of Brittany.

M. JOSEPH HIRSCH, professor at the Paris Conservatoire des arts et métiers and inspector of bridges and highways, has died at the age of sixty-five years.

DR. W. SCHUR, professor of astronomy and director of the observatory at the University of Göttingen, died on July 1, aged fifty-five years.

WE also regret to record the death of Dr. Antonio Piccone, professor of botany at Genoa,

and Dr. Otto Wiedeburg, professor of physics in the Institute of Technology at Hanover.

ON August 31, there will be a civil service examination for the position of instrument-maker, Coast and Geodetic Survey, at a salary of \$1,000. On September 3, there will be an examination for the position of computer in the Survey at the same salary.

MR. ANDREW CARNEGIE has presented the city of Winnipeg with \$100,000 for a free public library. The gift has been accepted by the City Council. Mr. Carnegie has also offered \$50,000 to build a library at St. Johns, Newfoundland.

WE learn from the *Astronomical Journal* that the government of the Republic of Ecuador has placed the Observatory of Quito at the disposal of the French Commission charged with the remeasurement of the Peruvian arc. M. Gonnessiat, astronomer of the Observatory of Lyons, has been entrusted with the direction of the establishment. The new director has taken possession of his post, and is actively engaged in organizing astronomical, meteorological and magnetic services.

THE Guttenberg Museum at Mayence was opened on June 23.

TWO further tracts of land, together somewhat less than an acre in extent, have been purchased for the U. S. Naval Observatory at a cost of \$6,000.

Nature states that the biological station which had been kept on Lake Baikal for a year by the East Siberian Geographical Society, at Goloustnaya, on the west coast, has been closed. A rich collection of fishes, especially of *Cottus* species, and a great variety of *Gammarus* species have, however, been secured, and the latter are in the hands of Professor Sars, of Christiania.

PROFESSOR TODD's eclipse expedition to Singkep, an island of the Netherlands Indies, secured 28 photographs of the corona on May 18, partly through clouds. Mr. Percy Wilson, of the New York Botanical Garden, who went out as collector of the expedition, has obtained many valuable exhibits and living plants, among them numerous orchids. Mr. Wilson is

now in Java, making further collections in Buitenzorg, and will return home in August.

THE daily papers say that Dr. A. H. Doty, health officer of the port of New York, proposes to try to exterminate the mosquitoes of Staten Island. Men are said to be at work mapping all the marshes, stagnant pools, etc., and crude petroleum is to be released beneath the surface of the water. The marshes, etc., will also be drained.

UNIVERSITY AND EDUCATIONAL NEWS.

MR. A. C. BARTLETT has increased his gift for a gymnasium for the University of Chicago from \$125,000 to \$200,000.

MR. JOHN S. NEWBURY, of Detroit, has given Yale University \$25,000 for an organ, to be placed in Memorial Hall.

A NEW astronomical observatory with increased equipment, including the equatorial telescope which formerly belonged to the late Judge Knapp of New Jersey, is being erected at Lincoln University, Pa. This will be used mainly for purposes of instruction under the directorship of Professor Walter L. Wright, Jr. who has, for a number of years, been in charge of the department of mathematics at that institution.

THE General Purposes Committee of the Birmingham City Council has decided to recommend a grant of the proceeds of a half-penny rate which will provide the University with the sum of £5,000 annually.

FOUR members of the faculty of the Connecticut Agricultural College, Storrs, Conn., have been asked to resign, as a result, it is said, of their alleged opposition to the policy of President Flint. They are: Nelson S. Mayo, M.S., D.V.M., professor of anatomy, physiology and veterinary science; Henry A. Ballou, assistant professor of forestry, botany and military science; Thomas D. Knowles, instructor in English, mathematics, history and physical culture; Charles E. Myers, instructor in farm accounts and business methods, and secretary of the faculty.

WE learn from *The Botanical Gazette* that the regents of the University of West Virginia

have abolished the professorship in botany without notice to the present incumbent, Dr. E. B. Copeland. Dr. Copeland is spending the summer at the Cold Spring Biological Laboratory.

THE chair of pathology in the University of Sydney is vacant and applications for it are invited. The salary is £900 per annum and a pension of £400 per annum is allowed on certain conditions after twenty years' service. The sum of £100 will be allowed for passage expenses from Europe or America. The successful applicant is to begin his duties on March 1, 1902. Further particulars may be obtained from the Agent-General for New South Wales, 9 Victoria Street, London, S. W., to whom applications, stating applicant's age (which must not be more than forty years) and qualifications, and accompanied by four copies of each testimonial submitted, should be sent not later than September 14, 1901.

AT the July meeting of the Board of Regents, Mr. L. W. Hartman was elected to the professorship in physics at the Kansas State Agricultural College for the coming year. For the past year and a half Mr. Hartman has been on the staff of the department of physics at Cornell University.

KARL WILHELM GENTHE, PH.D. (Leipzig), has been appointed instructor in natural history in Trinity College.

THE following have been appointed assistants in histology and embryology at Cornell University: Arthur M. Bean, A.B., of Iowa College; Charles W. Bunker, B.S., of the University of Nebraska; Bert R. Hoobler, B.S., of Wabash College; William C. Thro, A.M., of Cornell University; Gersham F. White, B.S., of Ohio University, and William F. Wismar, A.B., of Rochester University.

DR. ALFRED KOCH, of Oppenheim, has been appointed associate professor and director of the Institute of Agricultural Bacteriology at the University of Göttingen.

DR. EDMUND LANDAU has qualified as docent in mathematics at the University of Berlin, and Dr. G. Senn as docent in botany in the University of Basle.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

EDITORIAL COMMITTEE: S. NEWCOMB, Mathematics; R. S. WOODWARD, Mechanics; E. C. PICKERING, Astronomy; T. C. MENDENHALL, Physics; R. H. THURSTON, Engineering; IRA REMSEN, Chemistry; CHARLES D. WALCOTT, Geology; W. M. DAVIS, Physiography; HENRY F. OSBORN, Paleontology; W. K. BROOKS, C. HART MERRIAM, Zoology; S. H. SCUDDER, Entomology; C. E. BESSEY, N. L. BRITTON, Botany; C. S. MINOT, Embryology, Histology; H. P. BOWDITCH, Physiology; J. S. BILLINGS, Hygiene; WILLIAM H. WELCH, Pathology; J. MCKEEN CATTELL, Psychology; J. W. POWELL, Anthropology.

FRIDAY, AUGUST 9, 1901.

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THE ORIGIN OF THE MAMMALS.

SPECULATIONS as to the origin of the various existing groups of animals and plants are always dangerous, and yet they have for many a certain fascination. They partake, somewhat, of the nature of an algebraic problem in that there are unknown quantities to be discovered, but they differ from any such soluble problem in that we have not equations enough to allow us accurately to ascertain the values of x , y , z and the like. Here is a chance for the play of the imagination and a chance for close guessing at the values of some of the unknown elements. Different students have assigned different values to them, and hence the varying character of the answers we have had given to us. Recall the different forms which we have been asked to consider as ancestral to the vertebrates—coelenterates, nemertines, annelids, *Phoronis*, crustacea, arachnids, tunicates, *Balanoglossus*! Certainly there has been some error in the assignment of values to the unknown to produce such discordant results as these.

Yet these speculations have a certain value; they call attention to problems, they suggest lines of research, they are exercises of the logical powers. One of these genealogical problems is that which deals with the origin of the mammals. It has been twice 'settled,' and yet there is some new evidence, and there are new points of view.

Theromorphs

Until 1884 the general opinion among those who speculated on phylogenetic matters was that the group of mammals had an amphibian ancestry. Huxley was especially prominent in advocating such a line of descent, basing his conclusions upon the naked, scaleless skin, the double occipital condyle and other cranial features, some of which will be mentioned later. Yet this view was not universal, since Owen, in 1876, and Cope, in 1878 and in later papers, had suggested a reptilian ancestry for the group. Still, these speculations attracted but little attention until 1884, when Caldwell's famous dispatch, 'Monotremes oviparous, eggs meroblastic,' excited the enthusiasm of the British Association for the Advancement of Science, then meeting in Montreal. At that date embryology was the ruling force in deciding questions of phylogeny, and the discovery by Caldwell that the *Echidna* laid eggs, and that these eggs were like those of the reptiles rather than those of the amphibia in their segmentation, at once suggested to every zoologist a reptilian ancestry for the mammals. This was still further emphasized a few days later by Cope's paper upon the relations of the theriomorphous reptilia and the monotreme mammalia, read before the American Association at its Philadelphia meeting.

Since that day numerous students have built upon that foundation, and I need but allude to the papers of Cope, Seeley, Osborn, Howes, Lyddeker, Baur and Case, all of which accept the reptiles as the progenitors of the scaleless, hairy, milk-producing vertebrates that we know as mammals. They have brought forward much evidence—but solely osteological in character—in support of their views, and for the summary of this which follows I am largely indebted to the able papers of Osborn.

The particular group of reptiles which they have selected for this high honor is that

known as Theriomorphs, the fossils of which are found in rocks of Permian and Liassic age in Illinois, Texas, New Mexico, Scotland, Bavaria, Bohemia, the Urals, Bengal and South Africa. Then they suddenly disappear, for no traces of them occur in rocks of more recent age, and there is a vast gap between them and the earliest mammals of which we have any adequate knowledge. This group shows several features in which they approach the mammalia more closely than do any other reptiles, and a summary of these points may be of value now.

In the mammalia the skull is articulated to the atlas, the first bone of the vertebral column, by a pair of oval articular surfaces, the occipital condyles. These are borne one on each exoccipital bone. In most reptiles, on the other hand, there is but a single condyle, largely or wholly basioccipital in origin. In many of these theriomorphs the exoccipitals partake in the formation of this structure, and in some the basioccipital portion exhibits a tendency to recede, thus exhibiting a condition which, carried still farther, would result in two condyles like those of the mammals.

In the mammals there is a heterodont dentition; that is, there are different kinds of teeth—incisors, canines and molars. In recent reptiles and in amphibia there is no such differentiation, but in these theriomorphs one group presents a dentition which is strikingly suggestive of that of the mammals. Indeed, one species, described from a lower jaw, was at first regarded as a mammal.

In the mammals the anterior dorsal ribs bear peculiar relations to the vertebræ. These ribs bear two 'heads,' by which they are articulated with the backbone. One of these, the so-called tubercular head, articulates with a process, the diapophysis, which arises from the neural arch, while the other, or capitular head, has its articulation with

the bodies or centra of two vertebræ, in such a way as to suggest that its proper place was between them; that is, intercentral in position. This condition has led Cope and others to the view that a vertebral element, the intercentrum, once existed here as it does in many lower vertebrates, and that the rib formerly articulated with this. By the disappearance of this intercentrum the mammalian relations have been brought about. In some of the theriomorphous reptiles the capitular head is also intercentral.

In many mammals there is a small hole, with the disproportionately large name of entepicondylar foramen, in the inner lower end of the humerus, the bone of the upper arm. This opening is for the passage of the brachial artery and the median nerve. In the lower vertebrates such a foramen is unknown, except in the theriomorphs.

Again, in the mammals the lower jaw articulates directly with the cranium by means of a shallow pit, the glenoid fossa, on the ventral surface of the squamosal portion of the temporal bone, no other element intervening between the two. In most of the lower vertebrates the lower jaw does not articulate direct with the cranium, but a movable bone, the quadrate, is inserted between them, and forms a suspensor

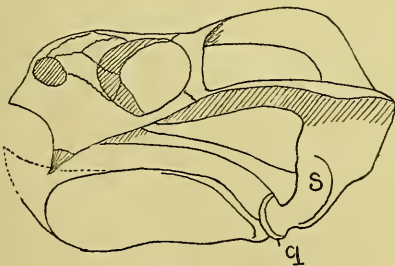


FIG. A. Skull of a Theriomorphous Reptile (*Gordonia*). Showing the quadrate bone (*q*) firmly united to the enlarged squamosal (*s*). After Newton.

of the lower jaw. In the theriomorphs and crocodiles the quadrate is fixed and immovable, and is held in position by a second

bone, the squamosal, which, together with the quadrate, takes part in the formation of the articulation of the lower jaw. Now, say the advocates of the reptilian ancestry of the mammals, if the quadrate were to become completely fused with the squamosal, the result would give a condition from which the mammalian articulation could readily be derived. In support of this view, they cite the case of a human skull, described by Albrecht, in which a separate bone, which he interpreted as the quadrate, appeared in this very region.

Further evidence, which is regarded as pointing in this same direction of a theriomorphous ancestry, is furnished by the pelvis, while the imperfectly known tarsal bones of these reptiles are doubtfully interpreted as supporting the same view. These features, however, are of secondary importance in comparison with those already enumerated, for the peculiarities of the mammalian pelvis and tarsus are as readily derived from the amphibibia as from the theriomorphs. The foregoing enumerates the chief osteological evidence for the reptilian ancestry of the mammals. The only other evidence recalled at present which points in the same direction is the character of the segmentation of the monotreme egg, already alluded to.

Within more recent years there has been a tendency upon the part of some zoologists to return to the support of an amphibian parentage of the mammals. Klaatsch, Maurer, Hubrecht and Beddard have pointed out features of the soft parts of mammals, which are more easily interpreted by this assumption; but, of course, this cannot be conclusive, for we can know nothing of these structures in the theriomorphs. Hence this evidence, which will be summarized later, can only be regarded as cumulative and not of first importance.

The osteological facts which have already been enumerated need analysis, for it is

possible that they will bear another interpretation than that usually accorded them.

The argument from the heterodont dentition can have but moderate value, for we know that different types of teeth have been developed independently in different groups of vertebrates, and it is possible that they could have arisen in the mammals and not have been inherited from the theriomorphs. So, too, with the entepicondylar foramen. The nerve and blood vessels exist in lower forms, and it is conceivable that the existence of the foramen in the two groups may be explained upon the ground of homoplasmy and without implying inheritance. This foramen certainly is of too little importance to be used as the basis of great speculations.

The matter of the ribs is more important. In the amphibia with bicipital ribs, the capitular head rests upon the so-called centrum, and not between two centra, as in theriomorphs and mammals. Yet, with our present knowledge, this is far from conclusive, for we know almost nothing of the morphology of the vertebræ in most groups of vertebrates. The researches of Fritsch upon the fossil stegocephalan amphibia have shown that the vertebral centra are by no means simple affairs, but are really composed of several (at least five) separate elements. Traces of at least some of these, more or less distinct, appear in the higher vertebrates; but until the homologies of these are worked out for the existing amphibia, the reptiles and the mammals, arguments based upon the relations of the ribs to centra and intercentra must remain inconclusive. As it stands at present, it must be admitted that the burden of proof, so far as the ribs are concerned, is against the advocates of amphibian ancestry.

The matter of the occipital condyles is even less conclusive. Until the discovery of the theriomorphs, the fact that both amphibia and mammals have two condyles

and the sauropsida but one condyle, was regarded by Huxley as the very strongest argument for amphibian ancestry, and the most that is claimed for the double condyles of the theriomorphs is that they show that these animals are not to be counted out upon reasons based upon the articulation between cranium and vertebral column.

Yet in none of these is there an exact reproduction of the mammalian conditions, for in all the basioccipital participates to a greater or less extent in the formation of the condyles, these structures being described at times as distinctly bilobed, at times having the basioccipital portion receded below the level of the rest, but still rather prominent. In other words, the double condylar condition of the theriomorphs—and hence that of the mammals—is supposed to have arisen from the single condyle of other forms by recession of the basi-occipital. In the development of the mammals there are, however, no traces of such a stage. All this, however, is aside from the more fundamental question, Is the occipital region of the skull homologous throughout the vertebrates?

Of far more importance than all these features is the problem of the quadrate. In fact, the whole matter of the ancestry of the mammals may almost be said to hinge upon the decision arrived at as to the fate of the quadrate in the mammals.

A brief review of some points of an anatomical character may make clear the discussion of the quadrate. In the first place, it must be kept in mind—and this is too frequently ignored by those who deal with bones alone—that there are two kinds of bones which differ greatly from each other in history, both ontogenetic and phylogenetic, and that while one may seemingly replace the other, there is no evidence whatever of one passing into the other. These two types are known respectively as cartilage bones and membrane bones. A

cartilage bone is always preformed in the peculiar substance known as cartilage, and in this only later is the chondrin matrix replaced by salts of lime. Membrane bones, on the other hand, never have a cartilage stage. They arise by the direct ossification of connective tissue membranes. Further, investigations seem to show that there may be at least two types of membrane bone, one of which, exemplified by most of the membrane bones of the skull and by the bony plates of the alligator, has arisen by the fusion of the bases of dermal scales or teeth, and the sinking of these to a deeper position. The other type, familiar in the kneecap and the bony strands so well known in the drumstick of the turkey, arises from the ossification of tendons.

In the sharks the skeleton of the jaws arises from a continuous stroma or anlage on either side of the head. Each of these strands—known as the mandibular arch—becomes interrupted in the middle as it becomes converted into cartilage. The upper half of each arch forms the upper jaw—the pterygo-quadrate of anatomy, while the lower half in a similar way gives rise to Meckel's cartilage, the skeleton of the lower jaw. These jaws do not articulate directly with the cranium, but the pterygo-quadrate is suspended in front by ligaments, while behind, besides a ligament, the upper half of the next or hyoid arch intervenes as a hyomandibular element between the jaws and the cranial wall, thus forming a suspensorium for these parts.

In the teleosts, or bony fishes, where bone largely replaces cartilage in the adult, the hyomandibular still acts as a suspensor, while the pterygo-quadrate, relieved of its functions as the upper jaw, ossifies in two portions; in front, as a pterygoid bone; behind as a smaller element, the quadrate. The quadrate articulates, on the one hand, with the hyomandibular; on the other, it supports the Meckelian, the hinge of the

lower jaw being formed by the articulation of Meckel's cartilage with the quadrate.

In the vertebrates higher than the fishes the hyomandibular disappears as a suspensor, and it is not to be recognized with absolute certainty in this region. As will be seen shortly, there is some evidence that it is not entirely lost, but persists with changed functions. In contrast to what obtains in the fishes, in amphibia, reptiles and birds, the quadrate articulates directly with the cranium in the region of the ear, and forms a suspensor for the lower jaw. In its history in all these groups the quadrate is preformed in cartilage, and hence, when it ossifies, it becomes converted into cartilage bone. In amphibia, reptiles and birds in the embryonic stages, the Meckelian cartilage, of course, articulates with the quadrate, but when the definitive lower jaw is formed, some features are introduced which must be described. In all the bony vertebrates the Meckelian does not furnish the bones of the lower jaw, but these arise as membrane bones arranged round the cartilage bar. In the amphibia and reptiles the most constant of these bones is a very large, tooth-bearing dentary in front, extending backwards on the outer side of the Meckelian. Further back, on the inner side, is a smaller bone, the splenial, which also may bear teeth. The third of these is the angular, which is placed behind those already mentioned on the lower and inner sides of the proximal end of Meckel's cartilage. The Meckelian ossifies only at its posterior end, where it articulates with the quadrate, giving rise at this point to a cartilage bone, the articular. In short, the lower jaw consists of a single cartilage bone, the articular, and three or more membrane bones.

The articular surface of quadrate and articular presents features which must be mentioned. In all the non-mammalian groups the quadrate has a rounded or some-

what semi-cylindrical surface which fits into a corresponding groove or cavity in the articular.

Another set of bones may be mentioned now. These are the bones of the middle ear, the ossicula auditus of anatomists. It seems probable that the sense of hearing appears in the vertebrates only with the assumption of a terrestrial life, and that the so-called ears of the fishes are organs for the maintenance of equilibrium. In the amphibia, then, true hearing appears. In the salamanders an opening occurs in that part of the cranium which surrounds the inner ear. This opening is the fenestra ovale, and is partly closed by a small cartilage or cartilage bone, the stapes, possibly to be homologized with the hyomandibular already referred to as apparently lacking in the non-piscine vertebrates. This interpretation receives some confirmation from the fact that in several salamanders the stapes articulates with the quadrate, a point which is of importance when we come to a consideration of mammalian structures.

In the frogs, reptiles and birds the stapes is a long slender rod,* frequently called the columella, and is in no way connected with

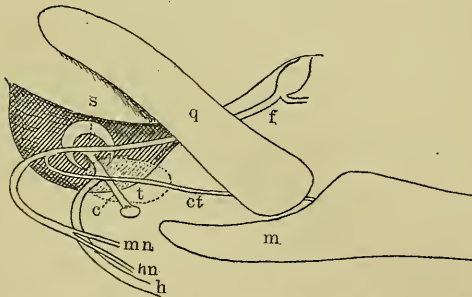


FIG. B. Diagram of Ear Region in a Lizard. *s*, stapes; *c*, columella; *q*, quadrate; *m*, lower jaw; *ct*, chorda tympani nerve.

the quadrate. It rather extends straight outwards from the fenestra ovale, across the cavity of the tympanum, or middle ear, to

* The columella is more than stapes, but for present purposes the details are not necessary.

reach the tympanic membrane. It thus becomes a sound-conducting apparatus, conveying the sound waves across the tympanum to the inner ear. This columella arises in the posterior wall of the tympanum, and, although it later moves forward into the tympanum, must consequently be regarded as a structure belonging to the post-tympanic region.

In the mammals, on the other hand, the sound-conducting apparatus is greatly different. Instead of a columella there is a chain of three bones leading from the fenestra ovale to the tympanic membrane. These are called, in order from within out, the stapes or stirrup bone, incus or anvil, and malleus or hammer, the stapes being situated in the fenestra ovale, the malleus being connected with the tympanic membrane and the incus intervening between these two. Many attempts have been made to homologize these bones with the columella of lower forms, but none of these attempts have been successful, and it is probable that complete homology does not exist. This is shown almost conclusively by two facts of anatomical relationship. In the first place, the middle member of the mammalian chain—the incus—arises in front of the tympanic cavity, and hence cannot correspond to any part of the columella, which, as we have seen, is post-tympanic in origin. Again, the incus lies in front of that branch of the seventh or facial nerve which is known as the chorda tympani, while the columella lies behind it. Now, nerves are older structures than skeletal elements, and any cartilage or bone placed in front of a major branch of a nerve cannot be homologized with a skeletal element lying behind the same nerve in another vertebrate.

Now, if these ear bones of the mammals are not homologous throughout with the columella, with what structures in the lower vertebrates can they be compared?

Here embryology comes in to assist. The development of these bones has been followed by many, and it is a rather significant fact that while the embryologists are in substantial agreement in their interpretations, their opinions are at variance with those of the students who have attacked the problem from the stand-

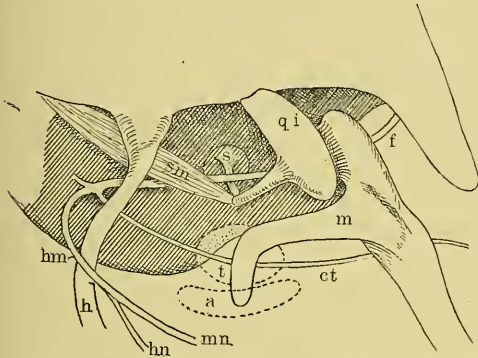


FIG. C. Diagram of the Ear Region in a Mammal. *s*, stapes; *i*, incus; *m*, malleus; *ct*, chorda tympani nerve.

point of adult structure. Now, since the embryologists have the wider view, the larger basis of facts at command, on *a priori* grounds their conclusions should be given the greater weight. Embryology plus comparative anatomy certainly forms a better basis for conclusions than comparative anatomy alone.

In the embryonic mammal, before the appearance of cartilage, a strand of denser mesenchyme extends from the point where the anlage of the stapes can be recognized into the lower jaw. Position and relationships show that this strand is the first appearance of the mandibular arch. With the formation of cartilage this arch becomes divided into a proximal portion, which can be traced, step by step, until it develops into the incus and a more distal portion, which is as clearly Meckel's cartilage, extending into the lower jaw. This incus soon develops an articular surface for connection with the stapes, while a second set of sur-

faces is found between the incus and the proximal end of the Meckelian cartilage. The incudal surface of this last is convex, while the corresponding articular surface on Meckel's cartilage is concave. It follows from these facts of development and structure, as well as from others which cannot be detailed here, that the incus fulfills, in the embryonic stages, every condition demanded for the quadrate, while the great size of these elements in the early condition can only be interpreted as indicative of some function in their ancestral history different from that of a sound-conducting apparatus. Again, it is a matter of no little importance in what will follow, that this quadrate articulates with the stapes just as in many urodele amphibia, while such relationships are unknown in any reptile, living or fossil. In the third place, this incus for a time articulates directly with the skull, just as does the quadrate in the lower forms, a condition not easily explicable upon any other view than that regarding this as the quadrate.

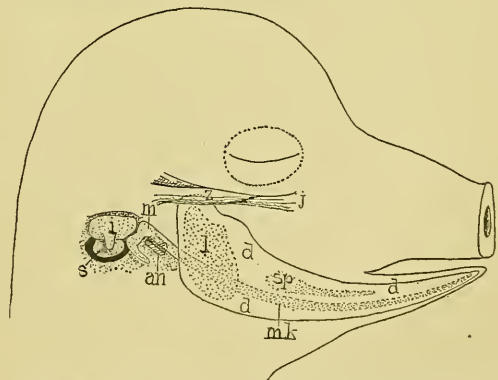


FIG. D. Diagram of the Ear and Lower Jaw in the Pig. *an*, angular; *d*, dentary; *i*, incus; *j*, jugal; *l*, cartilage of articular region of lower jaw; *m*, malleus; *mk*, Meckelian cartilage; *s*, stapes; *sp*, splenial; *z*, zygomatic process of temporal—the letter lies just in front of the glenoid fossa.

The malleus is largely formed by the ossification of the proximal end of Meckel's cartilage, and this fact, together with every

other relation except one to be mentioned immediately, goes to prove that it is the equivalent of the articular. In the formation of the malleus a membrane bone is concerned. This arises in front of the articular proper on the inner and lower side of the cartilage—that is, in the right position for the angular—and forms the process Folianus of the malleus. At some distance from the malleus two membrane bones form the lower jaw of the adult. The larger of these, from its relations and position, is clearly the dentary, while the smaller and inner one is as plainly the splenial. Thus we can apparently recognize in the mammalian lower jaw the articular and the three membrane bones most constant in the lower vertebrates. In some mammals, according to Parker, two additional membrane bones, each with its equivalent in the lower vertebrates, are said to occur. Besides all these there exists a patch of cartilage in either half of the lower jaw which arises entirely independently of the Meckelian, never unites with it, and which is, so far as I know, without any equivalent in any amphibian, reptile or bird.

To the identification of the bones of the lower jaw which have just been given, there is one very serious objection. The articulation with the cranium is not homologous with that of the lower vertebrates. After the formation of all the bones of the jaw the Meckelian cartilage becomes absorbed between the Folian process and the hinder margin of the dentary, leaving the jaw proper without connection with the quadrate. The posterior portion of the dentary extends up around the second cartilage mentioned, and articulates with the squamosal, the dentary furnishing the articular condyle, the squamosal the glenoid fossa. It is not easy to say how this new articulation can have been introduced, for it is hard to see how an organ in constant use like the jaw

could transfer its hinge from the quadrate to the squamosal. And yet, from any point of view, it seems impossible to escape the conclusion that it is not homologous with the articulation of the lower vertebrates, for the articulation in the non-mammalian forms is at the proximal end of Meckel's cartilage, while in the mammals the Meckelian does not come anywhere near the region of the glenoid fossa. Again, in the glenoid fossa there is no trace of any cartilage which could be used as a basis for the view that the quadrate has disappeared at this point.

A word about Albrecht's supposed quadrate may be inserted here, since it has often been quoted in this connection. Albrecht found, on one side of the skull of an idiot, a separate bone in the region of the zygomatic process of the temporal bone, and since the lower jaw articulates at this point, he at once jumped to the conclusion that this bone must be the missing quadrate. Now, the fact that cartilage is unknown in this region would at once negative any such conclusion, while the further fact that the skull in question was that of an imbecile and the additional bone occurred on one side only, is certainly suggestive. No history of the case was given, but it is not beyond the bounds of possibility that an injury to the head may, at the same time, have caused the imbecility and have produced the supernumerary bone, upon which, as a very slender basis, a considerable superstructure of speculation has been built.

There is one series of facts which may possibly lead to an explanation of this change in point of articulation. In certain sharks there occur labial cartilages which lie outside of the jaws and perfectly free from them. Now, the cartilage mentioned above as occurring in connection with the dentary bone of mammals, occupies the position of one of the lower of these labial cartilages—Parker has, indeed, identified

it as a labial—and this has apparently been concerned in the transference of the hinge of the lower jaw. This, however, is mentioned only as a suggestion; details have yet to be worked out, and further study may show that this view is untenable.

Now, summing up the evidence of the bones, we may say that the characteristics of the ribs, the heterodont dentition, and the entepicondylar foramen point more strongly towards a reptilian rather than towards an amphibian ancestry for the mammals. On the other hand, the occipital condyles are even stronger evidence in the other direction. But, when we consider the relations of the ear bones and the quadrate, the weight of argument is very strongly opposed to a reptilian ancestry, while these same relations, and especially the articulation of the quadrate with the stapes, go far towards supporting the theory that the mammals have descended from the amphibia.

There is another series of osteological facts which also seems to point in the same direction. In the mammals, as in the amphibia, the ankle joint is formed between the bones of the shank (tibia and fibula) and the proximal row of tarsal bones. In all reptiles of which we have adequate knowledge, the joint is between the proximal and distal rows of tarsal bones—is intratarsal. This, however, is not conclusive, since the foot structure of the theriomorphs is very imperfectly known.

Besides the osteological evidence for the descent of the mammalia from amphibian-like forms, there are facts derived from the soft parts which have a cumulative value. They, however, are not conclusive, for we cannot say what may have been the relations in the theriomorphs. It may be that these extinct reptiles possessed one or all of these features, but the fact that they are lacking in all modern reptiles lends plausibility to the view that they were ab-

sent from the older members of the group. A detailed account of these would far transcend the limits of this paper, and but the briefest mention can be made of them.

In the first place, mammals are strongly marked off from all other vertebrates by the existence of hair. For a long time it was thought that hair, feathers and scales were homologous structures, but Maurer has shown that hair is totally different from the others. It is true that Weber has criticised Maurer, but his criticisms seem far from conclusive. According to Maurer—and he offers a large mass of facts in support of his contention—the only structures in the lower vertebrates which can be conceived to have given rise to hair are lateral-line organs of the amphibian type. Now, lateral-line organs are unknown in any terrestrial form. Even in the frogs and salamanders they are lost during the metamorphosis which precedes a life on land. Hence it is very probable that they were lacking in the theriomorphs, all of which were apparently terrestrial in habit.

The student should also read Klaatsch's account of the mesenterial structures, especially of the superior mesenteric artery, to see how impossible it is to derive the relations of these from any known condition in the reptiles. In the mammals these structures are far more primitive than in the reptiles, and Klaatsch concludes that their origins must be sought in forms below the existing amphibia.

Mammals alone have well-developed external ears, and these, as well as the tube leading to the drum—the external meatus—are supported by cartilages. All who have worked at these agree that they must have been derived from opercular structures, like those of fishes, supported by the hyoid arch. Now, all such structures are absent from all known reptiles, nor do we know of them in the amphibia. They must be sought in

forms between the fishes and the stegoccephali.

The thoracic duct of the mammals is the primitive lymphatic duct of the left side; that of the right is greatly reduced and receives no lymph from the lower part of the body. Exactly the same conditions occur in the urodeles, but not in the reptiles.

Another item of interest in this connection is that mammals and amphibia get rid of their nitrogenous waste in the form of urea, while reptiles void uric acid.

As we saw earlier, embryology was an important factor in directing attention to the reptiles as ancestors of the mammals, but now the weight of its evidence is in the opposite direction. The fact that the monotreme eggs are meroblastic is far from conclusive, since similar conditions have arisen independently several times in the animal kingdom. Hubrecht, however, has pointed out that certain other features of development—those connected with the foetal envelopes of the mammals—are not to be derived from the conditions known in any reptile, but that they are easily explained as arising from a type of egg found in the amphibia. As these arguments, so far as I am aware, have not been summarized in English, they may be given in a brief form here, omitting all points which have no immediate bearing upon the question at issue, such as the two types of foetal circulation, the nutritive functions of the trophoblast and the like.

As is well known, the mammals, like the sauropsida, form a foetal envelope, continuous with the sides of the body—known as the amnion; and from the fact that the sauropsida are lower than the mammals, the natural view has been that the reptilian type has been the ancestral one, from which that of the mammals has been derived. Were this envelope to arise in all mammals in the same way that it does, for instance, in the sheep or the rabbit, this conclusion

could not be gainsaid; but when the amnion of the guinea-pig, the hedgehog, the flying fox and that of man are considered, we meet conditions which it is extremely difficult, if not impossible, to explain in such a way.

Forget for the moment the well-known diagrams of amnion formation which appear in any text-book, for they will confuse. In the hedgehog there arises very early in development a two-layered vesicle, the layers being, according to Hubrecht's interpretation, ectoderm and entoderm. At one end of the vesicle the ectoderm is much thicker than elsewhere, and projects like a cone or papilla into the central cavity. Soon a splitting occurs in this ectodermic thickening, so that the whole structure now forms a double vesicle, its two cavities being separated by a partition formed of ectoderm and entoderm, the larger and older cavity having walls of ectoderm and entoderm, the later one walls of ectoderm alone. From this partition the embryo will arise.

There are now clearly two kinds of ectoderm present in the germ; one the embryonic, the other forming the outer walls of both vesicles. For this latter Hubrecht has proposed the name trophoblast in allusion to its nutritive functions, and he distinguishes two kinds or regions of trophoblast; that of the smaller cavity being called the allantoidan, that of the larger the omphalidian trophoblast, from their future relations to allantoic and vitelline circulations.

With the development of the mesoderm, which, of course, arises between the ectoderm and entoderm of the germinal area, an important change is introduced. The somatic sheet of this layer grows outward and then turns upward into the angle between the embryonic ectoderm and the omphalidian trophoblast, and then bends downward on the inner side of the latter, while the splanchnic mesothelium follows the deeper surface of the entoderm into the

same region. This last, however, has no concern for us at present.

From the angle just mentioned the somatic mesothelium now gradually extends upwards and inwards between the cells of the allantoidan trophoblast as a double sheet, dividing the trophoblast of this region into two layers. Finally, the mesothelium growing in from all sides meets and fuses above the embryo, which now lies in a cavity roofed in by an internal layer of ectoderm and an outer of meso-

but, of course, these are derived in a greatly different way. We see from this that the first splitting in the ectoderm described above is the separation of amnion from the rest of the ectoderm. In the sauropsida and in some mammals, as is well known, the amnion arises in quite a different manner; not by the splitting of the ectoderm, but by the upgrowth and overgrowth of folds from all sides of the embryo—each fold consisting of ectoderm and somatic mesothelium—the folds at

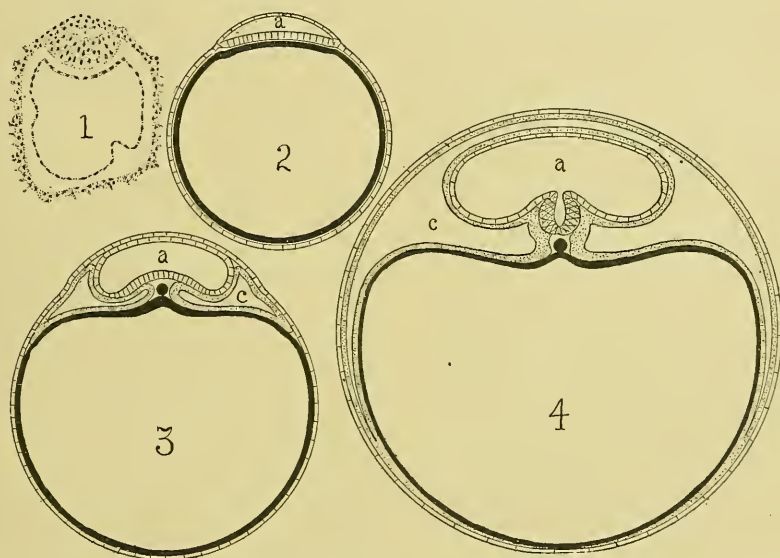


FIG. E. Diagrams of the Origin of the Amnion. 1. Section of an egg of *Erinaceus* after Hubrecht, showing the two layers and a cavity in the ectodermic thickening. 2, 3 and 4, diagrams of successive stages of formation of the amnion; ectoderm white; mesoderm dotted; entoderm black. *a*, Cavity of amnion; *c*, coelom. 2. Diagram of the stage of Fig. 1, the amniotic cavity formed by splitting of the primitive ectodermic thickening. 3. Appearance of the mesoderm and coelom, the somatic layer of the mesoderm growing upwards above the amniotic cavity, the roof of which is beginning to split into amnion and serosa. 4. Process of the amnion formation complete, the result closely similar to what is found in reptiles and birds.

thelium. Between this roof and the trophoblast there is now a space, lined on either wall by mesothelium, and hence clearly a part of the coelom. The cavity above the embryo is the amniotic cavity, and its ectodermal lining is the amnion. It now shows in every relation exactly the same features as are well known in the chick;

last meeting and fusing above the embryo, the final result closely simulating that described for the hedgehog. The question now arises, which of these two modes of amnion formation is the primitive and which the derived condition? Hubrecht's line of reasoning in settling this question is, in outline, as follows: The am-

nion, filled with fluid and surrounding the embryo, is clearly a protective apparatus. Its origin can in no way be explained by the presence of the large yolk or of an egg-shell, for in the sharks which have both no amnion appears. As a protective apparatus it, of course, would have the greatest value in an embryo developing inside the mother, protecting it, like a water cushion, from the peristaltic and other movements of the mother. Hence, it is more reasonable to look for the origin of the amnion in viviparous rather than in oviparous forms. Now, an amnion formed after the type found in the hedgehog can act as a protection from the very first, while one arising as in reptiles cannot have any protective value until the folds have completely closed over the embryo, and so it is difficult to account for the incipient stages in the reptilian type. Again, it is easy to derive the reptilian condition from that described, while the amnion of the hedgehog or of man is not easily explained on an hypothesis of descent from the reptilian condition. Hence it follows that there is no inherent improbability, and that there is much plausibility, in the view that the amnion formed by splitting is the primitive, that by overgrowth the derived type.

Now, where are there features that could have given rise to such structures? The ancestral form must have been viviparous, and it must have had a two-layered ectoderm. Now, the amphibia fulfill the conditions in both respects, for there are salamanders which bring forth living young, and nowhere in vertebrates, except in the amphibia, do we find a two-layered ectoderm, while here a two-layered condition occurs throughout the group; and further the outer layer does not participate in the formation of the embryo.

In conclusion, it may be said that at present the weight of evidence is in favor of an amphibian ancestry for the mammals,

but when the known forms of amphibia are examined none is found which will meet exactly the requirements of the case. The limbless cæcilians are, of course, out of the line; the anura, with their reduced vertebral columns and reptilian ear structures, are equally out of the question. The urodeles approach more nearly to the ancestral form, but their skull is so degenerate that it cannot give rise to the zygomatic arch so characteristic of the mammals. There remains only the group of stegocephala. These are extinct forms, the earliest fossils of which appear in the Carboniferous, the subclass dying out in the Triassic. In every known feature these are closer to what the ancestors of the mammal must have been than are any of the other groups, and yet not a single form of stegocephalan is known which can be said to meet the demands required for the ancestor of the mammals. This ancestor must be some form closely allied to, but yet more primitive than, any known stegocephalan. Further, it may be said that we cannot derive urodeles, cæcilians or anura from any stegocephala as yet discovered.

The earliest known stegocephala are well differentiated and widely distributed, and they have a structure greatly different from that of the crossopterygian ganoids from which they have in all probability descended. The ancestor of the mammals partakes of characters intermediate between those of the crossopterygians and those of the most primitive stegocephalan known, and yet one in which the amphibian characters predominate over the ganoid features.

We must, however, remember that the geological record is as yet imperfectly known. We have as yet found no form which serves to bridge the gap between the finned and the limbed vertebrates. Footprints have been found in Devonian rocks in Pennsylvania which, in the light of our present

knowledge, we can interpret only as those of a stegocephalan, but no hard parts have been found to show us what the animal was like. We may hope, yes, almost expect, that future exploration will show us stegocephalans in rocks of Devonian age, and when those are found it is possible that they will embrace types which will be decisive as to mammalian ancestry. Yet how slight are the chances of such discovery is shown by one fact concerning our knowledge of the mesozoic mammals. Nearly half of the known species of these were found in a bed of clay in southern England, the whole deposit measuring forty feet in length, ten in breadth and five inches in thickness.

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THE RELATION OF PHYSICAL GEOGRAPHY
TO OTHER SCIENCE SUBJECTS.*

IN geography we have not as yet reached that stage when vague spheres of influence give place to definite territorial boundaries. Our science is still unorganized, its frontiers are not demarked and the dividing lines of its provinces are not yet drawn. My subject compels me to take up a number of questions still so unsettled that I can hardly hope to suggest even a *modus vivendi* which in this time of boundary disputes will be acceptable in all its details to many besides its author.

At least in America, we shall all agree that physical geography is not identical in its limits with what our English friends term physiography. It is not a summation of our knowledge of nature. Such was the older physical geography, and valuable as was its view over the entire kingdom of science, it was found impracticable as an educational instrument. With its string of disconnected chapters on the elements of

physics, chemistry, astronomy, geology, botany, zoology, and ethnology, concluding perhaps with a chapter on precious stones, it is no wonder that there was sometimes applied to it the sacred definition of a circle whose center is everywhere and whose circumference is nowhere. And yet to many a boy it gave his only world-view, his only touch with nature. When Huxley spoke of it, this *Erdkunde*, as 'a peg on which the greatest quantity of useful and entertaining scientific information can be suspended,' it was not in disparagement; for he termed it one of the essentials of a liberal education.

Physical geography has often been treated as though it were equivalent to the 'science of geography,' as Strachey has defined it, or as synonymous with the 'general geography' of the Germans. But its note is neither the introduction of the causal notion nor a topical treatment of the subject. It is not to be set over against either descriptive or a real geography. Surely the adjective in the phrase may well have a restrictive influence. Either 'physical' as here used is equivalent to 'natural,' in which case our science reverts to physiography, or else it limits the subject to physical as distinct from biologic phenomena. Accepting this restriction, we may set the divisions of geography in the following scheme:

1. Chorographic geography.
2. Physical geography, with its subheads of the geography of the planet, the geography of the air, the geography of the sea, and the geography of the land.
3. Biotic geography, the distribution of animals and plants.
4. Anthropic geography, the geography of man.

The chorographic member, dealing with position, direction and dimension, is the rudiment from which the entire body of geography has developed. The map, its first product, remains its chief vehicle of

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expression. I can only stop here to notice that in education this member has but recently passed its culmination. The leading American geography of twenty-five years ago, on account of its many excellencies called by Col. Francis Parker in 1894 'the best geography in English ever issued,' touched the highwater mark of topography. Its map questions on the continent of South America required a knowledge by the pupil of 9 capes, 48 cities and 30 rivers. The boy who knew his lesson in Guyot could tell you that the leading affluents of the Orinoco are the Venture, Coroni, Auraca, Meta, and Guaviari rivers. To-day the pupil in Frye escapes from South America with a burden of but 1 cape, 11 rivers and 25 cities, a total of 37 place-names of these three kinds, as against the 87 which his father learned in Guyot.

The space saved by this shrinkage is largely given in recent texts to the physical side of the subject. Our 'advanced' or 'complete' school geographies open with a compend of physical geography, and a wealth of physiographic material is scattered with free hand throughout the text. In the high-school our science is commonly reviewed as a distinct study.

In its opening chapter on the geography of the planet, physical geography borrows freely from astronomy. Its view-point, however, is geocentric. Its astronomy is planetary, not sidereal. No fact nor theory is introduced except in direct and important relations to the earth.

The geography of the air is practically conterminous from our standpoint with meteorology. It makes drafts on the elementary principles of physics. It everywhere introduces the causal notion. Both the physical and the purely geographical contents are indispensable, and it would be futile to attempt to isolate either.

Under whatever name meteorology is

taught, it should have a large place in school programs, so many and so vital are our relations to this ocean of air at whose bottom we dwell, so fundamental are its effects on land forms, so immediate are its controls of the distribution of life. Few studies offer so good facilities for scientific observation. The apparatus it requires is inexpensive. The daily reading of its instruments, the search for the causes of to-day's weather changes and the effort to predict those of to-morrow, give training of high value. The school becomes in a way a member of a corps of scientific observers, since it receives each morning the records of the work of the Weather Service to compare with its own. Indeed, so valuable is meteorology as an educational instrument that it surely will win place as a distinct study in the high-school.

The geography of the sea is of minor importance to our subject, and we may pass at once to the pith of physical geography, the geography of the land, the science of land forms, or geomorphology, as it is technically and rather lengthily termed. It is here that our science presents the largest range and variety of phenomena. It is here that its relations to life are most direct and complex. So central is this portion of geography that all other divisions may be grouped about it in subordinate relations and the whole thus attain organization and unity. The geography of the planet, the sea and the air are prerequisite to the geography of the land, since it is by the action of the mobile envelopes that the forms of the lithosphere have been sculptured, while the applications of these physical conditions lead directly into the biotic and anthropic divisions.

It is not strange, therefore, that with the organization of the science the study of land forms has taken a large place. It is called by Penck 'the main part of geography proper.' The masterly treatise of de Lap-

parent 'Leçons de géographie physique,' is geomorphology pure and simple from beginning to end. Is this distinguished geologist of France biased by his profession? Well, here then is Boulangier, who in his 'Traité de géographie physique' reassures his readers that the author is *not* a geologist, and still defines his subject as 'the methodical and rational study of the surface forms of the planet.' Wagner excludes from our science both anthropic and biotic geography, while Supan admits, of the two, only the latter. Davis has given us under the name of physical geography the most complete and luminous treatise on land forms in the language, in which, however, there are everywhere introduced applications of physical conditions to the life of plant, animal and man—matter of great value usually omitted in European texts.

So rapidly, so lusty and so big has geomorphology grown that it has been suggested by Professor Dryer that it aims to play the part of the young cuckoo and oust from the nest the remainder of the geographical brood. It is scarcely of age, and yet the science of land forms has already rejuvenated geology and rationalized the domain of geography. Geomorphology is the child of geology and geography, and it inherits its father's strength and its mother's beauty. From geography it brings the 'half artistic' description of the features of the earth and their distribution; from geology it brings the reasoned processes of their formation. Just now it seems to be an educational question as to which of the parents the child should be given in keeping. Should land forms be taught in high-schools chiefly as physical geography or as geology? This is perhaps the most important question raised by my subject. It involves the relations of the two sciences and their educational values.

The overlap-land of geomorphology may be claimed by geology with as sure a right

as any of its other provinces, such as paleontology. It was by geologists that it was explored. The Committee of Fifteen accredits the advance in scientific geography the last few decades to the work of geographical societies, and to a limited extent this is surely true, in Great Britain especially. And yet, as one of the foremost British geographers, H. R. Mill, has stated, it is 'the recent work of three geologists, Penck, Davis and Lapparent,' that 'has brought this aspect of the relation between geography and geology boldly to the front.' Without question it is by geologists that the science of land forms has been created. The list of the founders and leaders of the American school of physiographic geology, whose primacy is so generally admitted, is quite too long for mention, but I cannot omit the names of Powell, Lesley, Gilbert, Davis, Dutton, McGee, Chamberlin, Russell and Tarr. How large, also, have been the contributions of foreign geologists, such as Ramsey and Geikie, Richthofen, Suess, Heim and Walther, Noe, Margerie and Lapparent. If some of these, as Penck and Davis—to the latter of whom Lapparent justly attributes 'the preponderating influence in the development of the new conceptions'—are officially known as professors of physical geography, they belong, notwithstanding, to the brotherhood of the hammer.

The attention of geology was early diverted from the study of land forms, but it brings on its return a wealth of material which compensates amply for its absence. The reports of the U. S. Geological Survey contain a body of physiographic information and doctrine unequaled in the publications of any scientific society. Our recent State surveys show the splendid results of the application of the methods of the geologist to the study of reliefs, as in the work of Salisbury in New Jersey, Calvin in Iowa, and Marbut in Missouri. The new geology describes the forms of the land with a pre-

cision and detail hitherto unknown. It refers them to their places in a genetic classification. It assigns them to their order in an evolutionary life history. Furthermore, it uses them as the older geology used fossils and the succession of strata; it reads in reliefs the story of the geological past. It not only explains the present by the past, but it also reveals the past by means of the present. The physiognomy of a region may be the record of a large part of its geological history. While the geomorphologist requires the special equipment and competence of the geologist, it is no less true that the geologist must now perform be a geomorphologist.

In the geological courses now offered in American universities land forms have a large and increasing place. It is given under different names, but with essentially the same content. In some, as in the University of Wisconsin, applications to human life are included, an essentially geographic subject. In the higher American schools, with one notable exception, Harvard, it is only in the laboratories and lecture rooms of the department of geology that the student of land forms can obtain adequate training. "The surest foundation," as Richthofen has said, "for the study of geography is geology, in its whole compass, as being the only means to an understanding of the earth's surface." Geology thus retains possession of the field both in research and in advanced instruction.

As Davis has pointed out, land forms are functions of three variables—structure, process and time. The first of these, structure, together with the causes which have produced it, is undoubtedly a geological subject, and it is from geology that the geomorphologist must here draw all his data. Process has always been treated under dynamic geology, and yet as a part of geophysics, as treating of agents now in action upon the earth, it belongs also to geography. The cycle of time, 'that un-

measured part of eternity,' during which process produces upon structure the evolving series of topographic forms may well be claimed by the science which deals with the past history of the earth. The position of geologists is well stated by Sir Archibald Geikie in answer to the argument of Sir Clements Markham, President of the Royal Geographic Society, who had drawn the line between the two sciences at the dawn of history, excluding geology from the study of the changes of the earth's surface since that time. "Since geology may be regarded as the history of the earth, whatever is necessary for the elucidation of that history will be claimed by the geologists as part of their domain. Only as they understand what is going on at the present day can they understand what took place in past time. If you take away from the geologist the study of all that is taking place now, and maintain that this study is not geology but physical geography, he will answer, 'I do not care what you call it. I must be at liberty to investigate the processes which are operating now, in order that I may be able to explain what has happened in past time.'"

The dependence of geography on geology often has been compared with that of painting or sculpture upon anatomy. But the simile is far from complete, unless the former science is content to remain descriptive only, dealing with the delineation of external form. For the reliefs of the land must be studied and classified not primarily or chiefly as to form, but by structure and genesis. So soon as the description of the features of the earth's surface and their distribution yields to an inquiry into their origin, the line is passed which divides the -graphy from the -logy.

These questions are not perhaps without some practical outcome. The organization of these sciences, and the theoretic limits between them in the field of research in-

fluence our high-school courses sooner or later. It is in this somewhat remote field that the deciding factor may be found which shall at last settle the matter as to whether the physiognomy of the land be chiefly taught in secondary schools as geology or as geography.

Fortunately certain criticisms of each science have been laid by recent educational progress. In view of our present textbooks, physical geography can no longer be called 'hash' nor can geology now be termed dry and dull. Neither of these earth sciences is dull except to the dullard. So large is the place of land forms in both the new physical geography and the new geology, that it is now a question of approach to a common content of knowledge.

Let me claim for geology the easier path of approach, the clearer and more natural method of presentation, the greater coherence and the vaster and more inspiring view.

The geological path is that of process. It studies the agents now in operation with the resulting structures and forms that are produced at each stage of the evolutionary cycle. It thus binds together cause and effect as closely as possible. It admits an inductive treatment based on the observation of common things. The geographical path is normally that of form. In many of our physical geographies this has been avoided and the geological approach frankly taken in its stead, this portion of the subject becoming an epitome of dynamic geology. It is perhaps owing to the personal equation that to me the method of classification by form seems somewhat miscellaneous and scrappy. It throws together, for example, phenomena as diverse genetically as the glacial plains of Iowa, the base plains of Russia, the lava fields of Oregon, the old lake floor of the Red River of the North, and the coastal plains of the Gulf. Supan is compelled by his method of arrange-

ment to take up the glacier under three of the five great divisions of his Physical Geography—under the atmosphere where the general description is given, under the Dynamics and under the Morphology of the Lands. There is no question of the value of such a classification to the advanced student. Is it as good for the high-school pupil as that of geology, which, in the case of the glacier, for example, draws from meteorology the climatic conditions, and from geography the description of its features, and then proceeds forthwith to treat of its work as a geological agent and of the land forms thus produced? It is perhaps because of the easier path and better method which geology offers that in the courses at Cornell University, N. Y., a year in it precedes the year offered in physical geography.

Geology also gives what a painter would term atmosphere to this common body of knowledge. It sets it in perspective. To an extent this is also done by physical geography, and I confess that I have been surprised to see how readily students of recent texts, such as Davis's, gain a realization of the time-element in the geographical cycle, though they have had no geological preparation. But these conceptions are enlarged and vivified by the detailed study of geologic time. It is well to know the geography of the Allegheny mountains, it is better still to know their morphogeny, but it is best of all to set the whole in geological perspective, to view their folding in the remote close of the Palæozoic, and their long waste during the Middle Age of geology to a plain whose gradual dissection after uplift and during subsequent cycles has sculptured these mountains to the forms we behold to-day.

It is also something to set to the credit of geology that it teaches the history of organic evolution. Perhaps we have not as yet learned to paint the panorama of creation so that its salient features are not

smothered in detail. But to know what the earth is we must know what the earth has been. The story of the planet and the life it has sustained is prerequisite to a complete understanding of the earth sciences and of the life sciences as well.

As an educational instrument geology has the advantage of concentration and homogeneity. If, like mathematics or physics, it lacks the warm human interest, the applications of geography to human life, yet its current is not shoaled by division into numerous channels. If either physical geography or geology must be omitted from our crowded high-school courses, let it not be geology, the more fundamental, the more coherent, the more educative of the two.

What then should be the place and sequence of the earth sciences in secondary programs? Can they be arranged so as to include the outlines of all, and yet without repetition? It seems to me that certain changes are desirable to secure this end. I should like to see nature study so enlarged in the lower grades that the common physiographic processes early become familiar. There is an evident trend toward the enlargement of the physical geography with which our advanced geographies are now introduced. To me this seems the proper place for the study, but while the treatment of all essential forms and processes which bear directly on the life and work of man may be expanded, all matter irrelevant to this should here be omitted. I should like to see the areal and descriptive geography which follows so enlarged that it will take in the American high-school the place it holds in the German *Realschulen* and *Gymnasia*. Each geographic unit, each region of our country, each national domain may then be treated thoroughly in all departments of the science. With the physical environment everywhere made basal, we need not fear to give anthropic geography the largest pos-

sible place. It may be that much might be brought in which a strict definition of geography would exclude. But with due selection of material, with grasp of principles, with historic perspective, and especially with a thorough knowledge of physiographic controls, the wise teacher of geography can afford to take as his motto, I consider nothing alien to myself that relates to man. The extension of anthropic geography, however, cannot be brought about by discussion, or criticism, or the writing of text-books. It must come in precisely the same way as has the extension of physical geography—by scientific research. It awaits the masters who will some time do for the sciences relating to man what geology is doing for the science of land forms.

The proper place, then, for physical geography is a place preliminary to the areal geography which applies its principles and consequences to special regions. To review it later as a separate study would then seem unnecessary. Instead, let the course in the earth sciences be concluded by meteorology and geology. The earth sciences may thus be so closely articulated as to form the vertebral column of secondary scientific instruction. So close is their touch with human life, so thorough and comprehensive is their discipline, so simple, so natural, so rational, and so real is their culture, that their extension only awaits their connection into one continuous line of study.

WILLIAM HARMON NORTON.

CORNELL COLLEGE, IOWA.

PROFESSOR FRAAS ON THE AQUEOUS VS. AEOLIAN DEPOSITION OF THE WHITE RIVER OLIGOCENE OF S. DAKOTA.

A SPECIAL expedition of the United States Geological Survey into the Bad Lands of South Dakota was led by N. H. Darton, of the Survey, assisted by J. B.

Hatcher, of the Carnegie Museum; with the party was also Professor Eberhard Fraas, of Stuttgart. The object of the expedition was to secure exact geological data for the monograph 'The Titanotheres,' now in preparation by Professor Osborn. The matters of chief importance were: first, to determine the mode of deposition of these beds in view of the arguments recently brought forward by Matthew, Davis and others that they were æolian rather than aqueous in origin; second, to determine the exact stratigraphical levels upon which the different types of skulls and skeletons have been found, verifying and extending the very careful records made by Mr. Hatcher between 1886 and 1888 while collecting for the United States Geological Survey, under Professor Marsh.

Mr. Darton will prepare the formal report of the geological results of this expedition, including a map showing the extent and exact thickness of the beds in different portions of this region. In the meantime it is interesting to learn the opinions of a highly trained European geologist, Professor Fraas, upon the nature of these beds, expressed in an informal letter to Professor Osborn:

"I take this opportunity to briefly present my opinion on the origin of the Oligocene of the Bad Lands. So far as I have been able to observe the beds during the past eight days, one can by no means speak of their structure as æolian in the ordinary sense of the word. It is quite possible that wind-transport may have taken some part in their formation, but the strata themselves appear to me to have been chiefly laid down under water. We ought, I think, to take into consideration the following series of different petrographical and structural conditions:

"(1) The *Titanotherium Beds*, which constitute the base of the Oligocene, I take to be the deposit of a slowly flowing river, which

emptied in the broad delta upon the level stretches of the Ft. Pierre [Middle Cretaceous]. This view is supported by the occurrence of large boulders of ground-conglomerate at the base of the *Titanotherium Beds*, as well as by the frequent embedding of sand and gravel in the clays and marls. The current was manifestly very gentle and laid down a continuous substratum, resulting in cross-bedding in the sands and gravels. Against the dune-structure (æolian) testify the widespread layers of sand banks, often very thin, the heavy gravel and the fine lamination of the clays. The current was directed from west to east, and corresponding to this the thickness of the gravel and sand layers diminishes as we pass eastwards. (2) It is very difficult to determine the origin of the overlying *Oreodon Beds* [Middle Oligocene, 560 feet in thickness]. We must take the following facts into consideration: (a) The entire material has undergone a strong metamorphosis; the sandy, non-calcareous clays were formerly marls rich in calcareous matter, the concretionary structure of the harder banks and the texture of the material giving positive evidence on this point. (b) Certain layers were very rich in gypsum and barite; both minerals are now represented only in pseudomorphs of chalcedony, formed out of gypsum and barite. Probably there was united with the tendency to gypsum formation, a similar tendency to rock-salt formation, but I have found no evidence of this. (c) The structure of the layers: In the *Lower Oreodon Beds* concretions are abundant, which originally were composed of clays rich in calcareous matter. (This is the principal layer of *Testudo* and of the mammals.) Here are also thin banks of clear limestone, now strongly silicified; land and fresh water snails are found here (*Helix* and *Limnæa*); sand layers are not found here. The very massive *Middle Oreodon Beds* are splendidly laminated and

horizontally banded; that is, the colors change regularly from clear to dark. At times, in the darker portions are observed harder layers of limestone rich in clay. In the lowest layers of these middle beds we find the greatest abundance of gypsum and pseudomorphs. A layer of compressed smooth lenses of sandstone frequently appears (*Metamynodon* and *Protoceras* sandstone). Where the lenses are thin and smooth the lamination is even, where the layers are thicker, with coarser material, we observe cross-bedding. The *Uppermost Beds* of the White River Oligocene are altogether different. They are composed of very uniform material (often of volcanic ashes according to Dr. Darton), containing numerous nodules and round concretions; there are also large concretions, with the turtles again abundant, in fact, arranged quite differently from the Lower and Middle Beds. This sedimentation is manifestly of æolian character.

"When we put together all these observations to form a conclusion as to the structure of these beds we come to the following result: At the beginning [of the Oligocene] a broad, slowly flowing stream spread out towards the east and formed a broad, widespread and uniform delta landscape (*Titanotherium* Beds); this even, swampy land was dry during the dry seasons, but was flooded in every high-water period; besides the water the wind frequently took part in the transport of the dust and materials. The concretions are structures of the percolating waters (Lower Oreodon Beds, numerous land mammals). Now followed a long period in which this region was flooded by a shallow rather than deep lake. The inflow of water did not exceed the evaporation, and so through the varying concentration there was a precipitation of the dissolved materials which gave rise to the banded layers. In the same manner the gypsum

and barite in these layers is explained. Stronger currents poured in sand, which accumulated in low elevations (Middle Oreodon Beds). At last there came a widespread æolian condition in the form of loess, which spread out upon the gradually retreating or evaporated levels of the lake."

CHARLES ANTHONY SCHOTT.

WITH the death of Charles Anthony Schott, Assistant, United States Coast and Geodetic Survey, closes a most useful life, led by a remarkable man.

He was born at Mannheim, Baden, Germany, August 7, 1826, and began his studies very early, learning to read before reaching four years of age, and it is stated that his work began as a small boy. He graduated from the Polytechnic School at Karlsruhe with the degree of C.E. in 1847.

He came to the United States in 1848 and entered the United States Coast Survey, thus beginning his life of enthusiastic work in the advancement of science by the solution of the problems which confronted this organization created to obtain accurate charts of the extension coasts of the United States. He was immediately attached to the Computing Division in the office of the Survey where he remained until October, 1849, when he was assigned to the schooner *J. Y. Mason* and steamer *Walker* as hydrographic draftsman. In July, 1850, he returned to the Computing Division and on July 1, 1852, he was regularly appointed to the position of computer. From time to time he acted as chief of the Computing Division in the absence of the regular Chief and in 1855 was permanently placed in charge of this most important Division. In 1856 he was advanced to the grade of assistant, the highest in the survey after the superintendent.

The ability, zeal, indefatigable industry and vast mental resource so eminently

shown throughout his career, was thus recognized by Superintendent A. D. Bache at an early day. This assignment was most fortunate for the interest of science in general and particularly so for the advancement of the work undertaken by the Survey. In the Computing Division the fundamental data obtained in the field is digested and discussed for publication and this data, after passing through the Division, furnishes the foundation upon which the work of the Survey is built up. A wonderful opportunity was thus offered to a man capable of distinguishing himself, and this opportunity was seized by Mr. Schott and utilized to the fullest extent. The results of his painstaking labor are shown in the numerous publications bearing his name in the annual reports of the Superintendent and in scientific journals.

Mr. Schott's regular duties in the office were interrupted from time to time by assignments to special duty in the field. As early as 1855 the records show that he was in charge of the magnetic work of the survey and in 1863, during the time of the national peril, he was engaged in surveying the defences of Washington. In 1869 he took a party to Illinois to observe the total eclipse of the sun and in 1870 went to Catania, Sicily, as a member of the Superintendent's party to observe an eclipse of the sun. At various times during the absence of the assistant in charge of the Survey Office, he acted in his place.

Mr. Schott continued in charge of the Computing Division until December 31, 1899, and on January 1, 1900, was relieved of this duty and assigned to the discussion of the arc measurements in the United States resulting from the extension triangulation already executed by the different organizations engaged in survey work. All the available triangulation of a sufficient degree of accuracy is utilized in these discussions. 'The Transcontinental Triangu-

lation and American Arc of the Parallel,' has already appeared as Coast and Geodetic Survey Special Publications No. 4, and 'The Eastern Oblique Arc of the United States' is now ready for the printer. The discussion of an oblique arc in California was far advanced before Mr. Schott's health failed and will bear the mark of his genius when it finally appears in print.

It is impracticable to give a *résumé* of Mr. Schott's work in the survey at this time and reference can only be made to the 'Annual Reports' of the survey covering the years of his services for the innumerable results of his labor.

The following extract from SCIENCE of January 12, 1900, is a fitting tribute to Mr. Schott's work as Chief of the Computing Division.

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 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.

In 1898 Mr. Schott attended the 'International Conference on Terrestrial Magnetism' held in Bristol, England, as the representative of the United States Coast and Geodetic Survey.

He took part in the discussion, and his proposal that a permanent magnetic observatory should be maintained for a series of

years in the Hawaiian Islands was received with acclamation.

Later in the year the French Academy of Sciences awarded him the Wilde Prize on account of his researches and publications in the field of terrestrial magnetism. This prize was founded by Henry Wilde, an English scientist who gave the French Academy of Sciences a sum of money, the income from which forms a prize described as follows, in the *Comptes Rendus Académie des Sciences*, France, No. 126, p. 144: "This prize will be awarded each year, beginning with 1898, by the Academy of Sciences, without regard to nationality, to the person whose discoveries or publications under astronomy, physics, chemistry, mineralogy, geology, or experimental mechanics, shall be judged by the Academy most worthy of reward, whether that discovery or publication was made in the same year or in some other year before or after the foundation of the prize."

In accordance with the deed of gift this prize was awarded for the first time in 1898, and Mr. Schott received it in due form through the Department of State and from the hands of the President. The following extracts are of interest from their bearing on this memorable incident:

Extract from *Comptes Rendus Académie des Sciences*, France, No. 127, p. 1097.

The Henry Wilde Prize.

Committee M. M. Sarrau, J. Bertrand, Berthelot, Michel Lévy; Mascart, Secretary.

At the session of July 12, 1897, M. H. Wilde presented to the Academy of Sciences, under the name of Magnetarium, a remarkable apparatus now in the Museum of Arts and Industries which permits of the reproduction on the surface of a sphere, with marvelous accuracy, the distribution of the elements of terrestrial magnetism and their secular variations.

The Commission has decided that, in order to render homage to the inventor of that great work, it is desirable to make the first award of the prize founded by M. Henri Wilde to researches relating to terrestrial magnetism.

Since 1869, the 'Annual Reports' of the United

States Coast and Geodetic Survey contain, almost every year, memoirs of the greatest interest by Mr. Charles A. Schott, on the determination of the magnetic elements at the permanent observatories of the United States, and at a great number of temporary stations. The extensive work accomplished by Mr. Schott can not be stated in a brief *résumé*. * * * One finds in his memoirs an explanation of the methods employed in the observatories and in the course of journeys; a comprehensive view of the results obtained since the first observations on the American continent and a certain number of foreign stations; an exhaustive discussion of the readings made of the apparent variations in certain observatories with the study of the diurnal change for the different months of the year, of the lunar influence and perturbations; and lastly a considerable number of personal observations in many isolated stations; this work permits the establishment of the lines of magnetic distribution in North America. The whole of this work furnishes one of the most important contributions in the history of terrestrial magnetism and the Commission is unanimous in awarding the Henry Wilde prize to Mr. Charles A. Schott.

From the *Public Press*, February 4, 1899.

"An interesting episode took place at the White House this afternoon at 4 o'clock, when, in the presence of the Secretary of the Treasury, the Superintendent of the Coast and Geodetic Survey, and twenty-five of Mr. Schott's colleagues, the President presented to Mr. Charles A. Schott the prize recently conferred upon him by the Academy of France. This prize of 4,000 francs was founded by an Englishman about two years ago, and was to be conferred by the Academy on any person, in any country, whose discoveries in science, or whose original investigations had been most valuable and had contributed most to human knowledge, in the direction of mathematics, mechanics, physics, chemistry or geology. The Academy, after due consideration, conferred the prize on Mr. Schott for his investigations into the laws of terrestrial magnetism.

"After the officers of the survey had been duly introduced to the President and to the Secretary, by the Superintendent of the Coast and Geodetic Survey, the official papers containing the award were placed by

the President in Mr. Schott's hands, and in doing so he alluded in the following words to the international character of the prize, and to the catholicity of scientific work :

"I have great pleasure in placing in your hands the formal papers which convey to you the 'Wilde Prize.' This prize, founded by an Englishman who has a deep interest in science, has been adjudged to you by a committee of eminent men chosen from the most famous organized body of scientists in the world—the Institute of France. According to the terms accepted by the Institute of France in founding the prize, it was to be given to the person from any nation whose discoveries in physics or mathematics, mechanics, chemistry or geology are most valuable, or whose original researches in these branches of science have been most successful. The prize has been awarded to you for researches in the important field of terrestrial magnetism.

"I congratulate you and American science, and in particular the Coast and Geodetic Survey (the scientific organization of which you are a member), that you have been chosen from all the world as the most worthy to receive this great honor.

"It is especially pleasant in this age when international relations are of high importance, when the methods of modern applied science have brought all nations, however geographically remote, into close contact, to know that in science there are no international boundaries ; and no pleasanter proof of this catholic spirit could well be given than this fine prize—one of the highest that can be conferred by a scientific body—founded by an Englishman, has been awarded by a Frenchman and won by an American."

Mr. Schott's ability and attainments have been widely recognized by learned bodies and scientific societies as shown by his election to membership on the following dates :

1871. Philosophical Society of Washington, D. C. (Founder).

1872. National Academy of Sciences.

1874. American Association for Advancement of Science (Fellow).

1896. Sociedad Científico Antonio Alzate, Mexico.

1898. Washington Academy of Sciences (Founder).
Accademia Gioconia di Scienze Naturali, in Catania, Sicily.

The long list of publications bearing Mr. Schott's name bear testimony to his untiring industry and his devotion to the interest

of the service, which he honored as a member and to the advancement of human knowledge.

ISAAC WINSTON.

GEORGE K. LAWTON.

IN the unexpected death of George K. Lawton, of the U. S. Naval Observatory, a young astronomer of great promise has passed away. The loss to American astronomy can be appreciated as yet only by those who had the good fortune to know him intimately. He was born October 20, 1873, and died at Washington, July 25, 1901, after a brief illness of twelve days, of typhoid fever; and was thus less than twenty-eight years of age. Under the guidance of his father, Professor U. W. Lawton, of Jackson, Michigan, he had enjoyed from childhood excellent educational advantages, and in 1895 graduated in classics at the University of Michigan, where he also pursued advanced astronomical studies under Professor Asaph Hall, Jr., at the Detroit Observatory. He then spent a year in post-graduate study at the University of Chicago, where the writer had the honor to be one of his teachers. He showed distinguished abilities in the study of celestial mechanics and of higher mathematics. He was afterwards attached to the Observatory of Yale University for a short time, occupied mainly with work on meteors; and then came to the Naval Observatory as one of the regular computers. In 1897 he took the degree of M.A. at the University of Michigan. While attached to this Observatory he participated in all the transit circle observations of the past five years, much of which has recently appeared in the *Publications of the U. S. Naval Observatory*, Vol. I., new series. Last year he bore an important part in the observations of the total eclipse of the sun, at Pinehurst, North Carolina. More recently he took a leading part in the reductions and revision of the Eros observations of this Ob-

servatory, and has been occupied partly with equatorial work. Only a month ago he was assigned to the 26-inch equatorial, and had entered upon researches of great promise.

On account of his extreme modesty, and the arreages of our publications, his scientific reputation at the time of his death was in no way commensurate with his merits. Yet he was already a member of the American Association for the Advancement of Science, and last year participated in the meeting of the Astronomical and Astrophysical Society of America.

His mind was developed in admirable symmetry and harmony, and his scholarship was almost as good in Latin and Greek and general literature as in modern science. He had that happy faculty of cool, quiet judgment, combined with good nature, which made him adequate to any occasion. Besides possessing scientific and literary talents of a high order, he was of a very high-minded and noble disposition, universally beloved by his associates. Unseen by men he continually did many acts of benevolence, and bestowed gracious remembrances which add to the charm of life and make us realize that the high types written of long ago have not wholly passed away. He was an active member of St. Thomas's Church in this city and of the Brotherhood of St. Andrew and of the Alumni Association of the University of Michigan. During his residence here of five years, he became fairly well known in the city, more by the reputation of his high character than by any very extensive mingling with the people. When the writer had to send the saddest of messages to his grief-stricken family, the telegraph operator who knew him only by reputation was nearly overcome, and said, 'That good man is not long for this world.' In all my experience I have never met quite so modest, so noble, and so lovely a character.

The sudden death of Mr. Lawton, almost at the very beginning of what promised to be a brilliant career, has cast a deep gloom over the entire Observatory. He was indeed the noblest of the noble, and his place can never be filled.

T. J. J. SEE.

WASHINGTON, D. C.,
July 27, 1901.

SCIENTIFIC BOOKS.

Astronomischer Jahresbericht. Mit Unterstützung der Astronomischen Gesellschaft herausgegeben von WALTER F. WISLICENUS. II. Band, enthaltend die Litteratur des Jahres 1900. Berlin, Georg Reimer. 8vo. Pp. xxv + 631. Price, M. 19.

This series of annual volumes, whose somewhat cumbrous title is officially abbreviated to the symbol AJB, owes its inception to its editor, Professor Wislicenus, who in September, 1898, submitted to the Astronomische Gesellschaft a well-elaborated plan for a year-book that should serve both as an annual summary of current astronomical literature and as a bibliography sufficiently complete for the use of students and other investigators. The proposal was favorably received by the Society, which not only gave its official sanction and pecuniary support to the undertaking, but also appointed a committee, consisting of Professors Seeliger, Bruns and Müller, to confer with the editor as to the contents of the future volumes and the manner of their arrangement.

The plans thus agreed upon and incorporated in the first volume, that for 1899, have been closely followed in principle in the present volume, although with greater completeness of detail, as is shown by the addition of nearly a hundred pages to its size. That so few modifications should be found necessary in the second year of publication is sufficient indication that future volumes may be expected to appear in substantially the same form and character as the two already issued.

Premising that in its entire scope the AJB is to be purely expository and not critical in its summaries, the editor indicates it to be his purpose to treat with all possible completeness the purely scientific and technical literature of

theoretical and practical astronomy and astrophysics, together with, in smaller measure, that of the higher geodesy. Mathematical and physical papers are to be included in the scope of the work only in so far as they have a direct bearing upon one or more of the topics above named, while the literature of meteorology and geophysics is wholly set aside as foreign matter. With regard to the popular literature of astronomy the editor sagely remarks that while for the most part it is of small scientific value, the bibliographic purposes to be served by the AJB call for a fairly complete summary of this literature, including even 'crank' papers, all of which are to be presented in a purely objective manner without comment or criticism, in order that 'the reader may be given an opportunity to form for himself a provisional judgment of the article abstracted.'

In respect of arrangement the subject matter of the AJB is divided into four principal categories, entitled: General and Historical; Astronomy; Astrophysics; Geodesy and Nautical Astronomy. These are appropriately subdivided, while a brief supplement, of only four pages, contains the miscellaneous matter that the editor has not found expedient to classify under any of the preceding titles. Noteworthy in this connection is the following criterion by which papers upon astronomy and astrophysics are assigned to their respective classes: Problems involving only space and time relations of the celestial bodies constitute astronomy; problems of the celestial bodies involving other elements than the above are to be classified under astrophysics. As the editor himself notes, this rule of classification assigns to astrophysics the visual estimation of stellar magnitudes even though made in connection with meridian circle work, while the spectroscopic determination of motions in the line of sight is assigned to astronomy. This reversal of the popular classification seems to the reviewer sound in principle and well adapted to become the general practice.

Some conception of the amount of labor involved in the preparation of the abstracts here presented may be formed from the list of nearly 200 periodical publications, including publications of observatories, which have been so

largely drawn upon for abstracts that the editor has found it convenient to assign to their names abbreviations for permanent use. To this material there must be added books independently published and periodicals rarely cited. As a type of the latter and a source not usually included under astronomical literature we note *The Congressional Record* and several of the monthly magazines commonly sold at news-stands and on railway trains. The bulk of material to be digested is beyond the competence of any one man, and the editor has therefore associated with himself seven foreign colleagues who are charged with the supervision of special portions of the work, in large part pertaining to the literature of their own countries. The American representative is Dr. H. S. Davis, who has elsewhere requested that papers of American origin which are germane to purposes of the AJB and are published in such manner as not to be readily accessible through the ordinary channels may be sent to him for review at the address, International Latitude Station, Gaithersburg, Md.

In respect of scope and plan the AJB is beyond question a welcome addition to the literature of astronomy, but one whose actual value must be tested by the experience of many persons in using it as a work of reference. A subject index is hardly to be expected in a volume of this character and no attempt at furnishing one is made, but the well-classified Table of Contents and an extended Index of Names, including institutions as well as persons, will be found of service by whoever uses the volume for serious purposes. A feature of special value to computers of orbits is the tabular Index of Observations of Comets and Minor Planets occupying no less than 34 pages of the volume, which cannot fail to save much time that has hitherto been spent in the endeavor to make complete the computer's list of observations of the object with which he is concerned.

So far as may be judged from its apparatus of classification, cross references, indexes, etc., there is no reason apparent to the reviewer why the AJB should not stand the test of time and use, and in those parts of its subject matter with which the writer is specially conversant he has found the work eminently complete,

satisfactory, and convenient to use. It is certainly worthy of a cordial reception by all who are interested in the progress of astronomy, and the editor should receive that cooperation which he solicits for future volumes by bringing to his notice all published articles which come properly within the scope of the work.

GEORGE C. COMSTOCK.

Les plantes tinctoriales et leurs principes colorants. By V. THOMAS (Chef des travaux de chimie appliquée à la Faculté des Sciences de Paris). Une publication de l'Encyclopédie Scientifique des Aide-Mémoire. Publiée par Gauthier-Villars, Paris, sous la direction de M. Léauté (Membre de l'Institut). Pp. 196. The author divides the study of tinctorial plants as follows:

1. The coloring matters themselves.
2. The glucosides; the form of combination in which coloring matters exist most frequently in plants.
3. The ferments capable of decomposing these glucosides into sugars and the coloring matter.
4. The tinctorial plants themselves, from the point of view of the coloring principles which they contain.

In a previous volume in this same series, 'Matières colorantes naturelles,' the author has already discussed those natural coloring principles which belong to the keton, xanthou, and pheno- γ -pyron groups.

Part I. (pp. 7-142), therefore, of the present volume, treats of the remaining important plant-coloring principles, arranged in the following chapters:

Chapter 1. Colors of the anthraquinon group; alizarin, xanthopurpurin, munjistin, rubiadin, chrysazin and chrysammic acid, purpurin, pseudopurpurin, alkannin, morindon and ventilagin.

Chapter 2. Brasilin and brasilein; including isobrasilein, and derivatives of brasilin and dehydrobrasilin, together with a review of the work done by Perkin, Kostanecki, Herzig and others, to establish the constitutional formula of brasilin.

Chapter 3. Hæmatoxylin and hæmatein; also isohæmatein and derivatives of dehydrohæmatoxylin.

Chapter 4. Miscellaneous coloring matters, as follows: cyanomaclurin, genistein, gossypetin, rottlerin, flemingin, orcein, santalin, carthamin, lokanic acid, crocetin, curcurmin, lapachol, lomatiol, and bixin.

A brief history of every color is given, then the most interesting and important methods for obtaining it, together with its most characteristic physical and chemical properties and a discussion of its structural formula. The tinctorial properties are dealt with briefly, tables being freely employed to show change of color with change of mordant, effect of various substituting groups upon the color, comparison of shades obtained from the natural colors with those obtained from the same colors prepared synthetically, etc.

Part II. (pp. 143-180), Glucosides. Includes the consideration of the following: ruberythric acid, glucosides of quercetin and its derivatives, apiin, vitexin, morindin, datiscin, crocin, fustin, lokaonic acid.

Then follows a list of the principal tinctorial plants, arranged alphabetically according to their botanical names, and showing the coloring matters which they contain; also an alphabetical table of the coloring principles themselves, giving their melting points and the references to the text where the same are described in detail.

The references to the literature form a commendable feature of the work, thus affording ready access to the original articles.

Upon the whole, the book gives a very good digest of the work in this field and should prove of value to the chemist.

MARSTON TAYLOR BOGERT.

Mosquitoes: How they live; how they carry disease; how they are classified; how they may be destroyed. By L. O. HOWARD, PH.D. New York, McClure, Phillips & Co. 1901.

One of the triumphs of the combined labors of modern biologists and students of medicine is the discovery of the animal parasite of malaria and of the fact that the parasite of yellow fever, whether it be an animal or a bacterium, is, like the malarial one, transmitted by the mosquito.

Already has the number of workers become numerous, and the literature extensive, while the probability that man will be able to cope with these two dreadful scourges of his race, and at least greatly curtail their ravages is very great. We need, then, the fullest knowledge of the structure, habits and transformation of mosquitoes, particularly of the genus *Anopheles*, the bearer and transmitter of these diseases, and of the nature and life-history of the parasitic organisms which cause these diseases.

As regards the mosquito Dr. Howard has given us a capital book. It is both popular and entertaining, and yet truly careful and scientific in its scope and treatment. The physician cannot do without it. As for the entomologist, we venture to say that nowhere will he find a more fresh and up-to-date account of the mosquito. He will look elsewhere in vain for the many details which have recently been discovered by Dr. Howard and other American and European observers.

The figures of the different forms, particularly of the malaria-bearer, *Anopheles*, are new and very carefully drawn; the larval and pupal forms are rendered with great apparent accuracy. Of the greatest interest is the new matter relating to the subject of parthenogenesis among mosquitoes, the food and mode of getting it by the mosquito larvæ, and the food of the adult. The latter subject is treated with a fullness of new details which is most satisfactory. It is some comfort to learn that mankind does not form the sole pasturage of the female mosquitoes, but that they will sting terrapins and puncture the head of young fish, besides sucking the blood of birds. We had previously only known of Dr. Hagen's observation of a mosquito feeding on the chrysalis of a butterfly. We also are told that mosquitoes are plant-feeders, apparently piercing the flowers of the wild cherry, and feeding readily on fruit, especially bananas; and that the male mosquito is exclusively vegetarian in its diet.

The life-history and oecology of the malarial mosquito, *Anopheles*, is very well done. First we have a full and well-illustrated account of the common *Culex pungens*, with which may be compared, thanks to the abundant and well-

drawn figures, the life-history and structure of the pestiferous *Anopheles*. The egg, the larva of different ages, with anatomical details, the pupa, as well as the fly, male and female, are represented, and there is added an account of the North American species. The food of the larva seems to be the spores of algæ, and in Sierra Leone a unicellular protococcus. How *Anopheles* bites and its length of life are also described.

The chapter on mosquitoes and yellow fever; mosquitoes and filariasis; the account of the mosquito (*Stegomyia fasciata*) which conveys the infection, with figures of the winged insect, its scales, larva and pupa, are of much value. It is refreshing to read of the immense inroads made by fishes upon the larvæ, by dragon flies and by birds, six hundred mosquitoes having been found in the crop of a single night hawk, but it will afford the reader still more satisfaction to know how easily these dangerous pests can be exterminated by the use of so simple a remedy as petroleum. On the last subject the book is strong.

A. S. PACKARD.

SOCIETIES AND ACADEMIES.

THE AMERICAN CHEMICAL SOCIETY.

THE following is a list of the papers thus far offered for the joint meeting of the American Chemical Society and Section C of the A. A. S. to be held in Denver during the last week in August:

1. 'Solid Hydrocarbons of the Series C_nH_{2n+2} and Liquid Hydrocarbons of the Series C_2H_{2n} in the Less Volatile Portions of Pennsylvania Petroleum' (by title): CHARLES F. MABERY.
2. 'Specific Heats and Heats of Volatilization of Hydrocarbons of the Series C_nH_{2n+2} , C_nH_{2n} , and C_nH_{2n-4} , in Pennsylvania, Texas, California and Japanese Petroleums' (by title): CHARLES F. MABERY.
3. 'Composition of Commercial Paraffine, Vaseline, and Solid and Pasty Mixtures of Hydrocarbons, collected in Oil Wells' (by title): CHARLES F. MABERY.
4. 'Composition and Properties of Asphalts from Different Petroleums' (by title): CHARLES F. MABERY.
5. 'Analysis of a Few Southwestern Coals' (10 min.): HERMAN POOLE.

6. 'Summary of Analyses of the Massive Rocks of Boulder County, Colorado': CHARLES S. PALMER.
7. 'The Indirect Weighing of Quantitative Precipitates' (by title): R. W. THATCHER.
8. 'An Automatic Filter Washer' (20 min.): J. M. PICKEL.
9. 'Some New Laboratory Furniture': PROF. LACHMAN.
10. 'Recent Developments in Physical Chemistry': WILDER D. BANCROFT.
11. 'Proper Methods of Teaching Physical Chemistry': WILDER D. BANCROFT.
12. 'Some Points on the Teaching of Chemistry': CHARLES S. PALMER.
13. 'What Constitutes Instruction in Technical Chemistry' (15 min.): EDWARD HART.
14. 'Discussion of Methods used in Different Universities for Giving Instruction to Large Classes in Elementary Laboratory Work': WM. MCPHERSON.
15. 'The Teaching of Chemistry in Secondary Schools': FREDUS N. PETERS.
16. 'Chemistry in Manual-Training High-Schools' (15 min.): ARMAND R. MILLER.
17. 'The Determination of Sulphur in Iron and Steel' (15 min.): WM. A. NOYES and L. LESLIE HELMER.
18. 'Copper as allied to the Sciences, and its Commercial Value' (7 min.): W. S. EBERMAN.
19. 'On the Decomposition of Sodium Nitrate by Sulphuric Acid'—Part III.: C. W. VOLNEY.
20. 'Quantitative Determination of Hydrofluoric Acid' (3 min.): W. E. BURK.
21. 'Methods of Standardizing Acid Solutions' (15 min.): CYRIL G. HOPKINS.
22. 'The Sulphohalides of Lead' (10 min.): VICTOR LENHER.
23. 'Hydrochlorated Mercury and Cadmium Sulphates' (5 min.): CHARLES BASKERVILLE.
24. 'Evidences of the Probable Complexity of Thorium' (10 min.): CHARLES BASKERVILLE.
25. 'Constitution of Alloys': J. A. MATHEWS.
26. 'Cryoscopic Experiments with Sulphur' (12 min.): ALEXANDER SMITH.
27. 'The Electrolytic Method applied to Uranium' (15 min.): LILY GAVIT KOLLOCK and EDGAR F. SMITH.
28. 'The Electrolytic Determination of Molybdenum' (15 min.): LILY GAVIT KOLLOCK and EDGAR F. SMITH.
29. 'The Precipitation and Separation of Silver in the Electrolytic Way' (15 min.): W. H. FULWEILER and EDGAR F. SMITH.
30. 'The Electrolytic Separation of Mercury from Copper': C. ROSCOE SHAW and EDGAR F. SMITH.
31. 'The Identification and Properties of Alpha and Beta-Eucaine' (15 min.): CHARLES L. PARSONS.
32. 'A Comparison of the Solubility of Acetylene and Ethylene' (15 min.): SAMUEL AUCHMUTY TUCKER and HERBERT R. MOODY.
33. 'On the Estimation of Urea in Urine' (10 min.): JOHN H. LONG.
34. 'On the Determination of Formaldehyde' (15 min.): A. G. CRAIG.
35. 'A Modification of the Sulphuric Acid Test for Formaldehyde in Milk' (5 min.): A. GUSTAV LUEBERT.
36. 'The Synthesis of Ketodihydroquinazolins from Anthranilic Acid' (by title): AUGUST HENRY GOTTHELF.
37. 'Researches on Nitrocellulose' (by title): G. LUNGE.
38. 'The Reduction in an Alkaline Solution of 2.4.5. Trimethylbenzaldazine' (20 min.): E. P. HARDING.
39. 'Preparation of 2.5. Dimethylbenzaldehyde; the Estimation and Preparation of some of its Derivatives': EVERHART P. HARDING and LILIAN COHEN.
40. 'A Study of the Chemical Composition of Meat Extracts' (10 min.): H. S. GRINDLEY.
41. 'Chemical Changes Produced by the Action of Bacteria' (10 min.): H. S. GRINDLEY.
42. 'Derivatives of Diphenyl Ether' (25 min.): A. N. COOK.
43. 'The Constitution of Azoxybenzine': PROFESSOR LACHMAN.
44. 'The Action of Zinc Ethyl on Nitro and Nitroso Compounds—a Reply to I. Bewad': PROFESSOR LACHMAN.
45. 'Recent Developments in Organic Chemistry': PROFESSOR LACHMAN.

DISCUSSION AND CORRESPONDENCE.

PSEUDOSCOPIC VISION.

THE experiment described by Professor Wood (SCIENCE, August 2, p. 185) is always striking and attractive when performed for the first time, and he is probably only one of many who have attained this binocular result independently. I did so twenty years ago; and my attention was called to such phenomena more than thirty years ago by the late Professor Joseph LeConte.

But the use of the unaided eyes for the at-

tainment of either orthoscopic or pseudoscopic binocular effects was described by Sir David Brewster as long ago as 1844 (*Edinburg Transactions*, 1844, Vol. XV., Part III., p. 360), and quite fully discussed in his book on 'The Stereoscope,' published in 1856. On the optical illusions due to cross vision Brewster based his geometric theory of binocular vision, which was fully elaborated in his book. In 1855 and 1856 the same theory was applied by Professor W. B. Rogers, founder of the Massachusetts Institute of Technology, in a series of articles published in the *American Journal of Science*. It has since been applied by various writers. The incorrectness of this theory is conclusively proved by the possibility of binocular vision by optic divergence (*Am. Jour. Science*, Nov. and Dec., 1881, March, April, May, Oct. and Nov., 1882).

Nevertheless, the subject is attractive, and the results attainable when the visual lines are made to cross at a high angle, such as 50° or 60° , suggest some interesting and perfectly legitimate geometric applications. But these experiments are somewhat trying to the muscles of the eyes.

W. LE CONTE STEVENS.

WASHINGTON AND LEE UNIVERSITY,
August 3, 1901.

SHORTER ARTICLES.

ADAPTATION IN VISION.

APPARENTLY no one has noticed formally the bearing upon brain physiology of one of the commonest phenomena of vision. Within certain very wide limits the percept we have of any object does not change at all while we approach or recede from it. If, for instance, I look at a chair thirty feet off and then walk straight toward it, the appearance of the chair does not alter. Now the retinal elements excited are totally different according to the distance I am from the object. We have then a succession of different physiological processes in the retina with the final result in consciousness of a constant feeling. We naturally suppose that a continuance of the same feeling is due to a continuance of substantially the same physiological processes in the central nervous system. If this is true we can account for the

phenomenon mentioned only by supposing that all the differing successive processes in the end organ somehow get shunted into the same central process. This involves a practical infinitude of associative systems of the subtlest and most complex sort. For with each of the objects of which we thus have a constant perception in spite of varying retinal conditions, different sets of associations are needed corresponding to different views of the object. Moreover, totally new objects suffer like treatment. This latter fact almost tempts one to put faith in a mysterious mental construction on the basis of sense stimuli. Surely if the brain itself does the work of unifying these multitudes of series of retinal events into constant processes corresponding to our percepts, the complexity of its mechanism has never been fairly stated. This, I take it, is what we must believe. We must find in this commonest case of vision a notable example of the fact that our feelings do not parallel outside events or even the sensory processes aroused by them, but are the results of selected adaptations, adaptations in this case presupposing much more involved neural action than the common reflex-arc conception of the brain seems to permit.

EDWARD L. THORNDIKE.

TEACHERS COLLEGE, COLUMBIA UNIVERSITY.

THE INJURY OF FUNGICIDES TO PEACH FOLIAGE.

THE writer has devoted several seasons to an investigation of the injury produced by fungicides to peach foliage. A bulletin giving the results of this work is soon to appear from the Tennessee Agricultural Experiment Station. A preliminary report on this investigation may not be out of place here. Following are some of the points established or rendered probable:

1. Pure copper hydroxide, copper oxide, or even metallic copper spread on the leaves is injurious to the foliage of the peach, but without visible injury to that of either the apple or the grape.

2. A solution of copper sulphate 0.00005 normal (=0.000795 per cent.) proved fatal to water cultures of the apple, while grapes and peaches under like conditions, though evidently injured, soon recovered, and the peaches thus

treated on October 8 remained alive over winter.

3. Peach foliage protected from rain and dew, as in a greenhouse, sustains no externally visible injury from spraying with either Bordeaux mixture or copper hydroxide. Under normal orchard conditions the leaves sprayed with Bordeaux in a situation so as to be partially protected from falling rain or dew are the last to succumb to the injurious action of the copper.

4. The presence of deliquescent salts (as $\text{Ca}(\text{NO}_3)_2$ and CaCl_2) greatly accelerates the injurious action of copper hydrate on the foliage of the peach.

5. Peach seedlings growing in a saturated atmosphere are not injured by Bordeaux mixture and but slightly by pure copper hydrate.

6. Peach leaves growing in a saturated atmosphere possess a thinner and much more easily permeable cuticle than those growing in a dry or less moist atmosphere. Following is a summary of measurements of paraffine sections stained with chloriodide of zinc :

Peach leaves.	Thickness of cuticle of upper surface.
Orchard Knoxville.....	1.17 micromillimeters
Orchard California.....	1.21 " "
Seedling greenhouse.....	0.86 " "
Seedling in moist chamber.....	0.60 " "

7. The presence of a certain excess of lime accompanying the copper hydrate on peach foliage retards or possibly entirely prevents the injurious action of the latter. This holds true of lime applied either as the hydrate or at once as the carbonate. The sulphate of lime does not produce this effect.

The writer believes that the above results go far toward explaining the conflicting testimony of different investigators along this line in this country. So far as shown to date, no injury will result to peach foliage sprayed with ordinary Bordeaux mixture until a certain proportion of the lime carbonate is washed out by heavy dews or rain, when it at once begins to manifest itself. One would thus expect but little injury in an arid region like parts of California. On the other hand, an atmosphere containing abundant hygroscopic moisture, such as is to be found in Georgia and Florida, would supply conditions similar to those produced in

the moist chamber as stated above, and thus atone to a certain extent for the washing out of calcium carbonate caused by precipitated water.

The practical application of this principle is readily suggested. It may be possible to follow up a spraying with Bordeaux mixture with one or more of milk of lime and thus prevent the injury which would otherwise occur. Experiments carried out here this season thus far show this method to be a success. Whether it will remain so to the end of the season is yet to be determined. There are, of course, other questions to be taken into consideration, such as the practical application of the method in the commercial orchard, the effect of the lime on the fungicidal action of the copper, etc.

It is hoped in the forthcoming publication above mentioned to describe in detail the experiments above outlined, in addition to a number of others finished and now nearing completion, looking toward the physiological explanation of the results obtained.

SAMUEL M. BAIN.

UNIVERSITY OF TENNESSEE, KNOXVILLE.

CURRENT NOTES ON PHYSIOGRAPHY.

THE NORTHERN ADIRONDACKS.

A 'Preliminary Report on the Geology of Franklin County,' N.Y., by H. P. Cushing (18th Rep. State Geol., Albany, 1900, 73-128, 8 pl., colored outline map) describes the northern side of the Adirondack mountains and the drift-covered paleozoic plain at their base. The transition from one area to the other is rather abrupt, but the height of the mountains decreases with some regularity towards the plain, and branches of the plain enter valleys among the hills. An old baselevel is inferred from the systematic northward decrease of summit heights, although its horizon is admittedly not closely definable. The present valley system is explained as of later origin, the result of erosion following a slanting uplift. No dates are given in this connection, although it is said that 'the Adirondack region has been continuously above sea level since Lower Silurian times' (78), a statement that seems open to doubt. The step-like descent of the mountains toward Lake Champlain is explained 'by a

series of meridional faults with downthrow to the east,' and the depression occupied by the lake itself is said to be 'a fault valley.' It is not stated whether these faults, more or less worn, are yet so recent that they dominate the topography, or whether they are ancient faults produced while yet a heavy series of strata overlay the present surface, and only developed into existing topographic features by erosion long subsequent to faulting. Glacial erosion is regarded as having rounded off the northern slopes of many of the mountains, leaving the southern slopes of greater declivity; and a few cliff-walled cirques are ascribed to local glaciers. Lakes are very numerous and are as a rule referred to drift obstruction; 'there is yet no evidence that any of them occupy rock basins' (84). The rivers have all developed reaches ('still-waters' or 'levels') on drift, interrupted by rapids on ledges. The drift plain bordering the mountains is well occupied, while the mountains are largely a rugged wilderness.

SLATE MOUNTAINS OF THE MIDDLE RHINE.

THE report of an excursion conducted by Professors Rein and Philippson over the plateaus and valleys of the middle Rhine ('Wiss. Ausflug, Siebengebirges-Rhein-Eifel-Mosel,' 19-25 Sept., 1899; Verhandl. VII. Internat. Geogr. Kongresses, Berlin, 1900, 328-344) presents some interesting details concerning that attractive region, its physiographic features being described by Philippson. The lofty mountains of Carboniferous deformation were reduced, partly by subaerial denudation, partly by marine abrasion, to a low torso, afterwards broken into blocks which were irregularly elevated and depressed. The Rhine crossed the region along a depressed block, whose surface it modified, producing a broad trough, which now stands at altitudes of 300-350 m. The Mosel eroded a branch trough, whose altitude is now 350-400 m. Pauses in the uplift of the region to its existing position are indicated by terraces, of which the principal one, strewn with river waste, reaches heights of 200 m. It is in the floor of this terrace that the narrow gorges of the Rhine and Mosel are cut. Troughs, terraces and gorges are the work of Pliocene and later time. Frequent mention is made of the extended views

over the plateau in which the troughs and the deeper valleys have been cut, of the volcanic cones and maare that ornament it, and of the ridges of resistant quartzite that rise over it. Yet it is concluded that the plateau is not a peneplain and that its history is still to be made out. Truly it is not a peneplain, everywhere almost completely worn down and still lying undisturbed close to sea-level; but the description given of it strongly suggests that it is a somewhat unevenly uplifted peneplain, bearing some linear residual mountains on its back, and more or less dissected by its revived streams. For example, "The High Eifel is a broad, flat-arched dome, which descends southward as a gently inclined plain towards the valley of the Mosel; beyond the Mosel, the same surface is continued in the Hunsrück as a nearly horizontal plain, rising wall-like in the high quartzite ridges of the Hochwald" (p. 332). To exclude a region thus described from the class of uplifted and dissected peneplains makes one wonder what conception the author attaches to this category of forms. The report forms a very serviceable guide for a physiographic excursion over this district. It is in many ways more satisfactory than the more elaborate essays by Pollman on the Eifel and by F. Meyer on the Hunsrück (*Forsch. deut. Landes und Volkskunde*, VIII., 1894, 195-282; XI., 1899, 73-106), which unfortunately leave much to be desired in this respect.

PHYSIOGRAPHY OF ACADIA.

THE general progress of physiographic development that has been found applicable to the Appalachian belt within the United States by various observers is extended by Daly to the provinces of New Brunswick and Nova Scotia with the adjoining islands ('The Physiography of Acadia,' *Bull. Mus. Comp. Zool., Harvard Coll.*, XXXVIII., 1901, 73-104, 10 pl., map). The uplands of inner New Brunswick and the 'southern plateau' of Nova Scotia are regarded as areas of Cretaceous peneplanation, now uplifted and dissected; while central New Brunswick, together with certain areas now submerged in bays, represent lowlands etched out of weak rocks beneath the Cretaceous peneplain, and now partly drowned. The author

concludes that Acadian land forms may be described in terms of these two topographic facets, each a nearly perfect plain of denudation, interrupted by residual hills and incised valleys. Regarding the uplands of Nova Scotia, it is remarked that undue emphasis has been placed on the hills, "apparently with the mistaken notion that the true lover of nature cannot be especially interested in her land-forms when they are subdued. Yet the marvel of Nova Scotian scenery lies in its flatness." Although the region borders the sea, preference is expressed for a subaerial origin of the peneplains here described; marine erosion is given a relatively subordinate value in their preparation, however active it has become upon them since submergence has brought the sea in over the land.

PREGLACIAL DRAINAGE OF OHIO.

SEVERAL papers on 'The Preglacial Drainage of Ohio' by Tight, Bownocker, Todd and Fowke are published by the Ohio State Academy of Science (Special papers, No. 3, Dec., 1900, 75 pp., plates and maps). Tight describes some of the drainage changes along a part of southeastern Ohio, with special references to the preglacial and postglacial valleys that lie to the southwest of the trenched col by New Martinsville, from which the preglacial streams flowed opposite ways and through which the Ohio now connects basins that were formerly separate. A high-level and broad-floored ancient valley is traced through the hills southwest of Parkersburg; it is now trenched across by several deeper-cut valleys. The most novel point is presented by Fowke, regarding a former northward discharge through the Miami valley of the waters from several rivers (Licking, Kentucky, etc.) whose courses lie between ancient cols at Manchester and Madison, east and west of Cincinnati. The northward discharge is now blocked by drift; the cols are cut across by the Ohio, and the gathered rivers are discharged westward. This involves an impounding of many north-flowing rivers by the ice sheet and the production of a temporary lake, compared to which the reputed lake caused by the supposed ice dam at Cincinnati would have been a comparatively small affair. Independent evidence of

the existence of the lakes is not yet announced. Both Fowke and Todd suggest that some of the preglacial streams followed courses that were determined in paleozoic time, a suggestion that seems to give too little importance to the many possible changes of secondary and tertiary time.

The technical book-making of this publication is not altogether creditable to a State Academy. There is no table of contents, except an imperfect one on the paper cover, which disagrees with the title page and with the titles of some of the articles; the same page heading is continued throughout; some of the maps are unnumbered, and all of them are poorly lettered.

SCHLESWIG-HOLSTEIN.

AN east-west section across the base of the Danish peninsula is described by R. Gredner ('Excursion nach Ost-Schleswig-Holstein und der Insel Sylt.,' Greifswald, 1900), from which it appears that the chief features of the district are systematically arranged with respect to the glacial moraine that forms its strongest relief. The eastern border shows the hills and hollows of the typical moraine, of rich soil and divided into well-cultivated fields by numerous hedges. The eastern shore line is irregular in consequence of a slight postglacial submergence; embayments known as Föhrde (etymologically related to fjords and firths) occur where interglacial valleys were deepened by scouring ice lobes; they lead navigable water in among the morainic hills, thus locating such towns as Flensburg and Kiel. Beyond the moraine comes a broad plain of washed sands and gravels, sloping gently to the west and traversed by shallow channels; it is covered with pine forests or heathery moors, and is infertile and thinly occupied compared with the moraine. As the plain slopes westward, its materials become finer and ground water stands nearer its surface; thus the moors become meadows, and at last dikes are needed along their borders to hold off high tides. The shallow edge of the sea is known as the Wattenmeer, where a great expanse of fine mud, traversed by winding channels, is laid bare at low tide. Fields are occasionally gained by diking in the shallowest

border of the tidal flats. The outlying islands, of which Sylt is here described, consist of remnants of Tertiary strata, overlaid by drift. Long wings of beach and dunes stretch north and south from the western front of the island, with slightly convex outline towards the North sea and in-bent hooks at their end. The wings are much longer than the front of the island from which they are spread.

W. M. DAVIS.

JESSE WILLIAM LAZEAR MEMORIAL.

ON the 25th of September, 1900, Jesse William Lazear, at that time Acting Assistant Surgeon in the United States Army and a member of the Government Commission for the investigation of yellow fever, lost his life from that disease at Quemados, Cuba.

Doctor Lazear was born in Baltimore County, Maryland, in 1866, and graduated from the academic department of the Johns Hopkins University in 1889. In 1892 he received the degree of M.D. from Columbia University. From 1892 to 1895 he spent his time in study and investigation in Europe and as an interne at the Johns Hopkins Hospital in Baltimore. During the following three years and a half, while a member of the staff of the Out-Patient Department of the Johns Hopkins Hospital, he did much valuable work as a teacher and investigator in the laboratory of clinical pathology. In February, 1900, induced by the opportunity for research concerning malarial and yellow fevers, Lazear became an acting assistant surgeon in the United States Army and was assigned special laboratory duties at Columbia Barracks, near Havana. Later, he was appointed member of a special government commission for the investigation of yellow fever. The brilliant discoveries of this commission concerning the ætiology and manner of infection of yellow fever have recently been referred to in public by a distinguished pathologist as the most important piece of work by American students since the discovery of anæsthesia. To these results Lazear, as a member of the commission, contributed largely. The final proof of their discovery that the disease is transferred by the bite of a certain mosquito could only be obtained by direct experiment

upon a human being. To this experiment Lazear, with another of the committee, courageously and heroically subjected himself, and in the performance of this noble duty he lost his life.

The many friends and admirers of the talented and accomplished student, of the brave, true, self-sacrificing man, desire to establish a lasting memorial to him and to his work. To this end a meeting was held on the evening of Wednesday, May 22, which was presided over by Professor William Osler. At this meeting it was concluded that the nature of the memorial could better be decided upon when some idea could be obtained as to the amount of money available. It was, therefore, decided that a committee consisting of Dr. Stewart Paton and Dr. William S. Thayer be appointed to arrange for the distribution of a circular among the friends and admirers of Lazear, setting forth the object of the meeting. It is earnestly hoped that not only those who have known and admired Lazear and his work, but also others, who appreciate courage and manliness and self-sacrifice, may contribute to the fund for the Jesse William Lazear Memorial.

Subscriptions may be sent to Dr. Stewart Paton, treasurer, 213 West Monument Street, Baltimore, Md. It is to be hoped that the response to this circular may be made early, as it is hoped to be able to decide upon the nature of the memorial by the middle of June.

WILLIAM OSLER, *Chairman.*

STEWART PATON, }
WILLIAM S. THAYER, } *Committee.*

THE AMERICAN LIBRARY ASSOCIATION.

AT the annual meeting of the American Library Association, held at Waukesha, Wis., the 3d to 10th of July, a Round Table meeting was devoted to professional instruction in bibliography. The chairman, Mr. A. G. S. Josephson, of Chicago, in his introductory remarks, pointed out the need of solid bibliographical scholarship as a prerequisite of the librarian and urged the establishment at some university of a post-graduate school of bibliography. Such a school should, in the opinion of the speaker, offer instruction in bibliography

proper—*i. e.*, knowledge of the repertories and the record literature; classification of knowledge and history of science as the foundation of the classification of books; bibliographical methodology—*i. e.*, the principles of cataloging; history of libraries and library administration; history of printing and publishing. A communication had been received from Dr. Med. J. Leche, of Göttingen, assistant to Professor C. Dziatzko, outlining the course of bibliography given by the latter. This outline was supplemented by reminiscences from a sojourn at Göttingen by Mr. A. S. Root, librarian and professor of bibliography at Oberlin College, who also spoke of the courses given by himself. Mr. G. W. Harris, of Cornell, and Mr. J. I. Wyer, of Nebraska, told of courses given by them. A most important contribution to the discussion was made by Professor Charles H. Haskins, of the University of Wisconsin, who not only told of the course in historical bibliography given by himself, but enlarged on the importance of bibliographical studies, not only for librarians but for scholars in general. He heartily endorsed the views of the chairman in regard to the importance of a special school of bibliography.

Several speakers, among them the librarian of the John Crerar Library, Chicago, Mr. C. W. Andrews, spoke of the difficulty of obtaining for library service men trained in science and at the same time familiar with bibliographical and library methods.

MR. CHAMBERLAIN ON THE FUNCTIONS OF
A UNIVERSITY.

At the first congregation of the University of Birmingham, Mr. Chamberlain made an address in the course of which, as reported in the *London Times*, he said: What should constitute an ideal university? It may be presumptuous in me to attempt a definition, and yet when we are at the outset of our career it is necessary, it is desirable, that we should have some clear conception of the standard at which we are going to aim. And I would venture to lay down four qualifications as necessary to a perfect university. In the first place, it should be an institution where all existing knowledge is taught. Such a university

may, perhaps, never yet have been attained; want of means may always prevent it, but at least that is the object at which we should aim, and we should never rest satisfied until we can say that no student desirous of instruction in any branch of learning shall be turned hungry away from the doors of this University. No doubt the enormous development of knowledge, and especially of its scientific side, during the present century requires a certain specialization in the teaching of that knowledge, and I think it may be desirable, I think it may be necessary, that universities also should be specialized, and that one university should pay more attention than another to particular studies; but I believe at the same time that it would be fatal if in our desire as a modern university to give a special development to the practical and thorough teachings of our scientific work, it would be a great mistake, I say, if we were to exclude or to neglect the older branches of learning. Well, then, in the second place, a university is a place where the knowledge that has been acquired has to be tested. And as to that I will only say that in the multiplication of examining bodies I hope that nothing will be done, either by us or by our successors, to lower the standards of proficiency, whether in the ordinary pass or in the highest honors. I conceive that common prudence should teach us to keep up the value of the degrees which we have begun to confer to-day, and nothing would be more unwise, more fatal to our reputation and to our ultimate success than that we should endeavor to multiply the number of our students at the expense of their quality. Then the third feature to which I should call attention, and which I am inclined to say is the most important of all, is that a university should be a place where knowledge is increased and where the limits of learning are extended. Original research, the addition of something to the total sum of human knowledge, must always be an essential part of our proposals. We want to secure that those who teach in this University shall never cease to learn, and that those who are students shall unite with them in the work of fresh and new investigation. And, lastly, a university is a place where the

application of knowledge must be indicated and directed. That perhaps brings us nearer to what may yet be the distinctive feature of our University. At all events we start with the belief that here we are going to combine theory with practice, and to see that in our University we shall combine both in one course of instruction, with due regard to the needs of our own time and of our own district. And now, if I may summarize in one sentence what I have been saying, it is that a university should be a place where knowledge is taught, tested, increased and applied.

PROFESSOR STARR'S RECENT WORK IN
MEXICO.

WITH his last journey to Mexico, which extended over four months, Professor Frederick Starr brings the field-work of four years' study of Mexican Indians to a close. This study has had for its object the careful definition of the physical types of the tribes of southern Mexico. Three kinds of work were done—measurement, photography and modeling. In each tribe one hundred men and twenty-five women were measured, fourteen measurements being taken of each individual. Photographic portraits were taken of typical subjects, a front view and a straight profile being made of each. Busts in plaster were made of those who appeared most perfectly to present the racial type, the molds being made directly upon the subject. During the four seasons over which his work has extended Professor Starr has visited the following twenty-three tribes: Otomis, Tarascans, Thaxcalans, Aztecs, Mixtecs, Triquis, Zapotec-Mixtecs, Mixes, Tehuantepec Zapotecs, Juaves, Chontals, Cuicatecs, Chinantecs, Chochoas, Mazatecs, Tepehuas, Totonacs, Huastecs, Mayas, Zoques, Tzendals, Tzotzils and Chols. While the physical types of the natives formed the chief subject of study, many views were also taken of the scenery, villages, houses, groups of Indians, native industries, etc., etc. The material results of the investigation include measurements from 2,850 persons, 1,200 or more negatives, varying in size from 8 x 10 inches to 4 x 5, 100 busts in plaster, and a large collection of objects—dress, weap-

ons, implements and products—illustrating the ethnography of the region. Several months will be necessary for putting all this material into shape for exhibition and publication. The printed results of the study will comprise five volumes. Of these, two will be albums of plates, illustrating the people and the country, under the title 'The Indians of Southern Mexico,' two will be pamphlets, printed by the Davenport Academy of Natural Sciences, entitled 'Notes on the Ethnography of Southern Mexico,' the fifth will probably be issued as a bulletin of the Department of Anthropology by the University of Chicago, and will present the results of the anthropological measurements and observations under the name of 'The Physical Characters of the Indians of Southern Mexico.' The first volume of the 'Indians of Southern Mexico,' and part first of the 'Notes on the Ethnography of Southern Mexico' have already been published. The remaining three volumes will be printed as soon as possible. It may be added that this work of Professor Starr is the first of its kind undertaken in Mexico.

SCIENTIFIC NOTES AND NEWS.

DR. PATRICK MANSON, F.R.S., has been awarded the Stewart prize of the British Medical Association, for his researches in the pathology of tropical diseases, especially in regard to the malaria of man and to the life-history of the malarial parasite both in man and in the mosquito, and in recognition also of the stimulating influence which he has exerted for many years on the study of tropical diseases in the British Empire.

PROFESSOR KOCH was entertained at dinner on July 24, by the Royal Institute of Public Health and was presented with the Harben medal for 1901. The presentation was made by Dr. W. R. Smith, president of the Institute, who was in the chair.

The British Medical Journal states that among the honors to be paid to Professor Rudolf Virchow on the occasion of his eightieth birthday will be the foundation of a *Virchow Haus*, at Berlin, with objects similar to those of the *Hofmann Haus*, which serves as a club house, library, etc., for chemists.

THE Royal Society has elected Professor Franz von Leydig, of Bonn, a foreign member.

THE University of Basle has conferred the honorary degree of Ph.D. on Dr. Robert Billwiller, director of the Meteorological Institute of Bonn, and on Professor Alfred Wolfer, director of the Astronomical Observatory at Zurich.

WE learn from *Nature* that the French Société d'Encouragement pour l'Industrie nationale announces the following awards of prizes: Grand gold medal to the Chamber of Commerce of Lyons for the organization of the commercial mission to China; 2,000 francs to M. Horsin-Déon for his work on beet root sugar; 500 francs to M. R. Fosse for his works on β -dinaphthol, and the same amount to M. Marcel Guichard for his works on molybdenum; 1,000 francs to M. Triboudeau for his study of the Pas-de-Calais, and 1,000 francs each to MM. Faure and Thénard for memoirs on the utilization of waters in agriculture.

THE Council of the Royal Society has awarded the Mackinnon studentship to Mr. J. J. R. Macleod, M.B., demonstrator of physiology in the London Hospital Medical College, for the purpose of enabling him to carry out researches in pathological chemistry. The studentship is founded under a bequest to the Royal Society by the late Sir William Mackinnon, director general of the Medical Department of the Army, for the foundation and endowment of prizes or scholarships for the special purpose of furthering natural and physical science, and of furthering original research and investigation in pathology. There were fourteen applications for the studentship which is of the annual value of £150.

MR. H. N. WHITFORD has been appointed collaborator in the Bureau of Forestry, U. S. Department of Agriculture.

C. E. VAN ORSTRAND, of the Nautical Almanac Office, has been transferred to be assistant physical geologist in the U. S. Geological Survey.

GOVERNOR STONE, of Pennsylvania, has appointed Miss Myra L. Dock of Harrisburg a member of the State Forestry Commission.

PROFESSOR J. BEHRENS has been appointed director of the agricultural experiment station at Augustenberg, in Baden, and Dr. R. Meissner, of Geisenheim, director of the station for grape culture at Weinsberg, in Würtemberg.

MR. HARLAN I. SMITH, of the American Museum of Natural History, has returned from a trip through the lower peninsula of Michigan, where he made a survey of the recently discovered 'Hauptman Earthwork,' a few miles southwest of West Branch, Ogemaw County. Three camp sites were also discovered along Indian River in Cheboggan County.

DR. A. W. NIEWENHUIS, medical officer of the Dutch colonial army, is at present in San Francisco, after having spent several years in scientific exploration in Borneo.

DR. FELIPE CALDAS, the Brazilian bacteriologist, sailed on July 24, for Cuba, accompanied by Dr. Angel Bellinzaghi, his assistant. They will conduct experiments with the serum that Dr. Caldas discovered.

PROFESSOR HERBERT B. ADAMS, who was connected with the department of history of the Johns Hopkins University since the opening of the University in 1876, has died at the age of fifty-one years.

DR. P. CALVIN MENSCH, since 1894 professor of the biological and chemical sciences at Ursinus College, at Collegeville, Pa., died on July 30.

CHARLES MOHR, Ph.D., whose death at his home in Asheville, N. C. we announced last week, was for many years connected with the U. S. Department of Agriculture, as special agent of the Forestry Division, and with the Geological Survey of Alabama, as botanist. His most important works during the past ten years have been: A study for the Forestry Division of the long leaf pine, a monograph on which was recently published by the Department of Agriculture; The 'Plant Life of Alabama,' a systematic account of the flowering plants and ferns growing without cultivation in Alabama; and 'The Botanical Resources of Alabama,' being an account of the useful and noxious plants of the State. The 'Plant Life of Alabama' was prepared under the joint auspices

of the U. S. Department of Agriculture and the Geological Survey of Alabama, and is now in press and about ready for distribution as a Bulletin of the Botanical Division of the Department. It will also be published as a report of the Geological Survey of the State. The volume on the economic botany of the State was being prepared for the Geological Survey, and was only partly in manuscript. The death of Dr. Mohr before the completion of this report must be counted as a misfortune both to the State of Alabama and to science in general, since there is no one else so well qualified as Dr. Mohr to write upon this subject. The collections in the Museum of the University of Alabama, in great part brought together, arranged and installed by him, will remain as enduring monuments to his memory. These are: A collection of dried specimens of the flowering plants and ferns of Alabama representing some 2,500 species; a similar collection of the mosses, liverworts, lichens and fungi of the State, numbering some 1,000 species; a forestry collection, consisting of about 150 blocks in book form illustrating the native woods, and a collection in about 150 individual glass front cases, showing the foliage, flowers and fruits of the timber trees of the State.

THE British Medical Association held its sixty-ninth annual meeting at Cheltenham last week, under the presidency of Dr. G. B. Ferguson.

The Botanical Gazette states that, under a commission from the United States Government, Dr. H. von Schrenk, of the Shaw School of Botany at St. Louis, is to spend the summer in Europe, in an investigation of the problems connected with the decay of railroad ties on the principal roads, this work being done in connection with a series of investigations on the same subject which he is undertaking for the U. S. Department of Agriculture, in which the principal American railroads are cooperating.

As we learn from the same source, Dr. J. N. Rose left about June 20 for his third botanical trip to Mexico. He expects to go first to the City of Mexico, working out from this point as a base southward towards Acapulco and eastward toward Vera Cruz, probably ascending

Mount Orizaba and Popocatepetl. The objects of his trips are to make a general botanical collection; to collect at type localities certain species of Humboldt, Galeotti, Schiede and other early collectors; and to acquire information in regard to the economic uses of Mexican plants, especially such as will supplement a second paper on the useful plants of Mexico which is now nearly completed.

THE examination for the position of assistant ethnologist in the Bureau of American Ethnology, recently announced in this journal, was passed creditably by Albert Ernest Jenks, Ph.D., of Madison, Wisconsin, and he has just been appointed to the position and assigned to work on the foods and other economic resources of the Amerind tribes about the Great Lakes.

WE are requested to state that the fossil vertebrates, to which we recently referred as having been collected under the auspices of the U. S. Geological Survey in the Triassic of Arizona were collected by Mr. Barnum Brown. They filled two boxes weighing nearly half a ton, and have been unpacked under the direction of Mr. F. A. Lucas, who will probably soon report as to their scientific value.

A CASE of the bubonic plague is at present on Swinburne Island, New York City, having been removed from a steamship that arrived in the port from Calcutta. The case was diagnosed by the quarantine laboratory and the diagnosis confirmed by the marine hospital service. The disease has not been exterminated in San Francisco and appears to be spreading at Capetown and in Egypt.

THE Liverpool School of Tropical Medicine will send another expedition, probably under the direction of Dr. Annett, to Sierra Leone. This is the seventh expedition sent by the school for the investigation of malaria.

THE British National Antarctic Expedition steamship *Discovery* left London on July 21. She will proceed to Spithead to complete her equipment and will stop at Cowes, where the King will bid good-bye to the members of the expedition.

A TELEGRAM from Reuter's Agency states that the St. Petersburg Academy of Science re-

ceived, on July 11, a telegram from the leader of the expedition which is shortly to bring to St. Petersburg the mammoth found in Siberia. The telegram, which is despatched from Yakutsk, reports that the expedition arrived at that place on June 14. It is proceeding by steamer up the river, and will then journey overland to Kolymsk, which is 3,000 versts off, and where it expects to arrive in two and a-half months. The mammoth found is unique of its kind. Its hair, skin and flesh are entirely preserved, and there are remains of undigested food in its stomach.

THE University of Montana biological collecting expedition has spent five weeks in the mountains of the State, and four weeks more are being devoted to the work of the station on Flat-head lake. During the trip several peaks have been ascended in the Mission and Kootenai ranges, and new names have been given to a number of unnamed peaks. Dr. Henry C. Cowles, of the University of Chicago, with a party of about twenty students, will spend ten days at the station studying the botany of the region. The work of the station will close August 16, when the instructors will attend the Denver meeting of the American Association.

A REPORT of the Geological Survey on the operations of the Kowak River party in Alaska has been submitted by Mr. Mendenhall, the geologist in charge of the work. He says the party reached Dawson, Yukon Territory, on June 4. Mr. Reaburn, of the party, with three camp hands, immediately began to survey a line from Fort Yukon to the mouth of Dall River, approximately 150 miles. This region of the Yukon flats offered no geologic problems other than those involved in the history of a large area of fluvial silts.

THE Council of Birmingham University has agreed to subscribe to a working 'table' at the Port Erin (Isle of Man) biological station, under Professor Herdman, to be placed at the disposal of Professor Bridge, for the use of his senior students when studying marine organisms, one student to occupy it for a month or more at a time.

DURING the opening week of the Minnesota Seaside Station on the west coast of Vancouver

Island, evening lectures were delivered as follows:

Professor Conway MacMillan, Univ. of Minn.: 'Waste in Nature.'

Mr. K. Yendo, Univ. of Tokio: 'Distribution of Algae in Japan.'

Mr. Harold Lyon, Univ. of Minn.: 'Phylogeny of the Cotyledon.'

Professor Conway MacMillan, Univ. of Minn.: 'Laminariaceae of the Straits of Fuca.'

Miss Eloise Butler, Central High School, Minneapolis: 'Collecting Seaweeds in Jamaica.'

Dr. Francis Ramaley, Univ. of Colorado: 'Distribution of Plants in Colorado.'

The new seaside station has had in attendance during its first season thirty students, most of whom have specialized in botany, but some zoological work has also been done.

PROFESSOR B. E. FERNOW, director of the New York State College of Forestry, Cornell University, and formerly chief of the U. S. Division of Forestry, gave a course of lectures at the University of Chicago, beginning June 24. He treated forestry in its botanical, practical and political aspects. The subjects were as follows:

'What is Forestry?' (Economic significance of forest resources and need for their management; definition of terms and historic development of the art of forestry.)

'The Forest as a Resource.' (Commercial value of forest products, extent of their use, relation to other industries, significance in the United States.)

'The Forest as a Condition.' (Forest influences claimed and observed on climate, water-flow, health.)

'How Trees grow.' (A chapter of biological dendrology: the development and life-history of the individual forest tree.)

'The Mathematics of Forest Growth.' (Accretion and its measurement; quantitative and qualitative wood production.)

'The Evolution of Forest Growth.' (Development of forest growths as organisms, ecologic relations.)

'Timber Physics.' (Characteristics, properties and uses of wood.)

'Principles of Silviculture.' (The art of planting, reproducing and improving forest growths.)

'Forest Exploitation and Forest Protection.' (Tending and harvesting the forest crop.)

'Business Aspects of Forest Management.' (Forest survey, forest regulation and forest finance.)

'Forest Policies of Foreign Nations.' (The relation of the state to forest resources and how it has evolved itself in Europe.)

'Forests and Forestry in the United States.' (A brief sketch of forest conditions in the United States, and history of the movement to establish forest management.)

THE following table, originally published in the Baltimore Sun, gives the maximum temperatures during the months of July in several different cities :

Day of Month.	Eastport.	Boston	New York.	Baltimore.	Atlanta.	Cincinnati.	Chicago.	St. Louis.	Kansas City.	St. Paul.
1	82°	92°	98°	103°	90°	96°	92°	100°	100°	82°
2	72	94	98	103	86	92	86	96	100	84
3	80	96	94	97	90	92	84	98	102	92
4	76	72	86	96	92	92	94	98	104	82
5	72	70	90	94	90	92	90	100	90	78
6	60	66	82	96	90	88	86	96	92	78
7	62	76	84	90	86	80	66	84	94	74
8	64	84	78	77	88	78	68	86	98	78
9	60	64	80	83	88	82	88	92	104	90
10	62	82	80	85	88	92	102	104	100	84
11	72	86	84	87	96	100	70	104	102	84
12	76	72	72	77	96	88	76	102	104	88
13	80	74	76	73	90	88	74	96	98	98
14	84	90	82	82	90	90	78	90	102	98
15	92	90	86	89	92	96	84	98	102	94
16	74	94	86	90	90	96	92	96	100	92
17	68	84	84	89	88	96	92	100	100	92
18	68	90	88	90	84	90	76	98	100	90
19	78	78	88	93	86	90	78	98	102	94
20	76	82	86	90	90	94	96	100	104	102
21	68	90	92	92	90	100	102	106	104	96
22	86	94	90	93	90	106	76	106	106	94
23	74	80	90	94	86	94	82	106	102	100
24	68	90	90	93	90	100	94	108	106	104
25	70	66	74	94	92	94	88	98	100	84
26	72	68	70	74	98	98	84	98	90	74
27	72	76	80	74	92	100	96	98	92	74
28	66	72	78	90	90	96	90	98	84	84
29	66	66	92	96	92	98	86	90	86	82
30	58	86	92	95	92	92	84	92	90	80
31	61	88	80	87	90	88	80	92	90	80

ON or about September 1, 1901, the Bird Club of Princeton University will publish its first *Bulletin*, edited by Mr. Wm. E. D. Scott, curator of ornithology, Princeton University. It will contain an annotated list of the birds of Princeton and vicinity, by William Arthur Babson, B.S., 1901. This list is the result of four years of scientific observation and study of the birds of Princeton. The *Bulletin* will contain about seventy or eighty pages, will be plainly bound in paper and will be sold for one dollar.

THE Regents of the University of Colorado have ordered the publication of an annual to be called the 'University of Colorado Studies.' It will contain papers from the various schools and departments—the result of experiment and investigation during the year. The first number will be issued soon.

THE council of the Institution of Electrical Engineers arranged a fortnight's visit of the members to Germany, where the leading installations and establishments connected with the science and practise of electricity were inspected. The party was divided into three sections, the first of which visited Berlin only, whilst the second visited Berlin and Dresden, and the third Nüremburg, Frankfurt-on-Maine, etc., in addition to the foregoing places.

THE work of the new anti-toxine laboratory of the N. Y. Department of Health, the establishment of which was provided for by the late Legislature, has begun. The scientific part of the work will be done in a part of the Bender Laboratory Building, Albany. Dr. H. D. Pease, of the Sheffield Scientific School, has been appointed director. An animal house is to be fitted up near the laboratory so as to secure the most perfect hygienic conditions attainable for such purposes. It will house about fifteen horses for the manufacture of serum. The laboratory will supply state institutions with diphtheria and other anti-toxines.

SURGEON GENERAL WYMAN, of the marine hospital service, has sent to the supervising architect of the treasury a request that plans be prepared for a laboratory for the marine hospital service. Congress, by the act approved March 3, 1901, appropriated \$35,000 for the buildings. A two-story main building and an animal house will be erected. The basement of the main building will contain heating apparatus, storage room for fuel, incinerator and store rooms; the first story will have one office room, library, quarters for attendant, rooms for the study of rabies, special investigating room, disinfecting room of 1,000 cubic feet and a room for micro-photography, with a dark room. The second story will have two special laboratory rooms, one office, animal room and two laboratory rooms of large dimensions. The animal

building, to contain apartments for animals, will be one story high, with loft for storage of food supplies; the interior of the walls and the floors to be moisture proof and to have ample water and sewer connections. Both buildings are to be lighted with electricity.

THE London *Times* quotes from the *Journal* of the Board of Trade, a report from the locomotive superintendent of the Oudh and Rohilkund Railway, on the working of ten American Baldwin engines supplied to that line last year. After describing the changes made in the engines to suit them to local requirements, and the chief defects which have shown themselves, the superintendent concludes: "Those ten engines have been working passenger trains, running at 30 to 35 miles an hour, and goods trains, running at 20 miles an hour, chiefly the former, and they have done their work well. They steam capitally and are remarkably good starters; they get away from a station with 55 loaded (wagons or coaches?), equal to about 1,300 tons, with the greatest ease. They are a little higher in coal consumption than our new B class. They are easily repaired, but repairs will have to be kept up, as, if not, they will go to pieces sooner than our other engines would. They do not, as far as I can see at present, cost more in repairs than other engines, and I am very satisfied with them." The cost of these engines, turned out complete, was Rs. 42,020 each, and the cost of the new B class engine, which is the engine used on the line for similar work, is Rs. 44,826.

UNIVERSITY AND EDUCATIONAL NEWS.

MESSRS. MCKIM, Mead and White have been commissioned to draw up general plans for the future buildings of the University of Cincinnati. The University has recently received \$25,000 to be applied to its engineering shops and laboratories.

At a meeting of the University Court of Glasgow University on July 11, it was announced that under the will of the late Mrs. M'Roberts, of Todhill, a sum of £10,000 had been bequeathed to the University for the purpose of founding and endowing a chair as the court may direct.

THE University of St. Andrews has received, by the will of the late Miss Malcolm, the sum of £4,000 for the establishment of medical scholarships.

WILLIAM STOKES WYMAN, LL.D., was elected President of the University of Alabama at the last meeting of the trustees in June, 1901. Dr. Wyman received his education at Harvard University and at the University of Alabama, and has for many years been connected with the latter institution as professor of Latin. He has served the University as president *pro tem.* on several occasions in the past, and his election to the presidency meets the hearty approval of all the alumni and friends of the institution.

At the University of Cincinnati, Professor Charles H. Judd, recently of New York University, has been appointed professor of psychology and pedagogy. Messrs. J. E. Ives, H. C. Biddle, E. F. Alexander and Wm. Baur, have been appointed instructors in physics, and Mr. Wm. Osburn instructor in zoology.

DR. S. S. COLVIN, Ph.D. (Strasburg), has been appointed assistant professor of psychology in the University of Illinois.

RALPH S. LILLIE, who this year received the degree of Ph.D. in zoology at the University of Chicago, has been appointed assistant in physiology in the Harvard Medical School.

HANNAH B. CLARK, Ph.D. (Chicago), has been made assistant professor of sociology in the West Virginia University, at Morgantown, W. Va.

DR. G. BREDIG, docent in chemistry in the University of Leipzig, has been called to an associate professorship in the University of Heidelberg; Giovanni Ossunna, chief engineer of the firm of Siemens & Halske, has been called to a full professorship of electrical engineering in the Technical Institute at Munich.

DR. MORITZ VON RUDZKI has been promoted to a full professorship of mathematical geodesy and meteorology in the University at Cracow; Dr. Ludwig Tetmajer, professor in the Zurich Polytechnic Institute, has been appointed full professor of engineering in the Technical Institute at Vienna.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

EDITORIAL COMMITTEE: S. NEWCOMB, Mathematics; R. S. WOODWARD, Mechanics; E. C. PICKERING, Astronomy; T. C. MENDENHALL, Physics; R. H. THURSTON, Engineering; IRA REMSEN, Chemistry; CHARLES D. WALCOTT, Geology; W. M. DAVIS, Physiography; HENRY F. OSBORN, Paleontology; W. K. BROOKS, C. HART MERRIAM, Zoology; S. H. SCUDDER, Entomology; C. E. BESSEY, N. L. BRITTON, Botany; C. S. MINOT, Embryology, Histology; H. P. BOWDITCH, Physiology; J. S. BILLINGS, Hygiene; WILLIAM H. WELCH, Pathology; J. MCKEEN CATTELL, Psychology; J. W. POWELL, Anthropology.

FRIDAY, AUGUST 16, 1901.

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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 DENVER MEETING.

THE Denver Meeting of the American Association for the Advancement of Science is an important event in the history of

science in America, giving as it does official recognition to the development of science in the west. The scientific men of the country have been mostly collected together on the Atlantic seaboard between Boston and Washington, and the membership of the scientific societies has been chiefly in this region. The American Association has not hitherto met further to the west than St. Louis, and at the meeting in that city, twenty-three years ago, there were only 134 members in attendance, while two years later at Boston the attendance was 997.

During its first hundred years the nation was in scientific matters somewhat in the relation of a colony to Europe. Our students went abroad for study; we depended on Europe for our journals and books, and did not contribute our share to the work of the world. During the subsequent twenty-five years great progress has been made. The opening of the Johns Hopkins University in 1876 marked and helped to create a new epoch in university education. In the same year, the American Chemical Society was organized, leading the way in the establishment of our national societies devoted to special sciences. At about the same

time our special scientific journals were first established. In the intervening period the scientific work under the Government has remarkably expanded. The membership of the American Association increased from 867 in 1876 to 2,033 in 1883.

But this period of scientific activity has been to a large measure confined to the Atlantic seaboard. Even at the present time, we find that of the 86 members of the National Academy only one lives west of Chicago, and of the 864 fellows of the American Association only about 60 live west of that city. The central and western states have been in the colonial relation to the Atlantic seaboard that it had previously held to Europe. Students have come to the eastern universities, and the scientific men for the central and western States have been drawn from the east. But the establishment of Chicago and Stanford Universities and the development of the State universities represent the same movement that occurred earlier in the east. Within a few years the center of population — slowly moving westward and now in southern Indiana — may be the center of scientific men and scientific activity. Omens and coincidences may not appeal to men of science, but it is perhaps worth noting that the fiftieth meeting of the Association in the first year of the new century should celebrate an epoch in the development of science in America.

A little while since (June 21) there was published in this journal an article calling attention to the importance of the American Association for science in America, and it is not necessary to repeat now what was

then said. We wish, however, to emphasize the significance of the approaching meeting and to urge the need of a large attendance and of a representative scientific program. The responsibility here rests with each member individually. It is not easy to say anything except the trite on such a subject, for we all know that scientific work, like everything else, depends on the willingness of all to unite for a common cause. The trip to Denver, either from the east or from the scientific centers of the west, is certainly long and expensive. When, however, the National Educational Association met recently in that city there was an attendance of 10,000 members, the largest in its history. The members of the American Association should at least aim at making the same record.

The permanent secretary informs us that many prominent scientific men from the east have signified their intention to be present, and that the representatives of science in the central and western states guarantee a large attendance. It cannot be expected that as many affiliated societies will meet at Denver as last year at New York, but the names of nine will be found on the preliminary program. We published last week a list of forty-five papers offered in chemistry, and other sciences are correspondingly well represented. The address of the President, Professor Woodward, of Columbia University, entitled 'The Progress of Science,' is certain to be an event of more than ordinary importance; and one of our most eminent students of the physical sciences will be succeeded in the chair by one of our most eminent students of the

biological sciences, Professor Minot, of Harvard University. The Association is promised a welcome by the Governor of the State, the Mayor of Denver and other dignitaries, and the people of the city are noted for their hospitality.

A few words in regard to routes may be of service to members in the East. The way to Denver is either by Chicago or St. Louis, the former being the quicker. Chicago may be reached from New York in about twenty-four hours by the Pennsylvania and New York Central Railways. For example, a train leaving New York at 7:55 A. M. by the Pennsylvania reaches Chicago at 7:45 the next morning, or a train leaving New York at 5:30 P. M. by the New York Central and Lake Shore reaches Chicago at 4:30 the next afternoon. The best train from Chicago leaves at 10 A. M. by the Chicago and Northwestern; at 1 P. M. by the Rock Island Route and 4 P. M. by the Burlington, reaching Denver at 1:40, 4:45 and 6:30, respectively, the next afternoon. Those who leave Chicago on Saturday, the twenty-fourth, by one of these trains will doubtless travel in good company. The rate from New York to Denver and return at one and one-third fare would be about \$65; the ordinary fare to Chicago and return is \$40, and the return ticket from Chicago to Denver is \$31.50. The latter method is not much dearer than the former and may be cheaper to members living west of New York. It is more convenient, as the tickets from Chicago may be purchased as early as August 10 and are good for return until October 31, and the route to Chicago may be varied and a stop may be made at

Buffalo or elsewhere. The headquarters of the Association are at the Brown Palace Hotel, and those wanting rooms should engage them in advance. There are, however, a number of good hotels at Denver.

Everyone knows that Denver is one of the great centers for excursions of scientific and general interest. The geologists, under the leadership of Professor Van Hise, have planned a ten days' excursion before the meeting. Other excursions of interest to chemists, engineers, geologists, zoologists, botanists, anthropologists and indeed to all members of the Association may be made during the meeting or at its close. It is sufficient to mention Pike's Peak, the Garden of the Gods, and the Grand Canyon of the Colorado, to all of which excursions have been planned. The trip to Colorado should be made by everyone and should be made now by all members of the American Association for the Advancement of Science.

REGENERATION AND LIABILITY TO INJURY.*

THERE is a widespread belief amongst zoologists that a definite relation exists between the liability of an animal to injury and its power of regeneration. It is also supposed that those individual parts of an animal that are more exposed to accidental injury, or to the attacks of enemies, are the parts in which regeneration is best developed, and conversely, that those parts of the body that are rarely or never injured do not possess the power of regeneration.

Not only do we find this belief implied in many ways, but we find this point of view definitely taken by several eminent

* One of a course of lectures on 'Regeneration' delivered at Columbia University, and shortly to be published in the Columbia University *Biological Series*.

writers, and in some cases carried so far that the process of regeneration itself is supposed to be accounted for by the liability of the parts to injury. In order that it may not appear that I have exaggerated the widespread occurrence of this belief a few examples may be cited.

Réaumur in 1742 pointed out that regeneration is especially characteristic of those animals whose body is liable to be broken, or, as in the earthworm, subject to the attacks of enemies. Bonnet (1745) thought that such a connection exists as has been already stated, and that the animals that possess the power of regeneration have been endowed with germs set aside for this very purpose. He further believed that there would be in each animal that regenerates as many of these germs as the number of times that it is liable to be injured during its natural life. Darwin in his book on 'Animals and Plants under Domestication' says: "In the case of those animals that may be bisected, or chopped into pieces, and of which every fragment will reproduce the whole, the power of re-growth must be diffused throughout the whole body. Nevertheless, there seems to be much truth in the view maintained by Professor Lessona* that this capacity is generally a localized and special one serving to replace parts which are eminently liable to be lost in each particular animal. The most striking case in favor of this view is that the terrestrial salamander, according to Lessona, can not reproduce lost parts, whilst another

species of the same genus, the aquatic salamander, has extraordinary powers of re-growth, as we have just seen; and this animal is eminently liable to have its limbs, tail, eyes and jaws bitten off by other tritons."

Lang, referring to the brittleness of the tails of lizards, points out that this is a very useful character, since the bird of prey that has struck at a lizard gets hold of only the last part of the animal to disappear under cover; the lizard escapes by breaking off its tail. The brittleness of the tail is, therefore, an adaptive character that has become fixed by long inheritance.

To this example may be added that of certain land snails of the Philippine Islands. The individuals of the genus *helicarion* live on trees in damp forests, often in great droves. They are very active, and creep with unusual swiftness over the stems and leaves of the trees. Semper has recorded that all the species observed by him have the remarkable power of breaking off the tail (foot) close behind the shell, if the tail is roughly grasped. A convulsive movement is made until the tail comes off, and the snail drops to the ground, where it is concealed by the leaves. Semper adds that in this way the snails often escaped from him, and from his collectors, leaving nothing behind but their tails. The tail is said to be the most obvious part of the animal, and it is assumed that this is, therefore, the part that a reptile or bird would first attack.* Lang states that in this case external influences have produced an extraordinarily well developed sensitiveness in the animal, so that it reacts to the external stimulus by voluntarily throwing off the tail. It would be, of course, of small advantage to be able to throw off the tail un-

* Delage and Giard give Lessona (1869) the credit for first stating that the phenomenon of regeneration is an adaptation to liability to injury; but Réaumur first suggested this idea in 1742 and Bonnet in 1745. Delage's interpretation, viz., that Lessona ascribed this to a '*prévoyance de la nature*' has been denied by Lessona's biographer, Camerano ('*La Vita di M. Lessona*' *Acad. R. d. Torino* (2), XLV., 1896) and by Giard ('*Sur L'autotomie Parasitaire*,' etc., *Compt. Rendus de Séances de la Société de Biologie*, May, 1897).

* Whether, having once failed in this way to obtain the snail, the bird or lizard would not learn to make a frontal attack is not stated. Or shall we assume the tail is all that is wanted?

less the power of regenerating the lost organ existed, or was acquired at the same time as the extreme sensitiveness that brings about the reaction. Lang does not state, however, explicitly that he believes the regenerative power to have arisen through the exposure of the tail of the lizard and the tail of the snail to injury, although he thinks that the mechanism by means of which these parts are thrown off has been acquired in this way. Several other writers have, however, used these same cases to illustrate the supposed principle of liability to injury and power of regeneration.

Weismann in his book on 'The Germ Plasm' has adopted the principle of a connection between regeneration and liability to injury and has carried it much further than have other writers. We can, therefore, most profitably make a careful examination of Weismann's position. His general idea may be gathered from the following quotation:* "The dissimilarity, moreover, as regards the power of regeneration in various members of the same species, also indicates that adaptation is an important factor in the process. In proteus which in other respects possesses so slight a capacity for regeneration, the gills grow again rapidly when they have been cut off. In lizards again this power is confined to the tail, and the limbs cannot become restored. In these animals, however, the tail is obviously far more likely to become mutilated than are the limbs, which, as a matter of fact, are seldom lost, although individuals with stumps of legs are occasionally met with. The physiological importance of the tail of a lizard consists in the fact that it preserves the animal from total destruction, for pursuers will generally aim at the long trailing tail,† and thus the ani-

mal often escapes, as the tail breaks off when it is firmly seized. It is, in fact, as Leydig was the first to point out, specially adapted for breaking off, the bodies of the caudal vertebrae from the seventh onward being provided with a special plane of fracture so that they easily break into two transversely. Now if this capability of fracture is provided for by a special arrangement and modification of the parts of the tail, we shall not be making too daring an inference if we regard the regenerative power of the tail as a *special adaptation, produced by selection, of this particular part of the body, the frequent loss of which is in a certain measure provided for*, and not as the outcome of an unknown 'regenerative power' possessed by the entire animal. This arrangement would not have been provided if the part had been of no, or only of slight, physiological importance, as is the case in snakes and chelonians, although these animals are as highly organized as lizards. The reason that the limbs of lizards are not replaced is, I believe, due to the fact that these animals are seldom seized by the leg, owing to their extremely rapid movements." Overlooking the numerous cases of the regeneration of internal organs that have been known for several years, and basing his conclusion on a small, unconvincing experiment of his own on the lungs of a few salamanders, Weismann concludes: "Hence there is no such thing as a general power of regeneration; in each kind of animal this power is graduated according to the need of regeneration in the part under consideration; that is to say, the degree in which it is present is mainly in proportion to the liability of the part to injury."

After arriving at this conclusion the following admission is a decided anticlimax: "The question, however, arises as to whether the capacity of each part for regeneration results from special process of adaptation, or whether regeneration occurs

* 'The Germ-Plasm.' Translation by W. Newton Parker, 1893, page 116.

† There are no facts that show that this statement is not entirely imaginary. T. H. M.

as the mere outcome—which is to some extent unforeseen—of the physical nature of an animal. Some statements which have been made on this subject seem hardly to admit of any but the latter explanation.” After showing that some newts confined in aquaria attacked each other, “and several times one of them siezed another by the lower jaw, and tugged and bit at it so violently that *it would have been torn off if I had not separated the animals,*” * and after referring to the regeneration of the stork’s beak, Weismann concludes: “Such cases, the accuracy of which can scarcely be doubted, indicate that the capacity for regeneration does not depend only on the special adaptation of a particular organ, but that a general power also exists which belongs to the whole organism, and to a certain extent affects many and perhaps even all parts. By virtue of this power, moreover, simple organs can be replaced when they are not specially adapted for regeneration.” The perplexity of the reader, as a result of this temporary vacillation on Weismann’s part, is hardly set straight by the general conclusion that follows on the same page: “We are, therefore, led to infer that the general capacity of all parts for regeneration may have been acquired by selection in the lower and simpler forms, and that it gradually decreased in the course of phylogeny in correspondence with the increase in complexity of organization; but that it may, on the other hand, be increased by special selective processes in each stage of its degeneration, in the case of certain parts which are physiologically important and are at the same time frequently exposed to loss.”

There are certain statements of facts in this chapter that are incorrect, and the argument is so loose and vague that it is difficult to tell just what is really meant. As a misstatement of fact I may select the

* The *italics* are, of course, my own. T. H. M.

following case. It is stated that *lumbriculus* does not have the power of regenerating laterally if cut in two, and it is argued that a small animal of this form could rarely be injured at the side without cutting the animal completely in two. As a matter of fact, *lumbriculus* can regenerate laterally, and very perfectly, as any one can verify if he takes the trouble to perform the experiment; but, of course, if the whole animal is split in two lengthwise the pieces die, or if a very long piece is split from one side the remaining piece usually disintegrates. If, however, the anterior end is split in two for a short distance, or if a piece is partially split in two, the half remaining in contact with the rest of the piece completes itself laterally. The same result follows also in the earthworm.

As an example of looseness of expression I may quote the following from Weismann: “A useless or almost useless rudimentary part may often be injured or torn off *without causing processes of selection to occur which would produce in it a capacity for regeneration.* The tail of a lizard again, which is very liable to injury, becomes regenerated because as we have seen it is of great importance to the individual and if lost its owner is placed at a disadvantage.” And as an example of vagueness, the following statement commends itself: “Finally the complexity of the individual parts constitutes the third factor which is concerned in regulating the regenerative power of the part in question; for the more complex the structure is, the longer and the more energetically the process of selection must act in order to provide the mechanism of regeneration, which consists in the equipment of a large number of different kinds of cells with the supplementary determinants which are accurately graduated and regulated as regards their power of multiplication.”

Without attempting to disentangle the ideas that are involved in these sentences,

let us rather attempt to get at a general idea of Weismann's views. In a later paper (1900); in reply to certain criticisms, he has stated his position somewhat more lucidly. In the following statement I have tried to give the essential part of his hypotheses: Weismann believes the process of regeneration to be regulated by 'natural selection'; in fact, he states that it has arisen through such a process in the lower animals—since they are more subject to injury—and that it has been lost in the higher forms except where, on account of injury, it has been retained in certain parts. Thus when Weismann speaks of regeneration as being an adaptation of the organism to its environment, we must understand him to mean that this adaptation is the result of the action of natural selection. We should be on our guard not to be misled by the statement that because regeneration is useful to the animal, it has been acquired by natural selection, since it is possible that regeneration might be more or less useful without in any way involving the idea that natural selection is the originator of this or of any other adaptation. It will be seen, therefore, that in order to meet Weismann on his own ground it will be necessary to have a clear understanding in regard to the relation of regeneration to Darwin's principle of natural selection. With Weismann's special hypothesis of the 'mechanism,' so-called, by which regeneration is made possible we have here nothing to do, but may consider it on its own merits in another chapter.

In order to have before us the material for a discussion of the possible influence of natural selection on regeneration, let us first examine the facts that bear on the question of the liability of the parts to injury and their power to regenerate, and in this connection the questions concerning the renewal of parts that are thrown off by the animals themselves in response to an external stimulus are worthy of careful consid-

eration. A comparison between the regeneration of these parts with that of other parts of the same animal gives also important data. Furthermore, a comparison may be made between different parts of the same animal, or between the same parts of different animals living under similar or under dissimilar conditions.

There are only a few cases known in which a systematic examination has been carried out of the power of regeneration of the different parts of the body of the same animal. Spallanzani's results show that those salamanders that can regenerate their forelegs can regenerate their hind legs also. Towle, who has examined in my laboratory the regeneration of a number of American newts and salamanders, finds also that both the fore and hind legs regenerate in the same forms. The tail and the gills, in those newts with external gills, also regenerate. It has also been shown in triton that the eye regenerates if a portion of the bulb is left. Broussonet first showed (1786) that the fins of fish have the power to regenerate, although, strangely enough, Fraisse and Weismann state that very little power of regeneration is present in the fins of fish. I have found that the fins of several kinds of fish regenerate, belonging to widely different families.* In *Fundulus heteroclitus* I have found that the pectoral, pelvic, caudal, anal, and dorsal fins have the power of regeneration. In reptiles the feet do not regenerate, at least no cases are known, but the tail of lizards has this power well developed. In birds neither the wings nor the feet regenerate, but Fraisse has recorded the case of a stork in which, the lower jaw being broken off, and the upper being cut off at the same level, both regenerated. Bordage has recorded the re-

* *Fundulus heteroclitus*, *Stenopus chrysops*, *Decap-terus macralla*, *Menticirrhus macralla*, *Carassius auratus*, *Phoxinus funduloides*, *Noturus* sp., and a few others.

generation of the beak of the domesticated fighting cocks (of the Malay breed) of Mauritius. In the mammals neither the legs nor the tail, nor the jaws regenerate, although several of the internal organs, as described in the next chapter, have extensive powers of regeneration.

The best opportunity to examine the regenerative power in similar organs of the same animal is found in forms like the crustacea, myriapods and insects in which external appendages are repeated in each or many segments of the body. In decapod crustacea, including shrimps, lobsters, crayfish, crabs, hermit-crabs, etc., regeneration takes place in the walking legs of all the forms that have been examined, and this includes members of many genera and families. I have made a special examination of the regeneration of the appendages of the hermit-crab. In this animal, which lives in an appropriated snail's shell, only the anterior part of the body projects from the shell. The part that protrudes is covered by a hard cuticle, while the part of the body covered by the shell is quite soft. Three pairs of legs are protruded from the shell. The first pair with large claws are used for procuring food, and as organs of offense and defense; the second and third pairs are used for walking. The following two pairs that correspond to the last two pairs of walking legs of crabs and crayfishes, are small, and are used by the animal in bracing itself against the shell. The first three pairs of legs have an arrangement at the base, the 'breaking-joint,' by means of which the leg is thrown off, if injured. The last two pairs of thoracic legs can not be thrown off. The first three pairs of legs are often lost under natural conditions. In an examination of 188 individuals I found that 21 (or 11 per cent.) had lost one or more legs. If one of the first three legs is injured, except in the outer segment, it is thrown off at the

breaking-joint, and a new leg regenerates from the broken-off end of the stump that is left. The new leg does not become full size, and is of little use until the crab has moulted at least once. The leg breaks off so close to the body, and the part inside of the breaking-joint is so well protected by the bases of the other legs, that it is scarcely possible that the leg could be torn off inside of the breaking-joint, and, as a matter of observation, all crabs that are found regenerating these legs under natural conditions do so from the breaking-joint. If, however, by means of small scissors, the leg is cut off quite near the body, a new leg regenerates from the cut end, even when the leg is cut off at its very base. The breaking-joint would thoroughly protect from injury the part of the leg that lies nearer to the body, and yet from this inner part a new leg is regenerated. Moreover, the new leg is perfect in every respect, even to the formation of a new breaking-joint. In this case we have a demonstration that there need be no connection between the liability of a part to injury and its power of regeneration.

In still another way the same thing may be shown. If the crab is anesthetized, and a leg cut off outside of the breaking-joint it is not, at the time, thrown off—the nervous system, through whose action the breaking off takes place, being temporarily thrown out of order. After recovery, although the leg is thrown off in a large number of cases, it is sometimes retained. In such cases it is found that from the cut end the missing part is regenerated. In this case also we find that regeneration takes place from a part of the leg that can never regenerate under natural circumstances.

The third and fourth legs of the hermit-crab can not be thrown off, but they have the power of regeneration at any level at which they may be cut off. They are in a

position where they can seldom be injured, and I have never found them absent or injured in crabs caught in their natural environment. The soft abdomen is protected by the snail's shell. At the end of the abdomen the last pair of abdominal appendages serve as anchors to hold the crab in the shell. These appendages are large and very hard, and can seldom be injured unless the abdomen itself is broken, and under these circumstances the crab dies. Yet if these appendages are cut off they regenerate perfectly, and after a single moult can not be distinguished from normal ones.

The more anterior abdominal appendages are present only on one side of the adult, although they are present on both sides of the larva, and to judge from a comparison with other crustacea these appendages have degenerated completely on one side, and have become rudimentary in the male, even on the side on which they are present. These appendages regenerate if they are cut off. In the female the appendages are used to carry the eggs, and are, therefore, of use. They also have a similar power of regeneration. The maxillæ and maxillipeds of the hermit-crab have also the power of regeneration, as have also the two pairs of antennæ, and the eyes.

In other decapod crustacea also it has been shown that the power of regeneration of the appendages is well developed. It has been long known that the crayfish and the lobster can regenerate lost parts. The first pair of legs, or chelæ, in these forms has a breaking-joint, at which the leg can be thrown off, yet in the crayfish I have seen that if the leg is cut off inside of the breaking-joint it will regenerate. The four pairs of walking legs do not possess a breaking-joint, but may be thrown off in some cases at a corresponding level. They regenerate from this level, as well as nearer the body and further beyond this region. Pizibram

has recently shown that, in a number of crustacea, regeneration of the appendages takes place, even when the entire leg is extirpated as completely as possible.

Newport has shown that the myriapods can regenerate their legs, and it is known that several forms have the power of breaking off their legs in a definite region at the base if the legs are injured, and I have observed in *Cermatia forceps* that this takes place even when the animal is thrown into a killing fluid. Newport (1844) has also shown that when the legs of a caterpillar are cut off new ones regenerate during the pupa stage. It has been long known* that the legs of mantis can regenerate, and Bordage, who has recently examined the question more fully, has shown that a breaking-joint is present at the base of the leg. The tarsus of the cockroach also regenerates, producing only four, instead of the five, characteristic segments.†

A number of writers have recorded the regeneration of the legs of spiders.‡ Schultz, who has recently examined more thoroughly the regeneration of the legs in some spiders, finds that the leg is renewed if cut off at any level. He removed the leg most often at the metatarsus, but also at the tibia, and generally between two joints. In some cases the leg was cut off at the coxa, at which level it is generally found to be lost under natural conditions. Wagner observed in tarantula that when the leg is removed at any other place than at the coxa the animal brings the wounded leg to its jaws, and bites it off down to the coxa. In the *Epeirideæ*, that Schultz chiefly made use of, this never happened. He observed,

* See Newport and Scudder.

† Brindley, '97.

‡ Lepelletur, *Nouveau Bulletin de la Société philomatique*, 1813, Tome III., page 254.

Heincken, *Zool. Journal*, 1829, Tome IV., page 284. (Also for insects, *ibid.*, page 294.)

Müller, *Manual de Physiol.*, Tome I., page 30.

Wagner, W., *Bull. Soc. Imp., Naturel.*, Moscow, '87.

however, even in these forms that when the leg is cut off at the coxa it regenerates better than when cut off at any other level. Schultz adds that we see here an excellent example of how regeneration is influenced by natural selection, since regeneration takes place best where the leg is most often broken off. On the other hand, the author hastens to add that since regeneration also takes place when the leg is cut off at any other level this shows that the power to regenerate is characteristic of all parts of the organism, and is not *only* a phenomenon of adaptation, as Weismann believes. It seems highly improbable that a spider could ever lose a leg in the middle of a segment, *i. e.*, between two joints, since the segments are hard and strong, and the joints much weaker, but nevertheless the leg has the power to regenerate also from the middle of the segment, if cut off in this region.

The formation of the new part takes place somewhat differently, according to Schultz, when the leg is amputated between two segments than when cut off at the coxa. In the latter case, there is produced from the cut end of the last segment a solid rod which, as it grows longer, bends on itself several times. Joints appear in the rod, beginning at the base. The leg is set free at the next moult. If the leg is cut off nearer the distal end a smaller rod is formed, that extends straight forward, or may be thrown into a series of folds. It lies, however, inside of the last segment, since the surface exposed by the cut is quickly covered over by a chitinous covering. The piece is set free at the next moult.

Loeb has found that if the body of the pycnogonid, *Phoxichilidium maxillare*, is cut in two there regenerates from the posterior end of the anterior half a new body-like outgrowth.

Without attempting to describe the many cases in worms and molluscs in which there

is no obvious connection between the power of the part to regenerate and its liability to injury, but where it is more difficult to show that it may not exist, let us pass to an examination of the regeneration of the starfish. It has been known since the time of Réaumur that starfish have the power of regenerating new arms if the old ones are lost. It has been claimed that in certain starfishes an arm itself can produce a new starfish (Haeckel ('78), P. and R. Sarasin ('88), von Martens ('84) and Sars ('75)), but this has been denied by other observers. It has not been found to take place in several species of starfishes, but if a portion—even a small piece—of the disc is left with the arm a new disc and arms may develop (Fig. 38, F). When the arm of *Asterias vulgaris* is injured it pinches off in many cases at its base, and a new arm grows out from the short stump that remains. These same starfishes that are regenerating new arms in their natural environment have the new arms almost always arising from this breaking region.* Thus King found out of 1914 individuals of *Asterias vulgaris* collected at random, 206, or 10.7 per cent., had one or more new arms, and all these except one arose from near the disc. In other species it appears that the outer portions of the arm may be broken off without the rest of the arm being thrown off. King has found that in *Asterias*, regeneration takes place

* The Sarasins have described several cases in *Linkia multiformis* in which an old arm has one or more new arms arising from it. In one case, copied in our Fig. 38, G, four rays arise from the end of one arm, producing the appearance of a new starfish. In fact the Sarasins interpret the result in this way, although they state that there is no madreporite on the upper surface, and they did not determine whether a mouth is formed at the convergence of the rays, because they did not wish to destroy so unique a specimen—even to find out the meaning of it. There seems to me little probability that the new structure is a starfish, but the old arm has been so injured that it has produced a number of new arms.

more rapidly from the base than at a more distal level. It may appear at first thought, that the more rapid regeneration of the arm at the place at which it is usually thrown off may be associated with its more frequent loss at this region—in other words, that the more rapid regeneration has been acquired by the region at which the arm is generally broken off. This interpretation is, however, excluded by the fact that, in general, the nearer to the base the arm is cut off, so much the more rapid is its regeneration. In other words, the more rapid regeneration of the arm at the base is only a part of a general law that holds throughout the arm. If the proposition is reversed, and it is claimed that the arm has acquired the property of breaking off at the base, because it regenerates more rapidly at that level, the following fact recorded by King is of importance, viz., that although the arm regenerates faster at the base, yet a new arm is not any sooner produced in this way, since there is more to be produced, and the new arm from the base may never catch up to one growing less rapidly from a more distal cut surface, but having a nearer goal to reach.

The results of our examination show that those forms that are liable to have certain parts of their bodies injured are able to regenerate not only these parts, but at the same time other parts of the body that are not subject to injury. The most remarkable instance of this sort is found in those animals having breaking-joints. We find in these forms that regeneration takes place both proximal and distal to this region. If the power of regeneration is connected with the liability of a part to injury, this fact is inexplicable.

If we turn now to the question as to whether regeneration takes place in those species that are subject to injury more frequently or better than in other species, we find that the data are not very complete

or satisfactory for such an examination. It is not easy to tell to what extent different animals are exposed to injury. If we pass in review the main groups of the animal kingdom, we can at least gain some interesting facts in this connection.

In the Protozoa nucleated pieces have been found to regenerate in all forms that have been examined, including amœba, difflugia, thalassicolla, paramœcium, stentor, and a number of other ciliate infusoria.

In the sponges it has been found by Oscar Schmidt that pieces may produce new individuals, but how widely this occurs in the group is not known. In the cœlenterates many forms are known to regenerate, and it is not improbable that in one way or another the process occurs throughout the group. The hydroid forms, hydra, tubularia, parypha, eudendrium, antennularia, hydractinia, podocoryne, etc.; the jelly-fish, gonionemus, and certain members of the family *Thaumantidae*, have been found to regenerate. Amongst the *Scyphozoa*, the metridium, cerianthus and the scyphistoma of aurelia regenerate and the jelly-fishes belonging to this group have a limited amount of regenerative power.

In the Platodes we find all the triclads, that have been examined, including planaria, phagocata, dendrocœlum, and the land triclad bipalium, regenerate. It has been shown that the marine triclads also regenerate, but less rapidly and extensively, while the marine polyclads have very limited power of regeneration. The regeneration of the trematodes and cestodes has not, so far as I know, been studied, neither have the nematodes been examined from this point of view.

Some of the nemerteans regenerate, others do not seem to have this power. A small fresh water form, tetrastemma, that I examined did not regenerate although some of the pieces, that were filled with eggs, remained alive for several months.

In the annelids we find a great many forms that regenerate—many marine polychæta have this power; all earthworms that have been studied regenerate; both land forms, as *lumbricus*, *allolobophora*, etc., and fresh-water forms, as *lumbriculus*, *nais*, *tubifex*, etc.

In the crustacea the appendages have the power to regenerate in all the forms that have been examined.

Several kinds of myriopods as well as a number of spiders are known to regenerate their legs. In the insects, however, only a few forms are known to have this power, as caterpillars, mantis and the cockroach. The large majority of insects, in the imago state, do not seem to be able to regenerate, although they have not been sufficiently examined.

In the molluscs regeneration of the head takes place under certain conditions. Spallanzani thought that if the entire head is cut off a new one regenerates. This conclusion was denied by at least eleven of his contemporaries and confirmed by about ten others. It was found later that the result depends in part on the time of year, and in part on the kind of snail. Carriere, who more recently examined the question, found that even under the most favorable conditions regeneration does not take place if the circumoesophageal nerve-commissure is completely removed with the head, but if a part remains, a new head develops. It has been stated that a new foot regenerates in *helicarion*, and I have found the foot regenerates also in the fresh-water snails, *physa*, *limncea* and *planorbis*. If the margin of the shell of a lamellibranch or of a snail is broken off it is renewed by the mantle. The arms of some of the cephalopods are known to regenerate, particularly the hectocotylyzed arm.

In all the main groups of echinoderms, with one possible exception, regeneration has been found to take place. Probably all

starfishes and brittle-stars regenerate their arms, and even if cut in two or more pieces new starfishes develop. The crinoids regenerate lost arms, and even parts of the disc; also the visceral mass. The holothurians have very remarkable powers of regeneration. In some forms regeneration takes place if the animals are cut in two, or even in more than two pieces. The remarkable phenomena of evisceration that take place in certain holothurians, if they are roughly handled, or kept under unfavorable conditions, are well known, and have been described by a number of writers. It has even been suggested that the holothurian may save itself by offering up its viscera to its assailant! Unfortunately for this view, it has been found that the viscera are unpalatable, at least to sea-anemones and to fishes. Ludwig and Minchin suggest that the throwing off of the cuvierian organs, that are attached to the cloaca, is a defensive act, and if carried too far, according to the latter writer, the viscera may also be lost. The holothurians have remarkable recuperative powers and may regenerate new viscera in a very short time. The sea urchins, form, perhaps, an exception in this group since there are no records of their regenerative power, but no doubt this is because they have not been as fully investigated as have other forms.

In the vertebrates we find that the lower forms, amphioxus, petromyzon and sharks, have not been studied in regard to their regenerative power. In the teleostean fishes, the fins of a number of forms have been found to regenerate. It is probable that this takes place in most members of the group.

In the amphibia we find a large number of forms that regenerate their limbs and tail, and other parts of the body, but limitations appear in certain forms. The rapid regeneration of the legs in the smaller urodeles has been often described. In larger

forms it takes place more slowly, at least in large forms having large legs. In proteus the regeneration may extend over a year and a half, and in necturus it takes more than a year to make a new limb, at least in animals in confinement. In the large form, amphiuma, that has extremely small legs regeneration takes place much more rapidly than in a form like necturus having much larger legs.

In amphiuma the feet are not used by the animal as organs of locomotion, since they are too small and weak to support the heavy body. They can be moved by the animal in the same way that the feet are moved in other forms, and yet are useless for progression. It is said by Schreiber that the regeneration of the legs of *Triton marmoratus* is relatively very slight as compared with that of other forms. Fraisse also found in this form that an amputated leg did not grow again, only a deformed stump being produced. The tail, also, is said to regenerate to only a slight extent, but, so far as I know, there is nothing peculiar in the life of this form that makes it less liable to injury than other large urodeles.* Weismann cites the case of proteus that is said also to regenerate less well than do other forms. It lives in the caves of Carniola, where there are few other animals that could attack or injure it, and to this immunity is ascribed its lack of power of regeneration, yet Goette states that he observed a regenerating leg in this form, but that the process was not complete after a year and a half. In necturus also, which is not protected in any way, regeneration is equally slow. Frogs are unable to regenerate their limbs, although they are sometimes lost, but the larval tadpole can regenerate at least its hind legs. In the reptiles the tail regenerates, though this is ac-

* I do not know whether this animal was kept long enough to make it certain that the legs do not regenerate.

complished more readily in some groups than in others, but at present we do not know of any connection between this condition and the liability of certain forms to injury. Turtles and snakes do not regenerate their tails. I do not know of any observations on crocodiles.

In birds, the legs and wings are not supposed to have the power to regenerate,* but in two forms † at least the beak has been found to possess remarkable powers of regeneration. There are a few very dubious observations in regard to the regeneration in man of superfluous digits that had been cut off. ‡

These examples might be added to by others in the groups cited, and also by examples taken from the smaller groups of the animal kingdom, but those given will suffice, I think, to show that the power to regenerate is characteristic of entire groups rather than individual species. When exceptions occur, we do not find them to be forms that are obviously protected, but the lack of regeneration can rather be accounted for by some peculiarity in the structure of the animal. If this is borne in mind as well as the fact that protected and unprotected parts of the same animal regenerate equally well, there is established, I think, a strong case in favor of the view that there is no necessary connection between regeneration and liability to injury. We may, therefore, leave this side of the question and turn our attention to another consideration.

It will be granted without argument that the power of replacement of lost parts is of use to the animal that possesses it, especially if the animal is liable to injury. Cases of usefulness of this sort are generally

* A statement to the contrary quoted in Darwin's 'Animals and Plants under Domestication,' is doubted by Darwin himself.

† The stork and the fighting cocks.

‡ See Darwin, *loc cit.*

spoken of as adaptations. The most remarkable fact in connection with these adaptive responses is that they take place, in some cases at least, in parts of the body where they can never, or at most very rarely, have taken place before, and the regeneration is as perfect as when parts liable to injury regenerate. Another important fact is that in some forms the regeneration is so slow that if the competition amongst the animals was very keen, those with missing legs, or eyes, or tails, would certainly succumb; yet if protected they do not fail to regenerate. If, therefore, the animal can exist through the long interval that must elapse before the lost part regenerates, we can not assume that the presence of the part is of vital importance to the animal and hence its power to regenerate could scarcely be described as the result of a 'battle for existence,' and without this principle 'natural selection' is powerless to bring about its supposed result.

It is extremely important to observe that some cases, at least, of regeneration are not adaptive. This is shown in the case where a new head regenerates at the posterior end of the old one in *Planaria lugubris*, or where a tail develops at the anterior end of a posterior piece of an earthworm, or when an antenna develops in place of an eye in several crustacea. If we admit that these results are due to some inner laws of the organisms, and have nothing to do with the relation of these organisms to the surroundings, may we not apply the same principle to other cases of regeneration in which the result is useful?

So firm a hold has the Darwinian idea of utilitarianism over the thoughts of those who have been trained in this school, that whenever it can be shown that a structure or a function is useful to an animal it is without further question set down as the result of the death struggle for existence.

A number of writers, being satisfied that the process of regeneration is useful to the animal, have forthwith supposed that, *therefore*, it must have been acquired by natural selection. Weismann has been cited as an example, but he is by no means alone in maintaining this attitude. It would be entirely out of place to enter here into a discussion of the Darwinian theory, but it be well worth while to consider it in connection with the problem of regeneration.

We might consider the problem in each species that we find capable of regenerating; or if we find this too narrow a field for our imagination we might consider the process of regeneration to have been 'acquired by selection in the lower and simpler forms' and trace its subsequent progress as it decreased in the course of phylogeny 'in correspondence with the increase in complexity of organization' or with the decrease of exposure to injury. At the risk of following the narrower point of view I shall confine the discussion to the possibility of regeneration being acquired, or even augmented, through a process of natural selection in any particular species.

The opportunity to regenerate can only occur if a part is removed by accident or otherwise. On the Darwinian theory we must suppose that of all the individuals of each generation that are injured *in exactly the same part of the body*, only those have survived or have left more offspring that have regenerated. In order for selection to take place it must be supposed that amongst these individuals injured *in exactly the same region* regeneration has been better in some forms than in others, and that this difference is, or may be, decisive in the competition of the forms with each other. The theory does not inquire into the origin of this difference between individuals, but rests on the assumption of individual differences in the power to regenerate, and assumes that

these differences can be heaped up by the survival and inbreeding of the successful individuals, *i. e.*, it is assumed that, by this picking out or selection through competition in each generation of the individuals that regenerate best, the process will become more and more perfectly carried out in the descendants until at last each part has 'acquired' the power of complete regeneration.

There are so many assumptions in this argument, and so many possibilities that must be realized in order that the result shall follow, that, even if the assumptions were correct, one might still remain skeptical in regard to the possibilities ever becoming realized. If we examine somewhat more in detail the conditions necessary to bring about this supposed process, we shall find ample grounds for doubt, and even, I think, for denial, that the results could ever have been brought about in this way.

In the first place the assumption that the regeneration of an organ can be accounted for as a result of the selection of those individual variations that are somewhat more perfect, rests on the grounds that such variations occur, for the injury itself that acts as a stimulus is not supposed to have any direct influence on the result, *i. e.*, for better or worse. All that natural selection pretends to do is to build up the complete power of regeneration by selecting the most successful results in the right direction. In the end this really goes back to the assumption that the tissue in itself has a fuller power to regenerate completely in some individuals than in others. It is just this difference, if it could be shown to exist, that is the scientific problem. But, even leaving this criticism to one side, since it is very generally admitted, it will be clear that in many cases most of the less complete stages of regeneration that are assumed to occur in the phyletic series could be, in each case, of very little use to the

individual. It is only the completed organ that can be used; hence the very basis of the argument falls to the ground. The building up of the complete regeneration by slowly acquired steps, that can not be decisive in the battle for existence is not a process that can be explained by the theory.

There is another consideration that is equally important. It is assumed that those individuals, that regenerate better than those that do not, survive, or at least have more descendants; but it should not be overlooked that the individuals that are not injured (and they will belong to both of the above classes) are in even a better position than are those that have been injured and have only incompletely regenerated. The uninjured forms, even if they did not crowd out the regenerating ones, which they should do on the hypothesis, would still intercross with them, and in so doing bring back to the average the ability of the organism to regenerate. Here we touch upon a fatal objection to the theory of natural selection that Darwin himself came to recognize in the later editions of the 'Origin of Species,' viz., that unless a considerable number of individuals in each generation show the same variation the result will be lost by the swamping effects of intercrossing. If this be granted, there is left very little for selection to do except to weed out a few unsuccessful competitors, and if the same causes that gave origin to the new variation on a large scale should continue to act, it will by itself bring about the result, and it seems hardly necessary to call in another and questionable hypothesis.

Finally, a further objection may be stated that in itself is fatal to the theory. We find the process of regeneration taking place not only at a few vulnerable points, but in a vast number of regions, and in each case regenerating only the missing part. The leg of a salamander can regenerate from every

level at which it may be cut off. The leg of a crab also regenerates at a large number of different levels, and apparently this holds for all the different appendages. If this result had been acquired through the action of natural selection, what a vast process of selection must have taken place in each species! Moreover, since the regeneration may be complete at each level and in each appendage without regard to whether one region is more liable to injury than is another, we find in the actual facts themselves nothing to suggest or support such a point of view.

If, leaving the adult organism, we examine the facts in regard to regeneration of the embryo, we find again insurmountable objections to the view that the process of regeneration can have been produced by natural selection. The development of whole embryos from each of the first two or first four blastomes can scarcely be accounted for by a process of natural selection, and this is particularly evident in those cases in which the two blastomeres can only be separated by a difficult operation and by quite artificial means. If a whole embryo can develop from an isolated blastomere, or from a part of an embryo without the process having been acquired by natural selection, why apply the latter interpretation to the completing of the adult organism?

Several writers on the subject of regeneration in connection with the process of autotomy (or the reflex throwing off of certain parts of the body) have, it seems to me, needlessly mixed up the question of the origin of this mechanism with the power of regeneration. If it should prove true that in most cases the part is thrown off at the region at which regeneration takes place to best advantage, it does not follow at all that regeneration takes place here better than elsewhere, because in this region a process of selection has most often

occurred. The phenomenon of regeneration in the arm of the starfish, that has been described on a previous page shows how futile is an argument of this sort. If, on the other hand, the autotomy is supposed to have been acquired in that part of the body where regeneration takes place to best advantage, then our problem is not concerned with the process of regeneration at all, but with the origin of autotomy. If the attempt is made to explain this result also as the outcome of the process of natural selection acting on individual variations, many of the criticisms advanced in the preceding pages against the supposed action of this theory in the case of regeneration, can also readily be applied to the case of autotomy.

T. H. MORGAN.

*SOME CONDITIONS INFLUENCING SUCCESS
AT SCHOOL.*

THE law of universal variation as demonstrated by the pupils of our public schools has presented a most difficult problem to the superintendent. He is 'between the devil and the deep sea' in his attempts to give the individual his rights, and at the same time conform to a system which is capable of turning out good material in large quantities. Procrustean beds, with semi-elastic foot-boards are about the best that can be provided for the little folks in the large cities, even under the best conditions. The problem is an important one and far from a satisfactory solution, but we have all confidence in the brains which are brought to bear upon it, and it cannot be very long before some one of the systems which are now in the experimental stage will show itself worthy of more extended adoption. Whatever variety there may be in the attempts to solve this problem of promotion in the schools—for after all, it resolves itself to that—there are certain facts

underlying it upon which there is a most perfect consensus of opinion. One of them is the universal variability already alluded to. In every grade known to modern school systems are found some pupils who seem to fit the conditions almost perfectly and others who are palpable misfits. They are not only misfits where they are, but have always been so wherever they have been, and will probably remain misfits to the end of the school chapter. This is not to characterize them as useless members of society, nor as vicious, but simply as odd-shaped cogs which do not quite fit the educational mechanism. Clumsy machinery might work fairly well with them, but not the carefully adjusted tools of a big public-school plant, and some modifications must be made for them. Nor are these failures to coincide all in the same degree. Some go through the whole mill with only a moderate amount of friction. Others find

This study does not present a panacea for these difficulties. It is not remedial, but rather in the nature of a further diagnosis of the conditions. It asks the question: What physical and mental conditions in the child most often accompany success and failure in grade work? It also attempts to answer the question for the limited field covered.

The method and scope of the problem are as follows: About 2,000 copies of the blank here printed were sent out to the superintendents of schools in eight cities and towns of the State of Colorado, who had, in response to a letter previously sent out, signified their willingness to help with the problem. Colorado towns were not chosen because of any special geographical value, but for the simple reason that I was a resident of the State and acquainted with its educators. In fact, the geographical restriction perhaps limits the value of the

Grade ———	City	Sex ———	Age ———
1. Height (for grade), Tall	— ; Above medium	— ; Below medium	— ; Short —
2. Weight (for grade), Heavy	— ; “ “	— ; “ “	— ; Light —
3. Health (apparent), Perfect	— ; “ “	— ; “ “	— ; Poor —
4. Native Ability—Bright	— ; “ “	— ; “ “	— ; Dull —
5. Habit—Industrious	— ; “ “	— ; “ “	— ; Lazy —
6. Temperament—Nervous	— ; “ “	— ; “ “	— ; Stolid —
7. Home Conditions—Good	— ; “ “	— ; “ “	— ; Bad —
8. Occupation of father		

STANDING IN CLASS.

(Based upon marks actually given.)

9. Grading: 1st $\frac{1}{4}$ class — ; 2d $\frac{1}{4}$ class — ; 3d $\frac{1}{4}$ class — ; 4th $\frac{1}{4}$ class —
 10. Department: ditto — ; ditto — ; ditto — ; ditto —
 Remarks

the wheels revolving too rapidly or too slowly. For the former, some parts must be gone through twice, for the latter, time is wasted. The greatest good for the greatest number is all that can be hoped for and in its accomplishments some few may long have to suffer for the weal of the many.

study, rather than enhances it. With the blanks were sent out full directions for filling them out. (1) That they be given only to such teachers as the superintendent felt would do the work with care and good judgment. (2) That the teachers to whom they were intrusted fill out one blank for each pupil in the grade, putting an X in

the proper space under each question. (3) That for each question there be an equal number for every grade, included in each of the four divisions of the question—*i. e.*, in the case of the first question for a grade of 32 pupils, let 8 be put down as tall and the same number for each of the other three classifications, and the same be done as nearly as possible for all the other questions (except 8). This it may be seen demanded careful judgment and discrimination on the part of the teacher, and I cannot vouch for its accuracy, but knowing many of the teachers as I do, I believe the returns are as valid as can be expected from any work of this kind. In the directions especial attention was called to the fact that answers to 9 and 10 were not to be based upon immediate judgment, but upon that of the past as far as possible. No exact measurements were called for even in cases of 1 and 2. The values are in every case relative and in this respect differ from those of other studies of a similar nature. This method has some advantages and some disadvantages. It obviates the necessity for exact measuring apparatus which the teacher might not know how to use, although it introduces an error of individual judgment. The important thing is, however, that we have for every individual grade or room considered, the fourfold classification along nine different lines, by a tabulation of which it is possible to determine whether, right through the grades, the pupils successful with their school work were as a rule the tall or the short ones, the heavy or the light, the healthy or the sickly ones, and by a fuller analysis possibly throw more light on the relative values of other conditions of heredity and environment.

In the preparation of the accompanying curves the data for only 1,000 pupils were used, and those wholly from the grades below the 7th. This was done that with

a later study a comparison might be made between the non-adolescent stage covered by this paper and the adolescent, made up of pupils of the 7th and 8th grades and possibly the first year or two of the high school.

The curves shown on the accompanying figures are all constructed upon the same general principles, and show the relation between the conditions of heredity and environment covered by the questions 1 to 9, inclusive (except 8), and success in school work covered by question 10. In other words, an attempt to show graphically the influence of the former upon the latter. Each figure shows this relation for a single one of the first nine questions. Neither specific grade nor age is considered, the grades from one to six being taken as a group. For each figure, the four columns represent the 1st, 2d, 3d and 4th quarter of the 1,000 pupils considered with respect to the condition of question 10, which has to do with their grading in school work. In every case the 1st column has to do with the pupils at the head of the class; the 4th with those at the foot; the other two, those of intermediate grading.

The curves upon the figures are for the condition covered by the other questions, and by their ordinate distances (*i. e.*, height above the base-line) show the relation between them and the grading. To explain more fully, upon each figure the heavy entire curve is for the first part of the question, tall, heavy, perfect, bright, etc., according as it is on the figure for height, weight, health, native ability, etc.; the dotted curve for the 'above medium' points of the question; the broken curve for the 'below medium'; and the light, entire curve for the remainder—the short, light, poor, dull, etc. Ordinate distances show percentages of children of each condition of heredity and environment in any of the divisions of the class with reference to the grading.

To interpret Fig. 1, which is for condition of height in terms of this description, by following the heavy curve—that for children designated 'tall'—we find that 8 per cent. (in every case omitting fractions of percentages) of such children were in the 1st quarter of the class in their grading (left-hand column), 23 per cent. in the 2d quarter (3d column), 28 per cent. in the 3d quarter (3d column), and 32 per cent. in the quarter at the foot of the class as far as scholarship goes (last column). By following in the same way the dotted, the broken and the light entire curve we can see the relation between the children adjudged to be above medium, below medium and short of stature. To generalize from the figure as a whole, its indications are that the short children, as a class, were the ones for whom promotion was most probable, while the tall children seem to stand lower in their school work according to

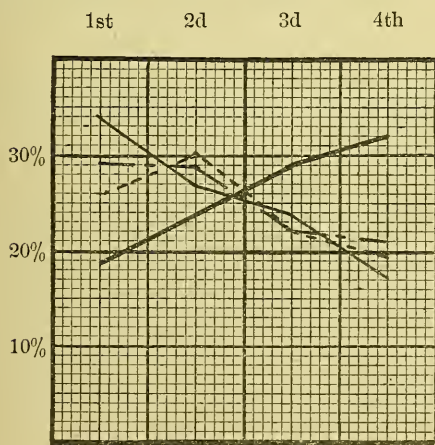


FIG. 1. Height.

the estimation of their teachers. This is not in accordance with the conclusions of some others who have studied the same problem; notably, MacDonald (see 'Ex. Study of Children,' *U. S. Com. Ed.*, 1897-8, Vol. I.), who finds a slight preponderance of height in favor of the bright pupils. A fixed relation, however, may exist between

height and physical conditions, and since the latter forms the basis of study for another figure I shall allude to it under that.

WEIGHT.

The curves upon Fig. 2, and the succeeding ones are to be determined exactly as the preceding. We find from an inspection of Fig. 2 that the heavy children gravitate toward the foot of the class, though not to a very marked degree. From the study of the separate sexes I find this to be more marked for the boys than the girls, though showing slightly for the latter. In the re-

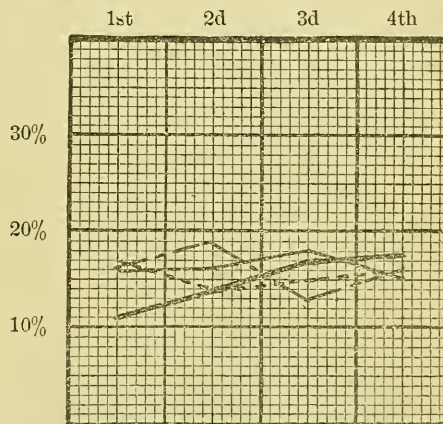


FIG. 2. Weight.

lation between weight and success in school work shown here we are also opposed by the authority just cited, as MacDonald states that in height, sitting height, weight and cranial circumference the bright boy excels the dull. This contradiction may be due to geographical differences. Something more than three-fourths of the children included in my study were residents of the mountain towns of an altitude of nearly two miles, and none were much lower than one mile. If the differences be due to this fact they are in accord with general anthropological studies made upon adults.

HEALTH.

We find upon Fig. 3 a very probable corroboration of the old dictum *mens sana in*

corpore sano. The seeming influence of good health upon good standing is certainly very marked, and the symmetry of the two curves for good and poor health is very striking. The study of the two sexes separately seems to throw some interesting side lights. For the boys and girls in perfect health about the same conditions are indicated as for the two groups, but for poor health it would seem that the direction is given the curve mainly by the boys. The percentages of girls of poor health in the 1st and 4th quarters of the class as to scholarship were the same (26 per cent.), while less than 1 per cent. of the boys in poor health were at the head of the class to 40 per cent. of them at the foot. This would seem to imply that even before the adolescent stage of development the girls have the power of forcing themselves to do work even when vitality is low, which has generally been attributed to them only at a

NATIVE ABILITY AND HABIT.

Conclusions based upon the answers to their questions have perhaps less value

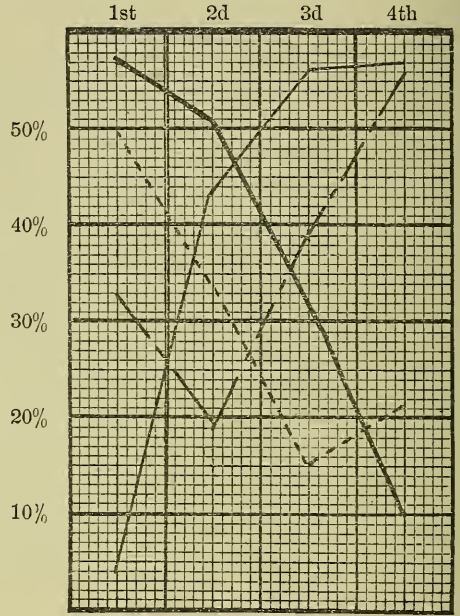


FIG. 4. Native Ability.

than any of the others, because of the difficulty the teacher must have in disassocia-

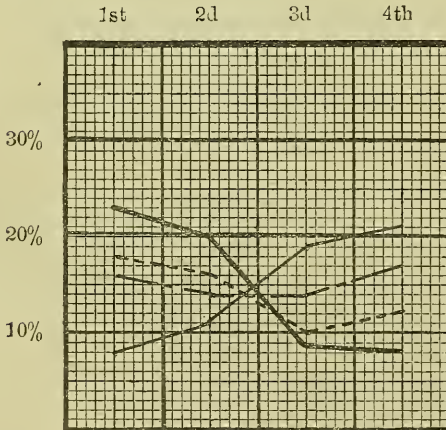


FIG. 3. Health.

later stage. If so, it is a fact which deserves more attention from the teacher, for it can only be accomplished at the expense of energy which is demanded by other activities. Pride and over-sensitiveness are responsible for many evils and probably are in evidence here.

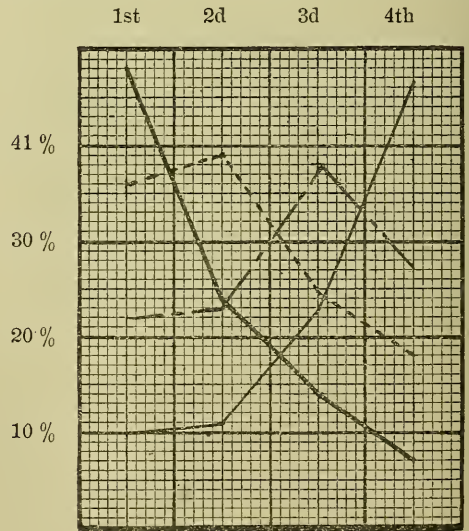


FIG. 5. Habit.

ting the conditions from those of scholarship

with which they are to be compared. When the teacher was answering them for a given pupil she could hardly fail to have in mind his class standing and be influenced by it; one can hardly tell how much influence this might have upon the results. We should expect, however, on other grounds to find the bright and industrious pupils in the 1st quarter of the class as to grading, and *vice versa*, and the curves show them to be there. Based upon the teachers' judgment, there seems to be little difference in the influence for the two sexes. In each case about half of the bright and industrious pupils were at the head of the class, while the other half were unequally distributed through the other three divisions, with very few at the foot.

TEMPERAMENT.

Fig. 6 shows that the children whom the teacher characterized as 'nervous' pre-

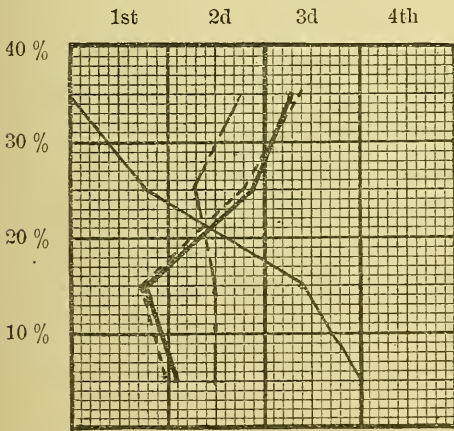


FIG. 6. Temperament.

ponderated in the upper half of the class, considered from the standpoint of work. No directions were given as to classification under this head, and we cannot say that all had the same conception as to its meaning. The term may be made to cover a multitude of different manifestations, but it is perhaps safe to conclude that for the most

it meant an excess of energy worked off through motor channels other than those of the legitimate business of the school. It will be noticed that the greatest percentage of 'nervous' children were in the 2d quarter of the class, with the first showing them next in abundance. This would seem to imply that an abundance of nervous energy is essential to good work but somewhat detrimental to the best of work. It has perhaps been noticed that in our treatment of the whole problem we have been forced to study each condition as if the others were not at the same time active. That is, in isolating the matter of temperament for the curves under discussion, we have disregarded native ability, habit, health and all the rest between which and temperament there may exist a fixed relation. In fact, it would be quite reasonable to suppose that such a relation did exist between some of them, and perhaps the most probable would be that between temperament and health. It was proved that children of poor health were seldom found at the head of the class. But children of poor health are not infrequently excessively nervous. Putting these two facts together, the failure to find the greatest number of nervous children in the 1st quarter of the class seems quite reasonable. For the other extreme of nervousness, which I have characterized as 'stolid,' there is a gradual increase in number from the head to the foot of the class. With the girls there seemed to be the greatest difficulty in overcoming the seeming impediment of stolidity, there being but a fraction over 1 per cent. of those so characterized in the 1st quarter of the class. Perhaps they lacked to an extreme the elements of pride, which is such an instigation to work.

HOME CONDITIONS.

The directions for answering this question stated that home conditions which

were to be considered as good were those which were considered as conducive to study and regular attendance at school, while bad home conditions were those that made this improbable. The latter might be due either to the general attitude of the parents toward school work in general, or the economic condition which left little time for study or caused frequent absences. The curves upon Fig. 7 are about what might with reason be expected, showing but a small chance for good scholarship under the latter condition. The study of the two sexes separately showed that the home influences had a wonderfully more tenacious grip upon the girls than upon the boys; less than 1 per cent. of the former whose home conditions were designated as poor, could force themselves into the 1st quarter of the class, while 20 per cent. of the boys managed to pull themselves out of the mire to that standing. Washing dishes

more dominating influence upon the girl of the attitude of the home toward educational matters. She can hardly escape from it. She carries it to school with her, and if it be poor it drags her down. With the boy it is different. A game of ball or of marbles before school puts him into another world, and he does not reenter the depressing one of home until he is forced to, and even then he makes an early escape.

DEPARTMENT.

I do not consider the curves upon Fig. 8 of much value. They show a very marked relation between good department and good

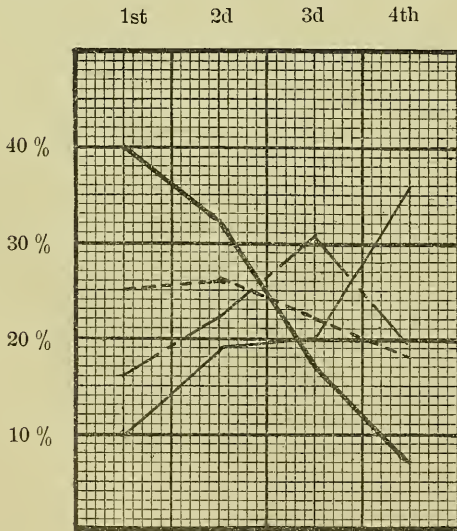


FIG. 7. Home Condition.

and doing other home duties may have had something to do with the difficulties of the girls—duties from which the boys frequently escape—but I am inclined to think that the difference is largely due to the

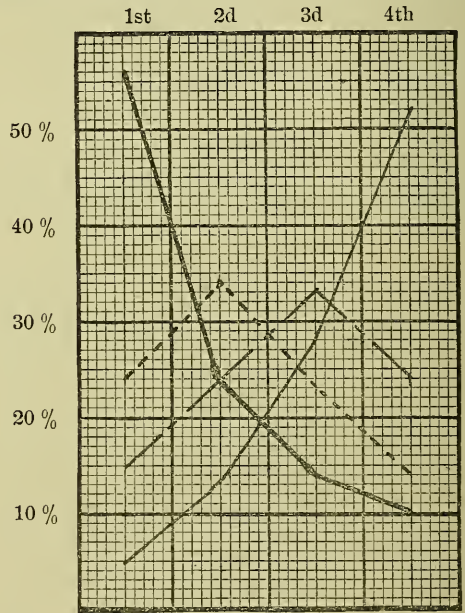


FIG. 8. Department.

class standing, but it takes a very hard-hearted teacher to give the best pupil in the grade, or those who are pushing him closely for honors, a mark for bad department, and I know the good teachers of Colorado too well to believe that they could easily do it. His marks, by a kind of mental osmosis intermingle, and with all respect for the good intentions of the teacher, I put this in more as a study of them and an apostrophe to

their good nature than as having any great scientific value from the standpoint of our problem.

EDWIN G. DEXTER.

UNIVERSITY OF ILLINOIS.

MEMBERSHIP OF THE AMERICAN
ASSOCIATION.

THE following have completed their membership in the American Association for the Advancement of Science during the month of July:

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William S. Andrews, Electrical Engineer, care of General Electric Co., Schenectady, N. Y.

Marshall H. Bailey, M.D., 47 Brattle St., Cambridge, Mass.

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Wm. C. Banks, Electrician, Gordon Battery Co., New York, N. Y.

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SCIENTIFIC BOOKS.

RECENT BOOKS ON PHYSICS.

Natural Philosophy for General Readers and Young People. Translated from Ganot's 'Cours élémentaire de physique,' by E. ATKINSON. Ninth edition, revised by A. W. REINHOLD. Longmans, Green & Co. 1900. Pp. 752.

Elements of Physics. By C. HANFORD HENDERSON and JOHN F. WOODHULL. D. Appleton & Co. 1900. Pp. 388.

A Brief Course in General Physics. By GEORGE A. HOADLEY. American Book Company. 1900. Pp. 463.

One Thousand Problems in Physics. By WILLIAM H. SNYDER and IRVING O. PALMER. Ginn & Co. 1900. Pp. 142.

A Manual of Laboratory Physics. By H. M. TORY and F. H. PITCHER. John Wiley & Sons. 1901. Pp. 288.

Advanced Exercises in Practical Physics. By ARTHUR SCHUSTER and CHARLES H. LEES. England, Cambridge University Press; New York, The Macmillan Company. 1901. Pp. 368.

It was in 1863 that Dr. Atkinson first put before English readers his excellent translation of Ganot's 'Éléments de Physique,' a book which quickly won favor by its good arrangement and lucidity. In the first edition he graciously apologized for the use of the metric system. It has passed through fifteen or more editions since its introduction. A demand soon arose for the more elementary course by the same French author, as a text-book for the middle and upper classes of schools preparatory to college. The popularity of this is manifested by the appearance now of its ninth edition, a considerable part of which had been prepared for the press before the death of Dr. Atkinson. The present volume has all the excellences of its predecessors, the illustrations being abundant, and some of them possibly a trifle too expensive. Colored lithographs of metallic spectra and of Geissler tube discharges were formerly fashionable, but in a general treatise to-day they seem almost out of date. For the general reader it would be hard to find a more pleasant and satisfactory book than this volume. For American school purposes, however, it is too diffuse; and it seems adapted only for recitatorial purposes where oral answers are given to questions relating to descriptive details and general principles. Physics is nothing if not a quantitative science. This idea is best instilled into the elementary student, even though his mathematical attainments be not sufficient to warrant the use of complex problems.

The present volume illustrates the difficulty of maintaining a text-book up to date by slight modifications and additions applied in succession to a long series of new editions. As years pass on, the necessity for omissions becomes as

important as for additions. On page 207 a paragraph about the audiphone states that "not merely deaf people, but even those who are deaf and dumb, can hear musical sounds and even speech." The amiable admission implied in what the present writer italicizes is evidently due to the acceptance of a Chicago advertisement. On page 370, in discussing the mechanical equivalent of heat, the name of Rowland has been forgotten by the reviser. A few wood cuts might have been omitted, such as that (page 27) in which the source of the wind that propels a sail-boat is a cherub face nestled among the clouds, its cheeks distended to the bursting point.

The 'Twentieth Century Text-book,' by Henderson and Woodhull, is decidedly more modern, and is comparable with Ganot in the abundance and attractiveness of the illustrations. An appeal is made to the student's human sympathies by the introduction of portraits, with short life sketches, of men whose researches have enlarged the domain of physics, such as Newton, Franklin, Tyndall, Faraday and Lord Kelvin. To this list is added Mozart, naturally in the chapter on music. A comparison of this chapter with those on heat and electricity indicates plainly, without reference to the title page, that the book has been prepared by two men of quite different tastes and aptitudes. The introductory chapters and those on sound and music indicate a writer whose fondness for metaphysics and æsthetics is quite equal to his appreciation of physics. A prosaic student, after studying through the first chapter, is stimulated by such problems as these :

1. "Select five events and analyze them into their matter and motion content."

2. "If a monkey sit on the top of a pole, and always face a man who walks around the pole, with his face always turned toward the monkey, can the man be said to walk around the monkey?"

The mathematical solution of the second problem is easy. Teachers may differ about the metaphysical solution. In the chapter on music are introduced themes from Beethoven, Schumann and Palestrina, in musical notation, as illustrations of melody, harmony and coun-

terpoint, respectively. The authors in their preface give the opinion that "laboratory exercises, questions and problems given in a text-book are manifestly inadequate and unsatisfactory." This expresses quite a reaction from the popular tendency manifested some years ago, especially in the text-books by Gage and Avery. Many will sympathize with them in thinking that the laboratory guide book and the class text-book should be kept separate. Printed questions are often less valuable than those formulated for the occasion by an experienced teacher. It is not so obvious, however, that problems should be excluded; indeed there are probably few teachers of physics who would agree with the present authors on this point. In fact the first part of the book includes several dozen problems and experiments, a few of which are not very well selected. The general style, selection of material and mode of treatment are, however, good, and the book will probably be popular, particularly on account of the emphasis given to the relations of physics on all sides to human life and the interests of educated people.

The leading idea in Hoadley's text-book is to insure the coordination of reliability in the text, class demonstrations of stated laws, practical questions and problems on the application of these laws, and personal experimentation in the laboratory. The volume is a combination of text-book and laboratory manual intended to cover the work of a scholastic year in the high school. If it be admitted that two small separate volumes should be so combined—and every teacher has a perfect right to judge for himself about this—the work done by the author is exceedingly good. Considerable labor, it is true, will be required of the teacher who uses this book for the first time, and therefore has to secure the construction of the special apparatus for which the laboratory exercises are adjusted. But these exercises are well selected and well described. The practical questions and problems are numerous, and every page indicates that the author is methodical, careful and well informed regarding the needs and limitations of the class of students for whom he writes. He does not shun algebraic formulas or 'dodge' any real difficulties. Some formulas are given,

without deduction, as statements of physical laws. For elementary students this is often necessary, and the mathematical formulation is quite as desirable as verbal expression. Statements of fact are so generally accurate that the author can afford to be reminded of an error on page 188, where he has defined 'discord' more sharply than the facts warrant, by failure to recognize Mayer's law, which expresses the duration of the residual auditory sensation as a function of vibration frequency, the equation being expressible in a curve which Professor Mayer published in 1894 (*Am. Jour. Sci.*, Jan., 1894). In the chapter on electricity a very clear elementary discussion is given of such recent developments as the Wehnelt interrupter, self-regulating vacuum tubes, and wireless telegraphy. The book is abundantly worthy of commendation.

Snyder and Palmer's little volume on 'Problems in Physics' is a good collection intended for use in secondary schools, every problem having borne already the test of class use. For the convenience of overworked teachers it seems very desirable that a collection of answers should be published. Any competent teacher can work out all these problems for himself; but in the majority of cases it is only necessary that the pupil should work out such as have been assigned him. The teacher may assume the labor of verification wherever this may seem desirable, but he should not be subjected to unnecessary burdens.

Tory and Pitcher's 'Manual of Laboratory Physics' constitutes the course of elementary physics given in the laboratory of McGill University, Montreal. For each experiment there is a list of references, a list of apparatus, a short statement of the theory involved, practical directions, and a tabulated example. The arrangement is excellent, and the deductions of formulæ under the head of 'Theory of Experiment' constitute a good review of principles which the student is supposed to have mastered before entering the laboratory. Like all manuals of this kind, the book is a collection of the separate manuscripts prepared by the authors, while they were associated together as demonstrators in the physical laboratory of McGill University.

The manual by Schuster and Lees covers much the same ground as that of Tory and Pitcher, but the instructions given are more discursive and the book is not so well methodized. For somewhat advanced students, who are not so dependent as the beginner is apt to be on the oral guidance of an instructor, the book will be found very valuable. The authors have not aimed at completeness, 'being convinced that a student learns more by carefully working through a few selected and typical exercises, than by hurrying through a large number, which are often but slight modifications of each other.' They attach great importance to neat and accurate work, recorded in good form. The introductory chapter includes a satisfactory discussion of errors of observation.

The acceptability of a new book depends jointly on the author and the publisher. On opening it the reader expects to be able to consult any page without doing roughly by hand what the publisher ought to have done neatly by machinery. The manual just noticed is mechanically unsatisfactory, because the publishers have been guilty of the unreasonable slovenliness of issuing it with edges untrimmed. This fault is bad enough in the case of a magazine, where the insufficient excuse is to make allowance for future binding; but in the case of a book already bound it is inexcusable. American publishers have for the most part risen superior to such a senseless fad; but in England it seems still to hold sway. The present volume of 368 pages is most readily commended to any one who is willing to cut its leaves, to submit to the inconvenience of frayed edges, and to endure the untidiness of such edges after the book has been in use for some time in the laboratory.

W. LeCONTE STEVENS.

Lehrbuch der vergleichenden Anatomie der wirbellosen Thiere. VON ARNOLD LANG. Zweite umgearbeitete Auflage. Zweite Lieferung. Protozoa, vollständig neu bearbeitet von Arnold Lang. Jena, G. Fischer, 1901. Mk. 10.

That this account of the Protozoa in the second edition of Lang's well-known 'Lehrbuch' is practically a new work is at once evident on

comparing the number of pages it contains with the number devoted to the Protozoa in the first edition of the same work. In the first edition 22 pages with 21 figures were given to this group; here we have 311 pages with 259 figures. The account of the Protozoa has thus been expanded until it occupies more space than was devoted in the first edition to the Protozoa, Porifera, Cnidaria, Plathelminthes and Vermes all together.

This increase in size gives opportunity for a most valuable résumé of the recent investigations among unicellular animals. Research has been exceedingly active among the Protozoa in the last decade, and a connected, well-digested summing up of the results of this and previous work, such as we have here, is most welcome. In the first edition of the 'Lehrbuch' all direct reference by name to the various investigators to whom the work was due was excluded from the text. In this edition Professor Lang wisely gives up this practice, so that the book serves likewise as a valuable introduction to the recent literature and history of the subject.

In plan of treatment there is much similarity to that of the first edition, though with some modifications. Most important of these is perhaps the preliminary monographic treatment (after the systematic outline) of three typical protozoa—a simple rhizopod, *Amoeba* (pp. 35-47); a complicated radiolarian, *Cœlospathis ancorata* (pp. 47-55), and a ciliate infusorian, *Paramecium caudatum* (pp. 55-79). Besides an extended account of the structure, much attention is devoted here to the recent physiological work on these organisms, especially to their movements and reactions. The criticism may be made that the relation of the movements and method of reaction in the infusoria to the form and structure of the organisms is not brought out, although this appears to be the central point in the recent work on this subject.

In the remainder of the work the plan is followed of treating special topics throughout the entire group of Protozoa. Thus, we have chapters on the Protoplasm, the Pellicle, the Nucleus, the Centrosome, Protective Organs, Organs of Movement, Organs of Nutrition, Respiratory and Excretory Organs, Sense Organs,

Reproduction, etc. The treatment is usually satisfactory, and is comparatively full. Thus, in the first edition the Organs of Nutrition are disposed of in a paragraph, while here twenty-five pages are devoted to the subject. Especially full and valuable is the account of the reproductive processes, which occupies nearly half of the text. Here the recent work of Schaudinn and others on the most varied members of the group is reviewed. The prominence of the Sporozoa is throughout noticeable, as compared with any previous general account of the Protozoa. Mention may be made of the especially full accounts of the reproduction and alternation of generations in *Trichosphærium* (Schaudinn), *Coccidium* (Schaudinn), the malaria parasite (pp. 229-239), and the Volvocidæ.

The text is clearly written, in an attractive style, and is well illustrated. Exception may perhaps be taken to the large figure of *Paramecium* on page 56, which shows an unnatural shape, deformed by pressure, and is so coarsely drawn as to be misleading.

The book forms an essentially independent work on the Protozoa, and is furnished with extensive literature lists, a table of contents, a table indicating references in the text to organisms usually studied in laboratory courses, an alphabetical list of figures and a full index. It will be found valuable to every one interested in this fundamental group of animals.

H. S. JENNINGS.

Morphology of Spermatophytes. By JOHN M. COULTER, Ph.D., Head of the Department of Botany in the University of Chicago, and CHARLES J. CHAMBERLAIN, Ph.D., Instructor in Botany in the University of Chicago. New York, D. Appleton and Company. 1901. Octavo. Pp. x + 188.

Methods in Plant Histology. By CHARLES J. CHAMBERLAIN, Ph.D., Instructor in the University of Chicago. Chicago, The University of Chicago Press. 1901. Octavo. Pp. viii + 160.

It speaks well for the intellectual activity of the corps of botanists in an American university that these two books, whose preparation must have involved a great deal of labor, have appeared within the past three or four

months. This is all the more notable when we observe that Dr. Chamberlain's name appears on both title pages.

In the 'Morphology of Spermatophytes' we have Part I. of what is evidently to be a work of considerably larger proportions, the present volume being fragmentary, dealing with the Gymnosperms only, and closing somewhat abruptly, even wanting an index. The preface was evidently written for the complete work, and this fact suggests the intention of the authors to bring out Part II. at no distant day. The part before us takes up stem, leaf, root, microsporangium, megasporangium, female gametophyte, male gametophyte, fertilization, and the embryo, for Cycadales, Ginkgoales, Coniferales, and Gnetales, devotes a few pages to fossil Gymnosperms (Cordaitales, Bennettitales, Cycadales, Ginkgoales, and Coniferales), and a few more to the phylogeny, and geographic distribution of the various orders mentioned above. The volume closes with a most useful bibliography of one hundred and ten titles. More than one hundred excellent illustrations (largely original, and often from photographs) add materially to the usefulness of the work.

This book must prove very helpful to the student who is working along morphological lines, and will tend to bring him back to strictly scientific work, in case he has been wandering through the fogs of so-called 'elementary ecology.' A valuable feature of the book is the citation and discussion of the different views held by botanists as to the morphology of particular structures. While the conclusions reached are not always those which we can approve, the treatment is such that the student is led to look on all sides of every problem before a decision is reached. We can not accept the authors' views as to the morphology of the structure supporting the ovules of *Ginkgo* (which we hold to be foliar instead of axial), nor that of the 'ovuliferous scale' of the *Abietinæ* (which we interpret as an enlargement and extension of ovular tissue; *i. e.*, it is ovular instead of axial or foliar in nature).

Dr. Chamberlain's book must prove useful in histological work in botanical laboratories in high schools and colleges. The plan of the

work includes two parts, in the first of which are ten short chapters on apparatus, reagents, the making of mounts, killing and fixing agents, staining and the celloidin and glycerine methods. The author's success as an investigator and teacher is a guarantee of the value of the suggestions made in these chapters. The second part is mainly a series of selected examples of algæ, fungi, bryophytes, pteridophytes, and spermatophytes, in which the preceding suggestions are applied. This portion of the book is an admirable introduction to the vegetable kingdom, and must commend the volume to teachers and students. The book closes with a handy chapter of formulæ of reagents, and a good index.

These works are creditable to the university from which they appear, and deserve to be widely used.

CHARLES E. BESSEY.

SCIENTIFIC JOURNALS AND ARTICLES.

No. LIII. of the *Journal of American Folk-Lore* begins with a paper by Dr. J. W. Fewkes, in which he explains and interprets the *Katcina* worship of the Hopi or Moki of Arizona. The word is used to denote a masked personage, who, in a ceremonial dance, represents a divine being. Dr. Fewkes shows that these beings are spirits of clan ancestors, who are supposed to return from their dwelling in the underworld. Thus in mortuary prayers, the dying are addressed as about to become *Katcinas*, and are implored to send rain. Of the *Katcinas*, some are eponyms of Hopi clans; others are imported from abroad, or are imaginary creations. Chief of these spirits are the Sun Father and Earth Mother, parents of all clans. With sun worship also are connected some of the festivals; in the two great feasts of the *Katcina* clan are dramatized the arrival and departure of the *Katcinas*, who are supposed to leave the pueblo in July and return in February. They are said to go to the San Francisco mountains; but the underlying idea is that they enter the underworld through the gate of the Sun-house, the situation of which is indicated by a notch in these mountains, being the place of sunset at the time of the winter solstice. In the dramatic action held in the

sacred room or kiva, the Sun is personated by a man disguised as an eagle, whose performances symbolize the fertilization of the earth. In his most curious and interesting article, Dr. Fewkes makes it clear that the original significance of the ceremonies has long been forgotten by the Hopi. The editor, in treating of Kootenay medicine-men, makes clear the manner in which Christian ideas have intertwined themselves with Indian beliefs; he is of opinion that the Nootka god Kätse, whose name is kept secret, save that the dying chief communicates it to his grandchild, with instructions as to the manner of praying to this being, is none other than Jesus Christ. Miss A. C. Fletcher informs us that admonitions urging industry formed a part of Indian traditional teaching. Professor Rodney H. True discusses the relation of folk materia medica to modern knowledge. The 'Record of American Folk-Lore' is as full and instructive as usual. Altogether the new editor, Dr. A. F. Chamberlain, may congratulate himself on the presentation of a valuable number.

The American Naturalist for July opens with the second instalment of William M. Wheeler's paper on 'The Compound and Mixed Nests of American Ants,' this part being devoted to the known cases of social symbiosis among American species. Professor Wheeler gives Wasmann's table of the varied conditions under which symbiosis may occur, and then presents a scheme showing a more exact and natural grouping of the cases, to each of which an appropriate name is given. Under each of these headings the various species are treated in considerable detail; the article is of considerable length and much interest. R. W. Shufeldt presents a paper 'On the Osteology and Systematic Position of the Alcæ,' considering that the auks constitute a suborder standing between the gulls and petrels. A. W. Peters describes 'Some Methods for Use in the Study of the Infusoria' and 'Outram Bangs' gives some 'Notes on a Small Collection of Mammals from the Liu Kiu Islands' including the description of a new bat, *Hipposideros turpis*. C. W. Prentis describes in detail an interesting 'Case of Incomplete Duplication of Parts and Apparent

Regulation in *Nereis virens* Sars.' The fourteenth instalment of the 'Synopsis of North American Invertebrates' contains the Hydro-medusæ, Part III., by Charles W. Hargitt. Like the others of this valuable series, this comprises full keys to the families and genera, but it also has descriptions of the species. This number of the *Naturalist* contains the 'Quarterly Record of Gifts, Appointments, Retirements and Deaths.' The total amount of gifts reaches well into the millions, largely through the sums given by Andrew Carnegie to found libraries.

The Popular Science Monthly for August has as its frontispiece a portrait of Dr. Ira Remsen, the recently elected President of Johns Hopkins University. The first article, by J. J. Thomson, is 'On Bodies Smaller than Atoms.' Brother Potamian gives a sketch of 'Gilbert of Colchester,' the author of 'De Magnete,' showing his numerous discoveries in magnetism, and we have Part II. of 'The Peopling of the Philippines,' by Rud. Virchow. R. M. Wenley discusses 'Science and Philosophy,' noting the estrangement that seems to exist between the two and calling for harmony between them. The ninth part of 'A Study of British Genius,' by Havelock Ellis, is devoted to personal characteristics, and William James treats of 'FREDERIC MYERS'S SERVICE TO PSYCHOLOGY.' 'The Pose of the Body as Related to the Type of the Cranium and the Direction of the Visual Plane' is the subject of a paper by George T. Stevens, the writer considering that many benefits and ills depend upon the direction of the visual axis, and that when these are so directed as to be injurious they can be rectified. The final article on 'The Great Mortality,' by Edward P. Cheyney, is a description of the 'Black Death,' now known as the bubonic plague, which devastated Europe in the fourteenth century.

Bird Lore for July-August, opens with 'First Impressions of Hawaiian Birds,' by H. W. Henshaw, an article which rather impresses the reader with the comparative scarcity of bird life and the difficulties in observing it. Frank M. Chapman contributes 'A Nighthawk Incident,' with some excellent illustrations, after photographs of the bird, and Verdi Burtch de-

scribes 'The Birds of a Marsh' near Keuka Lake, N. Y. The fifth series of 'Birds and Seasons' is devoted to the birds to be seen and studied in August and September, as noted by contributors from Boston to Stockton, Cal., with suggestions for the season's study and reading.

THE first number of *The Museums' Journal* of Great Britain is issued promptly, and naturally commences with a statement of the objects of the Museums' Association and its journal. The address of the President, Sir William Turner, delivered at the Edinburgh meeting of the Association follows, and this is devoted to the history of 'The Public Museums of Edinburgh.' A sample is submitted of 'A Museum Label,' descriptive of British pottery and as criticism is invited it may be said that it will strike some as rather long, although it is undeniably replete with information. 'Museum Notes,' 'At Home and Abroad,' complete the number.

IN the issue of SCIENCE for April 26, 1901, there was given a somewhat detailed account of a proposed journal for the statistical study of biological problems, suggested by Professor Karl Pearson and Professor E. F. R. Weldon. We are glad to learn that the first number of the journal, which is called *Biometrika*, will be published in October. Professor C. B. Davenport, of the University of Chicago, is one of the editors, the others being Professors Pearson and Weldon. The journal will be published by the Cambridge University Press and will appear about four times a year. The following papers are ready or in preparation:

'Biometry': FRANCIS GALTON.

'On the Terminology and Notation of Biometric Investigations.'

'Variationsstatistische Probleme und Materialien': Professor Dr. F. LUDWIG.

'Criminal Anthropometry and the Identification of Criminals': Dr. W. R. MACDONELL.

'Critical Bibliography of Statistical Memoirs. I. Heredity': Professor W. F. R. WELDON.

'Anthropometric Data from Australia': W. POWYS.

'Variations in *Synapta inhærens*': Professor C. L. EDWARDS.

'Homotyposis in the Egg of the House-Sparrow': Dr. A. LEE and Professor K. PEARSON.

'The Cuckoo's Egg': OSWALD LATTEK.

'Variation in *Aurelia*': E. T. BROWNE.

'Inheritance of the Duration of Life and the Intensity of Natural Selection in Man': Miss M. BEETON and Professor K. PEARSON.

'Artificial Selection, being a Comparison of the Distributions of Conscripts and Recruits in various Italian Provinces': Professor W. F. R. WELDON.

'Results of Cooperative Investigation on the Laws of Inheritance in Plants. I. The Shirley Poppy.'

'Variation and Correlation of the parts of the Human Skull. A Quantitative Study of the Naqada Crania': Miss C. D. FAWCETT.

'Extended and Improved Tables of Probability Integrals': W. F. SHEPPARD.

'Variation in the Form of the Helix of the Shell in *Chausilia laminata* (Montagu)': Professor W. F. R. WELDON.

'Mathematical Contributions to the Theory of Evolution. XI. The Influence of Natural Selection on the Variability and Correlation of Characters': Professor K. PEARSON.

'On a Physico-statistical Theory of Heredity': G. U. YULE.

'A Statistical Study of the Wild Bee': Professor F. Y. EDGEWORTH.

AN Index to the *Experiment Station Record*, covering the first twelve volumes, and containing more than one hundred thousand entries, has been prepared and will probably be published in the autumn.

THE Senate of the University of London has decided to publish periodically an official organ, to be called *The London University Gazette*, which will contain class lists, new regulations, dates of examinations, etc. The paper will appear about twenty times in the first year, beginning in October.

DISCUSSION AND CORRESPONDENCE.

THE VISUAL PERCEPTION OF SPACE.

THE fact to which Professor Thorndike called attention in the last number of SCIENCE must appear extraordinary to those who have not

considered the senses from the point of view of psychology. The ordinary man tends to regard our perceptions as copies or models of an outside world. The sense organs intervene, of course, and knowing that in vision the rays of light form an image on the retina, one is likely to think of the mind as viewing this picture from behind. As Professor Thorndike remarks, if one walks toward a chair, the apparent size of the object does not alter—at least not greatly or obviously—although the image on the retina becomes smaller. As I lecture to my class, the retinal images of the heads of the students on the back seats may be only one-tenth the size of those in front, yet they look only slightly smaller. But this is by no means the only disparity between the image on the retina and my perception. To begin with, the image is upside down and there are two images. Then the corners of my desk look like right angles, although they are by no means such in the pictures. I know by experiment that I can at one time have a distinct image of only one of the nearer heads, yet in my perception all the heads are distinct. A photograph in which very near and comparatively distant objects are included will in its distortion of perspective and blurring give some idea of what the image on the retina is like and how different it is from the perception.

Some of these facts were known to Berkeley, who in his 'New Theory of Vision,' first published in 1709, argues that visible objects are a system of arbitrary signs. In regard to apparent magnitude he writes :

When we look at an object, the tangible figure and extension thereof are principally attended to ; whilst there is small heed taken of the visible figure and magnitude, which, though more immediately perceived, do less sensibly affect us, and are not fitted to produce any alteration in our bodies.

60. That the matter of fact is true will be evident to any one who considers that a man placed at ten foot distance is thought as great as if he were placed at a distance only of five foot ; which is true, not with relation to the visible, but tangible greatness of the object : the visible magnitude being far greater at one station than it is at the other.

Professor James, as always, discusses the matter admirably. He says ('Principles of Psychology,' II., 179) :

When the object by moving changes its relations to the eye the sensation excited by its image even on the same retinal region becomes so fluctuating that we end by ascribing no absolute import whatever to the retinal space-feeling which at any moment we may receive. So complete does this overlooking of retinal magnitude become that it is next to impossible to compare the visual magnitudes of objects at different distances without making the experiment of superposition. * * * As I look along the dining-table I overlook the fact that the farther plates and glasses *feel* so much smaller than my own, for I *know* that they are all equal in size ; and the feeling of them, which is a present sensation, is eclipsed in the glare of the knowledge, which is a merely imagined one.

Professor Newcomb recently called my attention to the paradox that while we are



FIG. 1. The man and boy are of the same size.

said to judge the distance of objects of known size by the angles they subtend, our

perception of distance is more accurate than our perception of the visual angle. Owing to the fact that we must commonly ignore the visual angle in order to get useful perceptions, our interest in it is small and our knowledge vague. The moon, for example, always subtending the same angle, looks much larger at the horizon than at the zenith. If the reader is asked whether the little finger if held before the moon will cover it, he will probably say 'No,' or else hesitate to answer. As a matter of fact, the little finger covers the moon, and when it is removed we have a further illustration of the subject in the fact that the moon appears decidedly reduced in size, owing doubtless to a vague comparison with the finger.

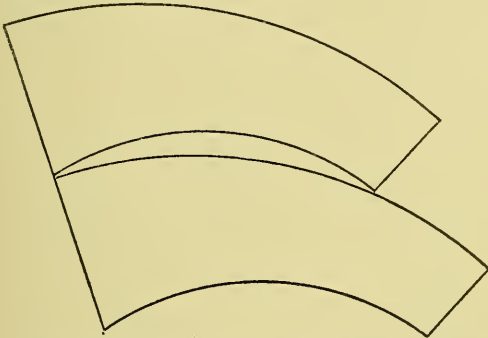


FIG. 2. The upper and lower areas are of the same size and shape.

I have made a few experiments on the accuracy with which the retinal area or visual angle can be judged under different conditions, and on the relation between the geometrical magnitude and the perception, and hope to continue them, though it is difficult to obtain quantitative results. The phenomena can be studied to advantage with the aid of mirrors, and it appears that data of interest can be secured by a consideration of photographs and of paintings and drawings. This I may illustrate by reproducing a figure from Professor Münsterburg's 'Pseudoptics,' in which the figures of the man and boy are of the same objective size.

While our ability to compare the retinal magnitude of objects at different distances and in different directions is very defective, the perception of visual magnitude when objects are side by side is perhaps the most accurate of all the senses, a difference of one-hundredth being noticeable. Yet even in this case the retinal area yields readily to suggestion as is shown by the accompanying figure, in which the two areas are of exactly the same size.

In a recent paper,* I have described what seems to me one of the most striking disparities between our perceptions and the physical world — no less than the perception of order in time as extension in space. If, for example, first a green and then a red surface pass rapidly behind a narrow slit, one does not see green followed by red, but simultaneously a surface with green below, white in the middle and red fading into black above. Physiologically we have a retinal process, consisting of a certain commotion caused by green light, lasting say 1/20 sec., then a mingling of this process with that excited by red, then that excited by red gradually subsiding. But this time series is perceived as a spatial continuum, and the field is, perhaps, three times as large as the window through which it is seen. If three squares, as shown on the left of the figure, are seen as they pass the window WW' , they do not appear one after the other, but are seen simultaneously as indicated to the right.

This conversion of a time into a space order is also what always happens in ordinary vision. If the eye moves so that the line of sight moves



FIG. 3. The squares at the left appear as shown at the right when seen as they pass the window (WW') of the size indicated.

* 'On the Relation of Time and Space in Vision,' *The Psychological Review*, 7 : 325-343, 1900.

over a row of fifty books, each retinal element is excited in succession by each book, but we do not see one book taking the place of the other, but all the books side by side. Further, when the eye sweeps over fifty books in 1/10 sec., each book is seen, or appears to be seen, with perfect distinctness, though if the books moved at the same rate over the eye they would completely fuse together. Our perceptions in no wise correspond to the physiological processes in the eye, but are what they should be for our safety and convenience.

J. McKEEN CATTELL.

COLUMBIA UNIVERSITY.

CIRCULAR OF INFORMATION IN REGARD TO
THE CAUSATION AND PREVENTION
OF MALARIAL FEVER.

RECENT investigations have shown that malarial fever belongs to that class of diseases which require for their transmission the active intervention of a definite kind of mosquito, *i. e.*, *Anopheles*. This genus is not the common one of this region, but is nevertheless present in many localities.

The organism causing malarial fever (*Plasmodium malarix*) is probably a true parasite, and, so far as we know at present, finds the conditions necessary for its existence only in the living human body and in this genus of mosquito, the latter becoming infected by sucking the blood from an infected human being. The malarial organism having thus entered the stomach of the mosquito, passes through certain changes in the body of the infected insect, and at the end of about ten days reaches the poison gland. After this time, if the mosquito bites another human being, the malarial organism is introduced into the circulation of the latter and malarial fever follows.

So far as we know certain localities are 'malarious' only because they furnish favorable conditions for breeding this mosquito. Malarial fever would not occur in any malarious district, unless some infected human being were in it, or came into it and infected the mosquitoes, which in turn infected other human beings.

Recent observations in the intensely malarial districts in Italy and Africa have shown that even newcomers in these regions who pur-

posely expose themselves by living in the most highly malarious area, for example the Roman Campagna, do not develop malarial fever, if they are carefully protected from the bites of mosquitoes; and further, it has been shown that this disease may be produced with certainty in any locality if a mosquito of the genus *Anopheles* is allowed to bite a person suffering from malarial fever and then, after a sufficient time, is allowed to bite a healthy person.

Certain simple precautions suffice to protect persons living in malarial districts from infection:

First.—Proper screening of the house to prevent the entrance of the mosquitoes (after careful search for and destruction of all those already present in the house), and screening of the bed at night. The chief danger of infection is at night, inasmuch as the *Anopheles* bite mostly at this time.

Second.—The confinement and continuous screening of persons in malarial districts who are suffering from malarial fever, so that mosquitoes may not bite them and thus become infected.

Third.—The administration of quinine in full doses to malarial patients to destroy the malarial organisms in the blood, and persistence in the use of the remedy even for a few weeks after apparent recovery.

Fourth.—The removal of the breeding places of the mosquitoes through drainage, filling up of holes and surface pools, and emptying of tubs, pails, etc., which contain stagnant water. These mosquitoes particularly breed in surface rain pools and surface stagnant water, where there are no fish; also exceptionally in pails, tubs, barrels and tanks of standing water, though they seem mostly to prefer natural accumulations.

Fifth.—In pools which cannot be drained or filled, the destruction of the mosquito larvæ by the use of petroleum thrown upon the surface, by the introduction of minnows and other small fish which eat the larvæ, or by both methods.

These measures, if properly carried out, will suffice greatly to restrict and largely to prevent the occurrence of new malarial infections.

It is the desire of the Department of Health to obtain information as to the location of the cases of malarial fever, so that the people may be instructed as to the danger of infection and the methods of avoiding it.

It must be remembered that when a person is once infected, the organism may remain in the body for many years, producing from time to time relapses of the fever. A case of malarial infection in a house, whether the person is actively ill or the infection is latent, in a locality where the *Anopheles* mosquitoes are present, is a constant source of danger, not only to the inmates of the house, but to the immediate neighborhood, if proper precautions are not taken.

Malarial fever is quite prevalent in certain boroughs of New York City. It is likely to extend to the boroughs of Manhattan and Brooklyn in view of the extensive excavations and consequent formation of rain-pools in various parts of these boroughs, if means are not employed for its prevention.

The Board of Health desires the cooperation of all physicians in its efforts to disseminate information in regard to the causation and prevention of malarial fever, and in its efforts to restrict the prevalence of this disease in New York City.

HERMANN M. BIGGS.

THE BRITISH CONGRESS ON TUBERCULOSIS.

THE Congress which met at London at the end of last month appears to have been remarkably successful. There were over 2,500 members, including the following delegates :

- United States : Professors Osler and Janeway.
- Austria : Professors von Schroetter and Davorak.
- Belgium : M. le Sénateur Montefiore Lévi and Van Ryn.
- Bulgaria : Mikailovsky.
- Denmark : Professor Bang and Dr. Charles Gram.
- France : Professors Brouardel, Boucharde and Nocard.
- Germany : Professors Gerhardt, Flügge, Von Leyden, Frankel, Koch, Werner, Dettweiler, Dr. Freund.
- Holland : Professor Thomassen.
- Hungary : Professor Koranyi.
- Norway : Dr. Malm.
- Portugal : Professor da Silva Amado.

Roumania : Dr. Cantacuzino was unavoidably absent.

Spain : Señor Don Antonio Espino y Capo.

Sweden : Hof Marshal Printzjold.

Switzerland : Dr. Neuman.

The Congress met in four sections : State and municipal, medical, pathology and veterinary, and there were besides a number of general meetings. The addresses of Professors Koch and Brouardel attracted special attention, more especially Professor Koch's claim that the bovine tubercle could not develop in the human body. No one present seems to have known of Professor Theobald Smith's careful research, showing that bovine and human tubercle bacilli are not identical. At the close of the Congress, the following resolutions were adopted :

That tuberculous sputum is the main agent for the conveyance of the virus of tuberculosis from man to man and that indiscriminate spitting should therefore be suppressed.

That it is the opinion of this Congress that all public hospitals and dispensaries should present every out-patient suffering from phthisis with a leaflet containing instructions with regard to the prevention of consumption and should supply and insist on the proper use of a pocket spittoon.

That the voluntary notification of cases of phthisis attended with tuberculous expectoration and the increased preventive action which it has rendered practicable has been attended by a promising measure of success and that the extension of notification should be encouraged in all districts in which efficient sanitary administration renders it possible to adopt the consequential measures.

That the provision of sanatoria is an indispensable part of the measures necessary for the diminution of tuberculosis.

That in the opinion of this Congress and in the light of the work that has been presented at its sittings medical officers of health should continue to use all the powers at their disposal and relax no effort to prevent the spread of tuberculosis by milk and meat.

That in view of the doubts thrown on the identity of human and bovine tuberculosis it is expedient that the Government be approached and requested to institute an immediate inquiry into this question, which is of vital importance to the public health and of great consequence to the agricultural industry.

That the educational work of the great national societies for the prevention of tuberculosis is deserving of every encouragement and support. It is through their agency that a rational public opinion

may be formed, the duties of public health officers made easier of performance and such local and State legislation as may be requisite called into existence.

That this Congress is of opinion that a permanent national committee should be appointed (*a*) to collect evidence and report on the measures that have been adopted for the prevention of tuberculosis in different countries; (*b*) to publish a popular statement of these measures; (*c*) to keep and publish periodically a record of scientific research in relation to tuberculosis; and (*d*) to consider and recommend measures of prevention. This Congress is further of opinion that such a committee should consist of representatives to be elected by the great national societies formed for the suppression of tuberculosis and also representatives nominated by the various governments. It is further of opinion that all international committees and great national societies whose object is the prevention of tuberculosis should be invited to cooperate.

That, in the opinion of this Congress, overcrowding, defective ventilation, damp, and general unsanitary conditions in the houses of the working classes diminish the chance of curing consumption and aid in predisposing to and spreading the disease.

That while recognizing the great importance of sanatoria in combating tuberculosis in every country the attention of governments should be directed towards informing charitable and philanthropic individuals and societies of the necessity for anti-tuberculous dispensaries as the best means of checking tuberculous disease amongst the industrial and indigent classes.

That the following question be submitted to the consideration of the next Congress: The constitutional conditions of the individual which predispose to tuberculosis and the means whereby they can be modified.

*GEOLOGICAL EXPLORATIONS AT PIKERMI.**

THE geological excavations which the Trustees of the British Museum have (by the kind permission of Mr. Skousés, the owner of the ground) been carrying on at the Pliocene deposits of Pikermi, near Athens, since the early spring, have now been brought to a conclusion for the season. Judging from the preliminary reports which have been received from Dr. A. Smith Woodward, who was sent out by the Museum to superintend the excavations, the results from a scientific and pecuniary point of view have well justified the trustees in their decision to undertake this important piece of

geological research. We believe that the initiative in the matter is due to Sir Edwin Egerton, H. M. Minister at Athens, who was also mainly instrumental in obtaining the necessary permit to excavate from Mr. Skousés, formerly Greek Minister for Foreign Affairs. The willing cooperation of the University of Athens in the person of Professor Skuphos, the accomplished paleontologist of the University Museum, was easily secured, and his help and advice have been invaluable throughout the whole period of the work. The most cordial relations have existed between Professor Skuphos and Dr. A. S. Woodward, and the division of the specimens which have been discovered has, it is understood, been amicably arranged by the British Museum and the University of Athens. It is said to be extremely doubtful whether there is any Greek law assimilating fossils to works of art; but, however that may be, we are happy in knowing that both the institutions concerned are satisfied with the agreement which has been arrived at as regards the portion of the collections which each is to retain.

Pikermi, where the fossils are found, is near the Marathon road, about 12 miles from Athens; and the specimens are usually found at a considerable depth below the bed of a mountain torrent. This is, of course, not the first time that excavations have been made in these deposits. In the early fifties Professor Albert Gaudry, the eminent French geologist, conducted some explorations which resulted in a great find of Tertiary mammalia, identical with those of Léberon, Samos and Maragab. Most of the specimens obtained by Gaudry are in the Paris Museum. Later, the Vienna Academy made a collection on a smaller scale from the same place; and about 1885 the Duke of Orleans was allowed to dig there, but he remained only a short time and found nothing of importance. Before the present occasion no Englishman had made any geological research at Pikermi, and the British Museum contained no collection from these beds. This deficiency in our great national storehouse has now been made good in a splendid manner, as may be judged from the fact that 47 large cases containing the Museum's share of the fossils found are at the present moment on their way to England.

* From the *London Times*.

Among the principal finds recorded may be mentioned remains of a huge proboscidean, including two femurs each over a meter in length, a fine series of excellently preserved skulls and other bones of rhinoceros; *Mesopithecus*, an old-world monkey, remains of which are rarely met with in any part of the globe as fossils; several almost complete skulls of *Mastodon*; skulls, teeth, and bones of *Machærodus*, the great saber-toothed tiger, remarkable for the great development of the canine teeth, and also for its wide geographical distribution. Remains of this animal have been met with in England in Kent's Cavern, Torquay, in Creswell Crag Caves, Derbyshire, and in the Norfolk forest-bed. Dr. Woodward also reports the discovery of innumerable bones of *Hipparion*, the three-toed and most immediate predecessor of the horse of the present day, hyæna and other carnivores, antelopes, giraffe with limb-bones very long and slender; *Helladotherium*, a short-necked giraffe allied to the *Okapi*, the new ruminant mammal recently brought home by Sir Harry Johnston from the Semliki forest in the Congo State; and *Samotherium*, a large ruminant, first discovered, it is believed, by Dr. Forsyth Major in the lower Pliocene beds of the Island of Samos, off Asia Minor, and said to connect *Helladotherium* and the giraffe with some of the ancient aberrant antelopes of Pikermi. Traces of *Chaloniens* were abundant and include, as one of the prizes of the explorations, remains of perhaps the largest tortoise ever found in Europe. Very few bones of rodents were met with, and birds do not seem to have been numerous; but a considerable collection of land shells was obtained. It is curious that no traces of plant life were observed.

The bones occur on definite horizons in immense numbers, and the marly material is quite soft until it is dried, when it hardens. In places the remains are so jammed together that it is difficult to extract or to separate them. The carcasses appear to have been buried entire, with the flesh and integument, in vast numbers, probably by torrential action, a great number having had their limbs sharply broken, evidently at the time of death. It is worthy of note that the extinct animals found in this

late Tertiary deposit at Pikermi mostly relate to the present African fauna.

Dr. A. S. Woodward, it will be seen, has carried out the official mission entrusted to him in a most creditable manner. By his exertions and careful superintendence the national collection of paleontology at South Kensington will be immensely enriched. Before returning home Dr. Woodward, at the request of Sir Edwin Egerton, has arranged to inspect another ossiferous deposit on the island of Eubœa.

SCIENTIFIC NOTES AND NEWS.

THE permanent secretary of the American Association, Dr. L. O. Howard, asks us to state that those who have responded to his invitation to send in their names and dates for special Association Pullman accommodation are so divided in their choice of route that it will be impossible for him to arrange to bring parties together on the journey in the way proposed. The Pennsylvania limited, which leaves New York at 9:55 A. M. and Philadelphia at 12:20 P. M., reaching Chicago at 8:55 A. M., was not included in the time-tables published recently in this journal. Neither were there given time-tables of the trains on the New York Central road, though for those living in New York and New England this is probably the most convenient route, as it is cooler than those further to the south. We may take occasion to call attention to the excursion to the Grand Canyon of Arizona arranged to follow the meeting, of which an advertisement will be found in this issue of SCIENCE. We are also requested to state that the meeting of the Council will be held at 3 o'clock on Saturday, August 24, instead of at 12.

THE seventy-third meeting of German Men of Science and Physicians will, as we have already stated, be held at Hamburg, from the twenty-second to the twenty-eighth of September. Professor R. Hertwig, of Munich, is president of the meeting, while Professor van't Hoff is president of the scientific sections and Professor Naunyn of the medical sections. There are in all twenty-seven sections for the medical sciences and eleven in the natural and exact sciences. The latter sections correspond in general with

those of our own Association, except that there are sections for applied chemistry, for geophysics and for geography, while there is none for social and economic science. Among the special lectures promised are the following: Dr. E. Lecher on 'Hertzian Waves,' Professor T. Boveri on 'Fertilization,' and Professor W. Nernst on 'Electro-chemistry.'

PRINCE HENRI D'ORLÉANS, who has made important geographical discoveries in Asia and Africa, died at Saigon, China, on August 9, aged thirty-three years.

We also regret to record the death of Professor August Tenne, curator of the mineralogical collections of the University of Berlin; of M. David Dickson, director of the practical School of Agriculture, at Berthonval, France, and of Mr. Carsten Holthouse, at one time lecturer on anatomy at the Aldersgate School of Medicine and the senior fellow of the Royal College of Surgeons, who was in his ninety-first year.

THE steamship *Discovery* of the British Antarctic Expedition, sailed from Cowes on August 6, and the *Gauss*, of the German Expedition, sailed from Kiel on August 11. The *Discovery* should reach the Cape about September 12 and Melbourne about a month later. It will proceed thence to Littleton, New Zealand, which place it will leave about the middle of December and will probably come in contact with the ice pack about the first of January.

MR. WILLIS L. MOORE, chief of the Weather Bureau, will leave Washington early in September for the Yellowstone National Park to make an inspection of that region with a view to the establishment of a meteorological observatory.

PROFESSOR LUCIEN M. UNDERWOOD, of Columbia University, and Mr. O. F. Cook, special agent for tropical agriculture for the Department of Agriculture, have returned from a botanical expedition to Porto Rico.

DR. PETER A. JODER has been appointed assistant chemist at the Utah Agricultural College and Station, and Mr. W. T. Shaw has been appointed assistant entomologist at the Iowa Station.

PROFESSOR H. C. WILSON, according to a telegram to the Harvard College Observatory, observed Encke's comet on August 5.

MR. A. L. ROTCH, director of the Blue Hill Observatory and the American member of the International Aeronautical Committee, made a balloon ascension from Strasburg, Germany, with his colleague, Professor Hergesell, on July 4, in connection with the eighteenth series in Europe. They reached a height of about 14,000 feet. The meteorological observations will be published in the United States *Monthly Weather Review*.

It is reported in *Nature* that the French Minister of War has asked the Paris Academy of Sciences to give an opinion as to the possibility of danger arising from the establishment of wireless telegraphy stations in the neighborhood of magazines containing powder or other explosives. It is suggested that the nature of the cases containing the explosive may be an important matter for consideration in connection with the subject.

THE British Institution of Mechanical Engineers held its summer meeting at Barrow-in-Furness, under the presidency of Mr. W. H. Maw, beginning on July 30.

MR. JAMES ANGUS, of West Farms, N. Y., who has given a valuable collection of butterflies to the American Museum of Natural History, and more recently a collection of Indian implements to the Providence Museum, has given to the latter institution his collection of corals and agates.

MR. J. EWING MEARS, of Philadelphia, has presented the George W. Mears Memorial Medical Library of Indianapolis with 4,000 medical books. The library was established as a memorial to his father, who practised medicine in Indianapolis.

ANDREW CARNEGIE has offered Montreal \$150,000 for a library, provided the city will contribute a site and spend \$15,000 yearly in maintenance.

THE secretary of the Marine Biological Association of the West of Scotland, Mr. John A. Todd, 190 West George St., Glasgow, has sent a notice stating that the General Committee of

the Association offers the following prizes, to be called the *Fred. P. Pullar Memorial Prizes*, provided by Sir John Murray, the honorary president of the Association, in memory of the late Fred P. Pullar, who was associated with him in the Bathymetrical Survey of the Scottish Fresh Water Lochs, who took much interest in the Millport Marine Station, and who lost his life in the unfortunate ice accident on Airthrey Loch, Bridge of Allan, on the 15th of February, 1901.

1. A prize of £50 for a paper on 'The Seasonable Distribution and Development in the Pelagic Algæ in the Waters of the Clyde Sea Area.'

2. A prize of £50 for a paper on 'The Reproduction, Development and Distribution of the Clyde Sea Area of the Genera *Nyctiphanes* and *Boreophausia*.'

3. A prize of £50 for a paper on 'The Formation and Distribution of Glauconite in the deposits of the Clyde Sea Area and the adjacent seas of Scotland.'

These prizes are open to investigators from any part of the world who conduct observations in the several subjects at the Millport Marine Station, and who produce, at any time before January 1, 1905, papers which, in the opinion of a committee of three scientific men, to be nominated by the committee of the Association and by Sir John Murray, shall be deemed of sufficient value to merit publication. Those proposing to work for any one of these prizes should make known their intention to the secretary of the Association in order that the necessary arrangements may be made.

At the last session of Congress the medical corps of the Army was increased from 192 to 321, and examinations for appointments as assistant surgeons in the U. S. Army will be resumed in Washington on September 2. The salary is \$1,600 per year, gradually increasing until after twenty years it amounts to \$2,500 and may be more if promotion to the position of lieutenant-colonel follows. The medical officers of the Army are also allowed free quarters, traveling expenses, instruments, books, etc. Candidates must have had a year's hospital experience or two years of private practice and must not be more than twenty-nine years of age. Details in regard to the examination can be obtained from the Surgeon-General's office, Washington.

THE United States Civil Service Commission announces that the examination which was announced to be held on September 3 for the position of computer in the Coast and Geodetic Survey has been cancelled, for the reason that the position for which the examination was to have been held has been filled by the transfer of a person already in the classified service.

THE organizing committee of the fourteenth International Medical Congress, which meets at Madrid next April, held a meeting on June 11, at which plans were discussed and promises of support given on behalf of the government and the municipality. The work of the Congress is to be divided into sixteen sections, as follows: (1) Anatomy (anthropology, comparative anatomy, embryology, descriptive anatomy, normal histology and feratology); (2) physiology, biological physics and chemistry; (3) general pathology, pathological anatomy and bacteriology; (4) therapeutics, pharmacology, and materia medica; (5) internal pathology; (6) neuropathology, mental diseases and criminal anthropology; (7) pædiatry; (8) dermatology and syphilography; (9) surgery and surgical operations; (10) ophthalmology; (11) otology, rhinology and laryngology; (12) odontology; (13) obstetrics and gynæcology; (14) military and naval medicine and hygiene; (15) epidemiology and technical sanitary science; (16) forensic medicine.

THE foreign trade of the United States during the fiscal year ended June 30 aggregated in value \$2,310,413,077, being an increase of \$65,988,811 compared with that of the previous year. Of this total the exports comprised \$1,487,656,544, exceeding those of the previous year by \$97,173,462, and the imports aggregated \$822,756,533, being \$27,184,651 less than those for the fiscal year 1900. The balance of trade in favor of the United States for that period reached a total of \$664,900,011, being an increase of \$120,359,113 over the balance for the previous year. Under the new relations with Hawaii and Porto Rico the commerce with those islands is no longer included in the regular statement of the foreign commerce of the United States. Had they been so included, as has been the case in former years, the total exports would have exceeded \$1,500,000,000,

as the exports to those islands during the year have aggregated about \$25,000,000.

THE St. Petersburg *Novoe Vremya*, as reported by Reuter's Agency, learns from Yeniseisk that Lieutenant Kolomütseff, in command of the steamer *Zaria*, which has on board the members of the Russian Polar expedition, under Baron Toll, has just arrived at that place to re-coal. Lieutenant Kolomütseff reports that the *Zaria* wintered in the Bay of Taimyr in $76^{\circ} 8'$ north latitude, and $95^{\circ} 6'$ east longitude, and that the winter passed fairly well except for some cases of scurvy among the crew. Lieutenant Kolomütseff twice endeavored to reach Kamchatka by land, but without success. He started on his first attempt on February 2, but was obliged to return at the end of 18 days, owing to lack of food for his dogs. His second fruitless attempt cost him 26 days, in the course of which he was able to explore the whole of the coast of Taimyr Bay. On April 18 he again left the *Zaria*, and arrived at Goldchik after a march of 40 days, during which he lived on the flesh of bears and reindeer. From Goldchik he proceeded with reindeer to Doudinki, and from there by boat to Yeniseisk. His present object is to establish coaling stations for the *Zaria* in Dickson Bay and on the islands of New Siberia.

PROFESSOR W. A. HERDMAN, as *Nature* learns, has received letters and natural history notes from Mr. Nelson Annandale and Mr. H. Robinson, who left Liverpool University College a short time ago for a year's exploration in the Siamese Malay States. Some of the observations made and material collected will be described at the forthcoming meeting of the British Association at Glasgow. Meanwhile, it is interesting to read the following notes from the naturalists: "We have obtained what is either a second species of *Periophthalmus* or a genus closely allied to it, and we have to-day ourselves collected a series of young specimens, which show that in extreme youth the eyes are normally placed on the sides of the head, and only migrate to the top later in life. We also got in water less than a fathom a most interesting case of commensalism, in which a small crab, with a very soft back, has the two last pairs of legs specially modified for holding on

a sea-anemone, which it grasps by the foot. * * * A good many cases of mimicry between different orders and families, principally between spiders and ants, homoptera and beetles, were noted—in at least ten cases the mimicked animal being an ant.

UNIVERSITY AND EDUCATIONAL NEWS.

MRS. CAROLINE STANNARD TILTON, of New Orleans, has given \$50,000 for a Tilton memorial library at Tulane University.

By the will of the late Herbert B. Adams, professor of history in the Johns Hopkins University, that University is made the residuary legatee. Amherst College is given \$2,000 for the library and the American Historical Association is given \$5,000.

WE are requested to state that in spite of the damage the building of the College of Physicians and Surgeons, Chicago, the medical school of the University of Illinois, suffered recently from fire, the administration of the College has suffered no serious disturbance and the institution will in the autumn be housed and equipped better than ever before.

DR. CHARLES BURTON THWING, professor of physics in Knox College, has been called to the same chair in Syracuse University.

PROFESSOR W. S. McCORMACK, of University College, Dundee, has been appointed secretary of the endowment for the Scottish universities, established by Mr. Carnegie.

THE Council of University College, London, has appointed Mr. J. D. Cormack, B.Sc., of Glasgow, to the chair of mechanical engineering vacant by the resignation of Professor Hudson Beare on his appointment as regius professor at Edinburgh, and Mr. Edgar Walford Marchant, D.Sc., to the lectureship in electro-technics vacated by Mr. Alfred Hay's appointment to a professorship at Coopers Hill.

DR. R. T. HEWLETT, of the Jenner Institute of Preventive Medicine, has been appointed professor of general pathology and bacteriology at King's College, London.

MR. R. C. PORTER, now lecturer in engineering at the government school at Cairo, has been appointed lecturer of mechanical engineering at Birmingham University.



Very truly yours
Joseph L. Carter

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

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FRIDAY, AUGUST 23, 1901.

JOSEPH LE CONTE.

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JOSEPH LE CONTE was born in Liberty county, Georgia, on February 26, 1823 ; he died in Yosemite Valley, July 6, 1901. In the years spanned by these dates he lived a life well worthy of respectful commemoration, a life whose record must exercise a benign influence upon the rising generation of scientific workers. To make such a record is not the purpose of this brief article. Here all that may be attempted is a grateful acknowledgment of having known and worked with the man, to outline his career, to indicate the goal he aimed at and the chief turning points on the highway of his life as he pursued that goal, and to make some loving comment on the most salient features of his personality. To those who feel keenly, as the writer does, the imperfection of this sketch, it will be a satisfaction to know that at the time of his death Professor Le Conte was engaged upon, and had practically completed, his autobiography, and that this will be published at an early date.

Joseph Le Conte was of French descent. His earliest American ancestor was Guillaume Le Conte, a Huguenot, who fled from Rouen after the revocation of the edict of Nantes, served under William of Orange in England, and finally settled in this country near New York, in the year 1698. His grandson Louis was born in 1782, graduated

from Columbia in 1800, and in 1810 moved to Liberty county, Georgia, where he had inherited a large plantation. Here he married Ann Quarterman, a lady of English Puritan descent. Of these parents Joseph Le Conte was born, one of a family of four sons and three daughters.

Louis Le Conte divided his time between the management of his estate and the pursuit of scientific studies, particularly chemistry and botany. He maintained a botanical garden which was famous in its day as one of the best in the country. Joseph Le Conte received his elementary education at a local school, but his father's tastes and scientific work exercised a powerful influence upon his youthful mind as it did also upon that of his brother John, and both were early drawn to the pursuit of science as their life work.

In those days almost the only profession that afforded an opening to scientific pursuit was that of medicine, so that, after graduating from the University of Georgia, both brothers entered upon the medical course at the College of Physicians and Surgeons, in New York, Joseph receiving the degree of M.D. in 1845.

It was in the summer vacation of 1844, when a young man of 21, that Joseph Le Conte made his first noteworthy geological excursion. In this year he joined the *first* prospecting and exploring expedition to the now famous mining district of the south shore of Lake Superior. The writer has several times listened with delight to Professor Le Conte's account of this boating cruise from the lower lakes to Keewenaw Point, of his camping adventures, and how, after a sojourn of a few weeks with the prospectors on Keewenaw Point, he and his cousin with some Indians proceeded on a long canoe voyage along the south shore to the present site of Duluth, and thence to the upper waters of the Mississippi and down to the Falls of St. Anthony, long before a

cabin existed on the site of the cities of Minneapolis and St. Paul.

After receiving his medical degree he practiced medicine at Macon, Georgia, from 1845 to 1850. In 1847 he married Caroline Elizabeth, the daughter of Alfred M. Nisbet, at Midway, near Milledgeville, Ga. His wife, one son and three daughters survive him. In 1850, feeling doubtless that the practice of medicine failed to afford those opportunities for the study of natural science to which he was so strongly inclined, and being drawn by the fame of Agassiz, he abandoned medicine and went to Cambridge. Here under the influence of the great interpreter of nature, his own career as a devoted student of science was finally determined. It is doubtful whether any other disciple of this great teacher has done more to advance the cause of nature study among the people of this country. In the early part of 1857 he was associated with Agassiz in a study of the keys and reefs of Florida, and it would be difficult to cite a more captivating study for two such kindred spirits, or a study where geological and biological interests are more intimately knit together. Late in the same year, having received the degree of B.S. at Harvard, he returned to Georgia and was elected to the chair of natural science in Ogelthrope University. This post he resigned the following year to accept the chair of geology and natural history in the University of Georgia, in which institution his brother John was the professor of natural philosophy. Here he taught for four years. In 1856 the brothers both resigned their chairs and accepted calls to South Carolina College, at Columbia, Joseph to be professor of geology and natural history and John to be professor of physics. They held these positions till 1862, when the college succumbed to the trouble arising out of the Civil War. These were busy years at Columbia; in the enjoyment of the con-

genial society of the place they were pleasantly spent, though sadly interrupted.

When teaching gave way to more serious duties Joseph offered his services to the Government of the Southern Confederacy, and was for a time engaged as chemist in the government laboratory for the manufacture of medicines, and later as chemist at the Nitre and Mining Bureau at Columbia, of which his brother John had been appointed superintendent. In this work he continued till the close of the war.

In 1866 the University of South Carolina was reorganized and the brothers resumed their professorships. But in the crippled condition of the community it soon became apparent that it would be long before opportunities for scientific work would be opened up. Their private fortune had been swept away by the war, and when in 1868 they were invited to join the initial staff of the University of California, then being organized, they both accepted. At the age of 46 Joseph Le Conte thus became professor of geology, botany and natural history in the University of California. The title of his chair was changed in 1872 to 'geology and natural history,' and this chair he held up to the time of his death.

From this brief sketch of the mere externals of Professor Le Conte's career, the character of his life-work as a student and teacher of natural science must impress the reader. This impression will be sustained and strengthened by a glance at the long list of his writings appended to this article. He was no narrow specialist, yet he was an authority in advance of his contemporaries in several distinct lines of scientific and philosophical inquiry. His earliest writings of scientific importance had to do with the phenomena of binocular vision, which he discussed in a long series of papers, published chiefly in the *American Journal of Science* and in the *Philosophical Magazine*, between the years 1868 and 1880.

These essays were enlarged and published in his well-known book of several editions entitled 'Sight.' This work is generally recognized as an important contribution to our knowledge of the subject and is remarkable for that lucidity of style and felicity of graphic illustration and simile which characterize, indeed, all his writings. While issuing these papers he was, after coming to California, actively engaged in geological studies. Various excursions in the Sierra Nevada and in the Cascade Mountains of Oregon led to important discoveries. He announced the age and character of the Cascade Mountains and their relation to the great Columbia lava flood; he described the ancient glaciers of the Sierra Nevada, and was among the first to recognize the post-Tertiary elevation of the Sierra Nevada, as shown by the river beds. His studies on mountain structure led him to important generalizations on the origin of mountains in general, and he became one of the chief exponents of the 'contractional theory' of mountain building. His studies on ore deposition at Steamboat Springs, Nevada, and Sulphur Bank, California, led him to a discussion of vein formation in general; and his classification of ore deposits has been widely recognized as resting on a sound basis and is not displaced in its essential features by the most recent attempts in the same direction. He also made important contributions to the subjects of seismology and coral growth in its geological aspects.

In 1878, he published his 'Elements of Geology,' a book which has had, perhaps, a more extensive use in the schools and colleges of this country than any other textbook in the natural sciences. This was followed in 1884 by his 'Compend of Geology,' a more elementary treatment of the same work. He was also interested in many other scientific and medical subjects such as 'The Problem of Flight,' 'The Func-

tions of the Liver,' 'Ptomaines and Leucomaines in their Relation to Disease,' 'The Larynx as an Instrument of Music,' etc. The mere mention of these varied subjects indicates the breadth of his interests and sympathies, but they by no means measure his intellectual activity. He was an active and successful exponent of the doctrine of evolution, and extended its principles to many fields of thought. Indeed, the evolutionary idea was the dominant note in nearly all his many philosophical writings and addresses. His strong advocacy of evolution as a principle running through all nature may be regarded as the most fruitful of his life's labors. On the battle ground, not long since so fiercely contested, between science and religion, he did splendid work, not, however, intensifying and embittering the strife, but in the work of conciliation, in the demonstration to thoughtful men in the camp of the churches that there could be no real conflict between seekers for truth whether in the pulpit or in the laboratory; that science sought simply the truth, nothing more, nothing less, and that in so far as scientific truth rested on a verifiable basis it was futile for the church to assail it.

But science, philosophy and religion failed to suffice his vigorous intellectual appetite. He was strongly interested in art; and the principles of art and their relation to science was one of his favorite themes.

It is needless to say that a man so fruitful of ideas as Professor Le Conte, so happy and so forceful in their expression, was eminently successful as a lecturer and public speaker. While he rather shrank from extempore addresses he was always willing to speak on public occasions and was always in demand.

Professor Le Conte's scientific work and influence extended beyond the writing of papers and books. He entered heartily

into the scientific life of the nation and took an active interest in various organizations which have for their purpose the strengthening and extending the love of science among the people. He was a member of the National Academy of Sciences, associate fellow of the American Academy of Arts and Sciences, corresponding member of the New York Academy of Sciences, member of the American Philosophical Society, fellow of the American Association for the Advancement of Science and past-president of the same, fellow of the Geological Society of America and past-president of the same, life member of the California Academy of Sciences, member of the Boston Society of Natural History, honorary member of the Brooklyn Ethical Association, member of the Iowa Academy of Sciences, member of the Davenport Academy of Sciences, member of the American Institute of Mining Engineers, member of the National Geographical Society, member of the International Geological Congress and once vice-president of the same, member of the California State Medical Society, honorary member of the South Carolina State Medical Society. He was also associated with the editorship of the *Journal of Geology* and of *SCIENCE*.

While Professor Le Conte, by his writings and by his active participation in the proceedings of the various societies just mentioned, had become a force in the intellectual life of the nation, this was only one element of his remarkable strength at the University of California. Here his intellectual achievements were overshadowed by the great and remarkable personality of the man. His singularly sweet and simple character seemed to seize upon all who came in contact with him and bind them to him as admiring friends. Indirection in any of its forms was utterly foreign to his nature. He was true to his ideals throughout life and his influence in the University

was always for the noblest and best in human effort. While too engrossed in his scientific and philosophic writings to take the initiative in University or public affairs, he was ever in touch with the progress of the time, and ever sympathetic and healthful in advance movements. He was of an exceptionally cheerful and happy disposition and was possessed of a fund of humor that made him a sparkling and entertaining conversationalist. He had the graces and manner and speech and chivalric instincts of a gentleman of the old southern school. He was beloved by the whole University, and with increasing years this love became a sort of veneration, so that he was in the later years of his life the veritable idol of the University community.

His death, without lingering pain, in the midst of the grand Sierra that he loved so well, surrounded by many of his friends, was a fitting close to his long life. His kindly presence and benign influence will long live in the memory of the University, and in the world of science he has certainly established for himself a monument more lasting than brass.

ANDREW C. LAWSON.

UNIVERSITY OF CALIFORNIA.

AN AMERICAN SENATE OF SCIENCE.

WHEN in the course of human events the most vigorous colonies of the New World deemed it necessary to found a nation, they cast aside tradition and example and invented a system of government based on the theory of human equality. The movement opened a new chapter in the history of nations; earlier governments grew into form much as the primitive implement takes shape by continued use, but this was a distinct creation, like the complex tool invented and made for a purpose; and the fundamental theory was new in application if not in thought. The invention of the colonists was applied experimentally, and

worked well; minor changes were found needful here and there in the adjustment of the mechanism to its work, yet remarkably enough the most sweeping changes led directly toward the fundamental theory of equality; and for a century and a quarter the world's first invented government has proved the world's most successful government. The device of governing by the people for the people was adopted by the component organizations with equally satisfactory results. The colonies, and after them the states, rested on the fundamental theory; the municipalities followed; counties and townships and villages adopted practice and theory together; and political organizations sprang from the theory to shape the practice of governmentation. In the smaller organizations as in the larger the governmental mechanism has worked well; difficulties have arisen, yet remarkably enough most of these have resulted from the opposition of one-man power to the theory of equal rights; and the world's most striking examples of growth in cities and States are found in numbers in the nation invented by its founders.

The essential mechanism of the invented government was that of control by equitably selected representatives. Provision for keeping the control adjusted to current needs was made by limiting tenure of office and excluding hereditary privilege; while provision against undue instability was made by arranging for the equitable selection of representatives of a second order, *i. e.*, representatives of representatives. In that branch of the government performing legislative (or constructive) functions, these representatives of representatives are organized in senates, whose powers are coordinate with those of the primary representative bodies. In general terms, the representative body is the progressive factor, the senate the conservative factor, of the body-politic; and it is the special function of the

senate to coordinate spontaneous movements, and thus to perpetuate the integrity and vitality of the organization. To borrow analogy from planetary assemblages, the representative body is as the centrifugal force, the senate as the centripetal force, combined in orbital progression. The important fact is that political organization of the modern and successful sort is incomplete without provision for the maintenance of internal harmony, of stability, of vitality—as in the senates of the invented nation and its constituent states.

Now America has become a nation of science. An unequaled proportion of her citizens are engaged in scientific research, while it is not too much to say that the masses of the people recognize the principles as well as the applications of science in their everyday avocations; the scientific spirit is fostered and diffused by a number of voluntary associations of scientific character probably larger in proportion to population than can be found in any other country; and our statesmen are guided by the conclusions of science, while our federal and State governments support science, in unequaled degree. Yet despite their activity and numbers, despite the extent and strength of their voluntary associations, American scientists have not profited by the example of the nation's founders, and have taken no steps toward shaping the further progress of science by representative organization. Many, if not most, of the voluntary associations indeed have executive bodies to exercise appropriate administrative and judicative functions, and perhaps to propose legislative action; but this mechanism merely simplifies the transaction of business, the powers of the elected representatives are limited to the affairs of a particular association of which the body is a part, and there are no representatives of the second order—no representatives of representatives—empowered to

act in the interests of science in general. It is not, of course, the function of science to govern, so that governmental organization *per se* is not required on the part of scientific men or their associations; but collective action for common interests demands organization—and one of the surprising features of American science (especially in view of the example set by statecraft) is its unorganized condition. True, each special science is fostered by one or more voluntary associations, sometimes of national character; true, general science is represented in each principal city by one or more voluntary associations, perhaps loosely confederated, as in New York and Washington; true, some fields of research have been preempted by the federal government in the public interest; true, different sciences are cultivated by the aid of special journals; yet the great fact remains that the scientists and scientific interests of America are not well coordinated, much less unified in a symmetric whole. The centrifugal tendency is strong; the centripetal factor requisite for independent character is lacking.

An effective mode of organizing American science is suggested by the constructive organization of the nation in which scientific progress has been most rapid—it is that of organizing the voluntary associations in what might be called a Senate of American Science. The successful example of American nationality would suggest that such a senate should be made up of delegates chosen by the voluntary scientific associations of the country, for limited terms, in numbers equitably proportionate to the size of the representative associations. The functions of the general body would naturally include (1) coordinating scientific interests and progress; (2) representing science in its broader aspects on behalf of the country; (3) forming a nucleus for scientific congresses, national and international; (4) fixing the bases of represen-

tation of the primary associations; and fulfilling any other duties connected with scientific interests and its own maintenance.

Two methods of procedure toward the organization of such a Senate of Science present themselves: The first suggestion is that of creation *de novo*, on the initiation of a few leaders in scientific thought. The chief advantage of this method would seem to lie in the freedom from entangling alliances; the chief obstacle would seem to grow out of the large initial energy required to set the mechanism in effective operation. The second suggestion is that of utilizing some existing organization, naturally of national character, as a nucleus. The chief advantage of this method would be that of economy in initial energy; while a serious obstacle might grow out of the indisposition of any existing association of national character to undertake the necessary reorganization. As between the two methods suggested, the sum of theoretical advantages would seem to favor the independent organization; though it might easily be that practical considerations would turn the advantage toward the method of reorganization of an existing society.

On reviewing the societies which might yield a nucleus for a national Senate of Science, several would seem worthy of consideration on various grounds; yet such consideration would seem to eliminate all but two or three from final review. These are (1) the American Association for the Advancement of Science, the oldest of our national scientific societies of general character, and the one most completely in touch with the scientists of the entire country; (2) the National Academy of Sciences, the most dignified and exclusive of our voluntary associations of scientific character; and perhaps (3) the Washington Academy of Sciences, one of the youngest and most vigorous of our scientific organizations, and

one already possessing (at least in inchoate form) a confederate character.

The availability of the last-named organization would seem questionable, primarily on the ground of its local character, partly because of its youth and the consequent uncertainty as to its real character and actual prospects. Although apparently available on casual consideration, the National Academy would seem on closer scrutiny to be fundamentally unsuitable as a nucleus for a coordinative super-organization; for it is based largely on foreign models, is out of accord with the theory and the practice of popular government, and has developed functions diametrically antagonistic to the limited tenure and representative character which would seem requisite for the success of a working senate. True, its membership comprises the most honored names in American science, men whose prestige and support would doubtless be essential to the success of a more general organization; but it would appear probable that most of the working members of this dignified body would enter in due course, by virtue of their standing, into a representative organization. The remaining society (the American Association for the Advancement of Science) would seem to offer an available nucleus through its Council, a body already representative in that it is made up largely of delegates nominated in the several nearly independent sections. It has the further advantage of serving already as a nucleus for other scientific organizations, a number of which meet with it annually, contributing materially to its standing and its influence on current thought concerning matters of scientific interest. This aspect of the Association and its Council was brought out clearly in a recent number of SCIENCE, and the exposition need not now be repeated; it suffices to note that the organization of the Association, its large and widely dis-

tributed membership, its strong hold on the sympathies of scientific men, the high appreciation in which it is held throughout the country, and the appropriate constitution of its Council, all point to the American Association for the Advancement of Science as a suitable nucleus for a Senate of Science—whenever the time arrives for establishing such an organization.

An obstacle in the way of instituting an American scientific body of general character may be noted: Our country is one of magnificent distances, so that the cost of attending meetings or sessions is necessarily large; and equitable representation in a general body would seem to require provision for meeting costs of travel incurred by delegates. Doubtless this could be effected through *pro rata* assessment on the constituent associations, if the central organization were once well under way; and it is possible that the burden might be measurably diminished by migratory meetings, after the fashion of the associations for the advancement of science in different countries. The difficulty might perhaps be overcome by securing a foundation through donation, bequest, or otherwise; certainly it is not insuperable in these days of unprecedented scientific prestige, and of rapid increase in material prosperity through the applications of science.

Summarily, it would seem appropriate for American scientists to draw inspiration and suggestion from American statecraft as to organization; it would seem timely to start a movement toward the more comprehensive organization of American science in connection with the first great assemblage of scientific men in the western half of the country; and it would seem especially fitting to initiate the movement at the approaching meeting in Denver of that organization which would most properly serve as a nucleus for an American Senate of Science.

W J M.

SOME STRANGE PRACTICES IN PLANT NAMING.

IN a recent issue of the *Bulletin* of the Catholic University of Washington, the distinguished professor of botany in that institution, Dr. Edward L. Greene, presents what he announces to be the first of a series of papers entitled 'Some Literary Aspects of American Botany.' It should be a source of gratification to the whole scientific fraternity that public attention has been thus called to the philological abuses so prevalent among the latter-day writers. This first paper contains a trenchant and forcible criticism of the titles applied to many recent botanical serials; and the author's commentary on such examples as 'Contributions to the Myxogasters of Maine,' and 'Contributions from the Herbarium of Franklin and Marshall College' is scarcely less instructive than entertaining.

It is a significant fact that this article by Professor Greene has already elicited a paper on a kindred topic, written by Dr. P. A. Rydberg and published in *Torreyia* for June. As the latter author confines himself, however, to a discussion of personal specific names and their mode of construction, I may be permitted to offer a brief commentary on the subject of plant names in general, from both the orthographical and etymological standpoint.

It has always been a widely accepted principle of scientific nomenclature that a specific once published cannot be subsequently altered in form except upon 'reasonable grounds'; but there has been, and still continues to be, a wide divergence of opinion as to what constitutes reasonable grounds for such alteration. The author of the name has usually been allowed more latitude in this respect than other writers; and in past botanical literature there are consequently many changes in orthography, corrections of typographical errors, etc., made either by the author himself, or more

frequently by other writers who may have had occasion to review his work. These alterations extend all the way from simple substitutions of one letter for another to the replacement of the name itself, generic or specific or both, by an appellation considered more appropriate. When to this uncertain element in plant nomenclature we add the whole vexed question of the principle of priority and the subject of type determination, it seems remarkable that in the progress of botanical science so few opposing schools of belief have been developed.

It may be profitable to give some consideration to the various views that have been entertained regarding the extent of alteration permissible in the case of incorrect or inappropriate scientific names. For convenience in discussion the various categories under which changes have been made will be taken up under separate headings.

1. *False Descriptive Names.*—Botanical nomenclature includes countless numbers of these, many of which have found acceptance from time immemorial. Thus *Polygala* is wholly destitute of milky juice; the stem-leaves of *Campanula rotundifolia*, which are frequently the only leaves discernible at maturity, are narrowly linear; *Viola villosa* is in no sense villous; and *Lunaria annua* is usually biennial. While the modern nomenclator would find little support in an attempt to change such names on the ground of their unsuitability, the practice was common among writers of the first half of the nineteenth century, as well as among the immediate successors of Linnaeus. Rafinesque, in particular, was fond of reading the riot act to his contemporaries for what he considered an outrageous disregard of natural characters in the assignment of plant names, as the following verbatim passage, selected at random from the 'New Flora of North America' (Vol. 2, page 95) will show:

"My genus *Diplostelma*, which Nuttall

had wrongly reduced to *Actinocarpus*, in Collins' herb. (there is no such genus, he meant probably *Actinospermum* of Elliott) has been described by him under the name *Chetanthera* in his new plants. * * * My name is the best, although Nuttall's dates of 1834, *Chetanthera* means bristly anthers, while this is not the case, he ought to have named it *Chetopappus*, but as the pappus is double and different mine is the best, and must be retained."

In the case of *Lunaria annua* mentioned above, published by Linnaeus in 1753, we find that Moench subsequently altered the name to *biennis* in recognition of its biennial character. Writers like Bentham and Gray did not adopt this extreme view, but if in the transfer of a species from one genus to another the specific designation became inappropriate through duplication of the idea contained in the generic name, they invariably took the liberty of changing it. Thus when *Anemonella thalictroides* was transferred to *Thalictrum*, it became *Thalictrum anemonoides*. Inasmuch as the acceptance of such a combination as '*Thalictrum thalictroides*' would imply an agreement with the doctrine of the entity of specific names it was entirely natural and logical for Bentham and his associates, who were strong opponents of that doctrine, to consider such cases exceptional to the rule of priority. If, however, we admit that a specific name is meaningless when disassociated with a generic, there seems no good reason why we should not continue the process of alteration, and follow in the footsteps of the immediate post-Linnaeans. There can be no half-way ground between him who would substitute '*biennis*' for '*annua*' on the one hand, and the botanist who believes in the immutability of specific names on the other.

2. *False Locality Names.*—The writings of Linnaeus and his contemporaries abound in instances of this sort. In many cases

the anomaly that now exists in such specifics as *Berberis Canadensis* and *Cercis Canadensis*—neither of the plants mentioned occurring beyond the Carolinian zone—results from the ignorance of geography displayed by the Old-World botanists of that day; frequently it is due to the great political changes that have taken place in this country during the last one hundred and fifty years. Even in modern times it is a common occurrence for a species to receive its designation from the State in which it was first discovered; and the fact that it may subsequently be found to extend into many other States has never been considered a sufficient reason for renaming it. But what are we to say of *Asclepias Syriaca*, which is exclusively an American milkweed? Decaisne promptly renamed it *Asclepias Cornuti*, and in this he was followed by Gray and other botanists. There are several writers of the present day who favor the alteration of names that state a geographical untruth.

A large number of genera, dedicated to individuals, have been incorrectly spelled, either through the author's ignorance or the compositor's blunder. Examples are Nuttall's *Wisteria*, dedicated to Dr. Wistar; Brown's *Lechenaultia*, named for Leschenault; and Rafinesque's *Scoria*, published as a misprint for *Hicoria*. De Candolle's rule in this connection was: "When a name is drawn from a modern language it is to be maintained just as it was made, even in the case of the spelling having been misunderstood by the author, and justly deserving to be criticized." Dr. Gray considered this rule too absolute, and admitted corrections not only of orthography, but also of errors in the construction of names of Latin or Greek derivation. If the eminent botanist of Harvard University were alive to-day it is to be feared that a large portion of his time would have to be devoted to this work if he wished to thoroughly revise the no-

menclatorial output of the present generation.

3. *Names falsely constructed.*—This includes words derived from modern languages without adaptation to the Latin or Greek form, and those compounded of elements from two or more languages. The writings of Adanson and Necker are full of generic examples of the latter type, and many of these have been taken up under the operation of the law of priority. Of the Adansonian names *Ananas*, *Sesban*, *Cajan*, *Sabal*, *Konig*, *Gansblum*, and *Rulac* it will be observed that none are in strictly correct Latin form, and with the exception of *Konig* and *Gansblum* they are all, I believe, of unknown derivation. It might naturally be inferred that the whole list should stand or fall alike; yet the curious inconsistency is found, that while *Sabal* has been accepted by botanists of every school for several generations, and while *Cajan*, *Sesban* and *Ananas* have been taken up under the Rochester code and are adopted by all its followers, the mere suggestion of *Rulac*, *Gansblum* or *Konig* as generic possibilities is received with amusement or contempt by the average botanist.

Before discussing these latter cases in detail, however, let us refer to the other class in my third category, consisting of so-called hybrid names constructed of elements from two distinct languages. Of these, modern botanical literature is furnishing a rich and ever-increasing store of examples. They may consist: (1) Of Greek terminations welded upon Latin nouns or *vice versa*, resulting in such products as 'graminoides' or the still more remarkable 'cenchrusoides.' (2) They may be compound adjectives, of which one element is Greek, the other Latin; this type is well illustrated by 'pseudocaudatum,' 'polyclavatum' and 'magnasora,' all of which have been recently published in the same journal. (3) Personal generic titles composed of an English proper name with a classical adjective used

as prefix or suffix, like *Vaseyanthus*, *Pringleophytum*, *Neonelsonia*, and *Paleohillia*. It was Dr. Otto Kuntze who astonished the world and carried off the palm in this class by the establishment of such genera as 'Sirhookera' and 'Peckifungus.'

I am quite well aware that these compound personal names have many defenders even among prominent scientists; it is argued that since personal genus-names are properly formed by the addition of the Latin suffixes *-a*, *-ia*, *-ella*, *-ina*, etc., there can be no objection to making these suffixes consist of an adjective or noun. But while the practice may not be technically incorrect, it is certainly not harmonious with the fundamental principles of etymology, and the results, whether we consider them from the standpoint of euphony or signification, are frequently ludicrous. Moreover, they often originate on account of an inordinate and misdirected desire to honor a collector with more than one generic dedication. This has become a common practice, although formerly it was held as a general principle that one genus, and one only, could be dedicated to a single individual; while in the case of species, it was customary to single out one striking new plant from the list and designate it in honor of the collector, other new species receiving descriptive names. But nowadays, if John Smith, let us say, visits some remote country and returns with a series of specimens containing several new genera and perhaps thirty new species, the botanist who determines his collection, finding a previously-published *Smithia*, establishes a '*Neosmithia*' and a '*Smithiophytum*,' perhaps also a '*Smithiocarpus*' or a '*Pseudosmithia*'; while among the new species we shall probably find a '*Smithii*' for each separate genus. The same traveler is likely to be similarly honored if he reaps an equally rich harvest in another locality the following year.

Another objectionable class of names belonging to the same general type are those derived from localities with the addition of the Latin suffix *-ensis*. Originally this was applied to names of States or countries already in the Latin form; and *Virginienensis*, *Carolinensis*, etc., are irreproachable. But then we began to have *Bostoniensis*, *Tennesseeensis* and *Wyomingensis*; one writer has furnished us with '*Bajensis*,' from Baja, the Spanish name of a small Californian town; and within the last few months a distinguished German systematist, having occasion to describe a new *Selaginella* from a certain locality in Africa, has applied to it the graceful and flowing designation '*njam-njamensis*.'

Whatever may be one's individual views concerning combinations of English personal names with Latin suffixes, I am sure that very few defenders will be found for the other classes mentioned, of which '*graminoides*' and '*pseudocaudatum*' are types. To those whose classical vocabulary is limited, the pages of the Latin lexicon afford numerous suggestions for specific names irreproachable in form and pregnant with meaning; it seems strange that so large a proportion of our systematists regard the rules of etymology and grammar as of so little importance in plant naming. Glancing over the pages of one or two of our prominent serials, I noted the following examples of Latin and Greek hybrids, many of which are as clumsy in their lack of euphony as they are faulty in their construction: '*paucicephala*,' '*pauciphylla*,' '*curvicarpus*,' '*crestencarpus*,' '*cuspidocarpus*,' '*arenicoloides*,' and '*polyclavatum*.' I have not thought it worth while to discuss such specific names as '*annulum*' for *annulatum*; '*areniculum*' for *arenicola*; and '*glabrissimum*' for *glaberrimum*, though these were actually published in all seriousness by authors of whom better work might have been expected.

In his review of De Candolle's 'Nouvelles Remarques sur la Nomenclature Botanique' Dr. Gray, in commenting upon the suppression of the fourth section of article 60 in the Paris Code, enjoining the rejection of names formed by the combination of two languages, observes: "Let us hope that we shall not be driven to the acceptance of the specific name 'acuticarpum' which one of our botanists has recently perpetrated." Whatever may be our views of nomenclature we must admit that in intellectual and philological attainments the botanists of the past generation are our superiors, and we cannot fail to award them respect and admiration for their vigorous efforts in behalf of the purity of scientific terminology. The list of recently published names above cited, on the other hand, may be accepted as evidence of what plant nomenclature in the twentieth century is coming to.

Having thus discussed at some length the various forms of false or otherwise objectionable plant names, with some slight indication of the historical practice in each case, we are led naturally to a consideration of the final question, what is to be done with these names? To my mind a serious discussion and an authoritative reply to this question are of vital importance at the present stage of botanical nomenclature in this country. We now have a working code, based on sound general principles and appealing in its practical operation to the spirit of law and order rather than to the fickle quality of individual judgment. Yet this code is absolutely silent upon the important question of correctness in plant naming. To be sure, it reaffirms the canons of the Paris code except where they conflict with its newly established principles. But the Paris Code is an instrument of considerable age, and, excellent as are most of its provisions, few botanists would now subscribe to all the Decandollean requirements. The modern tendency is to avoid interfer-

ence with any erroneously constructed terms unless the mistake is one of gender or orthography. The sentiment against altering false descriptive and false locality names like *Lunaria annua* and *Asclepias Syriaca* is even more strong; and this attitude seems reasonable, since these names are entirely correct in form, and the fact that they are untrue or anachronistic is frequently not the fault of the original author.

Objections, however, to the alteration of incorrectly constructed names like 'graminoides' are of little force in view of the position taken by many writers with regard to barbaric and other names not in the Latin or Greek form. I have already pointed out how certain Adansonian genera have been accepted without question while others of the same stamp are rejected. An attempt has been made to Latinize some of these by adding the termination *-a*; but the result is bastard Latin at best, and is far from the spirit of Adanson's original intention. Konig, for example, a word distinctly German in form, has been changed to Koniga! If by the mere Latinization of a name derived from some modern language it is to be considered legitimate, then why not take Gansblum of the same author and make it Gansblumia? The logical application of this theory would make it possible to adopt 'Washtubbia' and all of the other wonderful creations in the 'Nonsense Book of Botany.'

I am quite well aware that to retain in their present form the barbaric names of Necker and Adanson and the Aztec atrocities of ten or more syllables published by Hernandez in 1790 would be open to serious practical objection; but it is absolutely certain that all should stand or fall alike. *Sabal* has no more rights than *Rulac* or *Konig*; and if the Latin termination of *Bikukulla* entitles it to admission there is no shadow of an excuse for altering the *k*'s to

c's, as has been done in our recent manuals. If, on the other hand, we adhere to the view that a name, to be worthy of acceptance, must be in Latin form, we have no recourse but to abolish 'graminoides,' 'polyclavatum,' and the other hybrids, relegating them to the same limbo of obscurity with *Gansblum*, *Catjang*, *Rulac* and similar creations.

After uniformity in recognizing the rights of the doctrine of priority, the most important thing is to secure uniformity in our treatment of the names assured to us through the operation of that principle. It is true here, as in most other affairs, that the fewer exceptions we admit, the greater the practical benefit of the rule. At the present time our writers are serenely pursuing their individual preferences, correcting a name when they deem it advisable to do so, or even making substitutions of one name for another through one of the causes above discussed. It matters little whether we establish a rule of absolute permanency, retaining names in exactly the form in which they were first published, or whether we admit certain fixed exceptions; but the determination of a case should always be settled by authority and never left to personal caprice. No principle can be maintained if it is to be followed only at discretion.

One practical obstacle to any improvement of existing conditions is to be found in the tendency of the age itself. In this connection, let me quote a paragraph or two from the article by Professor Greene above referred to:

"It is easy to trace to its origin this condition of scanty mental equipment evinced by a great number of the botanical writers of to-day. Young men of the present are more than ever in haste to be earning wages and getting rich. It is a vulgar spirit which pervades—it is everywhere confessed—all classes of youth, as well as of older

people. Even they who aspire to what were once known as the learned professions, will hardly allow themselves the expenditure of time, not to say money, that is necessary to acquire anything beyond the most elementary and superficial education. * * * Nature study is captivating, perhaps much more so than grammatical, linguistic and metaphysical studies, to youth in general. There is no doubt of that. Neither need it be called in question that even a single branch of natural history study, long and ardently pursued, must have the effect of training a mind to careful and minute observation, and to reasoning and reflecting, and this is an important part of an education. But in our time few if any nature students are content with observing and thinking. All must write and print; and this whether they have or have not learned to write."

Against this somewhat discouraging state of affairs we are to set the tendency of the present time to recognize law as paramount and personal judgment as an uncertain guide. If botanists of all schools can be brought together in a strong and united effort to improve the literary and etymological side of nomenclature, it will not be difficult to secure agreement upon some sound general principle which will command the respect and win the adherence of every working scientist. There is here a subject upon which conservatives and radicals may unite, and a condition of affairs which cries aloud for attention and reform.

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THE USE OF HYDROCYANIC ACID GAS FOR EXTERMINATING HOUSEHOLD INSECTS.

WITH the growth of our population and the consequent crowding together of residences, the problem of the prevention and control of household insects is deserving of careful consideration from a sanitary stand-

point, but one that is usually overlooked. These pests are to be found in fewer or greater numbers of both species and individuals in every dwelling, office or storehouse, and no perfectly efficient means either to prevent their gaining an entrance, or to exterminate them when they are once established, has as yet been devised.

Recent successful applications of hydrocyanic acid gas for the extermination of insects infesting greenhouse plants have suggested the use of the same remedy for household pests. It is now no longer a theory, but an established fact, that .10 gram of 98-per-cent.-pure cyanide of potassium volatilized in a cubic foot of space will, if allowed to remain for a period of not less than three hours, kill all roaches and similar insects.

The experiments which led to this conclusion were made in a small building which is used for laboratory purposes by the Division of Botany. This structure has for some time been infested with several insect pests, the more numerous and troublesome being the common cockroach (*Periplaneta americana*). The building consists of one story and basement, the upper part being rather loosely built, as it is ceiled throughout with matched lumber. This method of construction provides numerous hiding places for the insects and also renders fumigation difficult, by permitting the gas to escape too quickly. Within the building are several sources of moisture, a rather high and constant temperature is maintained in some of the rooms, and large quantities of seeds and substances that serve as food for insects are stored, making conditions well adapted to the development of cockroaches.

During the early part of last year the roaches became so numerous as to be a detriment to the work of the laboratory and it was necessary to adopt some means of checking them. On the evening of May

10, 1900, the building was closed, and after opening up the interior of the rooms as much as possible the entire structure was fumigated experimentally with about .08 gram of 98-per-cent.-pure cyanide of potassium per cubic foot of space. The gas was allowed to remain during the night, or until it gradually escaped. When the rooms were entered the following morning there remained a perceptible odor of the gas, but this soon disappeared after opening the windows and doors. The ledges and window sills were strewn with dead houseflies and the floors bore abundant evidence of the effect of the gas on roaches. Not a single insect that showed indications of remaining life was to be found in the building. About a quart of the flies and roaches was gathered up and placed in a cage where they were allowed to remain until the following day, when two roaches showed signs of life by slow movements; these, however, could not walk when placed upon their feet and subsequently died.

For some time after this fumigation no roaches were to be found in the building, but eventually the eggs that had been previously deposited hatched and developed, adults were carried in from other buildings, etc., until in March of the present year the roaches had again become so numerous as to be a nuisance and a detriment to the work of the laboratory. The building was again treated with cyanide gas, this time at the rate of .10 gram per cubic foot of space, but was allowed to remain only fifty minutes, when the windows were opened and the gas permitted to escape. The roaches were strewn over the floors and several mice were found dead. A large number of the roaches were again collected and kept in a cage until the following day, when it was found that fully ten per cent. of them had not been killed and were as lively as before treatment; the mice, however, showed no

indications of life. The dose had been sufficiently strong, but had not been allowed to remain long enough to kill the more resistant of the roaches.

The third and most satisfactory experiment of the series was conducted on the evening of June 20, 1901, when an application of .10 gram per cubic foot was allowed to remain in the building over night. On the following morning the gas had not entirely escaped, and house-flies, centipedes, spiders, cockroaches, and mice were dead, with the exception of a few roaches that had secreted themselves between the sash and frame of a loosely fitting window and had thus secured enough pure air to prevent their being killed.

To convey an idea of the injury caused by the presence of large numbers of roaches in this laboratory it might be stated that frequently preceding this last fumigation, photographic plates placed on racks to dry and allowed to remain on a table for one hour were completely ruined by having the films eaten from the glass; packets of seeds stored in mouseproof tin boxes were so eaten as to allow the seeds to escape and in many cases the seeds themselves were destroyed. Since this fumigation no inconvenience has been caused by the work of roaches or mice.

By aid of the results obtained from the above experiments, together with our present knowledge of the action of hydrocyanic acid gas in exterminating greenhouse and scale insects, it may be stated that a dwelling, office, warehouse or any building may be economically cleared of all pests, provided that the local conditions will permit the use of this gas. It probably would be dangerous to fumigate a building where groceries, dried fruits, meats, or prepared food materials of any kind are stored. Air containing more than 25 per cent. of the gas is inflammable, therefore it would be well to put out all fire in an inclosure before fumigating. Hydrocyanic acid in all

its forms is one of the most violent poisons known and no neglect should attend its use. There is probably no sure remedy for its effects after it has once entered the blood of any of the higher animals. When cyanide of potassium is being used it should never be allowed to come in contact with the skin and even a slight odor of the gas should be avoided. Should the operator have any cut or break in the skin of the hands or face it should be carefully covered with court plaster to prevent the gas coming in contact with the flesh, or the possibility of a small particle of the solid compound getting into the cut, which would cause death by poisoning within a few minutes' time.

Hydrocyanic acid gas should not be used in closely built apartments with single walls between, as more or less of the gas will penetrate a brick wall. An inexperienced person should never use cyanide of potassium for any purpose, and if it be found practicable to treat buildings in general for the extermination of insects the work should be done only under the direction of competent officials. Our experiments have shown that a smaller dose and a shorter period of exposure are required to kill mice than for roaches and household insects generally, and it readily follows that the larger animals and human beings would be more quickly overcome than mice, since a smaller supply of pure air would be required to sustain life in mice, and small openings are more numerous than large ones.

The materials employed and the method of procedure are as follows: After ascertaining the cubic content of the inclosure, provide a glass or stoneware (not metal) vessel of two to four gallons capacity for each 5,000 cubic feet of space to be fumigated. Distribute the jars according to the space and run a smooth cord from each jar to a common point near an outside door where they may all be fastened; sup-

port the cord above the jar by means of the back of a chair or other convenient object in such a position that when the load of cyanide of potassium is attached it will hang directly over the center of the jar. Next weigh out upon a piece of soft paper 500 grams (about 17.1 ounces) of 98-per-cent.-pure cyanide of potassium, using a large pair of forceps for handling the lumps; wrap up and place in a paper bag and tie to the end of the cord over the jar. After the load for each jar has been similarly provided, it is well to test the working of the cords to see that they do not catch or bind. Then remove the jar a short distance from under the load of cyanide and place in it a little more than a quart of water, to which slowly add one and one-half pints of commercial sulphuric acid, stirring freely. The action of the acid will bring the temperature of the combination almost to the boiling point. Replace the jars beneath the bags of cyanide, spreading a large sheet of heavy paper on the floor to catch any acid that may possibly fly over the edge of the jar when the cyanide is dropped, or as a result of the violent chemical action which follows. Close all outside openings and open up the interior of the apartment as much as possible in order that the full strength of the gas may reach the hiding places of the insects. See that all entrances are locked or guarded on the outside to prevent persons entering, then leave the building, releasing the cords as you go. The gas will all be given off in a few minutes, and should remain in the building at least three hours.

When the sulphuric acid comes in contact with the cyanide of potassium the result is the formation of sulphate of potash, which remains in the jar, and the hydrocyanic acid is liberated and escapes into the air. The chemical action is so violent as to cause a sputtering, and frequently particles of the acid are thrown over the

sides of the jar; this may be prevented by supporting a sheet of stiff paper over the jar by means of a hole in the center through which the cord supporting the cyanide of potassium is passed, so that when the cord is released the paper will descend with the cyanide and remain at rest on the top of the jar, but will not prevent the easy descent of the cyanide into the acid. The weight of this paper will in no way interfere with the escape of the gas.

At the end of the time required for fumigation the windows and doors should be opened from the outside and the gas allowed to escape before any one enters the building. A general cleaning should follow, as the insects leave their hiding-places and, dying on the floors, are easily swept up and burned. The sulphate of potash remaining in the jars is poisonous and should be immediately buried and the jars themselves filled with earth or ashes. No food that has remained during fumigation should be used and thorough ventilation should be maintained for several hours. After one of our experiments it was noted that ice-water which had remained in a closed cooler had taken up the gas and had both the odor and taste of cyanide.

For dwellings one fumigation each year would be sufficient, but for storage houses it may be necessary to make an application every three or four months to keep them entirely free from insect pests. The cost of materials for one application is about fifty cents for each 5,000 cubic feet of space to be treated. The cyanide of potassium can be purchased at about thirty-five cents per pound, and the commercial sulphuric acid at about four cents per pound. The strength of the dose may be increased and the time of exposure somewhat shortened, but this increases the cost and does not do the work so thoroughly. In no case, however, should the dose exceed .22 gram or remain less than one hour.

The practical application of this method of controlling household insects and pests generally is to be found in checking the advance of great numbers of some particular insect, or in eradicating them where they have become thoroughly established. This method will be found very advantageous in clearing old buildings and ships of cockroaches.

W. R. BEATTIE.

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*ENGINEERING EDUCATION IN LONDON.**

JUDGED merely by the magnitude and diversity of the work actually carried out within its boundaries, London is by far the most important center in the world for civil, mechanical and electrical engineering. Its vast population includes a larger number of engineering employers and engineering workmen of every grade and in almost every branch of work than any other city can show. The demand for engineering instruction of every type is large and steadily increasing. Yet the provision now existing for engineering instruction can only be described—if we compare it with the needs of London in this age of steel—as trivial. Out of six millions of inhabitants the total number of engineering students above matriculation standard is estimated at 600. What provision there is seems good, as far as it goes, but it is ludicrously below the requirements of London, alike in extent, comprehensiveness, and variety.

The engineering instruction at present available in London consists mainly of three separate 'schools'—the Central Technical College of the City and Guilds of London Institute, University College and King's College—of a high standard of excellence in the somewhat limited work that they undertake, with a small staff of first-rate professors, and good, though not very

extensive, equipment. Their main drawback is their limited size and scope, the high fees which they are compelled to charge, and their limitation to day students. Their work is, moreover, narrowly restricted by lack of space, lack of staff and lack of funds. They contain, in the aggregate, only about 350 students in all branches of engineering. Supplementing these three 'schools' (which are all situated in West Central London, within an area of three square miles) there are about a dozen less completely organized centers of engineering instruction, each with one or two professors and instructors of university rank, aided by subordinates dealing with the less advanced classes. These include the Finsbury Technical College of the City and Guilds of London Institute, where first-rate professors deal with junior students, and the several 'polytechnics,' dealing with all ages and classes of engineering pupils. These centers are conveniently distributed in the different parts of London; they provide both day and evening instruction, and their engineering departments are rapidly increasing in size and importance. Their equipment and workshop accommodation, so far as mechanical and electrical engineering is concerned, is usually good, though somewhat limited. Besides many hundreds of elementary students in various engineering subjects, they contain in the aggregate about 250 engineering students doing work of university standard. This work could easily be extended, by strengthening the staff and improving the equipment of the several institutions, to an almost indefinite extent.

If we turn now to different branches of engineering, it may be noted that (apart from the Royal Naval College at Greenwich, which is not open to the public) absolutely no provision exists in London for instruction in marine engineering and naval architecture. Though the Thames is still one of

* From the *London Times*.

the great shipbuilding ports, and this local industry, moreover, has lately shown encouraging signs of revival, no young man in the Thames shipbuilding yards or marine-engine works can get access to instruction in his profession.

For civil engineering some small provision exists of high quality. But the instruction is limited in scope, given almost entirely in the daytime, and barred to most students by high fees. The position of London, as the capital of a vast empire, the center of organization for important engineering enterprises all over the world, and itself the scene of great municipal and capitalistic works seems to call for a considerable extension in the scope and variety of instruction in civil engineering. In connection with this need may be specially mentioned the lack of any systematic instruction for the large and growing class of municipal engineers; the absence of any school of railway engineering, dealing, among other things, with permanent way construction; the need for specialized training in dock and harbor work, for which London is the natural center, and, indeed, the total lack of any adequate treatment of hydraulics (for which alone Cornell University has a fully-equipped and well-endowed department). Moreover, this is perhaps the place to notice that (beyond one or two courses of professional lectures) London has nothing in the nature of a school of architecture. It contains far more architects than any other city in the world, and annually adds a larger quota to the profession than any other center. But it leaves them to pick up their art in the old-fashioned way, and makes no organized attempt to provide modern instruction. The result is that, whether on the constructive or the artistic side, we lag far behind the United States, France and Germany.

The provision for electrical engineering,

though lately much increased, is still inadequate, both in extent and in variety. Above all, there is lacking any adequate opportunity for research and instruction in the more advanced and newer developments. How much of the future of industry may not turn on the proper working out of the possibilities of high-tension transmission and polyphase currents? Where, too, is our school of electric traction, which will enable us to keep, at any rate, some part of this rapidly-growing industry in our own hands? It is not to our credit that, though Great Britain supplies the original ideas, the greater part of the equipment of the 'tube' railways has to be made in the United States and Switzerland.

Dealing with the matter geographically, we may say that, if all the existing centers were enabled freely to expand to meet the growing demand, and brought up to a satisfactory standard of efficiency and comprehensiveness, the greater part of the six millions of population would, as far as mechanical and electrical engineering are concerned, be adequately served. There would, however, still remain in the outer suburbs such important centers of population as West Ham, Croydon, Willesden, and Tottenham, containing in the aggregate over three-quarters of a million people, or as many as all Glasgow, needing engineering schools; and even within the county area additional engineering schools are required in the neighborhood of Hammersmith, Hackney, and St. Pancras. If these were provided the number of engineering centers within the radius would be raised approximately from 15 to 20, and it may confidently be predicted that the number of engineering students above matriculation standard could be, within two or three years, certainly trebled (*i. e.*, raised from 600 to, including all departments, at least 2,000); and would then still be far behind the number for Belgium or Saxony, with

which kingdoms—not with any one city—London has to be compared.

What is wanted in the faculty of engineering is, therefore :

1. Increase in staff of professors and instructors at existing centers—say £10,000 a year (£330,000).

2. Extensions at existing centers in buildings and equipment to accommodate additional students—say £150,000.

3. New centers—building, equipment, and endowment of engineering departments at—say seven at £50,000 (£350,000).

4. New subjects—provision for buildings, equipment and endowment of centers for marine engineering and naval architecture (£100,000); civil and municipal engineering (£100,000); railway, dock and hydraulic engineering, etc. (£100,000); electric traction (£100,000); architecture (£100,000), etc. We may say, therefore, that the faculty of engineering needs a capital sum of £1,330,000.

SCIENTIFIC BOOKS.

Bibliotics, or the Study of Documents. By PER-SIFOR FRAZER. Third edition. Philadelphia, J. B. Lippincott Co. 1901. Pp. xxiv+266.

The subject-matter of this book, not very clearly suggested by the title, is the methods used by the handwriting expert and by the chemist, in the identification of writing and the detection of forgery. A scientific man desirous of getting some insight into these methods—or into the best of them—will find this book good reading. It is written with a scientific bent. It considers handwriting much as a zoologist considers animals. The determination of the characteristics of a given handwriting is like the determination of the characteristics of a natural species. The older methods relied on general impressions or on the description of salient features; the newer methods rely on measurement of the details. A person's handwriting, like a natural species, is a variable thing, and the exact study of it must deal in averages and ranges of variation. "It will be readily conceded that at least two factors are

present in the performance of an act which is often repeated. One is the general similarity, and the other is the variation in some details which prevents any two acts or results from ever being exactly identical. These are analogous to the two important factors of the theory of evolution, called, by Charles Darwin, hereditary transmission and accidental variation. In order to arrive at an ideal standard of similar recurrent actions, it is necessary to eliminate, as far as possible, the accidental variations. The most obvious way to do this is to take the average or mean of the records of a number of such actions." The first method devised by the author for arriving at the mean was the graphic method of composite photography. This appeals to the eye, and shows directly which parts of a signature are most uniform and which are most variable. A disputed signature may better be compared with a composite of several genuine signatures, than with any one of them.

The more exact method of averages, also devised by the author, begins with actual measurement of details; and it is the inconspicuous details that are most characteristic. The salient features can be changed more or less at the writer's will, or imitated by another person. But the little tricks of curvature and slant and proportions, the minutiae of shading and alignment, as they are the expression of unconscious habits, so they cannot voluntarily be laid aside, and as they are undetected by the eye, so they cannot be reproduced by a forger. The most useful details for measurement are angles and the ratios of different lengths; these are very inconspicuous, yet fairly constant, not changing with the size of the letters.

If, then, a signature is disputed, several genuine signatures are obtained, and a certain number of details are measured in all the specimens; the average measurements of the genuine signature are computed, and the measurements of the disputed signature compared with them. Close agreement throughout stamps the disputed signature as genuine; wide divergence as spurious. Some divergence is of course to be expected, and in fact complete identity is evidence of tracing. But just how much difference can be allowed? How sure is the expert of his decision? It does not appear that the theory

of probabilities has been used in any rigid way. The author's experience leads him to adopt a difference of 15% between the average and the disputed signature as ground for suspicion. Differences of 5 or even 10% are not uncommon in genuine specimens. But differences of 15% are uncommon, and, especially if repeated, are suspicious. The expert's decision must often rest on rather weak foundation as judged from a scientific standpoint, and the more so since he often has but half a dozen specimens from which to determine his average. The work of Mr. Frazer is very suggestive of what might be done in the study of handwriting. An extensive study of the variability of the individual, and of the differences between different individuals, as regards these ratios, angles, and other details, would show how sharply individualized they are, and furnish a scientific basis for the expert.

Another method of the author is the microscopic examination of the margins of the strokes. Under a magnification of 120 diameters, or even much less, a pen or pencil stroke is seen to have irregular edges; it is full of serrations of different sizes, the smaller superposed on the larger. There are usually more of them in one margin than in the other, depending on the position of the pen and other peculiarities of the writer. Whether they are completely individual, it would be premature to say, but they can at least be often used to distinguish between the writing of two persons. With the cooperation of Professor Witmer, the author has made micro-photographs and camera lucida tracings of these wavy margins, and inclines to regard some of them as records of the minute, normal tremor of the hands, produced by fluctuation in the nerve currents that control the muscles. Machine-ruled lines, though not free from irregular margins, showed fewer serrations than lines made by hand. The reviewer is much inclined to doubt this interpretation of the wavy margins, since he finds the serrations more marked on rough than on smooth paper, whereas the friction of the rough paper would tend to conceal the tremor. The rate, too, at which the serrations are produced is not approximately constant, as that of the tremor is, namely, at 8-15 pulses per second; a fast stroke and a slow show about

the same number of serrations per millimeter and those in the fast stroke must have been made, in one line measured, at about the rate of 480 per second. Many of the irregularities are probably due to the texture of the paper, and others to vibrations of the pen. Yet one's manner of holding the pen might give rise to characteristic forms of margin.

Still other chapters of the book treat of the chemical and physical tests for inks, of tests for erasure and other tampering, of tests for 'guided hands,' and of other problems incidental to the detection of forgery. There are several excellent plates.

R. S. WOODWORTH.

Taxidermy, Comprising the Skinning, Stuffing and Mounting of Birds, Mammals and Fish. With numerous engravings and diagrams. Edited by PAUL N. HASLUCK. London, Paris, New York and Melbourne, Cassell & Company. 1901. 16mo. Pp. 160.

Within the last ten years at least three admirable books on taxidermy have been brought out in the United States, and any new work on the subject should either bring forward some new and improved process of preserving animals, or at least present the most approved methods in a clear and detailed manner. The little book under consideration does neither; the methods described in its pages are the old ones, and not always the best of those, while the amount of space given to each group of animals is so limited that the descriptions are necessarily brief, while there is nothing whatever on the mounting of large mammals, although this is seldom acquired from books alone.

However, the book is intended for the amateur who wishes to preserve some trophy of the chase rather than for any one who really intends to master the art of taxidermy, and there are directions for making screens, polishing horns, tanning skins, and doing various bits of taxidermic fancy work. The small size of the book enables it to be readily put in the pocket, and, as it takes but little room, it might readily be carried to seashore or country on the chance that it might be desired to save some bird, mammal or fish, or make a pair of wings into a screen.

F. A. L.

La Democrazia nella Religione e nella Scienza—Studi sull' America. By ANGELO MOSSO. Milan. 12mo. Pp. 450.

This book is a striking proof of the remarkable versatility of Professor Mosso, the Italian physiologist. It purports to be a résumé of impressions gathered on his visit to this country in 1899, but the book has a wider bearing and goes quite beyond the scope of a journal of travel. It is a very suggestive survey of some of the most characteristic aspects of American life, and Professor Mosso, who was already known as a writer of unusual brilliancy and cleverness in his own field of physiology, shows here a decided taste for sociological investigations—a feature quite new in the personality of the author of 'La Paura.' He is too modest to consider himself anything but a dilettante in the study of social facts and problems. But the thoroughly scientific training of Mosso's mind, his experimental habits and trend of thought, his keen power of observation, raise the value of his sociological impromptu and give his studies of American life a deeper significance, which cannot fail to command the attention of the 'specialist' himself.

The book includes eleven chapters and, as an appendix, the lecture on 'Thought and Motion' delivered at Worcester, Mass., on July 7, 1899, on the 10th anniversary of the foundation of Clark University. The first chapter is mainly descriptive. It is a series of notes taken while travelling through the country. Mosso, who is a fine writer, shows here his characteristic qualities of vividness and brilliancy. The second is a study of the general features of the population. Here the physiologist has his way and shows himself at every step. The various aspects of the population, anthropological characters, mental and moral traits, the demotic composition, the birth-rate, the criminal and suicidal tendencies, etc., are all systematically taken up and discussed with great clearness and lucidity. Mosso is struck by the unmistakable evidence of nervous strain exhibited by the American population, as a whole. "Perhaps," he says (p. 38), "we have reached in this country the maximum limit of work that can be attained by the neuro-muscu-

lar system." Mosso is a firm believer in the influence of climate upon the race.

"The transformation of the anthropological characters under the influence of climate is," according to Mosso, "a physiological fact that cannot be doubted" (p. 75). Climate and education—meaning, of course, by the latter the action of social environment—are the only sources of dissimilarity in men (p. 106). This is the thought that runs through Chapter III., in which the racial question is taken up and discussed in the light of recent literature. Mosso does not believe in the form of the skull as being the differential element of racial types and an index of the psychical tendencies of each. "This is," as he puts it, "a puerile form of materialism. Our present knowledge of the structure and function of the nervous system does not warrant our attributing such a prominent importance to the form of the skull. The alleged measurements of the anthropologists are entirely worthless as a means of determining the psychical tendencies of a man or a nation" (p. 80). The difference in the form of the skull and in the color of the hair, upon which the entire structure of Ammon and Lapouge's anthropo-sociology is based, is due to the combined action of altitude and temperature—*i. e.*, to the climate. Inhabitants of the mountains have fair hair, while inhabitants of the plains have dark hair. Livi has conclusively shown that all over Italy—including Sicily and Sardinia, where the so-called northern races never reached—the mountains are inhabited by fair-haired men. Since the color of the hair is dependent upon the deposition therein of a varying amount of pigment ultimately derived from the blood, it is not difficult to trace the connection between the climate and the phenomena of oxidation which are at the bottom of the production of pigmentary matter. On the other hand, the dissimilarity in the form of the skull, upon which so much stress has been laid by anthropologists, is merely due to the lack of correlation between the size of the body, which is influenced by altitude and temperature, and the size of the brain, which is left unchanged (pp. 82–83). There are no races in the old metaphysical meaning of ethnic groups governed by congenitally blind impulses. The

differences among men are all traceable to the action of climate and education (p. 96). The Germans and the Scandinavians are, together with the Latins, the representatives of the same Mediterranean race, which, according to the most accepted view (Sergi, Ripley) was the primitive inhabitant of Europe. The so-called northern peoples are merely that part of the original racial stock that went north and became fair-haired, taller and dolicocephalic through the combined action of climate, social environment and natural selection (p. 97). This leads Mosso to refute the legend of Latin decline and to discard the assumption that there exists a congenitally organic difference between the Americans—as representing the northern races—and southern or Latin races.

While we agree with Mosso in his refutation of the fantastic theories of Ammon and Lapouge, we cannot leave unchallenged a statement made at the very beginning of this interesting chapter. Mosso says (p. 79) that “a physiologist cannot possibly admit the existence of differences among white men in regard to the aptitudes of the nervous system. Sociologists,” he says, “are largely responsible for the widespread belief that the causes of historical facts should be traced to different impulses originating from an alleged structural dissimilarity of the nervous system.” Without admitting the skull theory and all the nonsense connected with it, we cannot deny the existence of two mental types, a motor and a sensory, to which correspond, on the volitional side, the impulsive and the obstructed, as masterfully described by James. Now, these mental types cannot but be the outcome of some peculiarity in the ultimate structure of the nervous system. There must be some deep physiological condition to account for the fact that in one set of brains we have a quicker discharge into the muscles than in another set where we have a distinct damming up of the nervous impulse. We are as yet unable to determine what this deep-seated peculiarity is. Probably we have to deal with a chemical problem, and the difference between the two classes of brains in question is in some way related to the metabolism of the nervous element. The fact, however, is undeniable and Mosso, as a physiologist, cannot possibly think

that these two mental types have no physiological substratum. Space forbids an exhaustive discussion of this interesting topic, but we must say that the unequal distribution of these two types of brains within a definite social group is probably the fact which affords the most conclusive explanation of the so-called racial differences. According to the predominance of one or the other of those two mental types, within the group, we have a different mental tone in the community and these various shades of mentality are, after all, the very essence of racial dissimilarity.

In the next chapter—the fourth—Mosso takes up the problem of Democracy and Religion. He is struck by the wonderful growth of Catholicism in this country, a fact which is in harmony with the expansion of Catholicism in Europe, and especially in England, within the last fifty years. Seeking an explanation, Mosso remarks that religion is necessary only for the mentally weak—*i. e.*, for the masses. A nation of philosophers might do without it, just as the intellectual élite does. But no religion can help those who believe better than Catholicism because this latter appeals more vividly to the emotional element, which is the very essence of belief (p. 128). Protestantism is, like the northern climates, gray and sad. There is an element of dullness in it which is in striking contrast with the warmth and life of Catholicism, and since religions have always been, as Mosso vigorously puts it, ‘a form of festival’ (*una forma di festa*) it is the one that appeals more vividly to the senses which has the greater power of propagation (p. 129).

On the other hand, civilization makes men more exquisitely excitable. This ‘effeminating’ influence of civilization is also at work in the expansion of Catholicism (p. 128). The tendency to mysticism which is quite evident in art and literature is a result of the increased intensity of excitability brought about by the refining influence of civilization. And mysticism is fatal both to science and to Protestantism. The clearness of Mosso’s position is somewhat obscured by the fact that he refers to Catholicism as being both the religion of the ignorant masses and the religion of the hypercultivated mystical. Now, Catholicism can be

one or the other of these two things, but cannot be both at the same time. Perhaps the latter interpretation is the nearest to truth. The expansion of Catholicism in England within the last fifty years is evidently related to the undercurrent of mystical tendencies which has been pushing Saxon art towards archaic forms. But, as far as this country is concerned, the growth of Catholicism is dependent upon increase in immigration from Catholic countries, a factor which has been somewhat underestimated by Mosso.

In the following chapters—V., 'The Weakness of Religious Feeling,' VI., 'The Protestant Universities,' VII., 'The Catholic Universities and Canada,' VIII., 'Americanism,' IX., 'Modern Tendencies in Education'—Mosso takes up the different aspects of the problem upon which his interest is mainly centered, *i. e.*, the problem of the relation that democracy bears to religion and education. Particularly worthy of mention are the chapter on 'Americanism,' which gives a very clear account of the controversy waged between the Roman Curia and some prominent representatives of Catholicism in this country, and those in which he describes the peculiarities of American university life. Chapter X.—'The Crowd and the New Aristocracy'—is a study of American political life as influenced by the formation of a powerful aristocracy of millionaires. The tenth chapter, on 'Primitive America,' is a hymn to nature. It is a vigorous description of some of the most picturesque aspects of this continent, in its wildest regions, where civilization has not yet spoiled the divine charm of an enchanting nature. Here Mosso shows his decided literary tastes, and some of his pages are really beautiful.

On the whole, Mosso's book will prove both interesting and instructive to his own compatriots as throwing a fuller light upon this wonderfully growing country, which is called to play such a tremendous rôle in the drama of the century. While to the American reader who can afford to take hold of this charming book, it will undoubtedly be a source of deep gratification to see how the noble efforts of this valiant race towards a high ideal of civilization are appreciated by a scholar and a scientist of Mosso's standing and fame.

GUSTAVO TOSTI.

Atoms and Energies. By D. A. MURRAY, with an introduction by PROFESSOR FREDERICK STARR, of the University of Chicago. New York, A. S. Barnes & Co. 1901.

"It is a long time since I have read a work in physical science which has given me so much pleasure as 'Atoms and Energies.' The subject is interesting, the point of view novel, the argument clear, the book itself satisfactory."—Professor Starr.

In writing this short review our chief aim is to make reply to Professor Starr, for we too have been trying to interest him and others not specially devoted to the subject in physical science.

From the contents of the little book before us it appears that the author knows nothing of the works of the great builders of that marvelous Engine of Interpretation, the atomic theory. Among these works may be mentioned the following, each of which is monumental in character. The list will serve to indicate to the reader the present scope of the atomic theory. Maxwell's and Boltzmann's contributions to the 'Kinetic Theory of Gases,' Sohncke's 'Theory of Crystal Structure,' Poisson's contributions to the 'Molecular Theory of Elasticity,' van't Hoff's 'Stereo-chemistry,' Planck's 'Electro-atomic Theory of Radiation,' and J. J. Thomson's 'Corpuscular Theory of the Electric Discharge,' to say nothing of such works as Johnstone Stoney's on 'The Electron Theory,' and Lord Kelvin's on 'The Vortex-atom Theory,' both of which are devoted to 'many an assumption that is not exactly necessary,' to use Helmholtz's words, which are quoted in the next paragraph.

What are atoms? we are inclined to ask when we take up Mr. Murray's book, although under ordinary circumstances the question does not much concern us. In so far as we have anything to do with them we believe they are mere logical constructions. Bacon long ago listed in his quaint way the things which seemed to him needful for the Advancement of Learning. Among other things he mentioned 'A New Engine or a help to the mind as a tool is a help to the hand,' and the greatest achievement of the nineteenth century in physical science is the realization of Bacon's idea, in a great body of useful theory. As Helmholtz

says: "It is a great advantage for the sure understanding of abstractions if one seeks to make of them the most concrete picture possible, even when the doing so brings in many an assumption that is not exactly necessary." Just how much of this useful theory is to become the common property of all men it is impossible to say. For one thing, the theory is not by any means fixed and may not be for a century to come, and no one but the most determined specialist can be expected to appropriate and use the more complex theories which depend upon the keenest mechanical sense, the sharpest algebraic faculty, the strongest geometrical imagination and the most devoted study; but there is a great and growing body of simple conception and theory which can and does represent to the understanding a vast array of fact. Every one should know that the physicist's idea of a thing such as a gas, an electric current, or a beam of light comes very near to being a working model of the thing. The elements out of which such models are made are purely notional, and although the physicist habitually speaks of them in objective terms for the sake of concreteness and clearness, it is of the utmost importance that the thought be chiefly directed to the physical facts which are represented and not to the models themselves. Thus the chemist may speak of the tetrahedral carbon molecule with assymmetrically attached molecular groups, while the thought is directed chiefly to those remarkable physical properties of sugar and tartaric acid which are intended to be represented.

There is a tendency among reflecting men to confuse the boundaries between our logical constructions and the objective realms which they represent to the understanding. In fact, Münsterberg maintains that this confusion is the gravest danger of our time. It seems to us that these logical constructions constitute the noxious gases mentioned by Professor Woodrow Wilson as escaping from our laboratories, and that they become noxious by confusion and misuse. The old idolatry is the worship of external form—imagine a remote ancestor worship fully contemplating the newly invented club instead of using it—and the new is the con-

templation of our logical constructions in an aspect in which they are not real, a vaporous idolatry which is frightfully prevalent.

We are impressed more and more every day with the fact that the most satisfactory specialist to talk with is the biologist. His knowledge is not represented to his mind by means of that mathematical-mechanical system of conceptions which is the basis of all our knowledge in physical science, but it approaches art in its close association with external form. Conversation with a physicist, however, is very like looking into the mechanism of a Mergenthaler type-casting machine with the machine out of sight, feasible enough among designers and builders, but scarcely a satisfactory basis for the flow of thought when one party in the conversation happens to be unfamiliar with and perhaps not interested in the mechanism in question. Nevertheless a seriously minded physicist cannot help feeling mortified when he sees a colleague of Professor Starr's standing examining a more or less fanciful, inoperative, and obsolete pea-shooter with the pleasurable conviction that he is unraveling the intricacies of a complicated mechanism of the latest and most approved construction.

W. S. FRANKLIN.

SCIENTIFIC JOURNALS AND ARTICLES.

The American Anthropologist for April-June, which has just reached us, contains the following articles:

'The Owaküiti Altar at Sichomovi Pueblo': J. WALTER FEWKES.

'Chalehuhuitl in Ancient Mexico': ZELIA NUTTALL.

'Notes on the Alsea Indians of Oregon': LIVINGSTON FARRAND.

'Kootenay Group-drawings': ALEXANDER F. CHAMBERLAIN.

'Ethnology in the Jesuit Relations': JOSEPH D. MCGUIRE.

'Rare Books relating to the American Indians': AINSWORTH R. SPOFFORD.

'Summary of the Archeology of Saginaw Valley, Michigan': HARLAN I. SMITH.

'Mummification, especially of the Brain': D. S. LAMB.

'Decorative Symbolism of the Arapaho' (with plates V. and VI.): A. L. KROEBER.

'Initiation Ceremonies of the Wiradjuri Tribes': R. H. MATHEWS.

'The Development of Illumination': WALTER HOUGH.

THE contents of the *American Journal of Science* for August are:

'Experiments on High Electrical Resistance,' Part II.: O. N. ROOD.

'Mineralogical Notes': A. J. MOSES.

'Motion of Compressible Fluids': J. W. DAVIS.

'Action of Sodium Thiosulphate on Solutions of Metallic Salts at High Temperatures and Pressures': J. T. NORTON, JR.

'Secondary Undulations shown by Recording Tide-gauges': A. W. DUFF.

'Mathematical Notes to Rival Theories of Cosmogony': O. FISHER.

'Studies of Eocene Mammalia in the Marsh Collection, Peabody Museum': J. L. WORTMAN.

'Electromagnetic Effects of Moving Charged Spheres': E. P. ADAMS.

'The Nadir of Temperature and Allied Problems': J. DEWAR.

The *American Geologist* for July contains a 'Sketch of the Life and Work of Augustus Wing,' by Henry M. Seeley. In this article the work of Mr. Wing, the teacher and preacher, in solving the early problems in New England geology is set forth. A portrait accompanies the article. 'Beach Structures in the Medina Sandstone,' is discussed by Professor H. L. Fairchild. The Medina sandstone is described as shallow water deposits, following the conclusions of Dr. James Hall and controverting the theory of Dr. Gilbert, who recently maintained that certain structures in said sandstone are giant ripples formed in deep ocean. The writer compares the structures in question to the beach formations on Lake Ontario at the present time. The article is accompanied by five plates from photographs. 'The Michipicoten Huronian Area,' by S. B. Wilmott, describes an area north of Lake Superior. It is accompanied by a geological map of the region. Mr. Oscar H. Hershey discusses 'The Age of the Kansas Drift Sheet,' and gives reasons why the Kansas drift as well as others of the lower Mississippi is a very old one. 'The Georgia Bauxite Deposits: Their Chemical Constitution and Genesis,' by Thomas L. Watson, is accompanied by a plate showing the distribution of

that mineral in Georgia. 'The Age of the Kansas-Oklahoma Redbeds' is discussed by J. W. Beede. The author put the deposits in question in the Permian. This paper is followed by 'A Short Discussion of the Origin of the Coal Measure Fire Clays,' by T. C. Hopkins, and the usual Comments and Reviews.

SOCIETIES AND ACADEMIES.

SECTION H. ANTHROPOLOGY. TITLES FOR PRESENTATION AT THE DENVER MEETING.

'Sculptured Stone Images of Man by the Aborigines in Nicaragua': J. CRAWFORD.

(1) 'The Stanley McCormick Hopi Expedition of 1901'; (2) 'The Sacred Bundle of the Osage'; (3) 'Games of the Pawnees'; (4) 'Hand or Guessing Games of the Wichitas': GEORGE A. DORSEY.

'Influences of Racial Characteristics on Socialization': FRANK W. BLACKMAN.

'Exhibit of curves of speech': E. W. SCRIPTURE.

'The Physical Characters of the Various Pueblo Indians, including the Mokis and Zuñis': ALES HRDLICKA.

'Current Questions in Anthropology': W J McGEE.

'A Plea for Greater Accuracy and Greater Simplicity in the Writings of the Future regarding the American Aborigines': CHARLES E. SLOCUM.

(1) 'The Teaching of Anthropology in the United States'; (2) 'The Anthropological Collections of Yale University Museum'; (3) 'Twenty Years of Section H'; (4) 'The Sherman Anthropological Collection, recently purchased by the Scientific Society of Holyoke, Mass': GEORGE GRANT MACCURDY.

QUOTATIONS.

PRIORITY IN THE DISCOVERY OF THE MALARIAL PARASITE.

AN unfortunate controversy having arisen on the question of priority in the proof of the mosquito theory of the transference of malarial infection, Major Ronald Ross has published some correspondence on the subject which shows that the claims of some of the Italian observers cannot be substantiated ('Letters from Rome on the New Discoveries in Malaria,' 1900). These eight letters were written by Dr. Edmonston Charles, a resident in Rome, to Major Ross, then in India, and date from November 4, 1898, to January 14, 1899; a letter from Dr. Daniels is included, and they are preceded by a critical

introduction, and terminate with a postscript and bibliography by Ross. At this period the Italians, notably Grassi, Bignami and Bastianelli, were endeavoring to follow Ross's investigations on the development of the malarial parasites in the mosquito, and Dr. Charles acted as an intermediary, informing Ross of the progress made by the Italians, and similarly communicating to the latter Ross's observations and handing them his specimens. In the first letter, Charles asks for specimens for Marchiafava 'of the mosquito in which human malaria develops.' Grassi now denies that Ross ever detected this species. It is pointed out how closely the Italians followed and how well informed they were of the details of Ross's work, yet now Grassi states that his labors were independent of Ross. In the third letter, with regard to the cultivation of crescents in the 'dappled winged mosquito' by Ross, Charles says, "He (Grassi) seemed perfectly satisfied that your description referred to the *Anopheles claviger*." Grassi now contends that he could not identify the malaria-bearing mosquito from Ross's description. Bignami, Grassi and Bastianelli have frequently stated that Ross's first successful experiments with human malaria were unsound, because the insects employed might have already bitten another animal before having been fed on man. Yet in Ross's publication it is clearly premised that the insects had been bred in bottles from the larvæ.—*Nature*.

IMPRESSIONS OF A GERMAN CONGRESS.

AN occasional correspondent, who speaks from experience, has been moved to unburden his soul as to the mode in which discussions are carried on at some German scientific congresses. The picture he draws is not, he declares, exaggerated, but his remarks must be understood as applying only to those congresses which are not divided into sections but in which the discussions take place in plenary session. There is a large room where the congress is to take place, filled with hundreds of our colleagues, of German and other nationalities. These gentlemen are prepared for several days' *ennui*, but are also resolved not to let it be all dull. They present a very varied ap-

pearance, and produce a very varied impression by the complexity of sound which their conversation, before the commencement of the proceedings, creates. The management consists of a chairman, who is changed at each sitting, and his *confrères*, the president, the secretary, and the other members of the council. The chairman opens the day's proceedings by informing the readers of papers that the time limit, namely, half of an hour for papers, and ten minutes for discussion speeches, will be rigidly adhered to. At first all goes smoothly until a speaker has occupied the attention of the House for twenty minutes or so, when there is heard an ever-increasing buzz of conversation from the back part of the room. Of this the speaker takes no heed, and when the half-hour is past, the chairman merely stretches himself and remains quiet. The next speaker has obviously not been fortunate in the impression that he has made on the House, for the conversation, begun during the last speech, continues, and becomes disturbing. But he, being accustomed to such trivial inconveniences, labors on steadily. The hands of the clock steal slowly onward, and when they register that the speaker has been standing at the desk for nearly twenty minutes, a single cry of 'End!' (*Schluss*) is heard. Soon the air is rent with wild delighted cries of 'End!' and feebly tempered by a few subdued remonstrating '*Gsch.*' The chairman rings his bell. Some order is restored, and he tells the speaker that he has two minutes more. Poor speaker! He has lost the thread of his argument (for papers must be given from memory, not read), he is face to face with the fact that he has but two minutes more to live—as a speaker—and he thereupon invariably pitches himself headlong into his subject, at such an enormous rate, and with so much energy, that it becomes a matter of impossibility to understand what he is speaking of. The noise at the far end of the room continues, and in one minute the second 'sound' of the bell is heard. The chairman now shows his humanity and asks the House to decide whether the speaker shall continue or not. This is done either by direct appeal and an interpretation of the responsive sound, as to what the

wish of the majority is, or by a show of hands. There is a subtlety in the decision, for if the chairman wishes he can rule on a single show, or he may ask for 'Ayes' and 'Noes,' or he may compare the number of hands shown with the number of persons present. But it is decreed that our friend, the speaker, must stand down, and there is something pathetic in his self-conscious, proud and satisfied bow, and the death-like silence which follows it for one moment. A discussion now takes place. At first absolute oblivion of time seems to surround the Chair, and the first intimation which the occupant of it receives of the fact that one member has occupied the platform for nearly half an hour is that his conversation with a colleague is interrupted by a dozen eager members who wish to have their say. Then he rings the bell and asks if the speaker has much more to say, but to do this he waits until the latter has reached the middle of a sentence. 'I am just finishing,' is the reply. Five minutes later a further ring, the same question, the same reply. Still five minutes later the chairman says that Herr X. is in possession of the platform, and requests the loquacious one to stand down. He forgets to bow, and, collecting his notes and papers slowly mumbles that he has had no time to give his most important points of argument. Will he try to continue his arguments at next year's congress?—*British Medical Journal*.

CURRENT NOTES ON PHYSIOGRAPHY.

THE MARYLAND COASTAL PLAIN.

A LUMINOUS generalization concerning the geological history and the geographical features of our Atlantic coastal plain has lately been announced by Shattuck ('The Pleistocene Problem of the North Atlantic Coastal Plain,' Johns Hopkins Univ. *Circulars*, No. 152, 1901). Five shore lines with wave-cut and wave-built terraces, accompanied by spits, bars and lagoon deposits, are recognized. The uppermost is the Lafayette on the margin of the Piedmont uplands at altitudes of from 300 to 500 feet. The lowest is on the present coast. The development of each shore line was preceded by a period of erosion during a somewhat higher stand of the land; hence when submergence to

the new level occurred, the shore was of irregular outline. Valleys were thus repeatedly drowned, and rivers transformed into estuaries; for one may trace the younger terraces along the sides of the older valleys. The changes of level do not seem to have been accompanied by so much warping as has been inferred by other observers: the conclusions thus announced are thought to be applicable to the coastal plain for some distance northeast and southwest of Maryland. A fuller description of the topographic details on which these changes are based will be waited for with interest.

DUNMAIL RAISE.

THE low pass between Windermere and Keswick in the English Lake district, annually crossed by thousands of tourists in stage and on foot, is known as Dunmail Raise. Its elevation is 782 feet, between Helvellyn, 3,118, and Scafell pikes, 3,210. R. D. Oldham ('On the Origin of Dunmail Raise, Lake District,' *Quart. Journ. Geol. Soc.*, LVII., 1901, 189-195) points out the striking disproportion between the size of the local streams and the dimensions of the opposing valleys that head in the open pass, and concludes that it is the work of a large river which once flowed from north to south through the mountains, long maintaining its course in spite of their upheaval, until at last overcome by a too rapid warping. While the conditions of such an origin are readily conceived, the consequences by which the conditions may be tested are not explicitly stated, and the reality of the postulated river is left in doubt. The present form of the opposing valleys being held to be beyond production by the existing streams, the valleys are taken as the product of the extinct river. The valleys being still but little modified by their streams, the warping by which the river was broken in two must have been relatively recent. The slopes of the opposing valley floors being strong and of recent origin, the warping that produced the slopes must have been rapid. As the present north-sloping valley descends against the slope of the extinct river for ten miles or more, the warping must have affected the district for a number of miles north of the pass. So rapid and extensive a warping can hardly have been

limited to the valley of only one river; its effects should be visible in all the neighboring valleys of the lake district, and until these effects are carefully deduced and systematically searched for, it seems safer to regard the erosion of the pass by a recently extinct river not as a probable conclusion, but only as an open suggestion.

A possible origin of the pass by glacial erosion in a preglacial notch of less depth is considered by Oldham and dismissed, because traces of glaciation were not found at a sufficient height; but on the latter point other observers do not agree, some maintaining the occurrence of an extensive local glaciation before the minor glaciation referred to by Oldham. Hanging valleys are not rare in these mountains ("We find in the Lake district a number of tributary valleys occurring in the hearts of the ridges, and opening out far above the bottoms of the main valleys, discharging their waters down the slopes in cascades." Marr, 'Scientific Study of Scenery,' 136), and one of them may be seen opening in the mountain side on the east just north of Dunmail summit. Glacial erosion as well as river erosion may, therefore, still deserve consideration in discussions as to the origin of the pass.

BRITTANY.

ONE of the excursions of the International Geological Congress held at Paris a year ago was led through Brittany by Barrois. An interesting account of it has been prepared by H. Credner under the title of its ancient name ('Armorika,' *Geogr. Zeitschr.*, VII., 1901, 21 p.). In contrast to the great deformation of the ancient rocks, moderate reliefs prevail to-day, much of the surface being nearly level to the eye for long distances. The region is peneplain, with occasional ridges and uplands maintained by the stronger rocks, but even there the forms are well subdued. The plain is usually clothed with a deep soil. It is here and there incised by narrow, steep-sided valleys, on whose walls the firm rock is exposed. The uplift of the peneplain, whereby the incision of young valleys has been permitted, is not explicitly stated, and the assertion that 'the valleys are extraordinarily old' is liable to misunderstand-

ing, until the reader infers that it is the predecessors of the present valleys that must be meant. The coast is generally marked by cliffs, torn into a ragged outline by a violent sea. The destructive work of the waves has been aided by a submergence of the land, of which there is not only geographical evidence in the form of bays and drowned valleys, but historical also, in the form of the ruins of a submerged town, of Roman roads that lead into the sea, and of megalithic monuments visible only at extreme low tide. The separation of England from France is ascribed to this submergence as well as to marine abrasion.

W. M. DAVIS.

A NEW ARCHEOLOGICAL PUBLICATION.

COMMENCING about September 1, the Archeological Section of the Wisconsin Natural History Society will publish, at regular intervals, a little 6- or 8-page sheet to be devoted to the cause of Wisconsin archeology. By this means it is hoped to keep alive and further the interest of the students, educators and collectors of Wisconsin in bringing about a better state of affairs as regards the preservation of the prehistoric monuments of the State.

The as yet uninterested attitude of the legislators argues that, for a year or two, at least, no bill favoring a State survey can be introduced. It is best, at present, to band together all persons interested until the time for action shall arrive so that the project can be carried to a successful issue.

The Bulletin is to be the organ of the campaign for a State archeological survey. It will not trespass upon the field of the journals now being published and which, being of too high price for the majority of State collectors and of a nature technically beyond their training, are not available for this purpose. It is intended to publish articles of local interest, short, general articles intended to train the average student, editorials favoring the free study and preservation of antiquities, notes, contributions of state collectors and students, notices of books bearing upon Wisconsin archeology, and all matter which will make the Bulletin of particular value to the archeologist of Wisconsin.

Dr. Charles E. Brown, of the Milwaukee Public Museum, is acting editor of the Bulletin, which will be known as the *Wisconsin Archæologist*.

HARLAN I. SMITH.

GOVERNMENT RAILWAYS IN EUROPE.

DR. A. VON DER LEYEN, a railroad expert, has published an article in the June number of the *German Review*, concerning the management of the government railroads of Prussia, of which Consul General Günther sends an abstract to the Department of State.

He demonstrates that the example of Prussia in buying the private railroads and running them on government account has contributed to popularize this system in other countries, and states that not only have the other German states followed it, but that almost all the other European countries have purchased the existing railroads.

The Austrian government railroad net has to-day a mileage of almost 6,300 miles; that of Hungary, about 8,150 miles. Since 1882 a great change has taken place in Russia; of the then existing 14,000 miles of railroad, only about 40 miles were owned by the government. The total mileage in 1897 was about 24,300 miles, of which 15,780 miles belonged to the government. To this must be added the government railroads in Finland and Asiatic Russia, the Trans-Caspian and the Siberian railroads. The Servian, Roumanian and Bulgarian railroads are owned exclusively by the respective governments. Of the northern European kingdoms, Denmark has a government railroad system of 1,167 miles and 525 miles of private railroads. Norway's railroads belong almost exclusively to the government. Sweden has 2,303 miles of government and 4,387 miles of private railroads. The government has not yet succeeded in acquiring the latter, although efforts have been made to do so. Belgium, in 1898, through the purchase of the Grand Central Belge and some minor private roads, became the possessor of the whole Belgium railroad system. Holland acquired all the remaining private railroads in 1890; they are, however, operated by two private companies. The Italian Government purchased all

private main railroads of Italy in 1885 and leased them for twenty years to private corporations. Mr. von der Leyen states that both the last countries have had unpleasant experiences with this arrangement. Switzerland, after long discussion, resolved by federal law in October, 1897, to gradually purchase all the private railroads. On January 1, 1901, the first federal railroads were operated by the Government. By agreements of 1883, the six large French private railroads had their rights recognized by the Government, and no change has been made in the policy in that country. The relatively small Government railroad system, located between the Orleans and the Western railroads, has remained intact. As the private railroads, however, have received large subsidies from the Government, and as they will revert to the State in the second half of the present century, they can hardly be considered purely private railroads. Of the countries which have a private railroad system exclusively, only England and the United States remain.

SCIENTIFIC NOTES AND NEWS.

THE fiftieth annual meeting of the American Association for the Advancement of Science, as all the readers of this Journal are doubtless aware, opens with a meeting of the council, at three o'clock on the afternoon of Saturday, August 24. The first general session of the Association, however, begins at ten o'clock on the following Monday, when Professor Woodward, the retiring president, will introduce the president-elect, Professor Minot. Addresses of welcome will be made by the Hon. J. B. Orman, Governor of Colorado, and Hon. R. R. Wright, Jr., Mayor of Denver. Honorary President, J. B. Grant, will introduce General Irving Hale and Aaron Gove, who will welcome the Association on behalf of the business men of Denver and the educators of Colorado. To these addresses President Minot will reply. After announcements have been made by the secretaries, the general session will adjourn and the sections will be organized. The addresses of the vice-presidents are delivered in the afternoon, and the retiring president will give his address entitled 'The Progress of Science' on Tuesday evening. The Sections of

the Association and the nine societies affiliated with it will hold their regular sessions on Tuesday, Wednesday, Thursday and Friday. The general committee will meet on Thursday evening for the election of officers and agreement on time and place for the next meeting.

Two of the prizes created by the will of Alfred Noble will be awarded to Dr. Niels R. Finsen, of Denmark, for discovering the light treatment for lupus, and to Professor I. P. Pavlov, the Russian physiologist, for his researches in nutrition.

Nature quotes from a London daily the statement that Professors Haeckel, Conrad and Fraas, of Jena, Halle and Stuttgart Universities respectively, announce that the sum of 1,500*l.* has been placed at their disposal as a prize for the best work on the question, "What do we learn from the principles of the theory of heredity in reference to the inner political development and legislation of States?" Manuscripts must be in German and sent not later than December 1, 1902, to Professor E. Haeckel, Jena.

THE University of Glasgow has appointed John Ferguson, professor of chemistry, F. O. Bowers, professor of botany, and R. M. Wenley, formerly of the University of Glasgow and now professor of philosophy at the University of Michigan, as representatives at the bi-centennial celebrations of Yale University.

E. R. BUCKLEY, assistant superintendent of the Wisconsin Geological and Natural History Society and instructor of commercial geography in the University of Wisconsin, has been appointed State geologist of Missouri.

THE Baly Gold Medal of Royal College of Physicians of London for special distinction in the science of physiology has been awarded to Dr. F. W. Pavy, F.R.S.

PROFESSOR A. C. HADDON expects to retire from the chair of zoology at the Royal College of Science, Ireland, in order to devote himself more exclusively to anthropological work.

DR. ERNST MACH, professor of philosophy in the University of Vienna, has been compelled by ill health to retire from the active duties of his professorship.

PROFESSOR E. HAECKEL, of Jena, has made public the announcement that owing to the state of his health, his advanced age and pressure of work, he will not in future make any public addresses or attend any scientific congresses.

PROFESSOR ED. SUESS, the eminent geologist, gave on July 13 a formal lecture to his present and former students on the occasion of his retirement from the chair of geology. He has reached his seventieth year and his forty-fourth year as a university teacher. A scholarship has been established in the University at Vienna in his honor.

IN honor of the sixtieth birthday of Dr. A. Kirchof, of the University of Halle, and at the same time of his twenty-fifth year of service to the university, a fund amounting to 12,500 Marks has been collected for the furtherance of geographical research.

THE Saxon Academy of Sciences at Leipzig has elected to membership Dr. Arthur von Oettingen, honorary professor of physics at Leipzig, and Dr. E. Ernst Abbe, honorary professor of meteorology and astronomy at Halle.

PROFESSOR A. R. CROOK, who holds the chair of mineralogy and petrography at Northwestern University, is at present engaged in explorations in Mexico. He is intending to ascend Mount Orizaba.

DR. CHARLES E. BROWN, of the Milwaukee Public Museum, is continuing his studies, begun several years ago, in the department of anthropology of the Field Columbian Museum, Chicago.

THE town of Amalfi has arranged to have this month a celebration in honor of Flavio Gioja, who lived in that city six hundred years ago, and is supposed to have invented or improved the compass.

A MEDALLION of Charles Hermite, the great mathematician, who died this year, will be placed in the Court of Honor of the Sorbonne.

WE learn from the *British Medical Journal* that a portrait of Dr. Thomas Young, from the painting by Sir Thomas Lawrence, has been placed in the Victoria Hall, Milverton, Somerset, with the following inscription: "Thomas

Young, M.D., F.R.S., etc. Born at Milverton, 1773. Died 1829. Physician, Natural Philosopher, and Master of many languages; he first established the undulatory theory of light, and translated the Rosetta Stone, which is the key to our understanding the Egyptian hieroglyphics."

DR. ADOLF ERIK NORDENSKJÖLD, the well-known arctic explorer and naturalist, died on August 13, in his sixty-ninth year. He first visited Spitzbergen in 1858 and again in 1861, 1864 and 1868, and visited Greenland in 1870 and 1875. In 1878-79 he made his famous voyage in the *Vega* through the northeast passage. He was professor in the Royal Museum of Natural History at Stockholm.

THE deaths are announced at the age of 55 years of Dr. W. Schur, professor of astronomy at Göttingen, and of Dr. E. Rehnisch, professor of philosophy at the same university, at the age of 62 years.

M. CASIMAR DE CANDOLLE was elected honorary president of the recent International Congress of Botanists at its meeting in Zurich on August 8, and Professor Claudet, of Geneva, was elected acting president.

THE British Mycological Society will hold a meeting at Exeter during the week beginning September 23. Professor H. Marshall Ward, of Cambridge University, will give a presidential address.

AMONG the Americans in attendance at the International Congress of Zoology are Professors Wilson of Columbia, Mark of Harvard, Patten of Dartmouth, McMurrich of Michigan, Woodworth of California, Dr. Allen of the American Museum of Natural History, Dr. Elliot of the Field Columbian Museum, Dr. Stiles of the U. S. Department of Agriculture and Mr. Stejneger of the U. S. National Museum. News has not yet reached this country regarding the meeting of the Congress, but about 150 papers have been promised in advance to be presented before seven sections, as follows: (1) General zoology; (2) vertebrata (biology, classification, distribution); (3) vertebrata (anatomy, histology, embryology); (4) invertebrata, except arthropoda; (5) arthropoda; (6) economic zoology (fisheries, etc.); (7) nomenclature. Lec-

tures before the Congress as a whole have been arranged by Professor G. B. Grassi on 'The malaria problem from a zoological standpoint,' by Professor A. Forel on 'The physical characters of ants,' by Professor E. B. Poulton on 'Mimicry and natural selection,' by Professor Wilhelm Branco on 'Fossil human remains' and by Professor Ives Delage on a subject not announced. Dr. P. L. Selater is expected to exhibit the skull of the *Okapi Johnstoni*, the remarkable mammal recently discovered in the Semliki forest of the Congo State. The entertainments were expected to include an excursion to Potsdam, a theatrical performance, a luncheon by the Berlin Zoological Society and a dinner in the Zoological Gardens. Following the Congress an excursion is planned to Hamburg and Heligoland.

THE American Institute of Electrical Engineers began its annual meeting in New York City on August 14, with a large number of foreign delegates in attendance. The members then proceeded to Buffalo, stopping to visit the works of the General Electric Company at Schenectady, and are this week holding meetings for the presentation of scientific papers and inspecting the electrical equipment installations at the Exposition and at Niagara Falls.

A HISTORICAL Congress will be held in Rome in the spring of 1902. We understand that the history of science will be specially included in the scope of the Congress.

DR. C. W. DANIELS left Liverpool, on July 8, for Sierra Leone, West Africa, to join the sixth malarial expedition of the Liverpool School of Tropical Medicine under Major Ronald Ross. Dr. Daniels was a member of the Royal Commission on Malaria, in which capacity he spent a long time in Central and East Africa recently. He will join Major Ross in Sierra Leone, and will probably proceed to the Gold Coast and Lagos. The expedition is now composed of Major Ronald Ross, Dr. Logan Taylor, Dr. McKendrick (officially attached to the expedition on behalf of the Indian Government), and Dr. Daniels. The seventh expedition of the Liverpool School, which will be despatched to the Gambia, is expected to leave for Bathurst about the end of the present month.

LARGELY through the agency of the 'Semper-virens Society' the State of California has appropriated \$250,000 to purchase and preserve the grove of redwoods near Santa Cruz.

THE exhibits of the German chemical industry at the Paris Exposition, valued at \$150,000, has been presented to the Technological Institute of the University of Berlin.

MR. CARNEGIE has offered \$50,000 to Burlington, Vt., for a library building on the usual conditions. He has also offered a building for Montrose, Scotland.

THE French Society for Colonial Expansion in France has instituted a special branch devoted to the assistance of doctors and chemists who desire to emigrate.

UNIVERSITY AND EDUCATIONAL NEWS.

BY the will of Mrs. Louise Frisbie, bequests amounting originally to \$28,000, but which may now amount to much more, are left to Smith, Vassar and Wellesley Colleges.

MRS. D. BANDY, who recently gave \$25,000 to Eureka College, Illinois, has given the institution land valued at \$60,000, subject to a life interest on the part of her daughter.

PROFESSOR W. VON ZEHENDER, of Munich, has given his valuable ophthalmological library to the University of Bern.

IT is reported in the medical journals that the University of Pennsylvania Veterinary Department will be moved to Thirty-ninth and Woodland avenue, instead of to the Flower Farm, on the West Chester Pike, as formerly intended. The reason assigned for the change in the plans is that the department would be too inconvenient for the public on the West Chester Pike, and too far from the university for the students. It is also stated that the work on the new \$60,000 buildings will begin in October.

THE Technical Education Board of the London County Council has directed the higher education subcommittee to inquire and report (a) as to the need and present provision for special training of an advanced kind in connection with the application of science (especially chem-

istry and electricity) to industry ; (b) as to what, if any, developments are needed to secure efficient training in these subjects for senior county scholars and other advanced students who desire to qualify themselves to take leading positions in scientific industries.

A COMMITTEE of the Birmingham City Council has recommended the council to make a grant to the Birmingham University of the proceeds of a halfpenny rate, which would provide an annual sum of about \$25,000.

THE University of Zurich has enlarged its anatomical building. A dissecting room with overhead light to accommodate two hundred students has been added and on the floor below a microscopical room of the same size. There is also a demonstration room with overhead light, a laboratory for anthropology, and a laboratory for advanced embryological study, together with rooms for the director. The old part of the building will be rearranged for a large lecture room, a reading and study room for the students, a museum, and the laboratories for assistants.

THE University at Erlangen announced a summer school for clergymen on the lines of the summer schools for teachers. It appears, however, that not sufficient clergymen felt the need of instruction, and the plan has been abandoned.

J. E. LOUGH, Ph.D. (Harvard), for the past four years professor of psychology at the State Normal School at Oshkosh, Wis., has been appointed to the professorship of psychology in the School of Pedagogy, New York University.

N. O. BOOTH has resigned his position as horticulturist in the University of Missouri to accept a position in the New York Agricultural College at Geneva.

MR. ROLLA R. RAMSEY, Ph.D., Cornell, '01, has been appointed instructor in physics in the University of Missouri. Dr. Ramsey is a graduate of the University of Indiana and has held graduate scholarships at Clark and Cornell. He has also been assistant in physics at Cornell and instructor at Indiana.

DR. VICTOR UHLIG, professor of paleontology at Vienna, succeeds Professor Ed. Suess in the chair of geology.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

EDITORIAL COMMITTEE : S. NEWCOMB, Mathematics ; R. S. WOODWARD, Mechanics ; E. C. PICKERING, Astronomy ; T. C. MENDENHALL, Physics ; R. H. THURSTON, Engineering ; IRA REMSEN, Chemistry ; CHARLES D. WALCOTT, Geology ; W. M. DAVIS, Physiography ; HENRY F. OSBORN, Paleontology ; W. K. BROOKS, C. HART MERRIAM, Zoology ; S. H. SCUDDER, Entomology ; C. E. BESSEY, N. L. BRITTON, Botany ; C. S. MINOT, Embryology, Histology ; H. P. BOWDITCH, Physiology ; J. S. BILLINGS, Hygiene ; WILLIAM H. WELCH, Pathology ; J. MCKEEN CATTELL, Psychology ; J. W. POWELL, Anthropology.

FRIDAY, AUGUST 30, 1901.

THE PROGRESS OF SCIENCE.*

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A CONSTITUTIONAL provision of our Association stipulates that "it shall be the duty of the President to give an address at a General Session of the Association at the meeting following that over which he presided." Happily for those of us who must in turn fulfill this duty, the scientific foresight of our predecessors set no metes and bounds with respect to the subject-matter or the mode of treatment of the theme that might be chosen for such an address. So far, therefore, as constitutional requirements are concerned, a retiring president finds himself clothed for the time being with a degree of liberty which might be regarded as dangerous, were it not for an unwritten rule that one may not hope to enjoy such liberty more than once. But time and place, nevertheless, as well as the painful personal limitations of any specialist, impose some rather formidable restrictions. One may not tax lightly, even in a summer evening, the patience of his audience for more than an academic hour, the length of which in most cases is less than sixty minutes. One must confine himself to generalities, which, though scientifically hazardous, serve as a basis for semi-popular thought; and one must exclude technical

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* Address of the president of the American Association for the Advancement of Science, given at the Denver Meeting, August 27, 1901.

details, which, though scientifically essential, tend only to obscure semi-popular presentation. Courtesy, also, to those who are at once our hosts and our guests requires that, so far as possible, one should substitute the vernacular for the 'jargon of science,' and draw his figures of speech chiefly from the broad domain of every-day life rather than from the special, though rapidly widening, fields of scientific activity.

Between this nominally unlimited freedom on the one hand, and these actually narrow restrictions on the other, I have chosen to invite your attention for the hour to a summary view of the salient features of scientific progress, with special reference to its effects on the masses, rather than on the individuals, of mankind. We all know, at least in a general way, what such progress is. We are assured almost daily by the public press and by popular consent that the present is not only an age of scientific progress, but that it is preeminently the age of scientific progress. And with respect to the future of scientific achievement, the consensus of expert opinion is cheerfully hopeful, and the consensus of public opinion is extremely optimistic. Indeed, to borrow the language sometimes used by the rulers of nations, it may be said that the realm of science is now at peace with all foreign parts of the world, and in a state of the happiest domestic prosperity.

But times have not been always thus pleasant and promising for science. As we look backward over the history of scientific progress it is seen that our realm has been taxed often to the utmost in defense of its autonomy, and that the present state of domestic felicity, bordering on tranquility, has been preceded often by states of domestic discord bordering on dissolution. And, as we look forward into the new century before us, we may well enquire whether science has vanquished its foreign enemies and settled its domestic disputes for good and

all, or whether future conquests can be made only by a similarly wasteful outlay of energy to that which has accompanied the advances of the past. Especially may we fitly enquire on an occasion like the present what are the types of mind and the methods of procedure which make for the progress, and what are the types of mind and the methods of procedure which make for the regress, of science. And I venture to think that we may enquire, also with profit, in some prominent instances, under what circumstances in the past science has waxed or waned, as the case may be, in its slow rise from the myths and mysticism of earlier eras to the law and order of the present day. For it is a maxim of common parlance, too well justified, alas! by experience, that history repeats itself; or, to state the fact less gently, that the blunders and errors of one age are repeated with little variation in the succeeding age. This maxim is strikingly illustrated by the history of science, and it has been especially deeply impressed upon us—burnt in, one might say—by the scientific events of our own times. Have we not learned, however, some lasting lessons in the hard school of experience, and may we not transmit to our successors along with the established facts and principles of science the almost equally well established ways and means for the advancement of science? Will it be possible for society to repeat in the twentieth century the appalling intellectual blunders of the nineteenth century, or have we entered on a new era in which, whatever other obstacles are pending, we may expect man to stand notably less in his own light as regards science than ever before? To a consideration of these and allied questions I beg your indulgence, even though I may pass over ground well known to most of you, and encroach, perhaps, here and there, on prominences in fields controversial; for it is only by discussion and rediscussion of such questions

that we come at last, even among ourselves in scientific societies, to the unity of opinion and the unity of purpose which lead from ideas to their fruitful applications.

From the earliest historic times certainly, if not from the dawn of primitive humanity, down to the present day, the problem of the universe has been the most attractive and the most illusive subject of the attention of thinking men. All systems of philosophy, religion and science are alike in having the solution of this problem for their ultimate object. Many such systems and sub-systems have arisen, flourished and vanished, only to be succeeded by others in the seemingly Sisyphean task. Gradually, however, in the lapse of ages there have accumulated some elements of knowledge which give inklings of partial solutions; though it would appear that the best current opinion of philosophy, religion and science would again agree in the conclusion that we are yet immeasurably distant from a complete solution. Almost equally attractive and interesting, and far more instructive, as it appears to me, in our own time, is the contemplation of the ways in which man has attacked this perennial riddle. It is, indeed, coming to be more and more important for science to know how primitive, barbarous and civilized man has visualized the conditions of, and reached his conclusions with respect to, this problem of the centuries; for it is only by means of a lively knowledge of the baseless hypotheses and the fruitless methods of our predecessors that we can hope to prevent history from repeating itself unfavorably.

Looking back over the interval of two to three thousand years that connects us by more or less authentic records with our distinguished ancestors, we are at once struck by the admirable confidence they had acquired in their ability to solve this grand problem. Not less admirable, also, for their ingenuity and for the earnestness

with which they were advanced, are the hypotheses and arguments by which men satisfied themselves of the security of their tenets and theories. Roughly speaking, it would appear that the science of the universe received its initial impulse from earliest man in the hypothesis that the world is composed of two parts; the first and most important part being in fact, if not always so held ostensibly, himself, and the other part being the aggregate of whatever else was left over. Though dimly perceived and of little account in its effects, this is, apparently, the working hypothesis of many men in the civilized society of today. But the magnitude of the latter part and its inexorable relations to man seem to have led him speedily to the adoption of a second hypothesis, namely, that the latter part, or world external to himself, is also the abode of sentient beings, some of a lower and some of a higher order than man; their rôle tending on the whole to make his sojourn on this planet tolerable and his exit from it creditable, while yet wielding at times a more or less despotic influence over him.

How the details of these hypotheses have been worked out is a matter of something like history for a few nationalities, and is a matter absorbing the attention of anthropologists, archeologists and ethnologists as it concerns races in general. Without going far afield in these profoundly interesting and instructive details, it may suffice for the present purposes to cite two facts which seem to furnish the key to a substantially correct interpretation of subsequent developments.

The first of these is that the early dualistic and antithetical visualization of the problem in question has persisted with wonderful tenacity down to the present day. The accessible and familiar was set over against the inaccessible and unfamiliar; or what we now call the natural,

though intimately related to, was more or less opposed to the supernatural; the latter being, in fact, under the uncertain sway of, and the former subject to the arbitrary jurisdiction of, good and evil spirits.

The second fact is that man thus early devised for the investigation of this problem three distinct methods, which have likewise persisted with equal tenacity, though with varying fortunes, down to the present day. The first of these is what is known as the *à priori* method. It reasons from subjective postulates to objective results. It requires, in its purity, neither observation nor experiment on the external world. It often goes so far, indeed, as to adopt conclusions and leave the assignment of the reasons for them to a subsequent study. The second is known as the *historico-critical* method. It depends, in its purity, on tradition, history, direct human testimony and verbal congruity. It does not require an appeal to Nature except as manifested in man. It limits observation and experiment to human affairs. The third is the method of science. It begins, in its elements, with observation and experiment. Its early applications were limited mostly to material things. In its subsequent expansion it has gained a footing in nearly every field of thought. Its prime characteristic is the insistence on objective verification of its results.

All these methods have been used more or less by all thinking men. But for the purposes of ready classification it may be said that the first has been used chiefly by dogmatists, including especially the founders and advocates of all fixed creeds from the atheistic and the pantheistic to the theistic and the humanistic; the second has been used chiefly by humanists, including historians, publicists, jurists and men of letters; and the third has been used chiefly by scientists, including astronomers, mathematicians, physicists, naturalists, and more recently the group of investigators falling under the

comprehensive head of anthropologists. The first and third methods are frequently found to be mutually antithetical, if not mutually exclusive. The second occupies middle ground. Together they are here set down in the order of their apparent early development and in the order of their popularly esteemed importance during all historic time previous to, if not including, this first year of the twentieth century.

No summary view of the progress of science, it seems to me, can be made intelligible except by a clear realization of these two facts, which may be briefly referred to as man's conception of the universe and his means of investigating it. What, then, in the light of these facts, has been the sequel? The full answer to this question is an old and a long story, now a matter of minute and exhaustive history as regards the past twenty centuries. I have no desire to recall the dramatic events involved in the rise of science from the Alexandrian epoch to the present day. All these events are trite enough to men of science. A mere reference to them is a sufficient suggestion of the existence of a family skeleton. But, setting aside the human element as much as possible, it may not be out of place or time to state what general conclusions appear to stand out plainly in that sequel. These are our tangible heritage and upon them we should fix our attention.

In the first place, the progress of science has been steadily opposed to, and as steadily opposed by, the adherents of man's primitive concepts of the universe. The domain of the natural has constantly widened and the domain of the supernatural has constantly narrowed. So far, at any rate, as evil spirits are concerned, they have been completely cast out from the realm of science. The arch fiend and the lesser princes of darkness are no longer useful even as an hypothesis. We have reached—if I may again use the cautious

language of diplomacy—a satisfactory *modus vivendi* if we have not attained permanent peace in all our foreign relations. Enlightened man has come to see that his highest duty is to cooperate with Nature, that he may expect to get on very well if he heeds her advice, and that he may expect to fare very ill if he disregards it.

Secondly, it appears to have been demonstrated that neither the *à priori* method of the dogmatists nor the historico-critical method of the humanists is alone adequate for the attainment of definite knowledge of either the internal or the external world, or of their relations to one another. In fact, it has been shown over and over again that man cannot trust his unaided senses even in the investigation of the simplest and most obvious material phenomena. There is an ever-present need of a correction for personal equation. Left to himself, the *à priori* reasoner weaves from the tangled skein of thought webs so well tied by logical knots that there is no escape for the imprisoned mind except by the rude process applied to cobwebs. And in the serenity of his repose behind the fortress of 'liberal culture,' the reactionary humanist will prepare apologies for errors and patch up compromises between traditional beliefs and sound learning with such consummate literary skill that even 'the good demon of doubt' is almost persuaded that if knowledge did not come to an end long ago it will soon reach its limit. In short, we have learned, or ought to have learned, from ample experience, that in the search for definite, verifiable knowledge we should beware of the investigator whose equipment consists of a bundle of traditions and dogmas along with formal logic and a facile pen; for we may be sure that he will be more deeply concerned with the question of the safety than with the question of the soundness of scientific doctrines.

Thirdly, it has been demonstrated equally

clearly, and far more cogently, that the sort of knowledge we call scientific, knowledge which has in it the characteristics of immanence and permanence, is founded on observation and experiment. The rise and growth of every science illustrate this fact. Even pure mathematics, commonly held to be the *à priori* science par excellence, and sometimes called 'the science of necessary conclusions,' is no exception to the rule. Those who would found mathematics on a higher plane have apparently forgotten to consider the contents of the mathematician's waste-basket. The slow and painful steps by which astronomy has grown out of astrology and chemistry out of alchemy; and the faltering, tedious, and generally hotly contested, advances of geology and biology have been made secure only by the remorseless disregard which observational and experimental evidence has shown for the foregone conclusions of the dogmatists and the literary opinions of the humanists. Thus it has been proved by the rough logic of facts and events that the rude processes of 'trial and error,' processes which many philosophers and some men of science still affect to despise, are the most effective means yet devised by man for the discovery of truth and for the eradication of error.

These facts are so well known to most of you, so much a matter of ingrained experience, that the categorical mention of them here may seem like a rehearsal of truisms. But it is one of the paradoxes of human development that errors which have been completely dislodged from the minds of the few may still linger persistently in the minds of the many, and that the misleading hypotheses and the dead theories of one age may be resuscitated again and again in succeeding ages. Thus, to cite one of the simplest examples, it doubtless appeared clear to the Alexandrian school of scientists that the flat, four-cornered earth of contemporary myths would speedily give way

to the revelations of geometry and astronomy. How inadequate such revelations proved to be at that time is one of the most startling disclosures in all history. The 'Divine School of Alexandria' passed into oblivion. The myth of a flat and four-cornered earth was crystallized into a dogma strong enough to bear the burden of men's souls by Cosmas Indicopleustes in the sixth century; it was supported with still more invincible arguments by Martin Luther in the sixteenth century; and it was revived and maintained with not less truly admirable logic, as such, by John Hampden and John Jasper in the last decades of the nineteenth century. To cite examples from contemporary history showing how difficult it is for the human mind to get above its primitive conceptions, one needs only to refer to the daily press. During the past two months, in fact, the newspapers have related how multitudes of men, women and children, many of them suffering from loathsome if not contagious diseases, have visited a veritable middle-age shrine in the city of New York, strong in the hoary superstition that kissing an alleged relic of St. Anne would remove their afflictions. During the same interval a railway circular has been distributed explaining how tourists may witness the Moki snake-dance, that weird ceremony by which the Pueblo Indian seeks to secure rain in his desert; and a similar public, and officially approved, ceremony has been observed in the heat-stricken State of Missouri.

Such epochs and episodes of regression as these must be taken into account in making up an estimate of scientific progress. They show us that the slow movement upward in the evolution of man which gives an algebraic sum of a few steps forward per century is not inconsistent with many steps backward. Or, to state the case in another way, the rate of scientific advance is to be measured not so

much by the positions gained and held by individuals, as by the positions attained and realized by the masses, of our race. The average position of civilized man now is probably below the mean of the positions attained by the naturalist Huxley and the statesman Gladstone, or below the mean of the positions attained by the physicist von Helmholtz and His Holiness the Pope. When measured in this manner, the rate of progress in the past twenty centuries is not altogether flattering or encouraging to us, especially in view of the possibility that some of the more recently developed sciences may suffer relapses similar to those which so long eclipsed geography and astronomy.

It must be confessed, therefore, when we look backward over the events of the past two thousand years, and when we consider the scientific contents of the mind of the average denizen of this planet, that it is not wholly rational to entertain millennial anticipations of progress in the immediate future. The fact that some of the prime discoveries of science have so recently appeared to many earnest thinkers to threaten the very foundations of society is one which should not be overlooked in these confident times of prosperity. And the equally important fact that entire innocence with respect to the elements of science and dense ignorance with respect to its methods, have not been hitherto incompatible with justly esteemed eminence in the divine, the statesman, the jurist and the man of letters, is one which should be reckoned with in making up any forecast. It may be seriously doubted, indeed, whether the progress of the individual is not essentially limited by the progress of the race.

But this obverse and darker side of the picture which confronts us from the past has its reverse and brighter side; and I am constrained to believe that the present status of science and the general enlightenment

of humanity justify ardent hopefulness if not sanguine optimism with respect to the future of scientific achievement. The reasons for this hopefulness are numerous; some of them arising out of the commercial and political conditions of the world, and others arising out of the conditions of science itself.

Perhaps the most important of all these reasons is found in the general enlargement of ideas which has come, and is coming, with the extension of trade and commerce to the uttermost parts of the earth. We are no longer citizens of this or that country, simply. Whether we wish it or not we are citizens of the world, with increased opportunities and with increased duties. We may not approve—few men of science would approve, I think—that sort of ‘expansion’ which works ‘benevolent assimilation’ of inferior races by means of a bible in one hand and a gun in the other; but nothing can help so much, it seems to me, to remove the stumbling blocks in the way of the progress of science as actual contact with the manners, the customs, the relations and the resulting questions for thought, now thrust upon all civilized nations by the events of the day. That sort of competition which is the life of trade, that sort of rivalry which is the stimulus to national effort, and that sort of cooperation which is essential for mutual protection, all make for the cosmopolitan dissemination of scientific truth and for the appreciation of scientific investigation. I would not disparage the elevated aspirations and the noble efforts of the evangelists and the humanists who seek to raise the lower to the plane of the higher elements of our race; but it is now plain as a matter of fact, however repulsive it may seem to some of our inherited opinions, that the railway, the steamship, the telegraph and the daily press will do more to illumine the dark places of the earth than all the apos-

ties of creeds and all the messengers of the gospel of ‘sweetness and light.’

A question of profound significance growing out of the extension of commercial relations in our time is what may be called the question of international health. An outbreak of cholera in Hamburg, the prevalence of yellow fever in Havana, or an epidemic of bubonic plague in India is no longer a matter of local import, as nations with which we are well acquainted have learned recently in an expensive manner. The management of this great international question calls for the application of the most advanced scientific knowledge and for the most intricate scientific investigation. Large sums of money must be devoted to this work, and many heroic lives will be lost, doubtless, in its execution; but it is now evident, as a mere matter of international political economy, that the cost of sound sanitation will be trifling in comparison with the cost of no sanitation; while further careful study of the natural history of diseases promises practical immunity from many of them at no distant day. International associations of all kinds must aid greatly also in the promotion of progress. Many such organizations have, indeed, already undertaken scientific projects with the highest success. Comparison and criticism of methods and results not only lead rapidly and effectively to improvements and advances, but they lead also to a whole-hearted recognition of good work which puts the fraternalism of men of science on a plane far above the level of the amenities of merely diplomatic life.

When we turn to the general status of science itself, there is seen to be equal justification for hopefulness founded on an abundance of favorable conditions. The methods of science may be said to have gained a footing of respectability in almost every department of thought, where, a half-century ago, or even twenty years ago,

their entry was either barred out or stoutly opposed. The 'Conflict between Religion and Science'—more precisely called the conflict between theology and science—which disturbed so many eminent though timid minds, including not a few men of science, a quarter of a century ago, has now been transferred almost wholly to the field of the theological contestants; and science may safely leave them to determine the issue, since it is evidently coming by means of scientific methods. The grave fears entertained a few decades ago by distinguished theologians and publicists as to the stability of the social fabric under the stress put upon it by the rising tide of scientific ideas, have not been realized. And, on the other hand, the grave doubts entertained by distinguished men of science a few decades ago as to the permeability and ready response of modern society to that influx of new ideas, have likewise not been realized. It is true that we still sometimes read of theological tests being applied to teachers of biology, and hear, occasionally, of an earnest search for a good methodist or a good presbyterian mathematician; but such cases may be left for settlement out of court by means of the arbitration of our sense of humor. It seems not unlikely, also, that there may persist, for a long time to come, a more or less guerilla 'warfare of science' with our friends the dogmatists and the humanists. Some consider this conflict to be, in the nature of things, irrepressible. But I think we may hope, if we may not confidently expect, that the collisions of the future will occur more manifestly than they have in the past in accordance with the law of the conservation of energy; so that the heat evolved may reappear as potential energy in the warmth of a kindly reasonableness on both sides, rather than suffer degradation to the level of cosmic frigidity.

Great questions, also, of education, of

economic, industrial and social conditions, and of legal and political relations are now demanding all the light which science can bring to bear upon them. Though tardily perceived, it is now admitted, generally, that science must not only participate in the development of these questions but that it alone can point the way to the solutions of many of them. But there is no halting ground here. Science must likewise enter and explore the domain of manners and morals; and these, though already largely modified unconsciously, must now be modified consciously to a still greater extent by the advance of science. Only within quite recent times have we come to realize an approximation to the real meaning of the trite saying that the proper study of man is man. So long as the most favored individuals of his race, in accordance with the hypothesis of the first centuries, looked upon him as a fallen, if not a doomed, resident of an abandoned reservation, there could be roused little enthusiasm with respect to his present condition; all thought was concentrated on his future prospects. How incomparably different does he appear to the anthropologist and the psychologist at the beginning of the twentieth century! In the light of evolution he is seen to be a part of, and not apart from, the rest of the universe. The transcendent interest of this later view of man lies in the fact that he can not only investigate the other parts of the universe, but that he can, by means of the same methods, investigate himself.

I would be the last to look upon science as furnishing a speedy or a complete panacea for the sins and sorrows of mankind; the destiny of our race is entangled in a cosmic process whose working is thus far only dimly outlined to us; but it is nevertheless clear that there are available to us immense opportunities for the betterment of man's estate. For example, to mention only one of the lines along which improvement is

plainly practicable, what is to hinder an indefinite mitigation, if not a definite extinction, of the ravages of such dread diseases as consumption and typhoid fever? Or what, we may ask, is to hinder the application to New York, Philadelphia and Chicago of as effective health regulations as those now applied to Havana? Nothing, apparently, except vested interests and general apathy. We read, not many years ago, that a city of about one million inhabitants had, during one year, more than six thousand cases of typhoid fever. The cost to the city of a single case may be estimated as not less, on the average, than one thousand dollars, making an aggregate cost to that city, for one year, of more than six millions of dollars. Such a waste of financial resources ought to appeal to vested interests and general apathy even if they cannot be moved by any higher motives. Thanks to the penetration of the enlightenment of our times, distinct advances have already been made in the line of effective domestic and public sanitation; but the good work accomplished is infinitesimal in comparison with that which can be, and ought to be, done. It is along this and along allied lines of social and industrial economy that we should look, I think, for the alleviation of the miseries of mankind. No amount of contemplation of the beatitudes, human or divine, will prevent men from drinking contaminated water or milk; and no fear of future punishments, which may be in the meantime atoned for, will much deter men from wasting their substance in riotous living. The moral certainty of speedy and inexorable earthly annihilation is alone adequate to bring man into conformity with the cosmic rules and regulations of the drama of life.

And finally we must reckon amongst the most important of the conditions favorable to the progress of science, the unexampled activity in our times of the scientific spirit

as manifested in the work of all kinds of organizations, from the semi-religious Chautauquan assemblies up to those technical societies whose programs are Greek to all the world beside. Literature, linguistics, history, economics, law and theology are now permeated by the scientific spirit if not animated by the scientific method. Curiously enough, also, the terminology, the figures of speech and the points of view of science are now quite common in realms of thought hitherto held somewhat scornfully above the plane of materialistic phenomena. Tyndall's Belfast address, which, twenty-seven years ago, was generally anathematized, is now quoted with approval by some of the successors of those who bitterly denounced him and all his kind. Thus the mere lapse of time is working great changes and smoothing out grave differences of opinion in favor of the progress of science in all the neighboring provinces with which we have been able hitherto to maintain only rather strained diplomatic relations.

Still more immediately important to us are the evidences of progress manifested in recent years by this Association and by its affiliated societies. Our parent organization, though a half century old, is still young as regards the extent in time of the functions it has undertaken to perform. It has accomplished a great work; but in the vigor and enthusiasm of its youth a far greater work is easily attainable. Exactly how these functions are to be developed, no man can foresee. We may learn, however, in this, as in other lines of research, by methods with which we are well acquainted, namely, by the methods of carefully planned and patiently executed observation and experiment. The field for energetic and painstaking effort is wider and more attractive than ever before. Science is now truly cosmopolitan; it can be limited by no close corporations; and no domain of scientific

investigation can be advantageously fenced off, either in time or in space, from the rest. While every active worker of this or of any affiliated society is, in a sense, a specialist, there are occasions when he should unite with his colleagues for the promotion of the interests of science as a whole. The results of the specialists need to be popularized and to be disseminated among the people at large. The advance of knowledge, to be effective with the masses of our race, must be sustained on its merits by a popular verdict. To bring the diverse scientific activities of the American Continent into harmony for common needs; to secure cooperation for common purposes; and to disseminate the results of scientific investigation among our fellow-men, are not less, but rather much more, than in the past, the privilege and the duty of The American Association for the Advancement of Science.

Viewed, then, in its broader aspects, the progress of science is involved in the general progress of our race; and those who are interested in promoting the former should be equally earnest in securing the latter. However much we may be absorbed in the details of our specialties, when we stop to think of science in its entirety, we are led, in the last analysis, back to the problem of problems—the meaning of the universe. All men ‘gifted with the sad endowment of a contemplative mind’ must recur again and again to this riddle of the centuries. We are, so to speak, whatever our prepossessions, all sailing in the same boat on an unknown sea for a destination at best not fully determined. Some there are who have, or think they have, the Pole Star always in sight. Others, though less confident of their bearings, are willing to assume nothing short of second place in the conduct of the ship. Others, still less confident of their bearings, are disposed to depend chiefly on their knowledge of the compass and on their skill in dead reckoning. We of the

last class may not impugn the motives or doubt the sincerity of the first two classes. We should find it difficult, probably, to dispense with their company in so long a journey after becoming so well acquainted with them; for among them we may each recall not a few of those rarer individuals of the genus homo called angels on earth. But it must be said in all truth, to resume the figure, that they have neither improved much the means of transportation nor perfected much the art of navigation. They have been sufficiently occupied, perhaps, in allaying the fears of the timid and in restraining the follies of the mutinous. Other types of mind and other modes of thought than theirs have been essential to work out the improvements which separate the earlier from the later nautical equipments of men; such improvements, for example, as mark the distinction between the dug-out of our lately acknowledged relatives, the Moros and the Tagalogs, from the Atlantic-liner of to-day.

At any rate, we are confronted by the fact that man's conceptions of the universe have undergone slow but certain enlargement. His early anthropocentric and anthropomorphic views have been replaced, in so far as he has attained measurable advancement, by views that will bear the tests of astronomy and anthropology. He has learned, slowly and painfully, after repeated failures and many steps backward, to distinguish, in some regions of thought, the real and the permanent from the fanciful and fleeting phenomena of which he forms a part. His pursuit of knowledge, in so far as it has led him to certainty, has been chiefly a discipline of disillusionment. He has arrived at the truth not so much by the genius of direct discovery as by the laborious process of the elimination of error. Hence he who has learned wisdom from experience must look out on the problem of the universe at the beginning of the twentieth

century, with far less confidence in his ability to speedily solve it and with far less exaggerated notions of his own importance in the grand aggregate of Nature, than man entertained at the beginning of our era. But no devotee to science finds humiliation in this departure from the primitive concepts of humanity. On the contrary, he has learned that this apparent humiliation is the real source of enlightenment and encouragement; for notwithstanding the relative minuteness of the speck of cosmic dust on which we reside, and notwithstanding the relative incompetency of the mind to discover our exact relations to the rest of the universe, it has yet been possible to measure that minuteness and to determine that incompetency. These, in brief, are the elements of positive knowledge at which we have arrived through the long course of unconscious, or only half-conscious, experience of mankind. All lines of investigation converge towards or diverge from these elements. It is along such lines that progress has been attained in the past, and it is along the same lines that we may expect progress to proceed in the future.

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*ZOOLOGY OF THE TWENTIETH CENTURY.**

LOOKING over the vice-presidential addresses given before the American and British Associations during the past year or two in an eager search for suggestions, I found a prevailing tone of retrospect. The advance of science in the nineteenth century was a favorite theme, and little wonder in view of the century's marvelous events. Since by the arrangement of the council I lost my opportunity to be an end-of-the-century historian last year, I shall essay the rôle of a prophet this. On the

historical side I could have given you something very interesting, I assure you. Not I, but the council that delayed my address to the following century, must be held responsible for the poor substitute I am able to present.

We have stood in retrospect at the close of the nineteenth century and marveled at what it brought forth. Here at the threshold of the twentieth century it is natural that we should wonder what it will unfold. Will the changes be as great, and in what direction will advance chiefly be made? I am the more content to consider such questions for three reasons: First, because we can use history to formulate predictions; second, because the attempt may possibly influence to some slight degree the future development of zoology; and third, because the attempt is tolerably safe, since we shall none of us know all that the century will bring forth.

Comparing the beginning of the twentieth century with that of the nineteenth, we find the most striking advances to have taken place in our morphological knowledge. The nineteenth may indeed be designated the morphological century. The demands of systematic zoology first made anatomical studies necessary. Later, comparison came to be accepted as the fundamental zoological method, and comparative anatomy, emancipated from its servitude to systematic zoology, became an independent science. Still later embryology arose, at first as a descriptive science and then as a comparative one. Out of embryology arose modern cytology, which in turn is creating a comparative histology. Partly as a result of studying embryology as a process has arisen the modern tendency toward comparative physiology. As a result of the general acceptance of the evolution doctrine, the study of the geographical distribution of organisms and of adaptations has gained a new meaning. From the great matrix of 'gen-

* Address of the Vice-president of Section F, Zoology, American Association for the Advancement of Science, Denver Meeting, August, 1901.

eral biology' there has begun to crystallize out a number of well-defined subsciences.

Looking broadly at the progress made during the past century, we see that zoology has become immensely more complex, due to its developing in many lines, and that the new lines are largely interpolated between the old and serve to connect them. The descriptive method has developed into a higher type—the comparative; and of late years still a new method has been introduced for the study of processes—the experimental. The search for mechanisms and causes has been added to the search for the more evident phenomena. The zoologist is no longer content to collect data; he must interpret them.

In view of the past history of our science, what can we say of its probable future? We may be sure that zoology will develop in all these three directions: (1) The continued study of old subjects by old methods; (2) the introduction of new methods of studying old subjects; and (3) the development of new subjects.

I am not of those who would belittle the old subjects, even when pursued in the old way. There is only one class of zoologist that I would wish to blot out, and that is the class whose reckless naming of new 'species' and 'varieties' serves only to extend the work and the tables of the conscientious synonymy hunter. Other than this all classes will contribute to the advancement of the science. No doubt there are unlabeled species, and no doubt they must, as things are, be named. And no doubt genera and families must be 'revised' and some groups split up and others lumped. So welcome to the old-fashioned systematist, though his day be short, and may he treat established genera gently. No doubt there are types of animals of whose structure we are woefully ignorant; no doubt we need to know their internal anatomy in

great detail. So welcome to the zootomist in this new century, and may he invent fewer long names for new organs. No doubt there are groups of whose relationships we know little and which have been buffeted about from one class to another in a bewildering way. We need to have them stay fixed. So welcome to the comparative anatomist and the embryologist, and may their judgment as to the relative value of the criteria of homology grow clearer. No doubt our knowledge of inheritance and development will be immensely advanced by the further study of centrosomes, asters and chromosomes. Welcome, therefore, to the cytologist, and may he learn to distinguish coagulation products and plasmolytic changes from natural structures. All these subjects have victories in store for them in the new century. To neglect them is to neglect the foundations of zoology.

But the coming century will, I predict, see a change in the methods of studying many of these subjects. In systematic zoology fine distinctions will no longer be expressed by the rough language of adjectives, but quantitatively, as a result of measurement. There is every reason to expect, indeed, that the future systematic work will look less like a dictionary and more like a table of logarithms. Our system of nomenclature, meanwhile, will probably break down from its own weight. Now that the binomial system of nomenclature has been replaced by a trinomial, there is no reason why we should not have a quadrinomial nomenclature or even worse. It seems as if the Linnæan system of nomenclature is doomed. What will take its place can hardly be predicted. The new system should recognize the facts of place-modes and color varieties. We might establish certain categories of variation such as those of geographical regions, of habitat, of color. A decimal system of numbers might be applied to the parts of the coun-

try or the kinds of habitat, and the proper number might take the place of the varietal or subvarietal name. Thus the northeastern skunk might be designated *Mephitis mephitica* 74 and the southeastern skunk *Mephitis mephitica* 75 (adopting the Dewey system of numerals). The Maine skunk would then be 741; that of New York 747, and so on. This much for a suggestion.

So likewise for the morphologist the coming century will bring new aims and new methods. No longer will the construction of phylogenetic trees be the chief end of his studies, but a broad understanding of the form producing and the form maintaining processes. The morphologist will more and more consider experiment a legitimate method for him. The experimental method will, I take it, be extended especially to the details of cytology, and here cytology will make some of its greatest advances.

Not only will the old subjects be studied by new methods, but we have every reason to believe that new sub-sciences will arise during the twentieth century as they did during the nineteenth. Of course we cannot forecast all these unborn sciences, as cytology and neurology could hardly have been forecast at the beginning of the nineteenth century. But we can see the beginnings of what are doubtless to be distinct sciences. Thus comparative physiology is still in its infancy and is as yet hardly worthy of the name of a science; there is no question that this will develop in the coming decades. Animal behavior has long been treated in a desultory way, and many treatises on the subject are rather contributions to folk-lore than to science. But we are beginning to see a new era—an era of precise, critical and objective observation and record of the instincts and reactions of animals. One day we shall reach the stage of comparative

studies, and shall have a science of the ontogeny of animal instincts. This will have the same importance for an interpretation of human behavior that comparative anatomy and embryology have for human structure.

Prominent among the advances of the century will be the ability to control biological processes. We shall know the factors that determine the rate of growth and the size of an animal, the direction and sequence of cell-divisions, the color, sex and details of form of a species. The direction of ontogeny and of phylogeny will be to a greater or less extent under our control.

The study of animals in relation to their environment, long the pastime of country gentlemen of leisure, will become a science. Some day we shall be able to say just what conditions an animal's presence at any place; and, more than that, we shall be able to account for the fauna—the sum total of animal life of any locality—and to trace the history of that fauna. This is at least one of the aims of animal ecology. It is a reproach to zoology that the subject of animal ecology should lag so far behind that of plant ecology. When zoologists fully awaken to a realization of what a fallow field lies here this reproach will quickly be wiped out. As it is, we have a notion that the factors determining the occurrence of an animal or of a fauna are too complicated to be unraveled. As a matter of fact, the factors are often quite simple. Let me illustrate this by some studies I have made this summer on the Cold Spring Beach. This beach is a spit of sand, 2,000 feet long and 50 to 75 feet broad, running from the western mainland into the harbor and ending in a point that is being made several feet a year through the cooperation of wave, tide and a silt-transporting creek of fresh water. On the outer harbor side is a broad, gradually sloping, sandy and gravelly beach, covered

by high tide and devoid of living vegetation. Above that is a narrow zone—the middle beach—covered with débris of storms, supporting a few annual plants, and bounded above by a storm-cut bluff. Above is the upper beach, covered with a perennial, sand-loving vegetation. On the lower beach the zonal distribution of animals is striking. Just above the water are found the scavenger mud snails and, further up, a crowd of *Thysanura*—small insects that rise to the surface of the water when the tide comes in. These find a living on the finer débris or silt that settles on the pebbles during the high tides. In this zone also *Limulus* lays its eggs in the sand, and its nests are crowded with nematodes that feed on the eggs. During the breeding season scores of the female *Limulus* die here, and their carcasses determine a complex fauna. First, carrion beetles (*Necrophorus*) and the flesh fly live on the dead bodies; then the robber flies and tiger-beetles are here to feed on this fauna, and finally numerous swallows course back and forward gleaning from this rich field. At the upper edge of the lower beach is a band of débris dropped at slack water and consisting especially of shreds of *Ulva* and many drowned insects, chiefly beetles. At this zone, or just above under the drier but more abundant wreckage of the last storm, occur numerous Amphipoda of the genera *Orchestia* and *Talorchestia*. Associated with these marine creatures are numerous red ants, sand-colored spiders and rove-beetles. The amphipods feed on the decaying sea-weed. The ants are here looking chiefly for the drowned insects. Their nests are further up on the middle beach, but the workers travel to the edge of the high tide to bring away their booty. The rove-beetles are general scavengers. The spiders, which are mostly of the jumping sort (of the family *Attidae*), feed on the active insects and amphipods. At a higher zone, and above all but the storm-driven

tides, one finds the nests of the ants, especially under logs, certain predaceous beetles and the xerophilous grasshoppers and crickets. Finally, on the plant-covered upper beach one finds characteristic leaf-eating beetles, grasshoppers and carnivorous insects. Now all this seems commonplace enough and not especially instructive, and yet if you go to the shore of Lake Michigan you will find on a similar beach closely similar, if not identical, forms (excepting the beach fleas and the horseshoe crabs) you will find similar ants, spiders, rove-beetles, tiger beetles and sand-grasshoppers. This fact alone shows the greater importance of habitat over geographical region in determining the assemblage of animals that occurs in any one place. It may be predicted that studies on the relation of animals to their habitat will multiply, that they will become comparative and that the science of animal ecology will become recognized as no less worthy and no less scientific than the science of morphology.

Studies on the origin of species were far from being unknown in the nineteenth century, but they were for the most part fragmentary, or speculative, or narrow in view. The opinion that there was one method of evolution seemed to hold sway. It seems to me that the signs of the times indicate that we are about to enter upon a thorough, many-sided, inductive study of this great problem, and that there is a willingness to admit that evolution has advanced in many ways. The attempt, therefore, to explain all specific peculiarities on the ground of natural selection, or on the ground of self-adjustment, or on the ground of sport preservation through isolation, we may expect equally to prove futile. All these causes are no doubt real in some cases, but to exclude any one or to deny that new causes may be found in the future is equally dangerous and unscientific.

It is often said that the factors of evo-

lution are inheritance and variation. In the new century careful and quantitative studies will be made on these factors. We shall get at quantitative expressions of the more complicated forms of heritage in the same way as Galton has given us an expression of a simple form of inheritance. We shall hope to understand why some qualities blend and others refuse to do so. We shall learn the laws of mingling of qualities in hybrids and get an explanation of the monstrosities and the sterility which accompany hybridization. What we call reversion and prepotency will acquire a cytological explanation, and it may be that the theory of fertilization will be seriously modified thereby. When we can predict the outcome of any new combination of germ plasms then, indeed, we shall have got at the laws of inheritance.

As for the other factor, that of variation, I anticipate interesting developments in our knowledge of its laws and of its causes. The methods by which this knowledge is to be acquired are doubtless comparative observation, experimentation and a quantitative study of results. Within the last decade a profound student of variation (Bateson) has declined to discuss its causes, holding that we had no certain knowledge of them. Even the categories of variation are still unenumerated. The science of variation is therefore one of those that we may hope to see established in this century. I feel convinced that statistical studies are first of all necessary to lay the foundations of the science.

As an illustration of an application of statistics to evolution studies I will give some account of my work during the past two years on the scallop of our east coast, *Pecten irradians*.

Pecten irradians is a bivalve mollusc of flattened, lenticular form, that inhabits our coast from Cape Cod southward. The Cape Cod limit is a rather sharp one, but

southward our scallop passes gradually into the closely related forms of the South American coast. This fact would seem to indicate its southerly origin. To get light on the evolution of the group, I have studied and measured over 3,000 shells, chiefly from four localities: (1) Cold Spring Harbor, Long Island; (2) Morehead, North Carolina; (3) Tampa, Florida, and (4) the late Miocene or early Pliocene fossils of the Nansemond River. The fossil shells, to which I shall frequently refer, were found imbedded in the sand at Jack's Bank, one mile below Suffolk, Virginia. The bank rises to a height of 25 to 30 feet. Shells were obtained from three layers, respectively, one foot, six feet and 15 feet above the base of the bluff. Of course, the upper shells lived later than the lower ones and may fairly enough be assumed to be their direct descendants. The time interval between the upper and lower levels cannot be stated. As I have measured sufficient shells from the bottom and top layers only I shall consider them chiefly. I wished to get recent *Pectens* from this locality, but the nearest place where they occur in quantity is Morehead, North Carolina. These *Pectens* may therefore stand as the nearest recent descendants of the *Pectens* of the Nansemond River.

The *Pecten* shells have a characteristic appearance in each of the localities studied. After you have handled them for some time you can state in 95 per cent. of the cases the locality from which any random shell has come. First of all, the shells differ in color, especially of the lower valve. In the specimens from Cold Spring Harbor this is a dirty yellow; from Morehead, yellow to salmon; from Tampa white through clear yellow to bright salmon. Second, the antero-posterior diameter of the shell becomes relatively greater than the vertical diameter as you go north. Thus, the antero-posterior diameter exceeds, on the average, the dorso-

ventral diameter : at Tampa, by about 1.5 mm.; at Morehead, 2.5 mm.; and at Cold Spring Harbor, 6 mm. The fossil *Pectens* have an excess of about 4 mm.

Comparing the fossils with the *Pectens* of Morehead we find, as shown above, that the fossils are more elongated. Comparing the depth of the right valves having a height of 59 mm., we get :

From the lowest level, Jack's Bank	8.8 mm.
" " " " " " "	9.1 mm.
" Morehead	19.7 mm.

Hence the recent shells are much more nearly spherical than the fossils; there is a phylogenetic tendency toward increased globosity.

The average number of rays in the different localities is as follows :

Lower level, Jack's Bank	22.6
Middle " " "	22.1
Upper " " "	21.7
Morehead and Cold Spring Harbor	10.3
[Tampa	20.5]

Here it appears that there is a phylogenetic tendency toward a decrease in the number of rays of *Pecten irradians*. To summarize: The scallop is becoming, on the average, more globose, and the number of its rays is decreasing and its valves are probably becoming more exactly circular in outline. The foregoing examples illustrate the way in which quantitative studies of the individuals of a species can show the change in its average condition both at successive times and in different places.

But the quantitative method yields more than this. It is well known that if the condition of an organ is expressed quantitatively in a large number of individuals of a species the measurements or counts made will vary, *i. e.*, they will fall into a number of *classes*. The proportion of individuals falling into a class gives what is known as the 'frequency' of the class. Now it appears that in many cases the middle class has the

greatest frequency (and is consequently called the mode) and as we depart from it the frequency gradually diminishes, and diminishes equally at equal distances above and below the mode. One can plot the distribution of frequencies by laying off the successive classes at equal intervals along a base line and drawing perpendiculars at these points proportional in length to the frequency. If the tops of these perpendiculars be connected by a line there is produced a 'frequency polygon.' The shape of the frequency polygon gives much biological information. When the polygon is symmetrical about the modal ordinate we may conclude that no evolution is going on; that the species is at rest. But very often the polygon is more or less unsymmetrical or 'skew.' A skew polygon is characterized by this: that the polygon runs from the mode further on one side than on the other. This result may clearly be brought about by the addition of individuals to one side or their subtraction from the other side of the normal frequency polygon. The direction of skewness is toward the excess side. The skew frequency polygon indicates that the species is undergoing an evolutionary change. Moreover, the direction and degree of skewness may tell us something of the direction and rate of that change. There is one difficulty in interpretation, however, for a polygon that is skew may be so either from innate or from external causes. In the case of skewness by addition we may think that there is an innate tendency to produce variants of a particular sort, representing, let us say, the *atavistic* individuals. In this case skewness points to the past. The species is evolving from the direction of skewness. In the case of skewness by subtraction there are external causes annihilating some of the individuals lying at one side of the mode. Evolution is clearly occurring away from that side and *in* the direction of skewness.

Now so far as we know at the present time there is no way of distinguishing skew polygons due to atavism from such as are due to selective annihilation. But in many cases at least the skewness, especially when slight, can be shown to be due to atavism; and this is apparently the commoner cause. This conclusion is based first upon a study of races produced experimentally and whose ancestry is known, and secondly upon certain cases of compound curves. Take the case of the ray flowers of the common white daisy. A collection of such daisies gathered in the fields by DeVries gave a mode of 13 ray flowers with a positive skewness of 1.2. The 12- or 13-rayed wild plants were selected to breed from, and their descendants, while maintaining a mode at 13, had the increased positive skewness of 1.9. The descendants of the 12-rayed parents had a stronger leaning towards the high ancestral number of ray flowers than the original plants had. The 21-rayed plants were also used to breed from. Their descendants were above the ancestral condition as the descendants of the 12-rayed plants were below. The skewness — 0.13 is comparatively slight. In this case we have experimental evidence that polygons may be skew toward the original ancestral condition.

Of the compound polygons it is especially the bimodal polygon that frequently gives hint of two races arising out of one ancestral, intermediate condition. Consequently we should expect the two constituent polygons to be skew in opposite directions; and so we usually find them to be. For example, Bateson has measured the horns on the heads of 343 rhinoceros beetles and has got a bimodal polygon. The polygon with the lower mode has a skewness of + 0.48; that with the higher mode a skewness of — 0.03. One might infer that the right-hand form, the long-horned beetles, had diverged less than the

short-horned from the ancestral condition. Again, as is well known, the chinch bug occurs in two forms—the long-winged and the short-winged. Now, in a forthcoming paper my pupil, Mr. Garber, will show that the frequency polygon of the short-winged form has a skewness of + 0.44, while that of the long-winged form has a skewness of — 0.43. On our fundamental hypothesis the ancestral condition must have been midway between the modes.

Still a third class of cases that gives evidence as to the significance of skewness is that where two place modes have moved in the same direction but in different degrees. Thus the index (breadth ÷ length) of the shell of *Littorina littorea*, the shore snail, as measured by Bumpus, has at Newport a mode of 90, at Casco Bay of 93. The skewness is positive in both places and greater (+ .24) at the more southern point than at Casco Bay (+ .13). This indicates that the ancestral races had a higher index even than those of Casco Bay, probably not far from 96, and also that the *Littorina littorea* of our coast came from the northward, since the northern shells are the rounder. We have historical evidence that they did come from the northward. Likewise the *Littorinas* from South Kincardineshire, Scotland, have a modal index of 88 and a skewness of + 0.065, while those of the Humber, with a mode of 91 have a skewness of + 0.048. These figures suggest that if the mode were 97 the skewness would be 0, and this would give practically the same value to the ancestral index as arrived at for the *Littorinas* of our coast. It will be seen from these illustrations that the form of the frequency polygon may be of use in determining phylogeny.

While skewness is thus often reminiscent, we must not forget the possibility that it may be, in certain cases, prophetic. This has come out rather strongly in a piece of

work I have been engaged on during the past year. I have been counting the number of rays in recent *Pecten irradians* from various localities and have obtained in some cases evident skewness in the frequency polygons. To see what phylogenetic meaning, if any, this skewness has I sought to get a series of late fossils. After careful consideration I was led to go to the Nansemond River for the late Tertiary fossils found there and already referred to. These served my purpose admirably. We may now compare the average number of rays from the two extreme layers at Jack's Bank and at Morehead with the indices of skewness of the frequency polygons from the same localities.

Place.	Avg. No. of Rays.	Index of Skewness.	σ
Morehead, N. C.	17.3	-0.09	0.81
Upper Layer, Jack's Bank.	21.7	-0.16	1.0
Lower Layer, Jack's Bank.	22.6	-0.22	1.24

This series is instructive in that it tells us that the gradual reduction in the number of rays has been accompanied at each preceding stage by a negative skewness. This skewness was thus *prophetic* of what was to be. The skew condition of the frequency polygon we may attribute to a selection taking place at every stage, and the interesting result appears that the selection diminishes in intensity from the earliest stage onward. It is as though perfect adjustment were being acquired. If adjustment were being perfected we might expect a decrease in the *variability* in the rays at successive periods. And we do find such a decrease. This is indicated in the last column where σ stands for the index of variability. From this column it appears that the variation in the number of rays has diminished from 1.24 rays in the Miocene to 0.81 rays in recent times. This fact again points to an approach to perfection and stability on the part of the rays.

Just why or wherein the reduced number of rays is advantageous I shall not pretend to say. It is quite possible that it is not more advantageous, but that there is in the phylogeny of *Pecten irradians* an inherent tendency towards a reduction in the number of multiple parts. As a matter of fact there are other *Pectens* in which the number of rays is less even than in *irradians*.

The reduction in the variability of the rays with successive geological periods has another interest in view of the theory of Williams and of Rosa, according to which evolution and differentiation have of necessity been accompanied by a reduction in variability. Evolution consists, indeed, of a splitting off of the extremes of the range of variation, so that in place of species with a wide range of variability we have two or three species each with a slight range of variability. In the particular case in hand, however, it is not certain that the lower Jack's Bank form-unit (named *Pecten eboricus* by some one) has given rise to any other form than something of which *Pecten 'irradians'* of Morehead is a near representative. The evidence indicates that the reduced variability is solely the effect of the skewing factors.

The upshot of this whole investigation into the biological significance of skew variation is then this: Skewness is sometimes reminiscent and sometimes prophetic. In our present state of knowledge it is not possible by inspecting a single skew curve to say which of the two interpretations is correct in the given case. But by a comparison of the frequency curves of allied form-units the state of affairs can usually, as in the examples given, be inferred. A method of interpreting the single skew curve is a discovery for the future.

I realize that I have been bold, not to say rash, in this attempt to forecast the zoology of the twentieth century. I suppose,

after all, I have merely expressed my personal ideals. Let those comfort themselves, therefore, who like my picture not and let them draw one more to their taste. These matters of detail are after all less important; but the general trend of the science I believe to be determined by the great general laws that will hold, whatever the detailed lines of development. First, students of the science will cling closer to inductive methods without abandoning deduction. Speculative web-spinning will be less common, will be less attractive, and will be more avoided by naturalists of repute. Great generalizations will be made, of course, but made with caution and founded at every step on facts. Second, the science will deal more with processes and less with static phenomena, more with causes and less with the accumulation of data. The time is coming when the naturalist who merely describes what he sees in his sections will have neither more nor less claim for consideration than he who describes a new variety of animal. It is relations, not facts, that count. Third, the science will become experimental, at least in so far as it deals with processes. Nothing will be taken for granted that can be experimentally tested. Better experimental laboratories will be founded and larger experimental stations, such as Bacon foresaw in the new world, will be established. Fourth, the science will become more quantitative. This is the inexorable law of scientific progress, at least where processes are concerned. I repeat that there is no reason to expect or desire the abandoning of the lines of work already recognized and followed for a half century or more. Rather holding fast to and extending the old lines of investigation, zoology will be enriched by new fields of study lying between and uniting the old. As chemistry and physics are uniting and occupying the intervening field, as geology and botany are coming close together in

plant ecology, so will zoology and mathematics, zoology and geology, zoology and botany find untouched fields between them and common to them. Working in these new fields and by the aid of new methods, the naturalist of the future will penetrate further into the nature of processes and unravel their causes.

The zoology of the twentieth century will be what the zoologist of the twentieth century makes it. One hundred years ago the prerequisites of the naturalist were few and the opportunities of getting them were small. He must have studied with some master or have worked as an assistant under a naturalist in some museum. The places were few, the masters often difficult of approach. Now while, on the one hand, the training required in vastly more exacting, on the other hand, the opportunities are generous. Just because of the fact that zoology is spreading to and overlapping the adjacent sciences, the zoologist must have his training broadened and lengthened. A zoologist may well be expected to know the chief modern languages (let us hope this requirement may not be further extended), mathematics through analytics, laboratory methods in organic as well as inorganic chemistry, the use of the ordinary physical instruments, advanced geology and physiography, botany, especially in its ecological, physiological and cytological aspects, and animal paleontology. The list of prerequisites is appallingly long; zoologists of the future will be forced to an earlier and narrower specialization, while at the same time they must lay a broader foundation for it.

But if the prerequisites of the zoologists are to be numerous their acquisition will be easy. Even now scores of universities put the services of the best naturalists at the disposal of students and offer free tuition and living to come and study with them. Librarians, great museums, great teachers

are made available to him who would work and has the requisite capacity.

All these advantages will, however, count for nothing if zoological research does not attract the best men, and if the best men be not accorded time and means for research. Our best students slip from our grasp to go into other professions or into commerce because we can offer them no outlook but teaching, administration, and a salary regulated by the law of supply and demand. We must urge without ceasing upon college trustees and corporations the necessity of freedom for research and liberal salaries if America is to contribute her share to the advance of zoology in the twentieth century.

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SCIENTIFIC BOOKS.

Leçons de physiologie expérimentale. By M. RAPHAEL DUBOIS, professor in the University of Lyons, with the collaboration of M. EDMOND COUVREUR. Paris, Georges Carré et C. Naud. Pp. vi + 380.

These lessons in experimental physiology constitute a course of demonstrations, or lectures illustrated by demonstrations, given successfully by Professor Dubois and his pupil and collaborator, M. Couvreur, to the students in physiology of the faculty of sciences of the University of Lyons. As the authors state in the preface, they are now published with the view "of relieving the students attending the demonstrations from the necessity of taking notes, so that they may be able to devote to what they see the greatest amount of attention possible." In addition to viewing the demonstrations, the students are expected to repeat for themselves, under the direction of a master, all the classical experiments. For those who do not possess the advantage of expert supervision it is intended that the exercises described shall serve as a guide by the aid of which they may acquire a practical knowledge of physiology.

While it is encouraging to learn that some-

thing is being done to improve the teaching of practical physiology in the countries of continental Europe, where hitherto it has in general scarcely entered as a factor of any importance into the education of the student of science and particularly of medicine, we doubt whether there is a single teacher of experience in America or England who would bestow an unqualified approval upon the method adopted in this book. At the same time we can most heartily congratulate the young gentlemen (and ladies, if such there be,) of Lyons whom it releases from the bondage of the note-book and the pencil, and whose eyes and fingers (*facile princeps* in the armamentarium of physiology) it sets free for the practical study of this fascinating science.

Two well-established methods of imparting a practical knowledge of the subject are in vogue among us in schools of good standing; demonstrations by a teacher to small classes of students and practical exercises performed by the students themselves. Each of these methods has its uses, although for most purposes, and wherever the number of students is not unmanageably large, the second is by far the most satisfactory. The French lesson in experimental physiology, as typified in the Lyons course, is neither a demonstration pure and simple nor an exercise calculated to guide the student in individual practical work. It is rather a lecture on some portion of physiology, with a certain amount of actual demonstration or of talk about instruments and methods 'shoved into the belly of it.' Not full enough for systematic lectures, not precise enough in the practical directions, nor arranged with sufficient simplicity and order to be of much use as a laboratory guide, such hybrid disquisitions are neither likely, we fear, to thoroughly instruct the learner in the facts of the science nor to introduce him to a real knowledge of the methods by which the facts have been ascertained.

But when this has been said, criticism has exhausted its quiver. Faulty as is the plan of these lessons for the purposes of the elementary student, they are capable of being used with much advantage by teachers of practical physiology whom they will supply, in a somewhat

smaller compass and at a much smaller expense, with the kind of information contained in the classical 'Methodik' of Cyon, now, we believe, out of print. The advanced student also, who is able to pick and choose and piece together the information suited for his purpose, may derive considerable benefit by using the book as a supplement to other less copious but more systematically arranged manuals of practical instruction.

Beginning with the principles and technical details of the most common graphic methods of recording, the authors describe in succession the methods of fixation and anæsthetization of the animals employed; the precautions necessary for aseptic operations; the general properties of nerves and nerve centers, including the various kinds of excitation, reflex action and the effects of lesions of the brain and bulb; the general properties of muscles, illustrated by the usual myographic experiments; the mechanical, nervous and chemical phenomena of respiration in mammals, birds, reptiles and other animal groups; the mechanical and nervous phenomena of the circulation; the chemistry of the blood, lymph, the digestive juices and urine. The last lesson is devoted to animal heat. The least successful part of the book is that occupied with the chemistry of the secretions, a subject already well treated from the practical standpoint in numerous works suitable for students. The descriptions of apparatus are clear and sufficiently full, and the illustrations are well executed. In this age of blatant 'patriotism' it would seem futile to quarrel with the almost exclusive selection of French instruments and the almost exclusive citation of French authorities. In any case, if the authors have erred in this respect, their fault will be readily condoned in view of the charming naïveté of their explanation.

In matters of detail it is, of course, always easy for the captious critic to pick holes in any book. The slips and blunders in this, apart from what we think the initial vice of its plan, are neither numerous nor serious, and some of them have been corrected in a table of errata.

In the description of the action of strychnine (p. 163) the student might easily suppose, from the context that in an animal poisoned with

this drug a single direct excitation of a muscle or nerve 'produces not a single contraction but a series of contractions more or less fused.' This is true, of course, only of a reflex excitation.

The statement (on p. 196), that "after double section of the pneumogastric death always takes place as a direct or indirect consequence of asphyxia (phénomènes asphyxiques) more or less rapid," is misleading.

On p. 231, the so-called 'total velocity of the circulation,' for which a better term is the mean circulation time, is not accurately defined. The only method of measuring it described is the antiquated one of Hering.

On p. 249, the automaticity of the heart-beat is attributed to the ganglia without qualification and without any indication that the majority of physiologists who, in recent times, have busied themselves with researches on this subject have come to the opposite conclusion.

We are entirely unaware of the existence of evidence sufficiently clear to justify the conclusions so boldly drawn from Stannius' experiment on p. 251, 'that the ganglia of Bidder constitute an insufficient excito-motor center, the ganglion of Remak a sufficient excito-motor center, and the ganglia of Ludwig (in the auricular septum) an excito inhibitory center whose tonus is by itself insufficient to counter-balance the excito-motor action of Remak's ganglion.'

On p. 267 it is stated that crystallized hæmoglobin (*i. e.*, reduced hæmoglobin) is unknown. Several competent authorities have described such crystals.

On p. 271, the band of reduced hæmoglobin is, for the English reader, rather comically disguised under the appellation, 'bande de Stokes,' meaning, of course, the 'band of Stokes.'

While the general rules laid down for operations on mammals and for the use of anæsthetics will, as a whole, commend themselves to all physiologists who have had much experience in the use of warm-blooded animals for teaching purposes, we must take exception to the advice that "in all operations, whether the animal is destined to be sacrificed at the end of the experiment or not, the vivisector should

apply as vigorously as the surgeon the rules of antiseptis and aseptis." We are convinced that while, in an experimental course carried out by students, it is perfectly feasible and of great utility to insist upon rigid antiseptic precautions in such experiments as require it, they not only introduce an unnecessary complication in cases in which the animal is to be sacrificed, but often interfere seriously with, and always distract the attention of the student from the real object of the observation. Further, most of the work on mammals which can and ought to be performed by students is of such a nature that a strict adherence to antiseptic technique throughout the whole experiment is practically impossible. If the argument that "it is a bad discipline to have two styles of operation, since certain details of the antiseptic method will be fatally neglected when one wishes in exceptional cases to apply it," be a sound one, we ought seriously to enquire whether the reckless custom of wearing one sort of dress in summer and another in winter is not very likely to result in a fatal confusion of times and seasons, muslins and mackintoshes, shirt-waists and sealskin coats, and to lead to such awful inversions as ducks in December and ulsters in July, or whether any man who respects his stomach and has a conscientious regard for the interests of his insurance company, can afford to permit his cook to dabble at the same time in the cumulative mysteries of roast and boiled.

G. N. I. S.

Ind.
4 *The Home Life of Wild Birds.* A New Method of the Study and Photography of Birds. By FRANCIS HOBART HERRICK. New York and London, G. P. Putnam's Sons. 1901. Pp. xiii + 148.

In 'The Home Life of Wild Birds,' Francis Hobart Herrick has given us a most valuable treatise and one which is sure to be of the greatest assistance to those who are following the perplexing pastime of bird photography. The author states the truth when he says that animals should be studied as animals and not as if they were human beings. If some others had shared this commendable belief, an enormous amount of trash would be absent from the book shelves and consequently seekers

of truth would be saved a corresponding amount of annoyance. We have no objection to well-written fairy tales, fables, or stories of personified animals, but when an author states or implies that his human thinking and acting animals are truthfully portrayed, and the alleged facts are taken from nature, then we consider he should be most severely criticised.

Taking advantage of that force which for convenience we term parental instinct, Mr. Herrick overcomes the chief difficulty that besets the bird photographer. The method is to remove the nest from its surroundings, whether it be in the tall tree, deep wood, swamp or impenetrable brier patch, and set it up in a good light, so that the branch or other support of the nest will occupy the same relative position as in the old site. It was found that the parent birds soon got used to the new surroundings and attended the young as if nothing unusual had happened. By the aid of a green tent which concealed the operator and outfit, and when in use was open only at a point in line with the lens, the affairs of the little family could be observed with perfect ease at a distance of only a few feet. In this manner the author spent what must have been many happy days in observing the interesting movements that were taking place in and about the nests of the robin, cedarbird, kingbird, chestnut-sided warbler, bluebird, brown thrasher, red-eyed vireo, nighthawk and many other species.

The 137 pages which detail these experiments are full of valuable facts and suggestions and will surely be welcomed by those who care to learn the mysteries of bird life. The numerous photographs which enliven the book, with the exception of a few distorted on account of the nearness of the object, are admirable, and in connection with the text undoubtedly will stimulate many to seek a fascinating recreation so well described and illustrated in this volume.

A. K. F.

WASHINGTON, D. C.

DISCUSSION AND CORRESPONDENCE.

THE COAST PRAIRIE OF TEXAS.

THIS physiographic feature, which extends for a distance of nearly four hundred miles, from

western Louisiana through Texas into Mexico, is one of the newest made and least understood of our American geographic provinces.

In topographic aspect it is apparently an almost level plain sloping at the rate of about one foot to the mile seaward, but within its area there are slight irregularities or undulations, hitherto unnoticed or at least not described, which are now attracting great attention, owing to their supposed relation to the occurrence beneath them of oil.

The Louisiana extension of the prairie is generally acknowledged to be a subsiding land as attested by actual bench marks, by the drowned character of the bayous and by the cycles of cypress growth on the swamps. I know of no actual previous observations bearing upon the isostasy of the Texas portion of the prairie, but McGee in a recent article in the *National Geographic Magazine* assumed that it was also subsiding.

I have just made some observations, however, which lead me to believe that west of the Trinity river, at least as far south as the mouth of the Colorado—beyond which we know nothing—the plain is rising.

Between the Trinity and the Colorado all the streams have new-cut channels, characteristic of rising land, while the Brazos is actually cutting down through its own alluvium at sea level and for many miles above its mouth. Not only is the coast prairie now undergoing differential movement—subsiding in one part and rising in another—but there is strong evidence that it is being wrinkled and folded, the strata so affected being so recent in age that they cannot be assigned to any other period of time than Pleistocene or recent. These folds are so slight that they could never have been detected had it not been for the discovery of oil on Spindletop Hill, four miles south of Beaumont, by Captain A. F. Lucas, in January last.

When this gentleman endeavored to point out to me this hill, my trained topographic eye could hardly detect it, for it rises by a gradual slope only ten feet above the sea of prairie plain which surrounds it. I was still more incredulous when Captain Lucas insisted that this mound, only two hundred acres in extent, was a dome, and that it had been uplifted by the

pressure of gas from the great pool of oil now proved to be coincident in extent beneath it. Captain Lucas said that I should be convinced of the uplift if I could see Damon's Mound in Brazoria County. I have just returned from Damon and a second look at Spindletop, and am convinced that if these hills are not recent quaquaversal uplifts no other hypothesis will explain their existence.

Damon's Mound is an elliptical oval hill a mile or more in greatest diameter. It rises ninety feet above the surrounding level plain. Its profile is everywhere convex instead of concave, and it is not a hill of erosion or of volcanic material. Furthermore, a bed of limestone follows the contour of its surface, showing deformation. The ascent of the plain will not carry the latter to the height of this mound for one hundred miles interiorward. The oil men have insisted on this structure and are spending \$200,000 upon Damon's Mound alone, merely upon their belief that its structure is anticlinal. Not only this, but they have seized upon every hill of this character on the coast prairie of western Louisiana and Texas, and are sinking at least 100 wells at an expense of \$10,000 a piece to demonstrate their theory.

Concerning the stratigraphy of the coastal plain, it can only be said that at Galveston it is composed of at least 3,000 feet of unconsolidated land, derived sands and clays, with occasional lignite logs and estuarine shells. All this is later than the Eocene Tertiary—the last datum point we have in the Tertiary and Pleistocene stratigraphy of Texas. Of this thickness Harris has shown 2,000 feet to be post Tertiary or not proved as old as Tertiary. Fossils from the Beaumont wells, depth 1,030 feet, have been assigned to the 'Neocene,' but as 'Neocene' means nothing—being merely a word to conceal our ignorance of all the later Tertiary strata of the United States—the position of the oil is still uncertain. It is my opinion that the oil is in strata which may as well be called Pleistocene or recent. They are certainly later than any proved Tertiary strata.

One thing is certain. This oil occurs in underground pools, and another thing is probable, that these pools underlie dome-shaped anti-

clines in the new-made recent coast prairies. Furthermore, these uplifts are most probably due to isostatic movements rather than to accumulations of gas.

Another interesting fact which is developing is that these oils are not associated with extensive beds of either plant or animal remains, but at one place, Saratoga, where they outcrop, they apparently originate in ferruginous sands, and this occurrence is strikingly suggestive of Mendeleef's theory that petroleum is formed by the action of warm waters on carbide of iron at considerable depths. But conclusions on this subject are as yet premature.

ROBERT T. HILL.

DISCORD AND BEATS.

TO THE EDITOR OF SCIENCE: In a review of books on physics in a recent issue of SCIENCE, I find on page 259 the remark that the author "has defined 'discord' more sharply than the facts warrant, by failure to recognize Mayer's law, which expresses the duration of the residual auditory sensation as a function of vibration frequency, the equation being expressible in a curve which Professor Mayer published in 1894 (*Am. Jour. Sci.*, Jan., 1894)." That authors of text-books of physics discuss *psychological* problems may be very well; for it is certainly better for the student to learn some psychological theories in the physical laboratory than to learn them not at all. But, unfortunately, it is rare to find a physicist who is sufficiently familiar with the psychological literature. Permit me to make these two statements: (1) That a 'discord' cannot be defined by 'beats,' the psychologists have some time since agreed upon. The physicists—on the authority of Helmholtz, whose 'Tonempfindungen' appeared 40 years ago—still make use of this definition. (2) Mayer's curve, as recent experiments (*Zeitschrift f. Psychol. u. Physiol. d. Sinnesorgane*, 20: 408-424; reviewed in the *Psychological Review*, 7: 88-90, 1900) prove, does not express the dependency of the duration of an after-sensation on the frequency of vibration. The duration of the after-sensation does not seem to depend upon the pitch at all.

MAX MEYER.

UNIVERSITY OF MISSOURI.

THE INTERNATIONAL CATALOGUE OF SCIENTIFIC LITERATURE.

TO THE EDITOR OF SCIENCE: Can nothing be done even at this stage to secure a better system of classification for the international catalogue of scientific literature now under process of preparation under the general supervision of the Royal Society in London? In library management this country is, as probably every one is aware, in advance of most, if not all, countries, and the result of this is that the practical application of the science of classification to the cataloguing of books and articles has been carried farther in this country than elsewhere. Published systems of classification here are more complete, there is a larger literature on the subject, and a greater number of libraries have been catalogued on a classified system. I do not think anybody familiar with classification and its practical application will hesitate in condemning the classification which has been adopted by the Royal Society. In botany, it is ridiculously incomplete. It is impossible, as I know from experience, to classify material on this subject, in the shape of papers, without a system which is at least carried down to families; and in many cases one extended to genera is wise.

The classification in geology is equally inadequate and makes insufficient provision for the great extension which has taken place in physiographic geology in the last ten years.

If any one wishes to see what can be done in the line of careful classification for geological purposes, M. Mourlon's 'Classified Index of Geological Papers' on the Dewey Decimal System will offer a striking contrast to that presented by the meager array of classification in the Royal Society. Mnemonic aids are altogether omitted in this classification, no common system of number being used for common types of classification in different subjects. In the biological field, no effort has been made to follow a similar arrangement of homologous subjects.

In fact, I think, I speak within bounds in saying that no one versed in this subject can examine this classification without feeling that it is prepared by some one who has neglected to study what has already been done in this field.

There are two subjects which every one appears to think can be done by nature. One is editing a newspaper and the other is classifying. Any one who has had any experience in either will feel differently.

TALCOTT WILLIAMS.

SHORTER ARTICLES.

NOTES ON THE LIFE HISTORY OF ANOPHELES PUNCTIPENNIS AND ON THE EGG-LAYING OF CULEX PIPIENS.

SOME time during the latter part of May, 1901, a ditch about four feet in depth was dug for the water main to the new textile building on the campus. The ditch was dug in sections, one of which ran down a considerable slope just at the end of the photographic building. This section of the ditch soon became partly full of rain water. At the lower end the water was two and a half feet deep, but the water did not extend more than a third of the length of the ditch up the slope. At the upper and shallower end of the body of water, it soon became covered with a thin green slime, which upon examination proved to be wholly of *Protococcus*. In this shallow, slimy water on June 4 the writer discovered an abundance of larvæ of *Anopheles punctipennis*. They were recognized at a glance as larvæ of *Anopheles* from Dr. Howard's excellent drawings and descriptions of the larvæ of *Anopheles maculipennis*. Glass jars were immediately called into requisition, and many larvæ were carried to the laboratory, from a study of which the following notes were made. It might be of interest to say just here that there was also an abundance of larvæ of *Culex pipiens* in the same water in company with *Anopheles*.

Eggs.—It was with some surprise and a good deal of pleasure that a number of eggs were found on the surface of the water in the jars. Like *maculipennis*, they are laid at random on the water, but naturally run together and cohere in loose irregular groups or strings of from three to a score or more. Some were found floating on their sides, but the greater number seemed to be floating with the convex side, or 'back,' up and the concave side down. They differ somewhat from the eggs of *maculipennis* in shape. These eggs resemble an Indian canoe in shape,

hence a cross section would be more or less triangular in outline. Seen from the side they are strongly convex above and concave below. One end is larger and blunter, while the other, as seen from the side, curves strongly downward, is smaller and more pointed. Above and on the sides the eggs are marked with a reticulate hexagonal sculpturing similar to *maculipennis*. Below, on the concave side is a dark wide line or band, extending nearly the length of the egg. It widens at each end into a club-like expansion. The writer could not be sure whether this was simply a band or a groove. Near the blunt end of the egg a transparent line runs from each side of the dark band obliquely down the sides of the egg. When the egg bursts, it breaks along these lines. At each end of the band are several dark, circular spots. The eggs varied from .45 mm. to .47 mm. in length. They hatched in 24 to 48 hours after being brought in, but no record was obtained as to the actual time of hatching after being laid, as none of the females laid eggs in captivity. It is probably safe to say, however, that they accord in this particular very closely with *maculipennis*.

Larvæ.—When first hatched the larvæ present a mottled appearance, owing to alternate dark and light transverse markings on the body. This appearance certainly suggests the spotted wings of the adult, although there perhaps can be no reason for thinking that the one in any way foreshadows the other. The larvæ retain this appearance up to the last molt, although it seems to grow less distinct with age. They lie in a nearly horizontal position just beneath the surface film of water, and when only slightly disturbed wriggle in a horizontal direction across the water instead of downward as *Culex*. When violently disturbed they wriggle downward. The more mature larvæ are more inclined to wriggle downward than the young larvæ, when disturbed. The feeding habits are almost identical with those of *maculipennis*, so fully described by Dr. Howard. The same rotary motion of the head with the under side uppermost in feeding was characteristic. There were no such differences between the larvæ of *punctipennis* and *maculipennis* as there were between the eggs of the

two species. Perhaps the mottled, or more properly the streaked, appearance of the larvæ of *punctipennis* is a distinguishing feature. Dr. Howard, we believe, mentions nothing of the kind in regard to *maculipennis*.

The duration of the larval stage, under normal conditions with plenty of food, varied from twelve to fourteen days.

On June 5 three larvæ were placed in a jar containing very little food. What food there was lay among some sand at the bottom. Two of them were very young, while the third could not have been more than half grown. These larvæ remained there until June 29, when the two younger died. These two did not go to the bottom after food and probably starved. The third and more mature one did go to the bottom after food and remained alive until July 3, when it was transferred to water containing an abundance of food. In a few days it transformed to a pupa. In this case the larval stage was over a month and could doubtless have been prolonged.

Pupæ.—The pupæ of *Anopheles* are not strikingly different from those of *Culex pipiens* to the unaided eye. A close observer, however, can learn to distinguish the two with the eye by the difference in length of the respiratory siphons. Those of *Anopheles* are much shorter. Under the microscope they are also seen to be of quite a different shape from those of *Culex*. The thorax and body of *A. punctipennis* differ quite markedly in shape from those of *C. pipiens*, when seen from above. Like the larvæ, the pupæ tend to wriggle in a horizontal direction when disturbed. They are not as active as those of *C. pipiens*, which fact is brought out very forcibly when one attempts to make a camera lucida drawing of the living pupæ of both in their natural position in the water.

The pupal stage of both males and females lasted with great regularity just about two days. At least it could not have varied more than a few hours from this, as the adults were found in every case on the second morning subsequent to the morning on which the pupæ were found.

Egg-laying of Culex Pipiens.—On July 17, in the back yard of a hotel at Magnolia, Mississippi, the writer found a pig trough five feet long,

containing water to the depth of about six inches. On the surface of this water by actual count there were 257 masses of eggs of *C. pipiens*. Since there were less than five square feet of surface, one can imagine the density of egg population. It was noticed that about a dozen of the egg masses were white, or yellowish white, in appearance. This led to a more careful examination, which resulted in the discovery of a female about to finish laying a batch of eggs. Time, 6 a. m. She was so busily engaged that we could watch her with a hand lens. She rested on the surface with the abdomen at a slight angle, because the caudal end was nearly touching the surface. The mosquito stood at one end of the mass, with her head away from it. As the eggs were deposited the mass was gradually pushed away from her. The end of the abdomen was slowly carried from side to side, so that the eggs might be placed across the end and the whole mass filled out and completed as she progressed. The process may be compared with the action of the hand as a bobbin is wound with thread. The eggs always came forth with the small end first. This end, since the abdomen was held closely to the mass, would strike the other eggs and appear to be slipped along the perpendicular sides of the others, and thus be brought to an upright position. However, the tip of the abdomen was curled slightly upward, so that the egg was directed upward and very likely would have been deposited in an upright position in any case. It would have been interesting to have seen the first egg deposited. There was an appreciable interval between the deposition of each egg, perhaps two seconds, although we did not time it.

GLENN W. HERRICK.

AGRICULTURAL COLLEGE, MISSISSIPPI.

RECENT ZOO-PALEONTOLOGY.

A MARSUPIAL EVOLUTION.

IN the April *Naturalist** is an important paper by Mr. B. Arthur Bensley upon the origin of the Australian Marsupialia. The evolution of the Marsupials is compared with that of the Pla-

* 'A Theory of the Origin and Evolution of the Australian Marsupialia,' *The American Naturalist*, Vol. XXXV., No. 492, pp. 245-269, April, 1901.

centals after the later Cretaceous, and the conclusion is reached that since the Placentals have radiated from a Creodont prototype beginning in the later Cretaceous period, it is quite possible that the Marsupials have during the same time radiated from a *Didelphys* prototype; there is a striking general resemblance between the early Creodonts and the opossum which tends to support this theory. It is practically the working out of a hint by Huxley in 1880, and of a very suggestive paper by Dollo upon the arboreal ancestry of the Marsupials. The idea of *Didelphys* origin, however, is original with Mr. Bensley, and the detailed comparison of the evolution of the teeth of Marsupials with that of Placentals promises to give most important and interesting results. Mr. Bensley is enjoying the extensive collections of the British Museum.

GEOLOGY OF THE JOHN DAY BASIN.*

As a result of the explorations by the University of California, John C. Merriam contributes a valuable paper upon the geology of this important region in Oregon, as preliminary to the revision of the vertebrate fauna. Although this region was first reported in 1861 and explored by Condon, Marsh, Cope, Scott, Sternberg and Wortman, this is the first exact description of its geology, and is therefore most welcome and important. The author divides the beds into the Lower (250-300 feet), which is reported to contain *Oreodon*; Middle (500-1,000 feet), chiefly distinguished by *Diceratherium*; and Upper, which contained *Paracotylops*. The exact correlation of these beds with those of the Oligocene White River awaits the precise comparison and study of the faunæ. The mode of deposition has generally been considered entirely lacustrine, as the series are everywhere uniformly stratified and bedded, on the other hand, the author presents strong reasons for an æolian origin for the finer portions of these beds. In fact the problem is precisely similar to that which is now being discussed for the finer beds of the White River formation.

* 'A Contribution to the Geology of the John Day Basin,' *Bulletin*, Dept. of Geology, Univ. of California, Vol. II., No. 9, pp. 269-314, April, 1901.

DISCOVERIES OF PLESIOSAURUS AND OF PORTHEUS.

During the past season Mr. Charles H. Sterüberg, well known for his years of explorations in the Kansas Chalk, made two discoveries of exceptional importance. The first is of a new type of Plesiosaur, the skeleton of which is preserved in an exceptional manner; this has been purchased by the University of Kansas and will be described by Professor Williston as part of his general studies upon Plesiosaurs. The second is a remarkable skeleton of *Portheus molossus*, of the suborder Acanthopteri, family Ichthyodectidæ—the characteristic predaceous fish of the Niobrara. The specimen is sixteen feet in length and is in an exceptional state of preservation. It has been purchased by the American Museum of Natural History, and will be mounted facing the great specimen of *Tylosaurus* from the Kansas Chalk which has already been described in this Journal.

H. F. O.

BOTANICAL NOTES.

SHORT NOTES ON RECENT BOOKS.

AMONG botanical books which are likely to attract attention is Dr. Wettstein's 'Handbuch der Systematischen Botanik' of which Part 1 (including pages 1 to 202) has been brought out by the Leipzig publisher Franz Deuticke. Resembling Warming's 'Haandbog i den Systematiske Botanik' and Schumann's 'Lehrbuch der Systematischen Botanik,' it promises to be much fuller and more helpful than either, and like them is to be a general survey of the structure and classification of the Vegetable Kingdom. The attempt is made to treat the subject from the phylogenetic standpoint, and whatever of success is attained in the work is largely due to this fact. In the part now issued forty-four pages are given to a general discussion of the principles involved, followed by the special discussion of representatives of the seven phyla recognized by the author, viz.: Myxophyta (including the single class *Myxomycetes*), Schizophyta (including the classes *Schizophyceae* and *Schizomycetes*), Zygomphyta (including the classes *Peridineae*, *Bacillariaceae* and *Conjugatae*), Euthallophyta (including the classes *Chlorophyceae* and *Fungi*, the latter in-

cluding the lichens), Phaeophyta, the brown algae, Rhodophyta, the red algae, and Cormophyta (including liverworts, mosses, ferns and their allies, and the seed-bearing plants). The work is admirably illustrated.

The appearance of the first half of the second volume of the new edition of Pfeffer's 'Pflanzenphysiologie' (Engelmann, Leipzig) is gratifying to botanists who have been using the first volume. This part covers 353 pages, indicating that Volume II. will be considerably larger than Volume I. The present half-volume includes ten chapters, as follows: (1) Growth Movements, (2) Mechanics of Growth, (3) Growth and Cell-increase, (4) Elasticity and Cohesion, (5) Tissue Tensions, (6) Influence of Environment on Growth-activity, (7) Cause of Specific Form, (8) Variation and Heredity, (9) Rhythm, (10) Resistance to extreme Influences. A hasty glance through these chapters indicates that the work maintains the high standard of the preceding volume. The second part of Volume II. is in course of preparation, and will complete the work.

Of Engler's 'Pflanzenreich' (Engelmann, Leipzig) four parts have already appeared, dealing with the families *Musaceae* (by K. Schumann), *Typhaceae* and *Sparganiaceae* (by P. Graebner), *Pandanaceae* (by O. Warburg), and *Monimiaceae* (by Janet Perkins and Ernst Gilg). The illustrations continue to be more than unusually helpful, being clear, well drawn, and judiciously selected. In the part devoted to *Pandanaceae* there are, in addition to the ordinary illustrations, four full-page 'half-tone' plates from photographs showing the gross appearance of different arboreal species with their natural surroundings.

Thomas Howell's 'Flora of Northwest America' (Howell, Portland, Or.), has reached Fascicle 4 which includes *Liguliflorae* to *Boraginaceae* (pages 387 to 474). As the author follows the Benthamian sequence it is easy to estimate by comparison with Gray's 'Manual' that the work is not more than one-half completed. The work, although marred by typographical errors (incidental to unprofessional printing) and an 'inky' page now and then, will be a very important help to the northwestern botanists.

The last-named work reminds us of a local

northwestern flora, 'The Flora of the Palouse Region,' by Charles V. Piper and R. Kent Beattie (Agricultural College, Pullman, Wash.), which appeared in May of the present year. The area covered is 70 kilometers in diameter with the town of Pullman, Wash., as a center, and includes about 24 townships in eastern Washington and 11 in western Idaho. In this region the authors describe 14 Pteridophytes, 9 Gymnosperms, 114 Monocotyledons and 526 Dicotyledons. The work of compilation appears to have been well done, and it is a pleasure to observe an attempt at a somewhat modernized terminology, and the use of metric measurements throughout. Engler and Prantl's System has been followed, and in nomenclature 'the so-called Kew and Berlin rules.' It must prove very helpful to students of northwestern Idaho and eastern Washington far outside of the limits covered.

The handy little book, 'Grasses,' by Dr. H. Marshall Ward, of Cambridge University (University Press, London), shows what may be done by a competent botanist in the way of making a difficult subject somewhat plain and not too technical. In less than two hundred small octavo pages the author gives a great deal of information, valuable not only to the student of grasses, but also to the practical man whose business it is to grow grasses for forage. There are chapters on the vegetative organs, anatomy, flowers and 'seeds' of grasses, followed in each case by a classification based on these characters alone. The book must be very useful in England and it suggests the need of a similar work for the United States.

POPULARIZING THE STUDY OF FERNS.

WHATEVER tends to increase the popular interest in plants is directly contributory to the advancement of science. Every book and every organization which stimulates an admiration and consideration of plants is to be encouraged by scientific men. Such a book is Mabel Osgood Wright's 'Flowers and Ferns in their Haunts' (Macmillan, New York), with its charming text, artistic cuts, and wonderfully accurate 'half-tone' reproductions of well-taken, well-selected, gray-mounted photographs of landscapes, where plants are shown in all their

glory. A chapter on 'The Fantasies of Ferns' is unequaled anywhere in fern literature. Not only is the text suited to the person whose mind 'is of the kindergarten order, that needs nice interesting object lessons,' but it will afford real pleasure and some instruction to the professional pteridologist, unless he has lost all sentiment, and love of the beautiful. It will prove a strong corrective for the mania which uproots every pretty, green thing. After reading it none but a confirmed vandal would wantonly disturb a colony of these beautiful plants.

Mrs. Wright's book may easily prepare the amateur for a more particular study of ferns, as suggested in Willard N. Clute's 'Our Ferns in their Haunts' (Frederick A. Stokes Co., New York). This is in fact a popular manual of the ferns of North America north of the Gulf States and east of the Rocky Mountains, and by the aid of an easy non-technical text, good cuts, and many 'half-tone' and colored plates, the subject is made so plain that no one need be without some knowledge of the ferns. It should find a place in the library of every amateur botanist, and it will do no harm to the professional botanist, who may well give it room on his shelves with other helpful books.

Why should not such books as these encourage those organizations which have for their object the cultivation of a love of Nature, and the protection of the native species? The Linnaean Fern Chapter of the Agassiz Association, which has recently issued its Eighth Annual Report (Miss Margaret Slossen, Secretary, Andover, Mass.) is such an organization of mostly amateur students of ferns. What a help such a society may become to the thousands of people who, away from herbaria and museums, desire to keep in touch with the work of others with like tastes. What an inspiration must come from membership in an organization whose members are scattered over the territory from Maine to California, and Canada to Florida and Texas, with one in England and another in far-away New Zealand.

A word may be said here in praise of a new society in Boston and its suburbs, named the 'Society for the Protection of Native Plants.' Its object is 'to check the wholesale destruction to which many of our native plants are ex-

posed.' Every botanist will wish this society the greatest success. Its secretary is Miss Maria E. Carter, Curator of the Herbarium of the Boston Society of Natural History. The urgent need of such a society is apparent not only in the densely populated Eastern States, but fully as much in the western summer resorts, where the hand of the vandal has already exterminated some species.

CHARLES E. BESSEY.

UNIVERSITY OF NEBRASKA.

THE PRESERVATION OF COLORADO CLIFF DWELLINGS.

THE Colorado Cliff Dwellings Association is endeavoring without aid from the legislature to preserve the ruins which lie on the Mesa Verde, a tableland twenty miles long by eight miles wide, in the southwest corner of Colorado. There are from three hundred to four hundred cliff dwellings including the noted 'Cliff Palace' on this mesa. These are all in the Ute Indian reservation and consequently the state or national government can not control the ruins. A ten years' lease has been made by the Association direct with the Ute Chiefs, by means of which control is had of the Mesa. The Secretary of the Interior having ratified the lease, the Association is now in charge of the ruins, and will open a toll road to them. The money received as toll will, however, be only part of the sum paid to the Indians as rent. The ruins will be kept from weathering and from the depredations of 'relic hunters.'

HARLAN I. SMITH.

PRESENTATION BEFORE THE FACULTY OF CANDIDATES FOR THE DOCTORATE AT THE UNIVERSITY OF PENNSYLVANIA.

THE University of Pennsylvania inaugurated this year what seems to be in many respects an excellent method of recommending candidates for the degree of Doctor of Philosophy. The usual method, borrowed from the German universities, of examining candidates before the faculty or letting them defend their theses before the faculty is not altogether suited to existing conditions. In Germany it is chiefly a form and appears to be falling into disuse. The

plan is scarcely fair to the candidate if the conferring of the degree depends on the result of a public examination; it is scarcely fair to the faculty if it is a mere formality, and, as a matter of fact, members of the faculty often do not attend. The plan adopted by the University of Pennsylvania is to let the candidate pass a written examination and then bring him before the faculty, where he is presented by the professor under whom he has taken his major subject. The presenter reads a sketch of the candidate's academic life and an outline of the scope and contents of his thesis, after which any member of the faculty may make enquiries of the candidate or the presenter. As an example of the way in which the candidates are presented and as the biographies are themselves of interest, we reproduce the credentials of the first candidate presented in each of the sciences:

Professor Smith, Presenter.

Gilbert Hillhouse Boggs was born at Memphis, Tenn., October 2, 1875. He received his early education in the public schools of Athens, Ga., and entered the University of Georgia as a freshman in 1892, graduating with the degree of Bachelor of Science in 1896. He entered the Department of Philosophy of the University of Pennsylvania, February 25, 1897 and remained in residence until February 10, 1898. He reentered October 5, 1898, and has remained in residence for the past three years. His major has been in inorganic chemistry, his minors in organic chemistry and analytic chemistry. He was granted a university scholarship in chemistry for the years 1897-98 and 1898-99, and was appointed to a Harrison Fellowship at Large in the same subject for the years 1899-1901. He was admitted to candidacy for the degree of Doctor of Philosophy when appointed to the Fellowship.

He has completed under the jurisdiction of Group Committee XIV. thirty three standard lecture courses, exclusive of the laboratory work which has occupied the greater part of his time for four academic years. He has satisfactorily passed written examinations in inorganic, organic and analytical chemistry on May 28-30, 1901, with Professor Smith, Drs. Lorenz and Shinn.

Mr. Boggs has presented a thesis entitled 'I. The Separation of Vanadic Acid from Metals by means of Hydrochloric Acid Gas. II. The Occurrence of Molybdenum in the Mineral Endlichite,' of which the following is an abstract:

Vanadium is being frequently found present in

traces in rocks and minerals. Its separation from allied metals is extremely difficult, and in this research the purpose has been to ascertain how completely hydrochloric acid gas will eliminate the vanadium, it being well established that from the alkali metals the vanadic acid is completely removed by this reagent. This study shows that with the exception of the alkali group of metals the new reagent is inadequate. An additional point of interest is that the metal molybdenum exists in the mineral endlichite, and that its presence there accounts for the fact that the vanadic acid of endlichite is removed by hydrochloric acid gas, probably because it exists as a vanado-molybdate of lead, a form different from that in which it is observed in vanadinite.

Mr. Boggs' thesis is now in the hands of the printer, and the required number of copies will be delivered to the Dean within a few weeks. Mr. Boggs is unanimously recommended by Group Committee XIV. to the Faculty of Philosophy for the degree of Doctor of Philosophy.

Professor Macfarlane, Presenter.

Henry Shoemaker Conard was born in Philadelphia, September 12, 1874. He received his early education at the Friends' Select School and Westtown Boarding School. He entered Haverford College as a junior in 1892, and graduated with the degree of Bachelor of Science in 1894. He was a graduate student at Haverford 1894-95, receiving the degree of Master of Arts in 1895. During the four years, 1895 to 1899, he was teacher of science in the Westtown School. He entered the Department of Philosophy, of the University of Pennsylvania, September 26, 1899, as Harrison Fellow in Biology, being thereby made a candidate for the degree of Doctor of Philosophy. He elected his major in botany, his minors in botany and zoology. He has completed in this University, under the jurisdiction of Group Committee XV., twenty standard lecture courses, besides spending practically all his spare time for two years in the laboratory, and has also received credit for his work at Haverford to the extent of four standard courses, making a total of considerably more than twenty-four. He has satisfactorily passed written examinations as follows: On May 28 and 29, 1900, in zoology; on February 7 and 11, 1901, in botany as a minor, and four further examinations in botany as a major, running from May 21 to 22, 1901.

He has presented a thesis entitled 'Water Lilies: a Monograph on the Genus *Nymphaea*.' It will be published in the next volume of the Series in Botany, issued by the University of Pennsylvania. A brief abstract of this thesis is subjoined:

Mr. Conard has described about thirty natural spe-

cies. A like revision has never appeared in English, and not in any language since 1853, during which time many new facts have been brought out. The classification differs slightly from that of previous workers, in view of recently discovered facts of hybridization. An attempt is made to arrange the types as nearly as possible in their evolutionary relationships. Twelve species, representing all the natural groups from all parts of the world, and a number of hybrids and varieties, have been studied carefully in cultivation in the Botanic Garden of the University. Others also have been studied in the collection of the Henry A. Dreer Company, at Riverton, N. J., and elsewhere. Each description takes up :

1. Diagnostic characters.
2. Literature and synonymy.
3. Minute morphological, physiological and, in some critical cases, histological descriptions of flower, leaf, stem and root, and the development from seeds and tubers.
4. Habitat.
5. Remarks, historical and critical.
6. Varieties similarly described.

The results of a number of observations on the times of daily opening and closing of the flowers are incorporated in the descriptions ; these, and the developmental histories of species are, for the most part, entirely new records. The paper is illustrated with photographs and line drawings.

Mr. Conard is unanimously recommended to the Faculty of Philosophy by Group Committee XV. for the degree of Doctor of Philosophy.

Professor Crawley, Presenter.

Burton Scott Easton was born in Hartford, Conn., December 4, 1877. He received his early education at the Hamilton School, Philadelphia, and with private tutors in Germany. He entered the University of Pennsylvania as a freshman in 1894, receiving the degree of Bachelor of Science in 1898. During the year 1898-99 he was instructor in mathematics and astronomy in the State University of Iowa, and pursued graduate work in the same institution. He entered the Department of Philosophy of the University of Pennsylvania, September 27, 1899, electing his major in mathematics, one minor in mathematics, and the other minor in astronomy. He was appointed Harrison Fellow at Large in Mathematics for the year 1900-01, and was transferred to the regular fellowship in mathematics and astronomy January 11, 1901. He has received credit for the following work : (1) For graduate work in mathematics pursued before receiving his Bachelor's degree, and not credited toward that degree, four standard courses ; (2) for graduate work in mathematics at the State University

of Iowa, six courses ; (3) for graduate work in this University since 1899, sixteen courses, a total of twenty-six standard courses. He has satisfactorily passed written examinations on March 30, April 4 and May 16, 1901, in mathematics with Professor Crawley, Assistant Professors Fisher and Schwatt and Dr. Hallett ; on March 16, 1901, in astronomy with professor Doolittle and Mr. Eric Doolittle. He has presented a thesis entitled 'Substitutions and Substitution Groups.' He has deposited with the Dean a copy of this thesis and the money necessary to print it. The thesis will appear in the spring of 1902. A brief outline of its contents is as follows :

The group theory is one of the most recent developments of mathematics. It is far-reaching in its applications and is a most prolific field of research at the present day. The literature of the subject is, however, principally to be found scattered through the pages of the mathematical and scientific journals, and is therefore disjointed and fragmentary not only in form but also in the manner of its presentation. Moreover, much of importance is almost useless from the difficulty of finding it when wanted.

The primary object of the dissertation is to present the results of the most recent investigations in this subject in such a manner as to give a coherent view of what has been done. The way in which this has been accomplished by the candidate shows good mathematical judgment, and a thorough appreciation of the philosophy of recent mathematics. Only a portion of what has actually been accomplished in carrying out this work is embodied in the dissertation, which is devoted in the main to a careful consideration of transitive and intransitive groups, primitive and imprimitive groups, and the isomorphism of one group with another. The limits of *transitivity* have received special attention. A certain looseness has been found to exist in the use of some terms, notably in the expression 'permutable groups.' Mr. Easton has given precise definitions in all these cases, and the necessary modifications in the subsequent developments have been introduced.

Mr. Easton is unanimously recommended to the Faculty of Philosophy by Group Committee XI. for the degree of Doctor of Philosophy.

Professor Doolittle, Presenter.

Henry Brown Evans was born in Dayton, Ohio, July 2, 1871. He was educated in the public schools of his native town, graduating from the High School in 1889. He entered the Freshman Class of Lehigh University the same year, and received the degree of Mechanical Engineer in 1893. He was instructor in mathematics and astronomy at Lehigh, 1894-95, and has been instructor in astronomy in this University

since 1895. He entered the Department of Philosophy October 23, 1895, electing his major in astronomy, his minors in mathematics and philosophy. He was admitted to candidacy for the degree of Doctor of Philosophy October 1, 1897. He has completed twenty-seven standard courses. He has satisfactorily passed written examinations in astronomy with Professor Doolittle on May 4 and 11, 1901; in mathematics with Assistant Professors Fisher and Schwatt on March 7, 1901; in philosophy with Dr. Singer on March 25, 1901. He has presented a thesis entitled 'The Right Ascensions of One Hundred and Eighty Latitude Stars,' and has deposited with the Dean a copy of the manuscript and the money necessary to print it. The scope of this thesis may be described as follows:

The determination of the latitude of any single point of the earth's surface, by the zenith telescope method, depends ultimately on the positions of the stars observed for that purpose. The object of this thesis is the determination from all available data of definitive values of the right ascensions of one hundred and eighty stars. This material is needed for the determination of the variations of latitude at the Sayre Observatory of Lehigh University and at the Flower Observatory of the University of Pennsylvania. A definitive investigation of the right ascensions has not been undertaken before this. The necessary data were found in the star catalogues heretofore published, from 1755 to date. Altogether positions of these stars were taken from about one hundred such sources. The observed positions were then combined by the method of least squares, and the definitive values of the right ascensions of the one hundred and eighty stars in question for 1875.0 were thus determined.

Mr. Evans is unanimously recommended to the Faculty of Philosophy by Group Committee XII. for the degree of Doctor of Philosophy.

Professor Patten, Presenter.

John Paul Goode was born at High Forest, Minn., November 21, 1862. He received his early education in the public schools of Olmstead County, Minn., and in the Rochester Seminary, Rochester, Minn. He entered the University of Minnesota as a freshman in 1885, and received the degree of Bachelor of Science in 1889. From 1889 to 1898 he was professor of the natural sciences in the State Normal School, Moorhead, Minn. He spent the summer of 1894 in the Summer School of Harvard University, that of 1895 as a graduate student in geology at the University of Chicago, that of 1896 as instructor in geology in the Summer School of the University of Minnesota. During the autumn and winter quarters of the year

1897-98 he was fellow in geology at the University of Chicago, being absent on leave from his professorship. During the four summers, 1897, '98, '99 and 1900, he was instructor in physiography and meteorology at the University of Chicago. In the year 1898-99 he spent the autumn, winter and spring quarters as a graduate student of geology and economics at the University of Chicago. In 1899 he was appointed to the professorship of the physical sciences and geography in the Eastern Illinois State Normal School, Charleston, Ill., which position he still holds, having been absent on leave during the past academic year.

He entered the Department of Philosophy of the University of Pennsylvania October 1, 1900, and remained in residence until April 5, 1901. On March 8, 1901, the Executive Committee decided to consider this period of residence as satisfying the rule requiring one year of residence. Mr. Goode elected his major in economics, his minors in geology and sociology. He completed in the University of Chicago fifteen standard courses in geology, two in mineralogy, and eight in economics. In this University he has completed in economics nine standard courses, making a total of thirty-four. He has satisfactorily passed written examinations on November 16, 1900, in physiography with Assistant Professor Brown; on March 30 and April 4, 1901, in economics with Professor Patten and Assistant Professor Seager; on March 23, 1901, in economic geology with Assistant Professor Brown, and on April 1 and 3, 1901, in sociology with Assistant Professor Lindsay. He has presented a thesis entitled 'The Influence of Physiographic Factors upon the Occupations and the Economic Development of the United States.' He has deposited with the Dean a letter from Mr. E. M. Lehnerts, guaranteeing the publication of the thesis in the *Bulletin of the American Bureau of Geography*. The scope of the thesis may be briefly described as follows:

1. A study of the geographic location of the United States, showing its relation to other lands and the effects that this position has on its climate.
2. A sketch of the geographical development of North America, and its effects on the distribution of mineral wealth, drainage and the formation of soils.
3. A detailed study of the physiographic provinces of the United States, showing how the relief of the land facilitates or obstructs settlement and trade. With this is given a classification of harbors and many illustrations of how they are formed and improved or destroyed.
4. A study of climate, of ocean currents and of the distribution of the rainfall.
5. The influence of forests on man; his debt to

wood as a material in the constructive arts. Future possibilities of forests when coal is gone.

6. A study of the common cereals and the conditions of soils and climate demanded by each species.

Mr. Goode is unanimously recommended to the Faculty of Philosophy by Group Committee X. for the degree of Doctor of Philosophy.

Professor Conklin, President.

John Raymond Murlin was born in Anglaize County, Ohio, April 30, 1874. He received his early education in the public schools of Mercer County, Ohio, at the Ohio Normal University, and in the Preparatory Department of Ohio Wesleyan University. He entered the Ohio Wesleyan University as a freshman in March, 1894, and received the degree of Bachelor of Science in June, 1897. During his senior year he was instructor in physiology and histology, and the following year was instructor in physiology and zoology in the same institution. He entered the Department of Philosophy of this University, September 24, 1898, electing his major and one minor in zoology, and one minor in botany. In 1899 he was granted a Harrison Fellowship at Large in zoology, this appointment carrying with it candidacy for the degree of Doctor of Philosophy. He was reappointed to the same Fellowship for the current year.

He has completed in this University twenty and one-fourth standard courses, and has in addition devoted practically his entire time for three years to laboratory work, the summers of these years being spent in the Marine Biological Laboratory at Wood's Holl, Mass. The laboratory work which Mr. Murlin has done would probably be equivalent to sixty standard courses. He has satisfactorily passed written examinations in zoology on May 28 and June 2, 1900, with Professor Conklin and Dr. Moore; on May 28 and 29, 1901, with Professor Conklin and Assistant Professor Montgomery, and in botany on May 30, 1900, with Professor Macfarlane.

Mr. Murlin has presented a thesis entitled, 'The Digestive System of the Land Isopods, with special reference to the Morphology of Absorption and Secretion,' and has deposited with the Dean a copy of it, together with the money necessary to print it. Its scope may be outlined as follows:

Structural and functional changes in the intestine of two common genera of land Isopods have been followed during (1) growth; (2) the process of shedding the chitinous lining; and (3) the stages of food absorption. The intestine might be described as a cylindrical conduit, the wall made up of a single layer of cubical elements of the same size, and lined with a homogeneous but porous intima. These elements, the cells, are very large, being visible in adult

specimens even to the naked eye. The minute structure of both cell-body and nucleus is seen with high powers of the microscope to be alveolar, *i. e.*, the protoplasm is composed of very small semi-fluid vesicles, between which is a homogeneous interalveolar substance and supporting fibers, running from the inner to the outer side of the cells. During growth of the animal the intestine increases in size both by multiplication (direct cell-division) and by enlargement of the cells. When the lining (chitin) is shed, the fibers on the side of the cells next the lumen disappear, and in their place is seen a fluid substance, by the hardening of which the new lining is laid down.

In the digestion of proteids, as is well known, several stages intervene between the insoluble condition in which the food enters the stomach, and the readily soluble condition which it must reach before it can be assimilated. Hitherto the food has been traced to the absorbing cells, and has been identified in different form in the blood of many animals after having traversed the cells. The purpose of this study was to follow the food *through* the cells. Albumose, the first soluble stage in the digestion of albuminous foods, is recognized in the cells eight hours after feeding. The food in this form traverses the interalveolar spaces, and may accumulate in the outer side of the cell from sixteen hours after feeding, onward. The course of the food through the wall of the intestine is not visibly influenced by the cell-structure except in a purely mechanical manner. Albumose is not found in the blood of the animal, which bathes the outer side of the intestinal wall; the inverse change back to albumen must therefore be effected before the food reaches the circulation. A finely granular substance comes from the nucleus and is associated with albumose in its passage through the cell; it probably acts on the albumose either to carry the digestive process farther, or to begin the inverse process (synthesis toward albumen), or both.

Carbohydrates are readily digested in the intestine, dextrose, the soluble form of starch, being found twenty-four hours after feeding. In the absorption of fats the indications are that splitting-up by ferment action into fatty acid and glycerine takes place in the lumen of the intestine, and synthesis by ferment action takes place within the cell.

The digestive secretion is first recognized in immature cells of the 'liver' in the form of (zymogen) granules. During the growth of these cells the granules increase in size, become looser in structure, more soluble in certain reagents, and more stainable. The secretion is set free into the lumen of the gland in the form of a proteid fluid by mere evacuation of the cells, or by fragmentation and dissolution of their luminal ends. Discharging cells are found from

twelve to ninety hours after feeding with proteids. The secretion is poured into the intestine, where it acts by means of its ferments on the three classes of foods: proteids, carbohydrates and fats.

Mr. Murlin is unanimously recommended by Group Committee XV. as a candidate for the degree of Doctor of Philosophy.

Professor Crawley, Presentor.

Roxana Hayward Vivian was born at Hyde Park, Mass., December 9, 1871. She received her early education in the public schools of Hyde Park, graduating from the High School in 1890. She entered the freshman class of Wellesley College the same year, receiving the degree of Bachelor of Arts in 1894. From 1895 to 1898 she taught Greek and mathematics in a preparatory school, and from 1896 to 1898 pursued graduate work in the same subjects at Wellesley college. She entered the Department of Philosophy of this University October 10, 1898, as alumnae fellow in mathematics. This appointment carried with it candidacy for the degree of Doctor of Philosophy. She was twice reappointed to her fellowship, holding it for three successive years. She elected her major and one minor in mathematics, and the other minor in astronomy. She has completed thirty standard courses, and has satisfactorily passed written examinations in astronomy with Professor Doolittle and Mr. Eric Doolittle, February 14, 1901; in mathematics with Professor Crawley, Assistant Professors Fisher and Schwatt and Dr. Hallett, on April 4 and 13, and May 11, 1901. She has presented a thesis entitled 'The Poles of a Right Line with Respect to a Curve of Order n .' The thesis will be printed at once. Pending its appearance Miss Vivian has deposited with the Dean a copy of the manuscript and the money necessary to print it. The scope of the thesis may briefly be outlined as follows:

The general subject of poles and polars with respect to Higher Plane Curves has been studied by numerous mathematicians, notably by Steiner, Cremona and Clebsch. Steiner gave in *Crelle's Journal*, Vol. XLVII., a large number of theorems relating to this subject, but he omitted the proofs. They were all proved subsequently by Cremona. Cremona's method was peculiar to himself, that is, he adapted a somewhat more general theory, that of the loci of harmonic means, to the theory of poles and polars. In discussing these problems Miss Vivian uses the analytic method. The particular line of discussion which she has taken up is one which has not been treated in any detail by any former writer. She has handled the subject ably, and has arrived at some very interesting results. In one or two instances her results show that the statements of former writers must be

taken with certain limitations, which do not appear to have been considered. Her principal object is to establish the ways in which the poles of a line are limited when the line has certain prescribed relations to the fundamental curve of the n th order, and to its allied curves, the Hessian and Steinerian. Under particular conditions certain points in the plane will be poles for all lines in the plane, while the other poles, called by the candidate 'free poles,' vary with the line. Many writers do not class the first as poles at all, but it seems more reasonable to class them with the other poles, since they have all the required properties of such points; and, besides, it is more in keeping with the present tendency of thought on these subjects to do so. The subdivisions of the paper are as follows:

1. The pencil of curves of which the poles are base points.
2. The related curves.
3. Poles when the curve $u-o$ has no singularities.
4. The inflection locus.
5. Poles when the curve $u-o$ has double points and cusps.
6. Intersections of higher order with the Steinerian.
7. $u-o$ with triple points and higher multiple points.

Miss Vivian was unanimously recommended to the Faculty of Philosophy by Group Committee XI. for the degree of Doctor of Philosophy.

SCIENTIFIC NOTES AND NEWS.

WE publish in this issue of SCIENCE the admirable presidential address given before the American Association, at Denver, on Tuesday, by Professor Woodward, and the vice-presidential address given by Professor Davenport before the Zoological Section, which is also a model of what such an address should be. We hope to publish next week an account of the meeting and one or two further addresses by the vice-presidents.

PROFESSOR THEODORE WM. RICHARDS, of Harvard University, has been invited to fill the newly established professorship of inorganic chemistry in the University at Göttingen. The position is entirely free from routine teaching, being confined to research work with the assistance of such advanced students as may be selected. It will be remembered that Professor J. H. van't Hoff was called from Holland to fill a similar position at the University of Berlin. The fact that Germany should invite two for-

eigners to such important positions demonstrates the broad-mindedness and freedom from prejudice which in part accounts for the high positions that its universities maintain. The creation of chairs devoted to research is also a forward movement in Germany, which it will be necessary for this country to follow. It is certainly a great compliment to the United States that Germany should seek here a professor for such a chair, more especially when we remember the very great number of chemists that are being trained in Germany. We are glad to learn that the president and fellows of Harvard College have taken action leading Professor Richards to remain in this country.

THE Veitch silver medal has been awarded to Mr. Thomas Meehan, of Philadelphia, 'for distinguished services in botany and horticulture.' Mr. Meehan is the third American on whom this medal has been conferred, the others being Professor Charles S. Sargent, of the Arnold Arboretum, and Professor Liberty H. Bailey, of Cornell University.

PRESIDENT LOUBET of France has conferred upon President W. R. Harper, of the University of Chicago, the decoration of the Legion of Honor.

MR. MARSHALL H. SAVILLE had been named Officier d'Académie by the French Government in recognition of his archeological researches in Mexico for the American Museum.

ON the recommendation of the Council of the Royal College of Physicians, England, it has been unanimously resolved "that the Baly Medal be awarded to Frederick William Pavy, M.D., F.R.S., F.R.C.P., for his researches on 'The Physiology of the Carbohydrates; their Application as Food, and Relation to Diabetes,' 1894; but more especially for his original investigations on sugar formation in the liver, which he has carried on during the last forty years, and with unabated enthusiasm during the last two years."

* DR. VINCENT CZERNY, the eminent professor of surgery at the University at Heidelberg, is on his way to the United States, in order to visit our medical schools.

WE noted recently that a monument to Chevreul had been unveiled in the Court of the

Museum of Natural History, Paris. We learn from French exchanges that addresses were made on the occasion by M. Edmond Perrier, director of the Museum, by M. Armand Gautier, representing the Academy of Sciences and the Academy of Medicine, by M. Arnaud, who in 1890 succeeded Chevreul in the chair of organic chemistry at the Museum, by M. David, director of the chemical laboratory of the Gobelin's Manufactory, and by M. Puglier-Conti, vice-president of the Paris municipal council. The marble statue is by M. Fagel, and is erected on a pedestal bearing the inscription:

CHEVREUL

MICHEL-EUGÈNE

NÉ A ANGERS LE 31 AOUT 1786

MORT A PARIS LE 7 AVRIL 1889

PROFESSEUR DE CHIMIE ORGANIQUE

1830-1889

DIRECTEUR DU MUSÉUM D'HISTOIRE NATURELLE

1863-1884

IT is proposed to erect a statue of Pasteur at Marnes, near Saint Cloud, where Pasteur spent the last years of his life. M. Duparquet, mayor of Marnes, is chairman of the executive committee.

DR. HENRY BENNER, professor of mathematics at Albion College, was drowned on August 14, in Lake Orion.

The death is announced of Dr. Domenico Stefanini, professor of bacteriology at the University of Pavia, at the age of eighty years; and of General Venukoff, a Russian geographer and geodesist living at Paris, at the age of seventy-one years.

THE Vienna Academy of Sciences announces that the prize founded by Freiherr von Baumgartner, will be awarded at the end of 1903 for a research enlarging our knowledge of the invisible radiations. The value of the prize is 2,000 crowns.

AT the meeting of the International Congress of Botanists which opened at Geneva, on August 7, it was voted to establish a Société Internationale de Botanique, and a series of laws was formulated which will be sent in print to botanists interested. It was decided to purchase the *Botanisches Centralblatt*, includ-

ing all back numbers, index and *Beihefte*, of the present publishers, Gebrueder Gotthelft, of Cassel. The journal is to be registered and a limited company formed in Holland. Shares will be sold to cover the purchase. Beginning with January, 1902, it will be published by E. J. Brill, of Leyden, with Dr. Uhlworm as editor and Dr. Kohl as assistant. Annual subscribers are to have equal rights with the stockholders in conducting the business. The Société elected Professor Karl Goebel of Munich, president, Professor F. O. Bower, of Glasgow, vice-president and Dr. J. P. Lotsy, Tjébodas, Java, secretary. The next meeting is to be held in Vienna, three years hence. Switzerland and France were most largely represented among the delegates present. The United States were represented by Professor J. C. Arthur, Dr. D. S. Johnson, Dr. F. E. Lloyd, Mr. W. Murrill and Dr. H. von Schrenk as delegates. The delegates were very hospitably received in Geneva, and a banquet was given in their honor. After the meeting some of the delegates, under the direction of Professor Chodat, of Geneva, made an excursion among the Swiss Alps.

ACCORDING to a cablegram to the daily papers the most important question of the meeting of the Zoological Congress came up on August 14, in the Committee on Nomenclature. Two propositions were presented. The French delegation proposed to make the existing nomenclature conform with the classic Latin, grammatically and etymologically. The American delegates proposed to make no changes, except in the case of obvious typographical errors. The Germans made a compromise proposition, which did not find favor. After a warm discussion the French proposition was accepted, the Swiss delegates giving the deciding vote for the proposal. The Dutch delegates and part of the German delegation voted with the Americans. The British delegates voted with France.

THE French Surgical Congress will hold its fourteenth annual meeting in Paris on October 21 and following days.

WE learn from the *British Medical Journal* that an Egyptian Medical Congress is to be held under the patronage of the Khedive at

Cairo from December 10 to 14, 1902, under the presidency of Dr. Abbate Pacha. The honorary presidents are Dr. Ibrahim Pacha Hassan, Dr. Pinching, and Dr. Ruffer. The general secretary is Dr. Voronoff. The work of the Congress will be divided among three sections, as follows: (1) Medical Sciences, presided over by Dr. Comanos Pacha; (2) Surgical Sciences, presided over by Dr. H. Milton; and (3) Ophthalmology, presided over by Dr. Mohammed Bey Eloui. The program of the Congress will include discussions on affections especially rife in Egypt, such as bilharzia, ankylostomiasis, bilious fever, abscess of the liver, etc. Special attention will be given to questions relative to the epidemics which for some years past have regularly visited Egypt, and the prophylactic measures to be taken against them. The following papers among others have been promised: 'Alcoholism and its Increase in Egypt,' by Dr. de Becker; 'The Frequency of Hydrocele in Egypt and its Treatment,' by Dr. Colloridi; 'Myxœdema in Egypt,' by Dr. Brossard; 'Plague,' by Dr. Gotschlich; and 'Tuberculosis in Egypt,' by Drs. Ibrahim Pacha Hassan, Eid. and Sandwith.

THE twelfth annual general meeting of the Institution of Mining Engineers will be held at Glasgow on September 3-6, under the presidency of Sir W. T. Lewis, Bart.

FOLLOWING the Congress on Petroleum, held in Paris in 1900, a second congress will be held in Paris in 1902. A permanent committee has been formed in Paris under the presidency of M. Ed. Lippmann, the secretary of the congress, and M. Dvorkovitz has recently established in London an institute for the scientific study of petroleum.

A MEETING of the Board of Visitors of the National Bureau of Standards was called in Washington, for August 23d, for the purpose of passing on proposed sites for the laboratory of the bureau. It will be remembered that the five members of the Board of Visitors were appointed by Secretary Gage, and are as follows: Dr. H. S. Pritchett, president of the Massachusetts School of Technology; Dr. Ira Remsen, president of the Johns Hopkins University; Dr.

Elihu Thomson ; Professor Edward L. Nichols, of Cornell University, and Albert L. Colby, of Pennsylvania.

ACCORDING to *Nature* the Paris correspondent of the *Chemist and Druggist* states that with a view to giving an impetus to the study of applied chemistry in Paris, it has been decided to build additional laboratories at the Conservatoire des Arts et Métiers. The initial expense is estimated at 500,000f. (20,000*l.*), and the annual upkeep at something over 3,000*l.* The laboratories will also be used for experiments in physics and mechanics.

THE German Government has sent an expedition to German East Africa for the purpose of organizing a systematic effort for the prevention of malaria. The expedition is under the command of Dr. Ollwig, Staff-Surgeon *à la suite* serving with the Imperial forces in East Africa.

A NORTH German Lloyd steamer has been chartered to leave Sydney, N. S. W., on October 11 for Kerguelen Land, conveying provisions and dogs for the German Antarctic expedition on board the steamer *Gauss*.

THE book on 'Mosquitoes' by Dr. L. O. Howard, recently reviewed in this journal by Professor Packard, is being translated into Spanish.

THE Station of the U. S. Fish Commission on the Great Lakes, with headquarters at present at Put-in-Bay, Ohio, is collecting the literature of fresh-water fauna and flora, and Professor H. S. Jennings, who has charge of the Station, will be glad to receive from authors and others publications in these subjects.

M. MAREY, the president of the International Committee on Physiological Instruments, will be glad to have sent to him at Boulevard Delesert, No. II., Paris, new physiological apparatus for presentation at the International Congress of Physiology to be held at Turin next month.

FOR the last week for which the report is at hand, the deaths from the plague in India numbered 1,125. At the same period last year there were only 200 deaths.

WE learn from *Nature* that the annual awards of prizes by the Reale Accademia dei Lincei, of Rome, are as follows: The Royal prize for chemistry has been adjudged to the late Pro-

fessor Amerigo Andreocci for his researches on heterocyclic compounds and on the santonine group, and other papers. The Royal prize for philosophy and moral science has been adjudged to the late Professor Carlo Giussani. In political science and jurisprudence no award has been made, and the same is true of the Santoro prize relating to agricultural zoology. The two prizes instituted by the Minister of Public Instruction in favor of teachers in secondary schools for work in natural science have been divided, awards being given to Professors Liberto Fantappiè (Viterbo), Antonio Neviani (Rome), De Toni (Venice), and Giacomo Trabucco (Florence). Two 'Ministerial' prizes of a similar character for philosophical and social sciences are awarded to Professors Luigi Einaudi (Turin) and Aurelio Covotti (Palermo).

THE annual meeting of the Fellows of the Royal Botanic Society, according to the report in the *London Times*, was held on August 10, in the museum in the society's gardens at Regent's Park. Mr. C. Brinsley Marlay presided. The Duke of Teck was elected president, Mr. G. J. Marjoribanks treasurer, and the Marquis of Breadalbane, Earl Howe, the Earl of Aberdeen, Sir Henry Oakley, Sir J. Blundell Maple, M.P., Mr. J. Fletcher, Dr. R. C. A. Prior and Mr. W. Sowerby were re-elected members of the council. The 62d annual report stated that the negotiations with the Department of Woods and Forests had been concluded and a new lease of the gardens had been granted for 31 years. The accounts showed that the year's working had resulted in a profit of £285, being nearly double that of the previous year. The number of fellows on the books was 2,124, which showed a steady increase in number, 88 new fellows having joined the society during the year. The garden's club continued to form one of the attractions of the society, 41 fellows of the society having joined the club during the year; and the past season had been a very successful one. The chairman, in moving the adoption of the report, said that the prospects of the society were decidedly better than they had been for some years past. Their lease had been renewed and a large number of their debentures—viz., £5,700—had been taken up. The so-

ciety was in a transition state. Mr. Austen Chamberlain, as representing the Treasury, had insisted that the society should open its gates to the public a certain number of days in the year; in fact the public had rights there which had to be recognized. Therefore the old character of the gardens had almost completely disappeared. The Society still retained its scientific character, however, and whatever facilities they could give to promote science, particularly botany, they would give. They had been unable to obtain a grant from the Government, and the scientific part of the gardens was, therefore, carried on with great difficulty. The subscriptions of the fellows were not sufficient to keep up the gardens as they should be kept up, and the council had to rely, therefore, in some measure upon the entertainments. Towards the end of the meeting the chairman called attention to the skill and beauty of a large number of Japanese drawings of flowers and birds, of which he had a very fine collection.

AT the last meeting of the Berlin Medical Society, held on July 25, Professor Virchow is reported by the *Lancet* to have alluded to the recently-enunciated views of Professor Koch as to the non-identity of tuberculosis in cattle with that affecting the human subject. In his sarcastic style he remarked that he was happy to find that Professor Koch's views had undergone a change and were now in accordance with his own, for he had maintained that the mere presence of the Koch bacillus was not the essential thing in tuberculosis; a tubercle was, in his opinion, a growth with a distinct anatomical structure, and he had always protested against the bacteriologists terming anything a tubercle simply because a Koch bacillus happened to be present. He said that the adherents to Koch's theory had believed his view to be rather old-fashioned, but it did not annoy him to recall to mind that he had sometimes been superciliously treated by the younger bacteriologists. Professor Virchow's ironical words produced a great impression on the meeting.

ACCORDING to the *Comptes Rendus*, as translated in the *Scientific American*, H. Becquere!

has confirmed, by an unpleasant experience, the fact first noted by Walkoff and Giesel, that the rays of radium have an energetic and peculiar action on the skin. Having carried in his waistcoat pocket for several periods, equal in all to about six hours, a cardboard box enclosing a small sealed tube containing a few decigrammes of intensely active radiferous barium chloride, in ten days' time a red mark corresponding to this tube was apparent on the skin; inflammation followed, the skin peeled off and left a suppurating sore, which did not heal for a month. A second burn subsequently appeared in a place corresponding to the opposite corner of the pocket where the tube had been carried on another occasion. P. Curie has had the same experience after exposing his arm for a longer period to a less active specimen. The reddening of the skin at first apparent gradually assumed the character of a burn; after desquamation a persistent suppurating sore was left which was not healed fifty-six days after the exposure. In addition to these severe 'burns' the experimenters find that their hands, exposed to the rays in the course of their investigations, have a tendency to desquamate; the tips of the fingers which have held tubes or capsules containing very active radiferous material often become hard and painful; in one case the inflammation lasted for fifteen days and ended by the loss of the skin; and the painful sensation has not yet disappeared, after the lapse of two months.

ACCORDING to a notice in *Nature*, the annual report of the Russian Geographical Society for 1900 notes the growing activity of the young branches of the society at Vladivostok, Kiakhta, Tomsk and Orenburg—their work being not limited to pure geography, but being mainly directed to the exploration of the geology, botany, zoology and prehistoric anthropology of the respective regions. A new local museum has consequently been opened at Troitskosavsk, near Kiakhta, in addition to those of Minusinsk and Yeniseisk. The chief medal of the Geographical Society, the Constantine medal, was awarded this year to V. Obrucheff, the explorer of the Nan-shan and Mongolia, who has also explored very large portions of Transbaikalia and the Pacific littoral, and whose preliminary

reports are always of the deepest interest for both the geologist and the orographer. The Count Lütke medal was awarded to M. E. Zhdanko for his extensive geodetical and hydrographical works in the far North, the Semenov medal to J. A. Kersnovsky for work in meteorology, and the Prjevalski medal to the Tomsk professor, V. V. Sapozhnikoff, whose explorations of the Altai highlands revealed hundreds of unknown glaciers, as well as widely-spread traces of glaciation, and threw much new light on the geography of the whole region. These researches are now embodied in a work, 'The Katufi and its Sources' (with maps and a summary in French).

THE Society of Chemical Industry held its annual meeting at Glasgow at the end of July. The secretary reported that the society was in the most prosperous condition, there being now 3,632 members. The president, Mr. J. Wilson Swan, chose as the subject of his address 'Electro-chemical Industry.' According to the abstract in the *London Times* he traced the progress of this branch of applied science from the early laboratory researches of Davy and Faraday down to the position it occupied at the present time. He gave particulars of the power at present utilized and products made in the 150 works using electricity for chemical and metallurgical purposes in Europe, and described the methods employed in the several branches of manufacture. In several instances the new methods of manufacture had already supplanted the old, while in others there was keen competition between the chemical and the electrolytic processes. Turning to the future, Mr. Swan pointed out that the united kingdom was severely handicapped as regards these new developments by her lack of water-power. In spite of this, however, many of the new electro-chemical industries could be carried on profitably with steam-power. The utilization of the waste gases of blast furnaces in large gas-engines for the generation of electrical energy would also become a realized fact, and would supply large quantities of cheap power for the industries under discussion. While, therefore, admitting that the position of the staple chemical and allied industries in England had been undermined to some extent by the rapid

growth of electro-chemical industries abroad, and that protective tariffs were being employed to shut out British products, Mr. Swan believed the future might be faced with some degree of confidence and hope. Speaking in one of the lecture theaters of a great university, whose long and splendid services to education has lately been commemorated, he could not but congratulate Scotland and the Scottish section of the society on the very advantageous position it occupied in that respect. In England and Ireland they were suffering acutely from dire educational neglect and destitution. They were giving to the classes at the bottom of the industrial ladder a disjointed smattering of miscellaneous science of no great value, though probably good so far as it went, while they were neglecting to thoroughly educate those upon whose shoulders would soon rest the weight of the management of the great manufacturing industries. A scientific training of university standard for our manufacturers and for our technical chiefs was an absolute necessity. One of the most pressing requirements of the moment, demanded not only in the interest of chemical industry, but in that of the manufacturing industries generally, was the adequate endowment and encouragement of research. The advances in knowledge, and the consequent revolutionary changes that had taken place in almost every branch of chemical industry during the last 100 years were probably not greater than those further changes that would be seen at the end of the present century, for change brought about by scientific discovery grew ever swifter and more sweeping. Change was the natural order of things; but, to take advantage of it, the fullest measure of assistance was demanded that education and energy could give.

MR. W. H. MAW recently delivered his presidential address before the members of the British Institution of Mechanical Engineers. Dealing with the question of the education of young mechanical engineers, he said, according to the *London Times*, that nothing was more disheartening to a student than to find at some stage in his career that he had been devoting time to learning things which were not only useless to him, but which it was desirable he

should unlearn, while, on the other hand, he had failed to acquire knowledge of which he stood badly in need. Yet this was a far too frequent experience with boys entering technical colleges from the public schools. The remedial changes which had so far been made in this direction were limited in extent compared with those really required, and there was still left to be done at the technical college much educational work which ought to have been done at school, the result being a waste of valuable time. The matter was one which merited the most careful attention of all interested in technical education. There came a time when every engineer must specialize if he really wanted to attain anything more than a subordinate position. This specialization should be at least commenced during the college career rather than subsequently, the student devoting the latter part of his course at college to the acquirement of a knowledge of the special principles which underlay practice in the particular branch of the profession to which he was about to devote himself. This meant that the college authorities must take a wider view of their responsibilities than many of them did at present. It would also probably mean in the future that certain colleges would acquire a reputation for certain branches of work. One of the chief aims of technical college training should be to develop independent thought and action in a student. It could not be too thoroughly appreciated that the vast development of mechanical engineering work which had been going on in the past half-century, and which was still going on at an ever-increasing rate, was producing a most important change in the conditions which secured both professional and commercial success. In the old days the leading firms of mechanical engineers had comparatively few customers, and they had, as a rule, to meet the great variety of requirements of those customers to the best of their ability. Repetition work was comparatively rare, and success depended largely on resourcefulness and the power of entering thoroughly into the conditions to be fulfilled. Nowadays the successful mechanical engineer was not he who made a great variety of things for the few, but a small variety of things for the many, at the same time pro-

ducing those few things in the most perfect way. Experience showed clearly that mere lowness of price was not in itself an inducement to purchasers, and the maker of an engine of exceptional economy or of a machine too, which excelled its competitors in the quantity or quality of the work it turned out would never find difficulty in obtaining proportionately good prices for his productions.

UNIVERSITY AND EDUCATIONAL NEWS.

BEREA COLLEGE, Ky., receives \$50,000 by the will of Stephen Ballard, of Brooklyn.

THE Department of Agriculture has received a communication from the University of California announcing that a dairy school is to be established at that institution and requesting that a butter and cheese expert of the department be permitted to go to California to assist in establishing the school. Mr. W. E. Griffith, one of the experts of the department, will be assigned to this work August 20.

PRESIDENT JAMES WHITFORD BASHFORD, of Ohio Wesleyan University, has been offered the presidency of Northwestern University.

DR. T. D. WOOD, professor of hygiene and organic training at Stanford University, has accepted a similar position at Teachers College, Columbia University.

ELLIOT R. DOWNING, Ph.D. (Chicago), who has been during the summer assistant in zoology at Chicago University, will in the autumn take charge of the biological department at the Northern State Normal School at Marquette, Mich.

DR. CHARLES F. HOTTES has been appointed instructor in botany in the University of Illinois. Mr. Hottes was formerly assistant in the botanical laboratory of the University, but has spent the last three years at the University at Bonn, studying plant physiology and cytology. Mr. H. Hasselbring, of the New York Agricultural Experiment Station at Geneva, has been appointed assistant in the Agricultural Experiment Station of the same University.

DR. FLORENCE M. LYON, of Smith College, has been appointed associate in botany in the University of Chicago and dean of Beecher Hall.

SCIENCE

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FRIDAY, SEPTEMBER 6, 1901.

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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 AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THE Denver meeting was notable in several particulars. It was feared that a meeting so far west would be poorly attended, but the registration reached 311, being larger than that of the second Detroit and Madison meetings, and nearly as large as that of the Columbus and fourth Buffalo meetings. The number of representative men of science was proportionally very large, so that the sectional meetings were well attended and were as full of interest as at larger meetings of the Association, more than 200 papers having been presented. In the registration Colorado led with 79 members, while the number of members residing west of the Mississippi reached 162.

The attitude of the citizens of Denver and of Colorado, as indicated by the press and by arrangements for the convenience and entertainment of members, was most happy. This is well indicated by the following extract from an editorial which appeared in the *Denver Post* of August 30 :

It is believed that the visit of the scientists has been one of pleasure, as well as profit, and that if the people of Denver have taken a thorough satisfaction in their presence, they, on the other hand, have found equal satisfaction in their sojourn here. The public is too apt to think that because men devote their lives to the pursuit of scientific inquiries they are apt to be dry, self-absorbed and technical. To such as these actual contact with the members showed them to be surprisingly genial, kindly and sympathetic, while in many of them was found a fine flow of humor flavored with a wit which was none the less attractive because it carried with it no sting. In the nature of things it will be some years before Denver may again hope to entertain them as a body, but every one concerned will feel for them a regard amounting to affection, and when their next session is held here they will get a reception such as no other city could accord them.

The Denver meeting was also notable for several important changes in policy, either adopted or presented for future action. Perhaps the most radical measure under discussion was that which contemplates a change in the time of the annual meetings. The summer meeting has become so fixed a part of the annual program of many members that a change to midwinter will call for considerable readjustment. The movement for a general convocation week following the holiday week has commended itself so generally to universities, however, that the Association has concluded that the experiment deserves a trial. Accordingly, the general committee of the Denver meeting has suggested to its successor at Pittsburg that the annual meeting of 1903 be held in Washington during the week in which January 1 falls. This action simply suggests the experiment of a winter meeting, without any recommendation as to the discontinuance of summer meetings. It may

be that the Association will conclude to hold two meetings a year, which could well be of somewhat different character.

An important amendment, which was adopted, provides for representation in the council from the affiliated societies. By this action, each affiliated society is entitled to elect one member, who is a fellow of the Association, as its representative in the council; and if the society contains more than twenty-five members who are fellows of the Association, it is entitled to two representatives in the council. It seems certain that this representation in the ruling body of the Association will lead to a more compact and efficient organization of the scientific interests of the country.

Another amendment was adopted, which provides that the council shall have power to change either the time or place of meeting. Heretofore, after the adjournment of the general committee, there has been no authority to make such changes upon any contingency. It is understood that this power will be exercised only in such extreme cases that the action will commend itself to all members. For example, the time set for the Denver meeting narrowly escaped a conflict with a national meeting of such magnitude that the Association could not have been accommodated.

Three amendments were presented to be acted upon at the Pittsburg meeting, which look to much greater efficiency in the conduct of the affairs of the Association. One provides for the election by the council each year of three councillors at large, who shall serve for a term of three years. This will add to the council nine members

who have been chosen for their experience and interest in the Association, and who will give greater permanence and efficiency to this very important body.

With the idea of increasing the efficiency of sectional organizations, another amendment proposes that secretaries of sections be elected for a term of five years. Under the present method a secretary serves only long enough to learn his duties. This makes it impossible to obtain that continuity of experienced service which is necessary to develop the interests of the sections. There is no reason why such service is not as essential to a section as it is to the Association in the person of the permanent secretary. The same desire to increase the efficiency of the sectional organizations also prompted the proposed amendment providing that each section shall elect, annually, one fellow as a member of the sectional committee and that he shall serve five years.

Several reports of committees seem to call for comment. The committee on the policy of the Association made three recommendations which were adopted. One was that Section D (Mechanical Science and Engineering) be not discontinued, as had been suggested, since the recent entrance of a large body of engineers into the Association gives promise of a strong section. A second was the organization of the new Section (K) of Physiology and Experimental Medicine, which promises to be one of the strongest sections of the Association. A third was that all abstracts be restricted to 400 words, that they be published in *SCIENCE* and that the titles only shall appear in the published volumes of the *Proceedings*.

The report of the committee on the relationship of the Association and *SCIENCE* was full of interest, since it involved the first official statement of the results of this relationship. It was reported that the fees of new members have paid the expense of sending *SCIENCE* to all members. In this connection it may be well to state that according to the contract with The Macmillan Company the Association pays two dollars a year for each member to whom *SCIENCE* is mailed. These publishers certainly deserve honorable mention for their interest in promoting this movement, for it is estimated that *SCIENCE* will not be in the same financial condition as before the arrangement until the Association contains 4,000 members. There seems to be no question in the minds of members that the relationship with *SCIENCE* has been of very great advantage to the Association.

This leads to a mention of the noteworthy increase in the number of members during the last year, an increase which bears the strongest testimony to the efficiency of the permanent secretary and his immediate associates. For a few years the published lists of members showed a gradual decrease in number, until at the beginning of the last New York meeting there were 1,721 actual members. At the close of the Denver meeting, about a year later, the number of members is approximately 2,800, over 1,150 members having joined within the last year. Such a record is remarkable, but its chief importance lies in the fact that it shows what can be done with proper effort. Conservative members are now putting the number to be expected at 5,000,

while a prominent officer at the Denver meeting thought it should be 10,000. However this may be, the work of the past year has demonstrated clearly that an effort to increase membership, when wisely directed and persistently followed up, is sure to be successful.

The financial side of the Association is also becoming impressive. The report of the permanent secretary for 1900, which does not include the still larger income accruing thus far during 1901, shows receipts amounting to \$12,321.60. Of this amount the sum of \$1,300 was paid over to the treasurer for endowment, and a balance of \$4,741.60 carried over to the next year. To meet the numerous expenses of so large an organization, and also to set aside more than \$1,000 towards the permanent endowment for grants is an achievement for which the administration of the Association is to be congratulated. The same outcome will appear in the next report, for the Council has already set aside \$1,000 from the receipts of 1901 for the permanent fund.

In regard to this permanent fund the treasurer's report showed that it now amounts to over \$11,000, having doubled in seven years. This is gratifying because the income is used for grants to special committees to aid in the prosecution of research. The reports of these committees form an interesting part of the proceedings. With an organized effort for an increase in the number of members, and with the frequent communication among members secured by the relationship with this Journal, there seems to be no reason why the Association should not include in its

membership all those who are engaged or interested in scientific work in this country and thus represent completely the organization of science in America.

The steady progress toward this end is demonstrated by the signal success of the Denver meeting. Heretofore the Association has been an organization expressing chiefly the scientific activities of the eastern states, no previous meeting having been held west of the immediate banks of the Mississippi river. Henceforth the Association is in fact as well as in name an organization expressing the scientific activities of the entire continent. This first Denver meeting, therefore, must be regarded as a noteworthy event in the history of American science.

*PROCEEDINGS OF THE FIFTIETH ANNUAL
MEETING OF THE AMERICAN ASSO-
CIATION FOR THE ADVANCE-
MENT OF SCIENCE.*

THE first general session of the Denver meeting was called to order in the auditorium of the High School Building at 10 o'clock in the morning of August 26 by the retiring president of the Association, Professor R. S. Woodward, of Columbia University, who introduced the president-elect, Professor Charles S. Minot, of Harvard University. President Minot introduced the Hon. J. B. Grant, president of the local committee, who, after some remarks welcoming the Association to Denver and to Colorado and the reading of a letter from the Governor of the State, introduced the Hon. R. R. Wright, Jr., Mayor of Denver; Mr. Charles F. Wilson, President of the Chamber of Commerce; General Irving Hale and Professor Aaron Gove, Superintendent of Schools, all of whom made addresses of welcome. To these addresses

President Minot replied in the words published below.

At the closing session the permanent secretary read the following report :

The fiftieth annual meeting of the A. A. A. S., which will be known in the future as the 'Denver Meeting,' or possibly, and let us hope, as the 'first Denver Meeting,' has been a most successful one. There have been in attendance 306 members and associates, making the meeting in this regard rank as the 22d largest meeting. What may be termed the geographic distribution of the members in attendance has been interesting. From the Atlantic Coast region there have been 92, or nearly one-third, from the Pacific Coast 11, and from foreign countries 6, leaving two-thirds from the great interior of the country.

The distribution by States has been as follows :

Colorado heads the list with	79
New York	30
District of Columbia	28
Iowa	15
Missouri	14
Massachusetts	13
Penn'a., Illinois	12 ea.
Kansas	17
California	10
Nebraska	9
Indiana	8
Wisconsin	7
Minnesota, Ohio, Connecticut, N. Mexico	5 ea.
Wyoming, Canada, Michigan	4 ea.
Texas	3
West Virginia, Montana, Arizona	2 ea.
Georgia, North Dakota, South Dakota, Oregon, Nevada, Oklahoma, New Hampshire, Tennessee, New Jersey, North Carolina, Arkansas, Louisiana, England, Ireland	1 ea.

It must be borne in mind, however, that the number registered, 306, includes only the actual members and associates of the A. A. A. S., and that the great national affiliated societies of specific aim which have met with us have drawn many more sci-

entific men and women to Denver within the past week, so that it has really been a scientific congress of much importance.

The papers which have been read before the Association proper and in joint sessions with the more closely affiliated societies have been numerous and of a high order. About 220 in all have been presented.

A number of important measures concerning the future of the Association have been considered. An amendment to the constitution providing for the representation in the Council of the affiliated societies seems one of the most important steps taken by the Association of recent years, while other amendments looking towards a more stable membership in the Council have been introduced and will be considered later.

About 50 new members have been elected during the meeting; and 186 members have been made fellows.

Denver and its vicinity have provided visiting points of great scientific interest, and the facts just stated, together with the great courtesy and warm-hearted hospitality of the citizens of Denver, have combined to make the meeting now coming to a close a memorable one in the annals of the old Association.

The members of the Council in attendance were :

Past President—R. S. Woodward, New York.

Vice-President of the Columbus Meeting—Marcus Benjamin, Washington.

Vice-Presidents of the New York Meeting—Wm. Trelease, St. Louis; Amos W. Butler, Indianapolis; Calvin M. Woodward, St. Louis.

Officers of the Denver Meeting—Charles Sedgwick Minot, Boston; James McMahon, Ithaca; D. B. Brace, Lincoln; John H. Long, Chicago; H. S. Jacoby, Ithaca; C. R. Van Hise, Madison; D. S. Jordan, Leland Stanford Jr. University; B. T. Galloway, Washington; J. Walter Fewkes, Washington; John Hyde, Washington; L. O. Howard, Washington; J. M. Coulter, Chicago; D. T. MacDougal, New York; G. A. Miller, Ithaca; John Zeleny,

Minneapolis; Wm. McPherson, Columbus; C. W. Comstock, Golden; H. B. Ward, Lincoln; Ernst Bessey, Washington; G. G. MacCurdy, New Haven; R. A. Pearson, Washington; R. S. Woodward, New York.

From the Association at Large—A fellow from each section: G. B. Halsted, Austin; E. L. Nichols, Ithaca; C. S. Palmer, Boulder; C. A. Waldo, Lafayette; T. C. Chamberlin, Chicago; F. M. Webster, Wooster; D. H. Campbell, Stanford; L. M. Underwood, New York; W. J. McGee, Washington; E. T. Peters, Washington; J. McK. Cattell, New York.

From the Affiliated Societies—American Chemical Society: F. W. Clarke, A. C. Hale. Geological Society of America: N. H. Winchell, H. L. Fairchild. Botanical Society of America: C. E. Bessey, B. D. Halsted. Society for the Promotion of Agricultural Science: W. J. Beal, Agricultural College.

The address of the retiring president was published in the last issue of this journal and the addresses of the vice-presidents and abstracts of the papers read before the sections are in course of publication. The more important business transacted by the Association was as follows:

An amendment to Article 18 of the constitution, submitted at the New York meeting in 1900, was reported at general session from the council for favorable action and adopted. The amendment is as follows:

In Art. 18, after the words 'The Treasurer of the current meeting,' omit 'with the addition,' and after the words 'by ballot on the first day of its meeting' insert 'of one fellow elected by each affiliated society and one additional fellow from each affiliated society having more than twenty-five members who are fellows of the Association.'

The following amendment to Article 20 of the Constitution was also adopted:

Add to the end of Art. 20 the words, 'But if suitable preliminary arrangements cannot be made, the council may afterward change the time and place appointed by the general committee, if such change is believed advisable by two-thirds of the members present.'

The following amendments to the constitution were read before the council and at the general session and will be acted on at the next meeting:

In Article 9, after the words 'with the exception of the Permanent Secretary' omit 'and,' and after the words 'the Treasurer' insert 'and the Secretaries of the Sections; and after the words 'The term of office of the Permanent Secretary' omit 'and,' and after the words 'the Treasurer' insert 'and of the Secretaries of the Sections.'

In Article 18, after the words 'who are fellows of the Association,' insert 'and of nine fellows elected by the Council, three being annually elected for a term of three years.'

In Article 23, after the words 'of a Section there shall be' omit 'three members or fellows' and insert 'a member or fellow,' and after the words 'Vice-President and Secretary of the preceding meeting' insert 'and the members or fellows elected by ballot at the four preceding meetings.'

Reports of standing and special committees were presented and their recommendations adopted as follows:

COMMITTEE ON THE POLICY OF THE ASSOCIATION.

The Committee on the Policy of the Association presents the following recommendations to the council in regard to certain matters which have been referred to it for consideration:

1. The Committee recommends that owing to the great increase of engineers in the membership of the Association, it would be inexpedient to consider the question of the discontinuance of Section D.

2. The Committee recommends that the proceedings of the annual meetings, including the addresses of the Vice-Presidents, the reports of committees and officers, and abstracts of all papers, be published immediately in *SCIENCE*, and further that the addresses of the Vice-Presidents, titles of all papers and reports of officers and committees, the constitution and lists of officers, members and fellows, be published by the Permanent Secretary in a volume as soon thereafter as possible. The Committee further recommends that authors wishing to make alterations in abstracts of their papers shall do so before the close of the meeting and that abstracts shall not exceed 400 words in length. It further recommends that the Secretaries of Sections shall forward these abstracts with an account of the work of the meeting to the responsible editor of *SCIENCE* within a week after the close of the meeting.

3. The Committee recommends that Section K organize at the present meeting by the formation of a Sectional Committee and that papers submitted for

this Section at this meeting be referred in accordance with their character to Sections H or F.

[Signed.] CHARLES S. MINOT.
R. S. WOODWARD.
L. O. HOWARD.

COMMITTEE ON THE RELATIONS OF THE
JOURNAL, SCIENCE, WITH THE
ASSOCIATION.*

This committee is able to report that the arrangement by which SCIENCE has this year been sent to the members of the Association has been satisfactory in every respect. It has been generally approved and has apparently strengthened the Association and the organization of science in America. The membership of the Association has greatly increased, the fees of new members sufficing to pay the entire expense of sending SCIENCE to all members of the Association. We recommend that we be authorized to renew for the year 1902 the present contract with The Macmillan Company. We also recommend that the treasurer of the Association be added to this committee.

[Signed] SIMON NEWCOMB, *Chairman*,
R. S. WOODWARD,
L. O. HOWARD,
J. MCK. CATTELL, *Secretary*.

COMMITTEE ON CONVOCATION WEEK.

The plan of setting aside the week in which New Year's Day falls as a convocation week for the meetings of scientific and learned societies has met with almost universal approval on the part both of societies and of institutions of learning. At the instance of this committee, the Association of American Universities passed unanimously a resolution recommending the establishment of a convocation week, and the thirteen universities composing the Association have with one exception either left the week entirely free from academic exercises, or will give all officers leave of absence. We have now begun correspondence with about fifty additional universities, colleges and technical schools.

In view of the favorable reception of the plan for a convocation week we recommend :

1. That this Association and its affiliated societies meet in Washington in the week in which New Year's Day of 1903 falls, without, however, committing ourselves at present to the abandonment of summer meetings.

* Mr. G. K. Gilbert, the remaining member of this committee, was absent in the field and unable to sign this report, but it is known that he concurs in its recommendations.

2. That the Council meet in Chicago during the Convocation Week of 1901-2, and that the Sectional Committees may organize meetings of their respective Sections, the expenses of each of which shall not exceed \$25, to be paid from funds in the hands of the Permanent Secretary.

3. That this Committee be continued.

[Signed] CHARLES S. MINOT,
R. S. WOODWARD,
EDW. L. NICHOLS,
L. O. HOWARD,
J. MCK. CATTELL.

NINETEENTH ANNUAL REPORT OF THE COM-
MITTEE ON INDEXING CHEMICAL
LITERATURE.

The Committee on Indexing Chemical Literature, appointed by your body in 1882, respectfully presents its Nineteenth Annual Report, embracing the fourteen months from June 1, 1900, to August 1, 1901.

WORKS PUBLISHED.

A Select Bibliography of Chemistry, 1492-1897. By HENRY CARRINGTON BOLTON. Section VIII., Academic Dissertations. City of Washington, published by the Smithsonian Institution. 1901. 8vo. Pp. vi + 534.

This forms No. 1253 of the Smithsonian Miscellaneous Collections, Vol. XLI.

This Bibliography of Academic Dissertations is a second part of the work published in 1893, and with the 'First Supplement,' issued in 1899, completes (if the term can be applied to bibliography) the undertaking begun by Dr. Bolton in 1888. The three volumes comprise about 25,000 titles. The dissertations found in the libraries of the Smithsonian Institution and of the U. S. Geological Survey are indicated by appropriate initials. There is a full subject-index.

The completed manuscript of a 'Bibliography of the Analytical Chemistry of Manganese,' by Professor Henry P. Talbot and John W. Brown, has been carefully examined by your Committee, and they have recommended it for printing to the Smithsonian Institution to which it has been presented.

WORKS IN PROGRESS.

Mr. Frank R. Fraprie reports progress on his manuscript 'Index to the Literature of Cæsium, Rubidium and Lithium,' which is to be completed within a twelve-month.

Mr. G. A. Smith, of Cornell University, reports that his 'Index to the Literature of Selenium and Tellurium' will be completed by the close of the academic year.

Dr. M. D. Sohon is preparing for the press a 'Subject-Index to the Journal of the American Chemical Society.'

Dr. H. Carrington Bolton has in preparation another 'Supplement to the Select Bibliography of Chemistry,' intended to cover the period beginning with 1897, and to include omissions.

Dr. Alfred Tuckerman has revised and prepared for the press the continuation of his 'Index to the Literature of the Spectroscope'; the MS. has been presented to the Smithsonian Institution.

NOTES.

During the last twelve months there have been published the following bibliographical works on chemical subjects:

Bibliographia Lactaria. Bibliographie générale des travaux parus sur le lait et l'allaitement jusqu'en 1899. Paris, 1900. 600 pp. 8vo.

Bulletin de la Société chimique de Paris. Tables des années 1889 à 1898, dressées par Th. Schneider. Paris, 1900. Two Parts.

Zeitschrift für physikalische Chemie, Stöchiometrie, und Verwandtschaftslehre. Namen und Sach-Register über Band I.-XXV., bearbeitet von T. Paul. Leipzig, 1900. 8vo.

And Professor A. K. Krupsky, of St. Petersburg, announces a 62-page 'Bibliography of Chemistry' in Russian, which your committee is as yet unable to describe more accurately.

H. CARRINGTON BOLTON (in Europe),
F. W. CLARKE,
A. R. LEEDS,
A. B. PRESCOTT,
ALFRED TUCKERMAN,
H. W. WILEY,

Committee.

COMMITTEE ON ANTHROPOMETRIC MEASUREMENTS.

At the New York meeting of the Association physical and mental measurements were made of about forty fellows of the Association, under the auspices of this committee. The number is not sufficient to permit of the publication of the results, but some points of interest were disclosed. We are anxious to continue these measurements, but cannot do so at Denver owing to the difficulty of transporting instruments and securing skilled assistance. We hope to overcome the former difficulty in future by the construction of instruments that can be packed in a dress-suit traveling case. The sum of \$50 appropriated last year for the committee has been used in constructing instruments with this object in view, a balance and measuring rod having been made that

can be readily transported. A traveling set of instruments of this character would be of value in anthropological expeditions.

The members of the committee resident in New York have continued anthropometric work, measuring the mental and physical traits of students of Columbia and Barnard Colleges, and of children in the schools. A thesis has been accepted for the degree of doctor of philosophy in Columbia University by Mr. Clark Wissler on 'The correlation of mental and physical traits.' This thesis, which has been published as a supplement to the *Psychological Review*, is the first full treatment by quantitative methods of the interrelation of mental and physical traits. Professor E. W. Thorndike has also at Columbia University carried on experiments on the correlation of mental ability, which will shortly be published.

For the completion of the traveling set of anthropometric instruments referred to, the committee asks a further grant of fifty dollars.

[Signed] J. MCK. CATTELL,
FRANZ BOAS,
W J MCGEE.

REPORT OF THE COMMITTEE ON THE QUANTITATIVE STUDY OF VARIATION.

The grant of one hundred dollars to this Committee was used to help defray the expenses of Mr. C. C. Adams, incurred in collecting for study molluscs of the genus *Io*, found in the headwaters of the Tennessee River. A preliminary report has been made by Mr. Adams, and this was printed in the *Proceedings* of the Association for 1900. Mr. Adams submits at this time a second report covering the results of study on the material collected last summer, but prefers to postpone further publication until after his final expedition, which he is making this summer. The main results so far are that he has shown by the aid of an elaborate series of measurements that the numerous species of *Io* run into each other in a very complete way, and that the differences between the shells are associated with their position up or down stream. Nevertheless there is in most streams a more or less marked discontinuity between the smooth, globular, up-stream shells and the spiny, elongated down-stream shells. The meaning of the discontinuity (which justifies, in a way, a division of the shells into two species) is still not perfectly clear. To test certain hypotheses in respect to this discontinuity, Mr. Adams has returned to the field this summer. This piece of work is, we believe, the largest and most thoroughgoing quantitative study of the variation of a species in nature that has yet been reported upon.

The committee requests the Council to grant it one

hundred dollars additional, to aid Mr. Adams in this his final summer's work on this topic.

The Committee is glad to report an increasing interest in the quantitative study of variation, and especially the establishment by Professors Pearson and Weldon of a new journal—*Biometrika*—devoted to the results of such study.

[Signed] FRANZ BOAS, *Chairman*,
 CHARLES S. MINOT,
 J. MCK. CATTELL,
 C. H. EIGENMANN,
 C. B. DAVENPORT, *Secretary*.

REPORT OF THE COMMITTEE ON THE RELATION OF PLANTS TO CLIMATE.

The investigations conducted under the guidance of the committee have been directed toward a study of the thermal relations of vegetation; an examination of the prevailing methods of meteorological observation in obtaining thermometric data has been made, and it is found that the data so obtained are incapable of direct application in the consideration of the seasonal development and distribution of plants.

As the result of two seasons of thermographic observation in the New York Botanical Garden and in the field in Montana and Idaho, a new method of calibration of the temperature exposures of plants has been formulated. This method is based upon a proposed hour degree-unit of temperature. Such unit of temperature may be defined as consisting in a departure of one degree Centigrade above or below zero for the period of one hour. The estimation of the number of such units affecting a plant in any given locality is obtained by the measurement of the areas enclosed by the thermographic curve above and below the zero line.

The number of such units of exposure to which the plants of two localities are subjected have already been estimated, and with incidental results will be presented to this Section at an early session. Thus, for instance, a meadow carpet in the New York Botanical Garden received 78,836 hour-degrees of heat during the year ending April 1, 1901, while the carpet in an adjacent hemlock forest received 68,596 hour-degrees of heat during the same period.

It is believed that the method of procedure outlined above will afford an exact method of dealing with the relation of plants to the temperatures of their environment, but it will be necessary to extend the observations over a number of years in the same locality in order to establish its usefulness and define incidental amendments.

The work involved in such observation entails constant observation by means of thermograph and much time in the calibration of thermographic curves.

Your committee asks a further grant of \$50 for the furtherance of this work, it being proposed that the sum named should be expended in clerical and mechanical assistance. A further sum of \$10 is asked for the repair of a thermograph wrecked in some recent field work in this connection, making a request for a total grant of \$60.

The following items of expenditure are presented against the grant of \$50 made by the Association to this committee at the meeting of 1900.

To freight charges on outfit from New York to Priest River, Idaho.....	\$24.86
To hauling same to camp on Priest River, to Priest Lake and return.....	25.00
To making temporary instrument shelters (partial account).....	.14
Total	\$50.00

[Signed] WM. TRELEASE,
 JOHN M. COULTER,
 D. T. MACDOUGAL,
Committee.

REPORT OF THE COMMITTEE ON THE TEACHING OF ANTHROPOLOGY IN AMERICA.

To the Council of the A. A. A. S.: Your committee beg to report careful consideration of the matter committed to them. Two meetings have been held since the last report, and one of the committee (Dr. George Grant MacCurdy) has, by authority, prepared an account of anthropologic teaching in America during the past year to be presented as a paper before Section H. It is recommended that the committee be continued and empowered to issue circulars relating to the introduction of anthropology in American universities and colleges, *provided* such circulars have the approval of the Permanent Secretary and be issued without cost to the Association.

[Signed] W J MCGEE, *Chairman*,
 GEORGE GRANT MACCURDY,
 FRANK RUSSELL.

August 27, 1901.

COMMITTEE ON THE 'EMMONS HOUSE MEMORIAL.'

The American Association for the Advancement of Science was organized in 1847. It was the organic descendant and enlarged outgrowth from the Association of American Geologists and Naturalists. The latter body was created in 1842 by the incorporation of the Naturalists within the Association of American Geologists. The Association of American Geologists is therefore to be looked upon as the legitimate organic ancestor of the American Association for the Advancement of Science.

The circumstances which led up to the organization of the Association of American Geologists are as follows:

During the prosecution of the Geological Survey of the State of New York the need of the geologists for consultation and interchange of view with others engaged in official geologic work led to the suggestion of an organization of a body of American Geologists. It appears that Lieutenant W. W. Mather, one of the New York geologists, suggested the subject of such a meeting to the Board of Geologists in November, 1838. He wrote :

Would it not be well to suggest the propriety of a meeting of the geologists and other scientific men of our country at some central point next fall, say in New York or Philadelphia? There are many questions in our geology that will receive new light from friendly discussion and the combined observation of various individuals who have noted them in different parts of our country. Such a meeting has been suggested by Professor Hitchcock and to me it seems desirable. It would undoubtedly be an advantage not only to science, but to the several surveys that are now in progress and that may in future be organized. It would tend to make known our scientific men to each other personally, give them more confidence in each other and cause them to concentrate their observations on those questions that are of interest either in a scientific or economical point of view. More questions may be satisfactorily settled in a day by oral discussion in such a body than in a year by writing and publication. (Letter from W. W. Mather to the Geological Board of New York, dated November 9, 1838, and addressed to Professor Emmons.)

It appears herein that the suggestion of this meeting was originally made by President Edward Hitchcock, of Massachusetts, who was the first to receive the appointment as geologist of the First District of New York from Governor Marcy. President Hitchcock has said in regard to the suggestion made by Lieutenant Mather : "As to the credit he has here given me of having previously suggested the subject I can say only that I had been in the habit for several years of making this meeting of scientific men a sort of hobby in my correspondence with such." (Address of President Edward Hitchcock at the inauguration of Geological Hall, at Albany, August 27, 1856. Tenth annual report New York State Cabinet of Natural History, 1857, page 23.)

Lieutenant Mather's letter to the Board of Geologists was taken up for consideration at a meeting held November 20, 1838, at the house of Dr. Ebenezer Emmons, corner of High street and Hudson avenue, Albany. (See documents herewith appended being A, a statement dictated by Professor James Hall, August 24, 1896, and B, a statement dictated by Ebenezer Emmons, Jr., February, 1900.) The action taken by the geologists was one of unanimous approval of the proposition, and Lardner Vanuxem of the Third District was commissioned to open com-

munication with other geologists, especially with President Hitchcock, with reference to carrying this project into effect.

The undertaking was not immediately successful and at a meeting held in the autumn of 1839 the purposes of the geological board were reiterated. This meeting was also held at Dr. Emmons' house, the four geologists and the paleontologist being present, and also Ebenezer Emmons, Jr., who still survives. As a result of the second undertaking on the part of the New York geologists a meeting was called in Philadelphia for April, 1840, where and when the organization of the Association of American Geologists was carried into effect. The following year the Association again met in Philadelphia, at which time the membership of the body was largely increased, and in 1842 the place of meeting was Boston and then, as already rehearsed, the name and the scope of the Association were, at the solicitation of the naturalists, both enlarged. President Hitchcock, addressing the New York public interested in the outcome of the work of their geologists, makes the following statement in the address already quoted :

It may be thought that the New York geologists in their invitation and the members of that first Philadelphia meeting had no thought of extending their Association beyond geologists ; but Professor Mather's language just quoted speaks of 'a meeting of the geologists and other scientific men of our country,' thus showing what were his aspirations, and they were shared by all of us who had anything to do with that first meeting. But we knew that only a short time previous the American Academy of Arts and Sciences at Boston had directed a request to the American Philosophical Society as the oldest of the kind in the country, that it would invite the scientific men of the land to such a meeting as the one we are now enjoying ; but the distinguished men of that Society decline through fear that the effort would prove a failure. Surely then it did not become us to announce any such intentions or expectations ; yet we did talk of them and could not but hope that what might fail if attempted on a large scale at first might be accomplished step by step. *Had not the New York geologists issued that modest invitation and confined it at first to the State surveyors probably even yet we might have been without an Association for the Advancement of Science.* (President Hitchcock's address, ut. cit.)

The committee appointed by this Association to consider the matter of placing a memorial tablet upon the Emmons' house in Albany, N. Y., begs to submit the foregoing as evidence of the prenatal history of the American Association and to recommend that this house, the home of the late Ebenezer Emmons, a man of eminence in his profession, of untiring diligence and enduring patience, be permanently marked by a tablet setting forth the interest of that spot to the history of the Association. It is suggested that such tablet bear the following inscription :

In this house, the home of
 Dr. EBENEZER EMMONS
 the first formal efforts were made, in
 1838 and 1839, toward the organization of the
 ASSOCIATION OF AMERICAN GEOLOGISTS
 the parent body of the
 American Association for the Advancement of
 Science
 by whose authority this tablet is erected
 1901

The committee further reports that the cost of this tablet will constitute no claim upon the treasury of the Association, but will be borne individually by one of its members, Dr. T. Guilford Smith.

JOHN M. CLARKE,
 C. H. HITCHCOCK,
 J. MCK. CATTELL,
 W J MCGEE.

A. Statement dictated to John M. Clarke, by Professor James Hall, August 24, 1896.

The organization of a body of American Geologists was proposed by the four geologists at Dr. Emmons' house at the corner of Hudson avenue and High street. It was during the fall of 1838. Vanuxem was asked to see or communicate with the Rogerses concerning it, but nothing came of it that year. The next year we reiterated our purpose as the intention was to get some means of comparing our results with those of other geologists in other States, especially in Pennsylvania. This meeting was held at Dr. Emmons' house, the four geologists being present and perhaps also Conrad. Ebenezer Emmons, Jr., was also there. We then decided to communicate again with the Rogerses and others for the end already suggested and to organize a Society of Geologists for this especial purpose. We wanted to compare our results with those of others and make up our nomenclature, and we had to do it soon, as we were required to publish. As a result of this unanimously expressed purpose a meeting was called for April, 1840, in Philadelphia. I was present then but not at the second Philadelphia meeting in 1841, as that year I was off in May and June with D. D. Owen on a flat boat sailing down the Ohio, sleeping on a box and collecting fossils all along from Louisville to New Harmony. As far as Rogers was concerned the meeting came to naught. He was not ready with his results and gave them only at the third meeting at Boston in 1842. It was here that the Naturalists proposed to join us and we agreed thereto, but the Boston meeting was called as the meeting of the Association of American Geologists and in the course of that meeting the name was changed to that of Association of American Geologists and Naturalists.

B. Statement dictated to John M. Clarke by Ebenezer Emmons, Jr., February, 1900.

I was present at the meeting of the four geologists at my father's house, in 1838. I was then about 16 years old, and had assisted my father in his

field work and making drawings and sketches. Mr. Conrad, the paleontologist, was also present. I recollect that the board of geologists then authorized Mr. Vanuxem to open correspondence with others for the purpose of effecting an organization.

COMMITTEE ON GRANTS.

The following grants are recommended :

1. To Committee on Quantitative Study of Biological Variation, \$100.
2. To Committee on Relation of Plants to Climate, \$60.
3. To Committee on Anthropometric Measurements, \$50.
4. To Committee on Determination of Atomic Weight of Thorium, \$50.

[Signed] R. S. WOODWARD,
Chairman.

The report of the treasurer and the financial statement of the permanent secretary were as follows :

REPORT OF THE TREASURER.

In compliance with Article 15 of the Constitution, and by direction of the Council, I have the honor to submit the following report, showing receipts, disbursements, and disposition of funds of the Association for the year ending December 31, 1900.

Receipts have come into the keeping of the Treasurer from four sources, namely: First, from commutations of fees of life-members of the Association; secondly, from excess of receipts over expenditures of the Permanent Secretary; thirdly, from a contribution to the Association by Mrs. Phoebe Thorne, of New York City; and fourthly, from interest on funds deposited in savings banks. The aggregate of these receipts is \$1,805.07.

Disbursements made in accordance with the directions of the Council amount to \$283.00.

The total amount of funds of the Association deposited in banks and subject to the order of the Treasurer, December 31, 1900, is \$10,189.18.

The details of receipts, disbursements, and disposition of funds are shown in the following itemized statement.

Dated June 1, 1901.

THE TREASURER IN ACCOUNT WITH THE
 AMERICAN ASSOCIATION FOR THE AD-
 VANCEMENT OF SCIENCE.

1900.	Dr.	
Jan. 1, to balance from last account.....		\$ 8667.11
Oct. 20, to amount received from L. O. Howard for 5 life-membership commutations.....		250.00

Oct. 20, to amount transferred from funds of L. O. Howard, Permanent Secretary	1000.00
Dec. 14, to contribution to the Association received from Mrs. Phoebe Thorne	250.00
Dec. 31, to interest on funds of the Association deposited in Savings banks, as follows:	
From Cambridge Savings Bank, Cambridge, Mass. \$35.70	
From Emigrant Industrial Savings Bank, New York, N. Y.	82.88
From Institution for the Savings of Merchants' Clerks, New York, N. Y.	99.55
From Metropolitan Savings Bank, New York, N. Y.	86.94
	305.07
Total	\$10472.18

1900.	Cr.	
Feb. 6, by cash paid Professor C. H. Eigenmann of Committee on study of blind vertebrates.....	\$	100.00
June 29, by cash paid Dr. D. T. MacDougal of Committee on study of the relations of plants to climate.....		33.00
Aug. 6, by cash paid Professor Chas. B. Davenport of Committee on quantitative study of biological variation.....		150.00
Dec. 31, by cash on deposit in banks as follows:		
In Cambridge Savings Bank, Cambridge, Mass	\$	1047.36
In Emigrant Industrial Savings Bank, New York, N. Y.		3030.85
In Institution for the Savings of Merchants' Clerks, New York, N. Y.		2818.97
In Metropolitan Savings Bank, New York, N. Y.		2889.80
In the Fifth Avenue Bank of New York, N. Y.		402.20
		10,189.18
Total.....		\$10,472.18

I have examined the foregoing account and certify that it is correctly cast and properly vouched.

EMORY MCCLINTOCK,
Auditor.

L. O. HOWARD, PERMANENT SECRETARY, IN ACCOUNT WITH THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, FROM JANUARY 1, 1900, TO DECEMBER 31, 1900.

Dr.	
To balance from last account.	\$4228.33
Admission fees previous to New York meeting.....	\$15.00
Admission fees New York meeting.	1275.00
Assessments for 1901.....	76.00
Assessments for 1900.....	4730.00
Assessments for previous years	1244.00
Associate fees.....	84.00
Life membership fees.....	300.00
Fellowship fees.....	134.00
Publications and binding....	194.80
Interest.	30.61
Miscellaneous receipts.....	9 86
	235.27
	\$12,321.60

Cr.	
<i>By publications.</i>	
Vol. 48.....	\$1131.45
Binding	94.55
Separates of addresses.....	74.01
Columbus pamphlet.....	109.85
Illustrations, Vols. 48 and 49.	58.01
Index, Vols. 48 and 49.....	24.25
	1492.12
<i>By expenses New York meeting.</i>	
Daily program.....	600.00
Preliminary announcements, sectional programs, etc....	101.78
Messengers, typewriters, placards, blanks, badges, etc.	94.16
Accounts of Secretaries of sections, and Gen. Sec.....	322.05
General expenses.....	107.11
	1925.10
<i>By general office expenses.</i>	
Circulars, tickets, blank forms, letter heads, etc.....	155.75
Postage.	350.93
Express.....	318.41
Extra clerical help, typewriting, etc.....	26.37
Telegrams, check book and miscellaneous small expenses.	29.65
	881.11
<i>By salaries.</i>	
Permanent Secretary.....	1250.00
Assistant Secretary.....	720.00
	1970.00
<i>By spreading information in order to increase membership (by order of Council).</i>	
Postage.	105.90
Circulars and blank forms....	82.23

Typewriting, addressing envelopes, etc.....	110.50	298.63
<i>By miscellaneous expenses.</i>		
Storage on back volumes.....	154.50	
Moving same to N. Y. for free storage.....	204.15	
Moving office effects, North Andover to Washington ...	27.73	
Grant to committee (order of council).....	17.00	
Overpaid dues returned.....	9.50	
Cash paid Treasurer.....	1300.00	1712.88
By balance to new account.....		4741.76
		<u>\$12321.60</u>

I hereby certify that I have examined this account and that it is correctly cast and properly vouched for, and that the balance was on deposit in Washington banks as follows: Citizens National (as per statement Jan. 8, 1901), \$3229.62; National Safe Deposit (incl. interest credited Jan. 1, 1901), \$519.43; American Security and Trust (incl. interest credited Jan. 7, 1901), \$1034.58; in all, \$4783.63.

G. K. GILBERT, *Auditor.*

The following is a list of the officers elected to serve at the next meeting, including also the permanent secretary and treasurer previously elected for a term of five years:

President—Asaph Hall, U. S. N., retired.

Permanent Secretary—L. O. Howard, chief entomologist, Agricultural Department, Washington.

Assistant Permanent Secretary—Richard Clifton, Agricultural Department, Washington.

General Secretary—D. T. MacDougal, director of the laboratories, New York Botanical Gardens.

Secretary of Council—Professor H. B. Ward, of the University of Nebraska.

Treasurer—Professor R. S. Woodward, Columbia University.

OFFICERS OF SECTIONS.

A (Mathematics and Astronomy)—*Vice-president*, G. W. Hough, Northwestern University; *secretary*, E. S. Crawley, University of Pennsylvania.

B (Physics)—*Vice-president*, W. S. Franklin, Lehigh University; *secretary*, E. F. Nichols, Ohio State University.

C (Chemistry)—*Vice-president*, H. A. Weber, Ohio State University; *secretary*, F. C. Phillips, Western University.

D (Mechanical Science and Engineering)—*Vice-president*, J. J. Flather, University of Minnesota; *secretary*, C. A. Waldo, Purdue University.

E. (Geology and Geography)—*Vice-president*, O. A. Derby, San Paulo, Brazil; *secretary*, F. P. Gulliver, Southboro, Mass.

F (Zoology)—*Vice-president*, C. C. Nutting, Iowa State University; *secretary*, C. W. Stiles, Department of Agriculture, Washington.

G (Botany)—*Vice-president*, D. H. Campbell, Lehigh University; *secretary*, H. Von Schrenk, Shaw School of Botany, St. Louis.

H (Anthropology)—Stewart Culin, University of Pennsylvania; *secretary*, H. I. Smith, American Museum of Natural History, New York.

I (Social and Economic Science)—Carroll D. Wright, commissioner of labor, Washington; *secretary*, W. F. Wilcox, Cornell University.

K (Experimental Medicine and Physiology)—*Vice-president*, Dr. W. H. Welch, Johns Hopkins University; *secretary*, Dr. F. S. Lee, Columbia University.

The recommendation of the general committee of last year that the Association meet at Pittsburg in the summer of 1902, was supplemented by Dr. W. J. Holland, Director of the Carnegie Institute, and it was decided to meet at Pittsburg from June 28 to July 3, inclusive, 1902.

The general committee recommended also that a meeting be held in Washington, D. C., during 'Convocation Week,' or the week in which the first of January falls, in 1903.

Professor Wm. Trelease and C. M. Woodward presented an invitation to the Association to meet in St. Louis during the time of the Louisiana Purchase Exposition in 1903. This invitation was referred, without formal recommendation, to the general committee of 1902.

JOHN M. COULTER,
General Secretary.

REMARKS OF PRESIDENT MINOT.*

I WAS impressed on my way here with the somewhat unexpected arrangements I found for securing my services as a visitor at Denver. We found it easy to get here because we paid for a night's journey upon the road and owing to the delay of the train we got two nights' journey instead of one, showing how attractive it is here and how liberally one is treated coming to Denver. But when I went to your ticket office to in-

* Made at the opening general session, and reported stenographically.

quire about going away I found we had to pay the price of two nights in order to pass one when leaving your city. So there seems to be every inducement to prolong our stay. I could not but think, as I read in the newspaper that this Association had fallen upon Denver, of an anecdote related to me a few days ago in the Yellowstone, when I was told a German visitor had been there and seen the geysers, and afterwards had gone to Niagara. When asked how he liked it, he said, "Oh, that is very fine, but you shall see the geysers, they fall oop." That is the way we have 'fallen upon' Denver. We are all wonderfully impressed by the extraordinary endowments of nature in this state. It is almost incredible to a visitor coming here for the first time that any tract of land should be so richly provided with all the raw resources which man needs for the construction of civilization. We, like you, are laboring in this process of building up civilization. As you have been working in your state, so we work in every territory of nature seeking to bring forth her hidden treasures and render them available for the service of mankind and for establishing a higher life in humanity than has yet been. It is not so in the east with us at home. There civilization has been going on longer. The resources which nature provides are known. The work of civilization proceeds there in established channels, and I felt at once in coming here that the newness and creative character of your work in Colorado made a sympathetic atmosphere for us who are striving to create what is new and get from nature her unused treasures which we can employ hereafter. Everything therefore speaks of sympathy and understanding between the practical life of Colorado and the scientific life of this Association. And we are, too, nearly co-temporaries. The Association was before Denver was, but not by many years. We have, as it were, grown

up together and have lived through the same period of our country's history. Therein, too, lies the power of appreciation—mutual, I believe—between you and us who are here playing a double rôle of both guests and, in our meetings, of your hosts—for hosts we would gladly be, inviting you to our meetings, for we are a kind of intellectual Salvation Army. We do not profess to do much for the saving of souls as our direct work, though we believe that all good work tends to that end, but we do believe that we can do a great deal to save brains, they being the only things in nature which in being used are best saved and made better. So if we stimulate you to use your brains more we shall have done some service, we shall have done something to save your intellectual life, to broaden it and make character. If as a biologist I survey the realm of nature and seek to make out what is the distinguishing characteristic of man, I have to recognize that it is the value of the individual which distinguishes the human species from every other living species in the world. Man alone is able to profit by the superiority of the individual members of his species. Animals may learn a little from one another. Man alone can learn much. It is owing to this peculiarity in nature of the human species that science exists, that civilization exists, and I believe the recognition of that fact should have a profound influence upon all our political and social questions whenever we have in mind the promotion of human welfare; because, it being a true fact in nature that the average civilization of a community is not correspondent to the average intellectual and moral calibre of its members, but very nearly to the intellectual and moral calibre of its best members, that fact imposes upon us a special duty, that of promoting the development and the education of the best members in the community. And if I were asked to say what in the west seemed to me

the very best thing you had to show, I should say without a moment's hesitation it is the high school buildings here and the high school buildings we have seen in the other cities as we have passed along—emblems, as they are, of the educational system which in the very establishment of its high schools recognizes the fact that there are superior individuals who are worthy a better education than is offered by primary and grammar schools below.

But it does not do to stop there. And I am glad to see that the State of Colorado has started already the development of a university which by its prosperity shows the earnestness with which it has been founded, the devotion which has been spent upon fostering it and which stands as one of the highest marks to the credit of the State. I believe that the very best that we could do for you would be to contribute something to the public recognition of the value of the State University. It seems to me that no citizen of Colorado who has the highest ideal for the future of the state can feel that the state has done its full duty until it has developed its university, not only as it has begun, but farther in the same direction, until it shall have become one of the great universities of the country—I would even say one of the great universities of the world. It is not enough for you to work here for the development of your material resources. It is not enough for you to apply science. We who are carrying on our investigations supply the power, we generate the steam pressure, and the practical man—if I may be pardoned for the innuendo—is the crank which transmits the power to a practical purpose. Unless a state is doing its quota towards the increase of knowledge, it is fulfilling only a part of its duty. If, therefore, our coming here can have such an influence upon any of you as to increase the belief in the value of your university and to spread

that belief among you, making it deeper rooted in the innermost convictions of your great community that the university is the greatest thing in the state, we shall have done a service to you which will show we are grateful for all the magnificent hospitality which has been proffered us, for the perfection of the arrangements made here for our comfort, and that we appreciate your words of welcome, those which have come to us from the Governor, from the Mayor of the city, from the representatives of the business interests of your community and of your educational system. All this we take to heart and we beg to thank you for it with all the sincerity with which we appreciate it. And in return we would offer you this thought which is the inspiration of the professor—that the country is governed by universities, because what is done in the country is done by the men who think, who come out into the world with thoughts which were never there before; and the men who do that, with very rare exceptions, are men who have had their minds severely disciplined by university training. If you look back through the history of the United States and recall men who as statesmen, as inventors, as authors, were creators of any kind of new intellectual product, you will find that there is but a trifling number among those great men who have not come from the universities. And, therefore, it is true as a historical fact that this country is governed by the universities, and there is not a complete government in any state, in the opinion of the members of this Association—I am sure in the opinion of all of them—until there is a great, well-equipped, richly endowed and largely attended university. It is therefore to me the greatest pleasure to say that Colorado has begun with this ambition, and I hope with all my heart that you will carry it through to a fulfilment corresponding to the extraordi-

nary fulfilment which you have achieved in all the other work you have undertaken in the development of your state, and with that wish and with thanks on behalf of our Association I would close with an invitation to you all to attend our meetings; and I would express particularly the hope that all of you who are interested in broad discussions and deep-thought views of scientific problems will take advantage of the opportunity to hear the address of our retiring President, which will be the central and most interesting event of our proceedings. With thanks, therefore, for your courtesy and kindness, and expression of pleasure on behalf of all the members of the Association who are here, I will now close my reply to the hospitable welcomes which have been made us.

*SOME POINTS IN THE EARLY HISTORY AND
PRESENT CONDITION OF THE TEACHING
OF CHEMISTRY IN THE MEDICAL
SCHOOLS OF THE UNITED
STATES.**

IN the scientific awakening of the latter part of the eighteenth century medicine was not the last of the great departments of human learning to take on new vigor. As in earlier years it drew largely from alchemical philosophy for the enrichment of its *materia medica*, and for the justification of a crude therapy, so now the great teachers of physic stood ready to accept the rapidly developing facts and generalizations of the new chemistry, and to apply them in the noble task of elevating a dogmatic empiricism to the plane of a scientific system. From the time of Paracelsus, alchemy, and its offspring, chemistry, had been but the handmaids of medicine, and much of the skill of the workers in these fields was devoted to the preparation of remedies for

various diseases. But, from the labors of Priestley, Scheele, Watt, Cavendish and Lavoisier, the relations were reversed, and the chemists and the apothecaries, the cooks in the kitchen of the doctor, seemed ready to usurp the proud positions of their former masters. The nature of oxidation and the phenomena of respiration changes explained, it was clear that medicine must now depend largely on the development of chemistry for its rational groundwork.

After the downfall of the old iatro-chemistry with its empiricism and evident hollowness, our science had fallen into disrepute in the great European centers of medical learning, and physicians were somewhat slow in taking up the new ideas. But, the way once opened, the development spread rapidly, almost too rapidly in fact, because of the danger always attending hasty generalization.

The educational influences at work in the American colonies in those days were almost wholly English, and the earliest medical schools established here were modeled after those of Great Britain. We find, therefore, that in each one of the medical schools founded in the pioneer days of attempt in professional education a chair of chemistry was provided for as furnishing a necessary part of the medical student's education. Indeed, the first chair of chemistry of any kind to be filled in this country was that in the medical school of the University of Pennsylvania, and the occupant was Dr. Benjamin Rush, a man justly famous in the early history of American medicine, but not known on account of any chemical writings. This was in 1769, and the position was held by him until 1789. In the autumn of that year Dr. Rush was transferred to another department, and Dr. James Hutchinson was elected to fill the place. The latter died in 1793, and Dr. John Carson was appointed his successor in January, 1794, but died

* Address of the Vice-president and Chairman of Section C, Chemistry, at the Denver meeting of the American Association for the Advancement of Science.

without serving. In this year Priestley came to America, and lived for a short time in Philadelphia. He was offered the chair, but after some delay declined it on account of poor health and the desire to lead a quiet life in a rural country, which he found later on the banks of the Susquehanna at Northumberland.

In July, 1795, the place was again filled by Dr. James Woodhouse, who served until 1809. His successor was John Redman Coxe, who was among the earliest writers on chemistry in this country, since he published in 1811 a small work entitled, 'Observations on Combustion and Acidification; with a Theory of these Processes founded on the Conjunction of the Phlogistic and Antiphlogistic Doctrines.' Dr. Coxe was followed by Robert Hare, who was a man of great ability and a credit to the new country. Hare made numerous discoveries himself, some of them of permanent importance, and besides rendered a service to students by bringing out an American edition of Henry's chemistry. Some years later he published a text-book on chemistry himself for the use of the medical students of the University of Pennsylvania. As Hare's position was unquestionably the most important one of the kind in the country, it may be well to give a few moments' attention to his work as typical of the best of the period.

Hare began his career at a time which, from one point of view, might be considered as very unfavorable for the development of chemistry in America. The early aspirations of the founders of the Philadelphia College had failed of realization because, as must be recognized, they were beyond the practical sympathies or comprehension of the masses. The requirements for the attainment of the degree of Doctor of Physic were relatively, and in some respects, perhaps, absolutely, far in advance of those of the present time, and this the colonies were not ready for.

Then came the Revolution, followed by a long period of political discussion and rapid internal development, and finally another bloody war. This left the country poor and yet farther behind again in the sphere of intellectual development. The great European wars of the same period had not hindered scientific discovery or cultivation in France and England, at least. Through these years of turmoil, the beginning which had been made in the few American centers where chemistry was taught had come almost to a standstill, and Hare entered upon what might appear a field of little promise. But the man was an independent thinker, and the example of Berthollet, Dalton, Davy, Berzelius, Gay Lussac, Humboldt and others was not lost on him. He began his work as a private student and partly in conjunction with the elder Silliman, who came to him before beginning at Yale, and while yet a young man attracted considerable attention by the discovery of the oxy-hydrogen blowpipe, a description of which was published in 1802. Later he constructed a new form of galvanic cell with very large plates which was known as the calorimotor or deflagrator, and this gave him no small reputation abroad as well as at home.

Hare's theoretical explanations of phenomena observed were not always correct, and in some of the many polemics in which he took part he certainly defended the weaker side of the argument, but in looking through his writings one cannot but be impressed with the ingenuity he displayed in contriving experiments to illustrate simple principles.

One of the best known works of chemistry of this time was that of Dr. Henry, of Manchester. The last American edition of this was brought out by Hare, and was used in his own classes and elsewhere in the United States. Later he brought out a book of his own with the title, 'A Com-

pendium of the Course of Chemical Instruction in the Medical Department of the University of Pennsylvania, by Robert Hare, M.D. For the use of his Pupils.' There were four editions of this. The last appeared in 1840-43. In the preface of this book I find this curious passage, which reads as if it might have been written yesterday: "A chemical class in a medical school usually consists of individuals who differ widely with respect to their taste for chemistry, and in opinion as to the extent to which it may be practicable or expedient for them to learn it," etc.

With this idea of the difficulty of the subject and of the slight inclination on the part of many medical students to master it, Hare prepared a work in simple style containing an unusually large number of experimental illustrations and practical suggestions for the pupil. How successful he was with students it is now impossible to say, but that he impressed himself as a powerful teacher I have been assured by one who remembered him in his later years. He remained with the University until 1847, and died in 1858. He continued actively engaged in scientific work to the time of his death, and contributed numerous articles to the journals. No less than 150 were published in *Silliman's Journal*. That his work was respected abroad as well as at home is shown by the fact that he maintained an active correspondence with Faraday, Liebig and other great men of the day, and that we find frequent reference to his articles in contemporary writers and in the earlier volumes of the *Jahresbericht*.

While Hare was prominent in Philadelphia, Silliman, Gorham and Mitchill were developing the departments of medical chemistry in Yale, Harvard Medical School and Columbia. In the last two medical schools chemistry was taught almost as early as in Philadelphia, but apparently with less vigor, while at Yale it was taken up later.

In 1802 Benjamin Silliman, then a young man, was appointed to the chair of chemistry at Yale, and before beginning work he visited other schools in search of ideas. Prior to 1800 there seems to have been but a single chair of chemistry in the country outside of the medical schools, and this was held by Dr. John MacLean at Princeton. Silliman went there first and profited by what he saw. Later he went to Philadelphia, where he met Woodhouse, Priestley, Hare and others. Hare seems to have made the greatest impression on him, and they worked often together. In the next few years Silliman visited Europe, and on his return to New Haven aroused much enthusiasm among the scientific and medical men. It was largely through his influence that a medical school was established at Yale, and of this he became the first professor of chemistry and pharmacy. The Medical Institution of Yale College, as it was called, was chartered October, 1810, and four professorships were provided for, 'the first of chemistry and pharmacy; the second of the theory and practice of medicine; the third of anatomy, surgery and midwifery; the fourth of materia medica and botany.' It will be noticed that the chair of chemistry is here mentioned first, doubtless a tribute to Silliman's reputation and influence. He continued to give instruction to medical as well as to general students for many years, and through his writings and the journal he established he became the best known scientific man of the day in America. Silliman's interests, however, were in lines remote from medicine, and he therefore failed to exert here the influence enjoyed by his friend Hare.

The Medical School of Harvard College was established in 1782, and in 1783 Dr. Aaron Dexter was made the professor of chemistry and materia medica, his time being devoted to teaching general and medical chemistry. It does not appear that he

published any researches or did much to advance his science, but he was a man of personal popularity, and it was through his influence that the Erving professorship was founded by Major Erving, who was one of his patients. Dexter served until 1816 and was followed by Dr. John Gorham, a man of marked ability, who published a number of researches showing skill and understanding, and who must be given credit for bringing out the first original book on chemistry published in this country. The two large volumes compare very favorably with the work of his European contemporaries. Gorham, who was recognized as a power in the medical school, now moved to Boston, and his reputation was of the first order among his colleagues. He laid the foundation for the excellence in a department which has steadily grown in importance to the present time. Gorham was followed by Dr. John White Webster in 1827, an alumnus of Harvard, and a man of promise who increased the reputation of the university, and especially of the medical school by his original scientific contributions and by editing several well-known foreign works. His text-book on chemistry on the plan of the work of Brandes has considerable merit. The fate of Webster in connection with the Webster-Parkman tragedy of 1850 is probably known to all here.

In New York the old King's College had become Columbia College, and in 1792 established its first professorship of chemistry. This was in the medical school, and Dr. Samuel Lathan Mitchill was given the chair. It was this man who introduced the Lavoisier nomenclature in the United States, and in consequence was engaged in many controversies with Priestley. In 1798 he established the *New York Medical Repository*, and managed it for many years. It was the first medical journal started in this country, and exerted no little influence,

receiving contributions in general science as well as in medicine.

In 1807 a charter was granted to the College of Physicians and Surgeons in New York, and in 1811 Dr. William James Macnevin was made professor of chemistry. He was a man of marked ability, having taken the medical degree at the age of twenty in Vienna. Several scientific contributions from his pen are found in the journals of the time, and among other things he wrote 'An Exposition of the Atomic Theory,' which attracted much attention.

It will not be necessary to trace the history of chemical teaching in the other early medical institutions, as practically nothing of consequence is found recorded. The schools referred to were far in advance of those established elsewhere, and have in a large measure maintained their superiority to the present time.

For many years chemistry was taught to medical students by lectures only, and the introduction of even simple laboratory work is of comparatively recent date. In Harvard Medical School, for example, laboratory courses were not given until 1872.

It would be a discouraging task to try to follow the development of chemical teaching in medical colleges down to the present time. Few institutions were blessed with such men as Hare, Silliman or Gorham, who exerted an influence of priceless value on medical men now rapidly passing away. Owing to peculiar causes which I need not try to explain here, medical schools multiplied very rapidly in the United States, and in most of them the chair of chemistry was considered in the light of a necessary evil. As a matter of form chemistry had to be taught, but how it was taught and how it was followed by the students, were questions of wholly secondary importance. It has long been the custom in the medical schools of this country to divide the chairs into the theoret-

ical and the practical. The American boy has been taught to hold practical things in the highest esteem, and chemistry was not practical. Professors and students alike felt it, and it is hard to tell who was the most to blame for the warped and stunted conception of chemistry held even at the present time by the great majority of medical men of this country. It is likely that much of the fault lay in the weak and wholly unsatisfactory manner in which chemistry was presented for fifty years in most of our medical schools. The professor of chemistry was usually a physician who, as a rule, was not considered sufficiently strong to fill the chair of practice, obstetrics or surgery, but who might teach acceptably the less important branch of chemistry. For the convenience of such teachers a peculiar system of chemistry called 'medical chemistry' was developed, and in some places persists to the present time. The idea that a man trained outside of a medical school could teach the kind of chemistry which medical students really needed was of slow development in the United States, and in some quarters fails yet of recognition. But, for part of the trouble we must go farther back. While students in general courses were taught the elements of the sciences, languages and mathematics by recitations and quizzes, medical students, with far weaker preliminary training, were supposed to be able to absorb the essential facts of a great department of human knowledge from lectures alone. The lecture system is responsible for much of the superficiality in the old-fashioned medical schools, and no real progress was made until it began to be recognized that a medical student must be taught as other students are. With the gradual dawn of this notion it became finally possible to introduce into medical colleges rational chemical instruction, and the laughable farce of presenting the so-called medical chemistry to students ignorant of

general chemistry will in time be a thing of the past.

This medical chemistry to which I call your attention was often a curious combination of the good and the absurd. Admitting that the student should know something about the chemistry of the blood, the bile and the urine, something about the nature of food stuffs and the processes of digestion, it was thought sufficient to present all these matters to him in condensed, so-called 'practical' form, and without first requiring a solid preliminary training in general and inorganic chemistry. It was considered the correct thing to memorize a lot of definitions, and to learn to recite in parrot fashion a number of empirical organic formulas. It must be admitted, however, that the fault was not confined to medical schools alone.

Chemistry in general may be studied from two standpoints. First, as in the college of liberal arts, as a fundamental discipline, regardless of the possible application which one may make of it. On the other hand, it may be pursued as a necessary preliminary to the understanding of something else, and in this case its mastery becomes all-important. One would naturally suppose that in the latter case the science would be much more thoroughly cultivated than in the former, but this is not always true. The discrepancy is perhaps most glaringly apparent in the chemical work of the medical schools. It cannot be expected of course that the chemistry offered to the medical student of to-day should be, as in the time of Hare, Gorham and the elder Silliman, more complete than that given to other students; this would be impossible and wholly unnecessary, as chemistry is now a great specialty with numerous departments branching in all directions and a literature as voluminous as that of scientific medicine itself. But this much should be reasonably expected, that

the medical student's elementary chemistry should be at least as thorough as that of the student in liberal arts. It seems absurd to think that a man preparing, possibly, for law or theology or commerce, or studying without thought of any specialty should be made to acquire a fuller, more accurate knowledge of chemistry than that expected of the future medical man. If chemistry is of value at all, it certainly is to the doctor, rather than to the preacher, lawyer or man of business, yet in the United States in the last fifty years, the doctor's training in chemistry has been, on the average, less exacting than that of the other classes mentioned. If any one is disposed to doubt what I say let him compare the numerous 'Essentials of chemistry for the medical student' with the text-books used in other schools in the same science. It is anomalous that the doctor's chemistry should be usually the weakest of all.

But we are gradually emerging from this discouraging situation, and the improved condition is mainly due to the recognition of this fundamental truth, that there is not one kind of elementary chemistry for the doctor, another for the lawyer and a third for the preacher. There is no royal road to the acquisition of the necessary groundwork, and the medical man's elements must be learned through the same kind of patient effort that is required of other men. In the best of the medical schools of the country to-day chemistry is no longer taught by practitioners of medicine, and an honest effort is being made to present the subject as it is presented to beginners in schools of science. Such a course of laboratory and recitation work should require at least ten hours each week through a year of eight months to cover the work preliminary to the proper study of medical or physiological chemistry in the second year.

This leads me to explain what I consider the minimum work in preparatory chem-

istry for the medical student, and the character of this work. First, he should have the usual lecture or recitation course of about seventy-five lessons in general and inorganic chemistry, with especial attention paid to the theoretical groundwork. A discussion of the common inorganic salts is of less importance. This work should be followed or accompanied by a laboratory course in experiments, including the preparation of a few pure substances. In most of our schools the value of preparation work has not been sufficiently recognized, the time which might be spent there going usually to qualitative analysis which I believe is correspondingly overestimated. Inorganic qualitative analysis for most students becomes a mechanical routine in which the important element of discipline is wanting. As in the future work of the physician this branch of analysis finds little or no application, I believe the time given to it in preparatory medical work may be greatly curtailed. During the past twenty years, in which I have given instruction to medical students, I have had abundant opportunity to observe this fact, that men who have entered with training in experiments and preparations and no qualitative analysis make as a rule far better progress than do those whose laboratory work has been wholly analytical. Many of our colleges still begin their laboratory work with qualitative analysis, which, perhaps, is a relic of concession to the old utilitarian notion, and I am convinced that for the average student the time so spent is largely wasted. On the other hand, volumetric analysis may be made a medium of imparting important knowledge in fundamental principles, and I believe it should find early presentation in all our courses, general as well as medical, that it should precede rather than follow gravimetric analysis as is customary. In the case of the medical student the im-

portance of volumetric analysis is twofold. Not only is it a valuable discipline in itself, and discipline is above all what is needed in preparatory medical training, but it also becomes an instrument of practical application in the physician's subsequent work. In his practical routine labor of a clinical nature the physician is constantly called upon to make a few qualitative tests which are soon learned and easily followed. He should be in a position to make a wider range of quantitative tests, and these, almost of necessity, must be volumetric. The preparatory medical course should provide this skill, not merely in a mechanical way, but by giving a thoroughly rigorous drill in the few fundamental principles of volumetric analysis. The statement I have just made may provoke a smile, inasmuch as I may appear to be giving advice on a matter which everyone well understands, and suggesting a course which is commonly already everywhere in practice. But it has been my experience that the matter is by no means as simple as it looks. The apparently elementary relations in volumetric analysis are not fully grasped by the general class of students, even by those who devote far more time to laboratory chemistry than is the case with the medical students of our best schools. In support of this I must state that in the last fifteen or twenty years it has been my fortune to instruct hundreds of medical students who had already had laboratory training in chemistry in excellent schools, well-known state universities among the number. While these men have often brought sufficient knowledge of facts, they have as often been very deficient in acquaintance with principles, leaving them unable to deal with cases presenting slight variation in conditions from those of their former practice. Our methods of instruction fail as long as they allow the memorization of facts and isolated methods to take the place

of a study of principles. I am often asked what the value of this or that inorganic volumetric process is to the medical student, and my answer is that it illustrates a principle not readily learned in any other way. And it is safe to say that almost any one of these illustrative methods may find practical application in the physician's own work. The titration of weak acids, for example, is now a common operation in connection with the examination of stomach contents, and the permanganate titration has come into common use in the most accurate process we have for the estimation of uric acid.

I trust that I have made myself understood in insisting that the groundwork of the medical man's education in chemistry should be in the group of topics usually classed as inorganic, and this largely because of the superior advantages of this branch of the science in the presentation of general principles. I feel, therefore, like combating strongly the notion often expressed by medical men that students in medicine should not be required to 'waste' time on inorganic chemistry.

A few words as to the place of general organic chemistry in the preparatory or first year course. The subject is one of such large proportions that at best only an outline can be attempted in the first year course, but that much should at least be given. Leaving the major portion of the discussion of the sugars and other carbohydrates, the fats and the products of fermentation to be taken up with physiological chemistry proper in the second year, I believe that a fairly satisfactory outline may be given in about thirty lessons in the first year course. Remember, I am not writing this for men who expect to be chemists, and I am describing the minimum requirement which I should insist upon. In a short course of the kind it will be necessary to omit many things often supposed to be

of prime importance in the so-called medical chemistry. I have seen text-books for medical students abounding in descriptions of processes for making many of the modern synthetic remedies along with discussions of the supposed structural formulas of these compounds. This knowledge is interesting, but it is far from essential, as few principles are cleared up by it which cannot be presented to the student in more tangible form. It should be further remembered that there is a distinction between chemistry and *materia medica*, and much matter presented to students as chemistry properly belongs in the other field. The time spent in memorizing the empirical formulas of the medicinal alkaloids and of the host of antipyretics, hypnotics, etc., might better be given to a study of principles. Of course I would not be understood as urging that the medical student need not be taught the constitution of any organic compounds, but I merely claim that there is a limit to the amount of this knowledge which may be considered practical or profitable.

I have spoken of the work just described as first year medical work, as it may be taken before entering the medical school or in the first year of the course in medicine. The time is not far distant when all the courses I have described, and doubtless more, will be required for admission to the best schools. At present Harvard Medical School has such a requirement, and other institutions have it under consideration. Many colleges of liberal arts and technical schools offer now a so-called preparatory medical year in which chemistry is the principal topic. Certificates for such a year's work admit to the second year of many of the medical schools of the country. In my experience the plan is not yet a satisfactory one, as the chemistry courses taken under these conditions seems to be lacking in rigor and discipline. They seem to be followed under the notion that medical school

chemistry is so completely lacking in thoroughness that anything may be pursued as its equivalent.

In the last few years students have begun to present high school certificates for chemistry work as equivalent to that in the first year of the medical school. The courses taken in the high school at first sight may appear to be more than equivalent to those in the beginning year of the medical course, but a careful consideration of many cases has convinced me that in general it would be very unwise to grant credit in the medical school for work apparently done in the high school in chemistry. At the age at which boys and girls now do their chemistry work in most of the high schools it is quite impossible that the subject can be properly mastered. In my opinion the superficial courses now given in science in hundreds, perhaps thousands, of high schools throughout the country constitute one of the weakest spots in our system of public education. The attempt is often made to cram more chemistry into the high school boy at sixteen than many of our smaller colleges find possible at twenty. In much of this work the glorification of the teacher, not the true edification of the pupil, seems to be the prime object in mind, and the result is deplorable. With these facts in view, I always feel justified in rejecting the application of the student for advanced standing on account of high school work in chemistry. I am therefore inclined to the opinion that under existing conditions the medical student's work in general and inorganic chemistry can be best done either as a part of a thorough and required college course, or after entering the medical school itself, and that wherever done it should be characterized by a much more systematic and painstaking drill in fundamental principles than seems now to be the case in many institutions.

It is not my intention to enter upon a

discussion of what the course in physiological chemistry should be in medical schools. At present this often consists of a laboratory course in urine analysis only, along with a few lectures on subjects belonging to *materia medica*, pathology or practice rather than to chemistry. In many of the larger and more progressive schools this work is broadened out so as to include experimental studies in the sugars, the fats, the albumins, the processes and products of digestion and the examination of milk, blood, the gastric juice, bile, etc. There is a great diversity of opinion as to how much of this work may profitably be taught in the medical school. It is my own view that it is all out of place if it is not preceded by the proper drill in general chemistry to enable the student to really understand what he is doing. Without this clear understanding the laboratory course in physiological chemistry, which looks so well on paper, and which fills a good amount of space in the college announcement, degenerates into a mere mechanical routine, and becomes as valueless from the standpoint of discipline as is the justly condemned 'test-tube drill' in qualitative analysis. If the student is so illy prepared for his work that the operation of stirring a heated mixture of alkali solution and fat means simply 'making soap,' he might just as well spend his time in turning a grind-stone, as far as intellectual benefit is concerned. Unless he can connect this operation with many similar ones, and with the other processes of splitting fats, the experiment fails of its object. I am firmly of the opinion that the explanation of the low value placed on chemistry by many medical men may be found in the fact that in their own student days they have been forced through this kind of a routine course lacking the preliminary knowledge that would enable them to comprehend it. I maintain then that unless the student has been

properly and systematically prepared in the elements of organic and inorganic chemistry, much of the matter presented to him in physiology and physiological chemistry must remain practically meaningless. As Professor Remsen well says: "It is difficult to see how, without some such general introductory study, the technical chemist and the student of medicine can comprehend what is usually put before them under the heads of applied organic chemistry and medical chemistry." (Preface to 'Organic Chemistry.') But, on the other hand, supposing that the medical student has been successfully prepared in an elementary preliminary course such as I outlined above, there is much indeed that he can really master in physiological chemistry proper. It is not necessary that he should be able to make many elaborate quantitative experiments. Most of the really important reactions in the study of the fats, the sugars and the proteids may be mastered with the aid of comparatively simple qualitative and a few volumetric tests. He will be able to demonstrate understandingly the essential facts connected with most of the digestive and other ferment changes, and to follow variations in excretion corresponding to variations in food consumption, or depending on pathological conditions. This carries the medical student as far as he is ordinarily called upon to go. Anything beyond this naturally belongs to the specialist, and besides would consume more time than can be usually spared from the medical course.

From a perusal of many of our textbooks on physiology and physiological chemistry, the student is very apt to draw erroneous conclusions as to the nature of some of the reactions in this department of science. For simplicity in didactic presentation the teacher or writer is too apt to show everything in an ideal way. A great many dogmatic assertions are made, for

example, concerning the digestion of the starches and the proteids, and the student almost expects to separate and recognize the half dozen or more beautiful products lying between corn starch and malt sugar, or the different hemis and antis, pros and paras in the still more complicated proteid family. The teacher who is not himself an investigator is but too ready to become an idealist, and to present all these intricate details in systematic tables and diagrams as he thinks they ought to be, and perhaps are, rather than as the original experimenters have actually been able to find them. The student must be warned against this, and not the least valuable function of the laboratory work in physiological chemistry in my judgment is to show him the inherent difficulties in much of our research work. An honest recognition of limitations will guard him against many future mistakes, against the preposterous analyses, for example, made by many young medical men while serving as hospital internes or in other capacity. I said a moment ago that there is much which may be easily and accurately learned in physiological chemistry by the medical student. It is evident that there is much more which in the ordinary college course cannot be mastered, and against pretended knowledge here the student cannot be too earnestly warned.

Physiological chemistry is in some institutions recognized as a distinct discipline, independent of medicine. This is true of the chair in several of the great European universities, and of at least one of the older American schools. Physiological chemistry is thus presented as is general biology or comparative anatomy. But in the great majority of cases it is looked upon as forming a part of medical rather than of general discipline, and doubtless for years to come the medical school will have many advantages in properly presenting the work.

Inasmuch as no small part of the material employed in the laboratory demonstrations in the later parts of the course must be drawn from hospitals and clinics, it would seem that the effort sometimes made by other schools to give the equivalent of the medical school's work in this field must be in part futile. I am forced to the conclusion, from several practical considerations, that the student of medicine should not as a rule attempt to take physiological chemistry as a preliminary study outside the medical college. There is generally something lacking in such courses which the student recognizes often only after it is too late to recover lost ground.

Occasionally the work in physiological chemistry is given as a part of the course in physiology, but this, I believe, is a mistake, as the study is often curtailed to a consideration of a few physiological problems instead of being treated as an independent science of broad dimensions. With the present rapid expansion of this field of effort, the work calls for the attention of the specialist in chemistry rather than in physiology. This is necessarily true with respect to research study, and it is becoming equally true as regards the matter of proper didactic presentation. Much of the valuable pioneer investigation in physiological chemistry was done by physiologists, but in its later development the chemist alone can be expected to follow the accumulating mass of detail, and to sift out that which is of permanent value. It requires often rare judgment to decide how much of the newer knowledge is suitable for laboratory or class study, for no one wants to burden the already overtaxed student with a load of premature generalizations. While much of the latest work is always interesting to the specialist, it may often be quite unimportant to the student, and where to draw the proper line of separation between the new and the old calls for the teacher's maturest

judgment. This same idea should be kept in mind in estimating the value of research work for the average professional student. The training of medical students in the United States is a vastly different thing in theory and in practice both from what it is in Germany, from which land we draw so many of our ideals. We give the title of 'Doctor' to the product of our schools, but in reality we are producing *practitioners* of medicine and in the shortest possible time. The man really learned in medicine should be able to present an original research, as the German idea assumes, but the practitioner may be just as successful in actual contact with disease without this skill. I would not be understood as underestimating the value of high scientific training for medical men. Indeed in certain specialties the medical man's success depends almost wholly on his preeminent scientific knowledge acquired by long and minute study. But there is still room for the general practitioner in medicine, and in my judgment he is, and should still remain, the most useful member of the profession. The American medical school is mainly concerned in the training of men of this class rather than of those with more special knowledge, and broad culture is of more importance here than minute acquaintance with bacteriology, physiological chemistry or histology. This is an age in which we are constantly called upon to do something new, regardless of whether the new thing is really needed or not. This criticism applies to research problems in physiological chemistry given to medical students as well as it applies in any other field. It will often be found that the teacher's interests rather than those of the student receive the first consideration, and this is certainly without justification in view of what I have said about the true field of work in American schools.

The teacher who attempts the proper

presentation of general and physiological chemistry in a medical school has indeed no easy task. His work is made doubly hard by the fact alluded to above, that chemistry among the older medical men is still looked upon as a comparatively useless study, and from his preceptor's office the embryo doctor often brings this notion to the medical school. To combat this idea honestly, and to put his science before the medical student as it would be presented in a scientific or general course to freshmen or sophomores, requires the full time and energy of any man, and often little room will be left for research investigation, or, what is to some more alluring, the emoluments of commercial or expert work. But the sacrifice, if indeed it may be called such, is worth the effort. There are about 25,000 medical students in the United States, and the number graduated each year is not far from 5,000, in all schools. The number of registered physicians is about 1 to 636 for the whole population. It is no small matter to be able to make the proper impression on the minds of these men, and positions as teachers in the growing medical schools of the country have been perhaps too long overlooked by the better class of chemical graduates in search of academic openings. There is a field here which is worthy of fuller cultivation.

While I have intimated above that the possibilities for research work in chemistry for the average medical student or teacher are limited, and necessarily so, I am far from underestimating such work. While it is indeed true that in many quarters a trifling research on some trivial point of wholly artificial interest may be more highly prized than is the most painstaking and successful effort in class-work, and while it is also true that the layman, or professional man of little experience as well, may often be deceived as to the real value of such efforts, it is likewise a fact

that there is always a proper appreciation of original investigation in lines of human interest. There is no more inviting field for labor of this kind than is found in the chemistry of life. The greatest problems in the scientific medicine of the future are undoubtedly chemical problems. Indeed there are no more important or inviting problems to be found in any line of study than are here presented, and the investigator will find in them enough to tax the skill and ingenuity of the most learned for years to come. This work naturally and properly belongs to the physiological chemist, and that it must be done before much further advance can be made in scientific medicine is already recognized by leading medical men. The idea was clearly presented by the Dean of the Northwestern University Medical School in the address on Medicine at the recent meeting of the American Medical Association at St. Paul, and we find it brought forward more or less emphatically elsewhere.

The chemical difference between certain of the tissues in health and disease may be very minute in some instances, but in other cases it is certainly more pronounced and capable of demonstration. This problem will unquestionably prove one of the most interesting for future investigators. We have long had considerable acquaintance with the products of renal excretion, somewhat less with the products formed or active in the stomach, and very much less with the complex reactions taking place in the lower stretches of the intestines. Investigation here is probably fully as important as in either of the other cases, but from its inherent difficulties has been but little developed. As the analysis of the urine gives us our most certain data for the diagnosis of diabetes and various renal disorders, so, it may be expected, will the rational chemical examination of the intestinal excretion prove of equal value in the exact diagnosis of other bodily ail-

ments. There is certainly as close a connection in the one case as in the other. These questions are purely practical, and will some day claim the attention of skilled and accurate analysts.

In the field of theoretical investigations the possibilities are even greater. Almost nothing, for example, is known of the steps in nitrogenous metabolism. Between the ingested albumin and the excreted urea and uric acid is a long distance yet to be traveled by the chemical investigator; a few of the possible resting places on the way are known, but the relations of one to the other are yet extremely obscure.

Scarcely less obscure in its fundamental bearings, although seemingly less intricate, is the question of the nature and mode of action of the soluble ferments or enzymes. This is the problem of chemistry rather than of biology, as the question of the production of these substances is merely an incidental one. The epoch-marking work of Buchner in separating the active enzyme from the cells of yeast has gone far to break down the old and artificial distinction between the soluble and insoluble ferments, and to show that all these so-called vital processes are accomplished through what are essentially chemical means. It has long been supposed that in their mode of action the work of the enzyme is purely analytical, but since the interesting observations of Croft Hill on the formation of maltose from dextrose have been confirmed by O. Emmerling, who found, however, that it was isomaltose that was produced, we have opened up a new line of possible investigation which may throw light on some of the processes taking place within the animal body, where it was assumed by Liebig and others that *syntheses* do not take place.

Lately a fruitful line of investigation has been suggested by Bredig in his work on the 'inorganic ferments,' where he shows that colloidal platinum in its oxidation-

assisting behavior presents the closest analogy to some of the common organic enzymes. The colloidal metallic solutions seem to be affected by the same kinds of poisons which are known to impede the action of the soluble ferments, and to recover finally in about the same way. All these matters become of the greatest interest to the physiological chemist when we recollect that nearly all the body processes are doubtless enzymic in their character, and that the toxins or disease producers are probably chemical agents of the same class.

But it was not my intention to discuss new discoveries in chemistry. I merely wished to emphasize the fact that the fields of physical chemistry and synthetic organic chemistry are not the only ones to claim the serious thought of active investigators. I wished to suggest that the chemistry bearing on the problems of life itself presents no less interesting possibilities, and that it is worthy of more enthusiastic cultivation in our American schools. While it is doubtless true that the elementary practical instruction given in chemistry to American medical students is now equal to or possibly more systematic and thorough than that given in the majority of European schools, I wish to express the hope that in the further development of our medical colleges research work may find fuller recognition, and that in the solution of the great problems hinted at our American scholars may contribute their rightful share of effort, and in the end reap the corresponding measure of reward.

NORTHWESTERN UNIVERSITY. J. H. LONG.

SCIENTIFIC BOOKS. *Jnd.*

+ *Research Papers from the Kent Chemical Laboratory of Yale University.* Vols. I. and II. Edited by PROFESSOR FRANK AUSTIN GOOCH. New York, Charles Scribner & Sons.

The present occasion of the collected publication of these valuable papers is the coming

of the two-hundredth anniversary of the founding of Yale University. The two volumes under consideration, containing an aggregate of 108 papers and 804 pages, form part of a series of Yale Bicentennial Publications. They form also a highly creditable evidence of the chemical activity in Yale College and a worthy tribute to the memory of Albert Emmet Kent, who endowed the laboratory. They cover a period of only thirteen years, the time which has elapsed since the completion of the building.

All except three of the papers included in the volume have already appeared elsewhere, chiefly in the *American Journal of Science* and the *American Chemical Journal*; and many of them have been translated into German and have been published in the *Zeitschrift für anorganische Chemie*. Hence the contents of the volume will be no surprise to chemists; the papers consist primarily either of proposals of new analytical methods or else of careful amplifications and revisions of old methods. In every case series of test-analyses are given, performed under varying conditions; hence a clear idea is afforded of the chemical error of each process. The papers cover too wide a variety of subjects to admit of detailed mention here; iodometry receives more extensive treatment than any other one subject. The value of the collection is much increased by admirably copious classified indexes.

Besides the names of the eminent director, Dr. Gooch, and his chief assistant, Dr. Browning, those of students too numerous to mention, including four ladies, are to be found at the headings of the separate papers.

The chief lack which some will feel on studying this work is the absence of frequent appeal to modern theory for assistance. As Dr. van't Hoff has pointed out, inorganic chemistry attains its greatest significance when viewed from the standpoint of modern physical chemistry. But in spite of this lack, the careful empirical investigations are so full of essential facts that no student of analytical chemistry can afford to be unfamiliar with them. The present bringing together of the scattered articles will facilitate access to these facts.

THEODORE WM. RICHARDS.

HARVARD UNIVERSITY.

The Insect Book. A popular account of the bees, wasps, ants, grasshoppers, flies and other North American insects, exclusive of the butterflies, moths and beetles, with full life histories, tables and bibliographies. By LELAND O. HOWARD, Ph.D., Chief of the Division of Entomology, U. S. Department of Agriculture. New York, Doubleday, Page & Company. 1901.

The very complete subtitle indicates the scope of the work, and if we add that 'where possible a typical life history has been given in each family treated,' we have the leading characteristic which distinguishes it from other American works which are nominally 'popular.' Another feature of importance is that these life histories, while interestingly and entertainingly presented, are nevertheless strictly correct and scientifically accurate, in strong contrast to some other 'popular' works where vague and extravagant statements to attract the wonder-loving are relied upon to win public favor.

Dr. Howard's book, then, in its plan and in its performance stands by itself in that it makes interesting reading for him who reads merely for general information, and helps the amateur who wishes to go a little further and learn something of the classification.

But it is in this latter feature that the only notable defect in the work is found; there is no introductory chapter that familiarizes the young student with the characters referred to in the tables, nor is there any explanation of how the tables are to be used. At the bottom of page 2 the last two lines read:

"1.—Pronotum not extending back to the tegulæ
2

Pronotum extending back to tegulæ, or the latter are absent.....3"

But what a pronotum is, or what are tegulæ, has not been previously indicated and is nowhere clearly explained.

Of course there are other books that explain all this; but it is a question whether in a book of this expressed scope these tables in such form are of any real assistance to the owner. They could have been omitted without any loss whatever.

On the other hand, the chapter on collecting

and preserving insects is in all respects admirable and exactly what is needed by the tyro whom the book may interest in the subject. The ground covered by the book is so great and the general treatment is so concise and to the point that, aside from the statement that it could scarcely be better done, little remains to be said.

A book of this kind, put out in attractive form, liberally illustrated and at a really low price (\$3), will do much to create an interest in a series of insects concerning which little is generally known.

The illustrations are deserving of separate commendation. There are 264 text figures and almost without exception these are admirable. There are 48 half-tone plates, of which a fair proportion are colored, and these illustrate interestingly the limitations of this process where detail is required for identification. Nothing better has ever been done by this process and perhaps nothing better can be done. Some plates, like I. and II., are eminently satisfactory; in others, like XIV. in the same order, the majority of figures are useless for specific identification.

The book is well printed, small 4to, with xxvi + 429 pages. It contains a very complete index and a well-arranged bibliography covering the orders treated.

JOHN B SMITH.

SCIENTIFIC JOURNALS AND ARTICLES.

THE *Journal of Comparative Neurology* for September (Vol. XI., No. 2) contains, in addition to the usual reviews of literature, but one paper, entitled, 'The Neurones and Supporting Elements of the Brain of a Selachian,' by Dr. Gilbert L. Houser, of the University of Iowa, a monograph of 110 pages, with eight plates. The entire central nervous system of the common dog shark, *Mustelus*, has been examined by a variety of the best neurological methods, both new and old, and the attempt is made to give a picture of the *complete* neurones characteristic of each important region of the brain. So far as this can be attained by the methods of Weigert, Golgi, Nissl and Haidenhain, among others, it has been quite successfully accomplished, and thus an important ad-

dition is made to our knowledge of a critical phylogenetic stage of the vertebrate nervous system. The supporting elements have been subjected to the same careful study. The phylogenetic point of view has been before the author throughout, and interesting general conclusions are suggested in connection with the various encephalic regions, notably, the problems of nerve components, the phylogeny of the cerebellum, Reissner's fiber and its associated mechanism for direct motor reflexes between the optic tectum and the body musculature, and the forebrain.

The Popular Science Monthly for September has for frontispiece a portrait of Charles Sedgwick Minot, President of the American Association, and a brief sketch of his life is to be found in 'The Progress of Science.' In the first article, 'The Greatest Biological Station in the World,' W. A. Herdman describes the Naples Station and its work in a most interesting manner, and no one could be found better capable of speaking authoritatively on the subject of zoological stations. C. K. Edmunds gives a sketch of 'Henry Cavendish,' that remarkable character known as the Newton of Chemistry, and Havelock Ellis gives the summary and conclusions of the 'Study of British Genius,' leaning towards Aristotle's dictum that 'no great genius is without some mixture of insanity.' C. B. Davenport presents a paper on the 'Statistical Study of Evolution,' the quantitative method in scientific study being one to which he has given marked attention. Robert Koch's address before the British Congress on Tuberculosis on 'The Combating of Tuberculosis' is not only very interesting but very encouraging in exhibiting the methods by which consumption may be checked. John T. Duffield describes the various steps in 'The Discovery of the Law of Gravitation,' and Byron D. Halstead discusses 'Plants as Water Carriers' and, after noting the mechanism by which this is performed, concludes that back of this is a vital force that has not been reduced to a physical or chemical basis. Edwin O. Jordan considers 'The Soluble Ferments or Enzymes,' stating that they simply influence the rate of change in any substance and do not cause the change itself. In

'The Progress of Science' is a most interesting note on Vitrified Silica.

The American Naturalist for August begins with a detailed description of 'The Texan *Kœnenia*,' by Augusta Rucker, who shows this peculiar arachnid to be distinct from the Sicilian species and names it *K. wheeleri*. Outram Bangs gives an account of 'Mammals Collected in San Miguel Island, Panama, by W. W. Brown, Jr.,' giving a list of twelve species, six of which are new and here named and described. Gary N. Calkins tells of 'Some Protozoa of especial Interest from Van Cortlandt Park,' giving a considerable amount of information regarding their habits, and Frank C. Baker discusses 'The Molluscan Fauna of the Genesee River,' showing the influence upon this of the falls of the Genesee at Rochester. Harold S. Conant describes 'The Conchometer,' a simple instrument for measuring the apical angle and length of gasteropod shells. The sixteenth part of 'Synopsis of North American Invertebrates' treats of the Phalangidæ and is by Nathan Banks, and H. L. Osborn presents some 'Variation Notes.'

The Plant World for July contains, besides a number of notes and short articles, 'The Dragon Tree of Orotava,' by Alice Carter Cook, with a fine plate of one of these curious trees, supposed to be 4,000 years old, at Teneriffe; 'Our Puffballs,' by C. L. Shear; 'A March Day's Flowers,' by Charles E. Jenney, and a biographical sketch of 'Thomas Conrad Porter,' by A. A. Heller. The supplement, 'The Families of Flowering Plants,' by Charles Louis Pollard, discusses various families of the Germinales.

The Museum Journal (of Great Britain) for August contains a report of the Edinburgh meeting of the Museums Association and prints one of the papers read there, on 'The Smallest Museum,' by Kate M. Hall. The other papers presented will appear later. The announcement is made of 'The Gift of the Horniman Museum to the London County Council.' The balance of the number is occupied with notes from various museums.

A NEW journal, entitled *Beiträge zur Chemischen Physiologie u. Pathologie*, has been estab-

lished in Strassburg under the editorship of Professor F. Hofmeister. It is to be published by F. Vieweg & Son, of Braunschweig. Twelve numbers will form a volume, to cost fifteen marks.

ACADEMIES AND SOCIETIES.

THE SUMMER MEETING AND COLLOQUIUM OF THE AMERICAN MATHEMATICAL SOCIETY.

THE Eighth Summer Meeting of the American Mathematical Society was held at Cornell University, Ithaca, N. Y., on Monday and Tuesday, August 19-20, 1901. The Third Colloquium of the Society opened on Wednesday, August 20, and extended through the remainder of the week.

About sixty persons, including forty-five members of the Society, were in attendance during the four sessions of the summer meeting. The president of the society, Professor Eliakim Hastings Moore, occupied the chair. An address of welcome by Professor L. A. Wait, representing the University, was the forerunner of a most generous hospitality extended by the University and its individual officers. Formal resolutions adopted by the Society at the close of the meeting express in part its sense of appreciation of this cordial reception.

At the meeting of the council, Dr. E. R. Hedrick, of Yale University, and Mr. S. W. Reaves, of Michigan Military Academy, were elected to membership in the Society. Twelve applications for membership were received. A committee was appointed to prepare a list of nominations of officers for the coming year.

The entire time of the four sessions barely sufficed for the presentation and brief discussion of the long list of papers. Owing to various circumstances, only two days could be devoted to the meeting, while three would not have been excessive. At future summer meetings more time must be provided. Probably the annual meeting in December will also be extended to cover two days.

The following papers were presented :

1. PROFESSOR MAXIME BÔCHER : 'On certain pairs of transcendental functions whose roots separate each other.'
2. DR. J. I. HUTCHINSON : 'On a class of automorphic functions.'

3. PROFESSOR A. PRINGSHEIM : 'Ueber den Gour-sat'schen Beweis des Cauchy'schen Integralsatzes.'
4. PROFESSOR A. PRINGSHEIM : 'Ueber die Anwendung der Cauchy'schen Multiplicationsregel auf bedingt convergente oder divergente Reihen.'
5. MR. W. B. FORD : 'On the expression of Bessel functions in terms of the trigonometric functions.'
6. PROFESSOR E. H. MOORE : 'On the theory of improper definite integrals.'
7. PROFESSOR OSKAR BOLZA : 'New proof of a theorem of Osgood in the calculus of variations.'
8. DR. G. A. BLISS : 'The problem of the calculus of variations when the end point is variable.'
9. DR. J. C. FIELDS : 'On certain relations existing between the branch points and the double points of an algebraic curve.'
10. DR. J. C. FIELDS : 'The Riemann-Roch theorem, and the independence of the conditions of adjointness in the case of a curve for which the tangents at the multiple points are distinct from one another.'
11. PROFESSOR E. B. VAN VLECK : 'A proof of the convergence of the Gaussian continued fraction

$$\frac{F(a, \beta + 1, \gamma + 1, x)'}{F(a, \beta, \gamma, X)}$$

12. PROFESSOR T. E. MCKINNEY : 'Some new kinds of continued fractions.'
13. PROFESSOR E. D. ROE : 'Note on symmetric functions.'
14. DR. G. A. MILLER : 'Groups defined by the orders of two generators and the order of their product.'
15. DR. H. F. STECKER : 'On the determination of surfaces capable of conformal representation upon the plane so that the geodetic lines shall be represented by a prescribed system of plane curves.'
16. MR. C. N. HASKINS : 'On the invariants of quadratic differential forms.'
17. DR. EDWARD KASNER : 'The cogredient and digredient theories of double binary forms.'
18. PROFESSOR MAXIME BÔCHER : 'On Wronskians of functions of a real variable.'
19. MR. F. G. RADELINGER : 'The analytical representation of a multiform function in the domain of an isolated singular point.'
20. DR. VIRGIL SNYDER : 'On the forms of unicursal sextic scrolls with a multiple linear directrix and one double line.'
21. DR. H. F. STECKER : 'Concerning the osculating plane of m -fold space filling curves of the Hilbert-Moore type.'
22. DR. H. F. STECKER : 'On non-euclidean properties of plane cubics and of their first and second polars.'
23. PROFESSOR L. E. DICKSON : 'Theory of linear groups in an arbitrary field.'

24. MR. H. L. RIETZ : 'On primitive groups of odd composite order.'

25. MISS I. M. SCHOTTENFELS : 'On the non-isomorphism of two simple groups of order $8! / 2$.'

26. PROFESSOR L. W. DOWLING : 'On the generation of plane curves, of any order higher than four, with four double points.'

27. PROFESSOR L. E. DICKSON : 'The configuration of the 27 lines on a cubic surface and the 28 bitangents to a quartic curve.'

28. PROFESSOR E. H. MOORE : 'Concerning the second mean value theorem of the integral calculus.'

29. DR. I. E. RABINOVITSCH : 'The application of circulants to the solution of algebraic equations.'

30. M. EMILE LEMOINE : 'Note sur la construction approchée de π de Mr. George Peirce.'

31. DR. C. W. MCG. BLACK :

32. PROFESSOR ALEXANDER PELL : 'Some remarks on surfaces where first and second fundamental forms are the second and first respectively of another surface.'

At the Colloquium, which was attended by twenty-three persons, two courses of four lectures each were presented :

PROFESSOR OSKAR BOLZA : 'The simplest types of problems in the calculus of variations.'

PROFESSOR E. W. BROWN : 'Modern methods of treating dynamical problems, and in particular the problem of three bodies.'

It is hoped that these lectures may be published in complete form. A summary of them will appear in the *Bulletin*.

The next meeting of the Society will be held in New York, on Saturday, October 26.

F. N. COLE,
Secretary.

PALEONTOLOGICAL NOTES.

VERTEBRATES FROM THE TRIAS OF ARIZONA.

As recently noted in SCIENCE, Mr. Barnum Brown was engaged during May and June of this year in making collections for the U. S. National Museum from the Trias of Arizona. The exploration was undertaken in the hope of obtaining ancestral forms of the Stegosaurus, and while unfortunately this hope was not realized much interesting material was obtained, although, like most Triassic specimens, in a very fragmentary condition. A large share of this represents the large Belodont from the Trias of Utah, described by the writer under the name of *Heterodontosuchus ganei*, and comprises frag-

ments of the skull, numerous dermal plates, many vertebræ, all badly broken, and portions of the pelvis and limbs, besides an absolutely complete humerus, ulna and scapula. That this last bone should have escaped destruction, while others far more solid were shattered and scattered beyond redemption, is one of the many puzzling facts that come under the notice of paleontologists. Associated with the Belodont are some bones of a Dinosaur, and as a few teeth referable to the genus *Palæoctonus* of Cope are present they also probably belong to that genus. A humerus has the deltoid and other muscular ridges remarkably well developed, indicating a reptile of the strength and agility that one might expect from the owner of such teeth; it is nearly solid and smaller than might have been expected from the size of the teeth.

In a bed of conglomerate Mr. Brown obtained a number of more or less fragmentary bones, which from the shape of some associated scutes apparently belong to Cope's *Episcopsaurus*. These specimens, and the clayey matrix containing them, are unluckily thoroughly permeated with alkali, which will make their preparation, or even preservation, a matter of difficulty.

Perhaps the most interesting of the specimens are the deeply sculptured ventral plates of some extremely large Labyrinthodont. The interclavicle, which is complete, is 40 cm. long, and 30 cm. broad, 16 by 12 inches, about the size of the corresponding bone in the European *Mastodonsaurus*. It may be of interest to note that when in Washington this spring Dr. Eberhard Fraas identified a fragment of a cranial plate from the same locality as the above as belonging to this genus.

It will be seen that all the species obtained are typically Triassic, the Belodont and *Mastodonsaurus* preeminently so.

F. A. LUCAS.

THE APPROACHING MEETING OF THE BRITISH ASSOCIATION.

THE British Association—for so it is universally called in Great Britain without any further specification, a testimony to its supremacy among associations—meets at Glasgow on Sep-

tember 11, and a comparison of its work with that of our own Association may be of use. As a rule the addresses of the president and of the presidents of the sections are better suited to their purpose than those of our own officers, although this year there is no reason to avoid a comparison. Indeed it seems evident that in recent years the general addresses before our Association have improved both in substance and in form, being addressed to a wide audience rather than to a few specialists. In regard to the proceedings of the sections, the American Association is on the whole the leader. There are usually at the British Association several eminent men of science, who take a prominent part in the proceedings, but the average number and average importance of the papers presented are probably less than in the case of the American Association. Thus at Denver over two hundred papers were presented; and their quality will compare favorably with those that will be presented at Glasgow. The social entertainments and excursions of the British Association are usually superior to ours. Owing to the interest taken in science by the upper classes in Great Britain, it receives a more marked social recognition than is the case in this country. This, however, is not a matter of great importance; and the British Association has doubtless never been entertained more generously than was the American Association at Denver. The British Association is certainly fortunate in securing the support of a large body of members, especially of annual members. Thus three previous meetings have been held at Glasgow. In 1840, there were in attendance 1,393 members; in 1855, 2,159, and in 1876, 2,800. These members were, however, chiefly local citizens who took an interest in science, attended the meetings and subscribed \$5 to support the Association. On the other hand, the American Association has a much larger proportion of scientific men in attendance; and the British Association has certainly never had an accession of nearly 1,200 permanent members, chiefly scientific men, in the course of a year, as has occurred with the American Association during the past year.

At the meeting of the British Association that opens next week, Professor A. W. Rücker,

the eminent physicist, recently elected to the presidency of the University of London, will preside and will deliver the inaugural address. The public lectures will be by Professor W. Ramsay, who has chosen as his subject 'The Inert Constituents of the Atmosphere,' and by Professor Francis Darwin on the 'Movements of Plants.'

The addresses of the presidents of the sections, for the preliminary announcement of which we are indebted to a forecast printed in the *London Times*, are as follows: In Section A (Mathematical and Physical Science), the president, Major P. A. MacMahon, will first give an account of the Mathematical Society of Spitalfields, 1717-1845; and, after some remarks upon the present state of mathematics and physics in Great Britain and the teaching of those subjects, will conclude by considering the work of a specialist in science and especially of a mathematical specialist, in relation to the general advance of scientific knowledge. The title of the address which will be delivered by Professor Percy Frankland, F.R.S., president of Section B (Chemistry), is 'The position of British chemistry at the dawn of the twentieth century.' He proposes drawing attention to the factors which have been instrumental in promoting the growing activity in original investigation during the past 20 years. Coming to the present time he will point out the disadvantages under which students of chemistry labor at the universities, and will indicate some of the more important reforms which he considers desirable in the immediate future. The president of Section C (Geology) is Mr. John Horne, of the Geological Survey Office, Edinburgh, who has chosen as the subject of his address, 'Recent advances in Scottish geology.' He proposes to review the progress of Scottish geological work since the last meeting of the Association in Glasgow. In Section D (Zoology), Professor J. Cossar Ewart will probably take the opportunity afforded him in his presidential address of summarizing the results of the long series of experiments he has been carrying out at Pennycuik in connection with the subject of inheritance and telegony. Dr. Hugh Robert Mill is the president of Section E (Geography), and in his address will deal

with research in geographic science. He will argue that geography deals with the forms of the crust of the earth and the influence which these forms exert on everything free to move on the surface. In his presidential address to Section F (Economic Science and Statistics) Sir Robert Giffen proposes to discuss the increase in population during the last 100 years in the chief European countries, in the United States, and in the English-speaking colonies. Among the topics referred to will be the changes in the relative position of European States to each other and to the United States in consequence of the differences in the increase of their population; the increasing dependence of other European countries besides the United Kingdom on supplies of food imported over sea, and the question whether changes in the rate of growth of population in recent years are likely to modify in a material degree the present relative development of the countries in question. Section G (Engineering) will be presided over by Colonel R. E. Crompton, who will first deal with the probable future development of passenger and goods transport as affecting railways, tramways and ordinary roads, and will then touch on the standardizing of parts of machines to facilitate manufacture, concluding with a consideration of the National Physical Laboratory.

In Section H (Anthropology) Professor D. J. Cunningham, F.R.S., of Trinity College, Dublin, will devote his address to a consideration of the part which the brain has played in the evolution of man, especially the structural changes in the brain which have rendered the associated movements required for articulate speech possible, and to arguing that the acquisition of speech has afforded the chief stimulus to the general development of the brain. In his presidential address to Section I (Physiology), Professor McKendrick will briefly pass in review the advance in our knowledge in this branch of science during the past quarter of a century; and he then proposes to discuss some of the problems of what may be called molecular physiology, more especially the question of how many organic molecules may be contained in the smallest particle of living matter, and whether in the ovum, for example, there

is a sufficient number of molecules to account for the facts of hereditary transmission. Professor I. Bayley Balfour is president of Section K (Botany). He will deal in his address with the construction of flowering plants, with the intention of showing that they owe their position as the dominant vegetation of the present epoch to their having solved best the problem of adequate water-carriage. The new Section L (Educational Science) is under the presidency of Sir John Gorst. The subject of his address has not been announced.

SCIENTIFIC NOTES AND NEWS.

THE Reale Accademia de Lincei of Rome has elected the following foreign members: Emile Picard, professor of higher algebra at the Sorbonne; Edward C. Pickering, director of the Harvard College Observatory; Samuel P. Langley, secretary of the Smithsonian Institution; J. H. Van't Hoff, professor of general chemistry in the University of Berlin; Heinrich Karl Rosenbusch, director of the Mineralogical and Geological Institute of the University of Heidelberg; Charles D. Walcott, director of the U. S. Geological Survey; Theodor Engelmann, of the Imperial Board of Health at Berlin; and Charles Richet, professor of physiology at the University of Paris.

ON the application of the Government of Victoria, Australia, for a director of agriculture, officers of the U. S. Department of Agriculture have recommended Professor B. T. Galloway, chief of the Bureau of Plant Industry, and Professor Willett M. Hays, agriculturist of the Minnesota Experiment Station.

DR. SANTOS FERNANDEZ, president of the third Pan-American Congress held recently at Havana, has been presented by the members of the medical profession in that city with a gold medal in recognition of his efforts to advance medical science in Cuba.

THE Alverenga prize of the College of Physicians and Surgeons of Philadelphia has been awarded to Dr. George W. Crile, of Cleveland, Ohio, for his essay entitled 'an experimental and clinical research into certain problems relating to surgical operations.'

THE Belgian government has awarded its an-

nual prize of 5,000 francs for the best work in the province of medical research to Dr. A. van Gehuchten, professor of systematic anatomy in the University of Löwen, for his researches on the human brain and spinal cord.

DR. WILLIAM HUNTER has been appointed assistant director of the Pathological Institute of the London Hospital.

As we have already announced Dr. David Starr Jordan, president of Stanford University, Dr. Barton W. Evermann, ichthyologist of the U. S. Fish Commission, and Dr. W. H. Ashmead, of the U. S. National Museum, who spent the summer in the Hawaiian Islands investigating on behalf of the U. S. Government the fishes and other aquatic resources of the Islands, returned to the United States early in August. The other members of the party will return in September, except Messrs. L. E. Goldsborough and George Sindo, who will go to Pago Pago in the Samoan Islands to make a collection of the fishes found there. The investigations proved very successful. The fishery methods, laws and statistics were carefully studied and large and important collections of the fishes were made. Upwards of 300 species were obtained, among which are many species new to science. Drs. Jordan and Evermann will soon submit a preliminary report to the Commissioner of Fish and Fisheries. The final report will not be made until more deep-sea work has been done about the islands.

MR. JOHN HYDE, statistician of the Department of Agriculture, has returned from Europe where he went to arrange with the agricultural bureaus of the leading countries for an interchange of crop reports by cable. His negotiations were successful and the plan will be in working order next year. He also investigated European methods of crop reporting, but found that they were less advanced than our own.

MR. PERCY WILSON, attached to Professor Todd's Eclipse Expedition to the East Indies, returned to the New York Botanical Garden on August 18, bringing a large collection of vegetable products for permanent exhibition from Singkep, Riouw, Malacca, Siam, Batavia, and the botanical gardens of Buitenzorg and

Singapore. Mr. Wilson has been absent with the expedition since March 2.

REUTER'S Agency states that a cablegram has been received by the Liverpool School of Tropical Medicine from Sierra Leone announcing that Major Ronald Ross is returning to England by the steamship *Phillippeville*, which was due to leave Sierra Leone on August 18. He is returning temporarily for the purpose of arranging for the despatch of an expedition, similar to that now under his charge, to the Gambia and the Gold Coast. In Major Ross's absence the work of the expedition in Sierra Leone is proceeding under the charge of the other medical men. During his present visit to the West Coast, Major Ross has been to the Gambia, Sierra Leone, the Gold Coast and Lagos.

M. A. TOURNOÛER has undertaken an expedition to Patagonia, under the auspices of the French minister of public instruction, with the purpose of continuing his researches on the tertiary mammals of South America.

A MEETING in memory of the late Professor Joseph Le Conte was held by the faculty and students of the University of California on August 21. The exercises were opened by President Wheeler, and speeches were made on behalf of the alumni by Dr. William E. Ritter, professor of zoology, and on behalf of the students by Ralph T. Fisher, former president of the Associated Students of the University of California. The College of Social Science was represented by Professor Irving Stringham, and Professor J. M. Stillman, of Stanford University, spoke as a former pupil of Professor Le Conte's. The closing address was by the Hon. Horace Davis, former president of the University of California, whose concluding words were:

The power of such a life is hard to estimate. For thirty years his name has been a tower of strength to the University, not simply for his scientific fame and intellectual attainments, but even more for his moral strength and beauty. His life has been woven into thousands of young expanding lives in this western commonwealth, and his cheerful hopes have lighted up their homes. The power of such a life cannot be estimated. You have felt it. I have felt it, and the world is better that he has lived.

Professor Edward R. Taylor then read an original sonnet entitled 'Le Conte and the Yosemite,' and the proceedings were brought to a close with selections of instrumental and choral music.

THE bust of Dr. G. Armauer Hansen, the discoverer of the bacillus of leprosy, was unveiled by Professor Visdal in the garden of the Museum at Bergen on August 10. The chief address was made by Professor Oskar Lassar, of the University of Berlin. Congratulatory addresses were received from all parts of the world, and the decoration of Commander of the Order of Ola was conferred on Dr. Hansen by the king of Norway. Dr. Hansen celebrated his sixtieth birthday on July 29.

It is announced in *Nature* that it has been decided to erect in Leoben, Austria, a statue of Peter Ritter von Tunner, who died on June 8, 1897, to commemorate his great services to the metallurgy of iron. A committee has been formed, with Mr. Ignaz Prandstetter as president, Professor J. G. von Ehrenwerth as vice-president and Professor Carl Fritz as honorary secretary, to collect subscriptions. At a recent meeting of the council of the British Iron and Steel Institute the matter was considered. As a contribution to the memorial could not be voted from the funds of the Institute, the members of council present decided to contribute two guineas each, and Mr. Bennett H. Brough, the secretary, has forwarded to the committee in Leoben contributions amounting to about \$230.

The British Medical Journal states that for the celebration of the eightieth birthday of Professor Virchow on October 13, a committee has been chosen for Switzerland, consisting of Professor Kocher, of Berne, representing the Swiss medical commission, Professor von Carenville, of Lausanne, who represents the Medical Society of French Switzerland, Dr. Haffter, of Frauenfeld, representing the Central Medical Society, and Dr. Reali, of Lugano, representing the Medical Society of Italian Switzerland. Professor Sklifasowski having been incapacitated by illness, Professor Tarantzi, head of the Medical Academy of St. Petersburg, has been chosen president of the Russian committee in his place.

AMONG the numerous greetings from all parts of the world addressed to Professor Süss, the eminent Australian geologist, paleontologist, and politician, on the occasion of his seventieth birthday, says the London *Times*, is one from the Geological Society in London. He was elected a foreign correspondent of the Society in 1863 and foreign member in 1876, while 20 years later it bestowed upon him its highest geological distinction, the Wollaston medal. The telegraphic congratulation of the Society concludes as follows: "Universally regarded here as the greatest living geologist, whose epoch-making work will bear fruit in the field of science for generations to come. Warmest congratulations and best wishes from British colleagues." To his own countrymen Professor Süss has been not only a distinguished pioneer in science. He has been an example of enlightened patriotism and devotion to the public welfare and an indefatigable reformer, whose works will remain a monument to his memory.

DR. THOMAS MASTERS MARKOE, the eminent surgeon, died on August 27, aged eighty-two years. Since 1860, Dr. Markoe had been connected with the College of Physicians and Surgeons of Columbia University as adjunct professor and professor of surgery and later as professor of the principles of surgery.

MR. ALBERT NELSON CHENEY, fish culturist of New York State, died at his home in Glen's Falls, N. Y., on August 18, aged about fifty years. He was the author of many contributions on pisciculture.

THE death is announced of Dr. Leroy Méricourt at the age of seventy-five years. Dr. Méricourt is known as one of the reorganizers of the French naval medical service and for his writings upon tropical medicine and hygiene. He was a chevalier of the Legion of Honor, a member of the Academy of Medicine and one of the founders of the *Archives de médecine navale*.

MR. ANDREW CARNEGIE has given £7,500 to Rutherglen, Lanarkshire, Scotland, for a public library and £10,000 to Motherwell, Lanarkshire, for a town hall. Gifts for libraries, under the usual conditions, of \$25,000 and \$37,000 are reported from Beloit, Wis., and Moline, Ill., respectively.

ACCORDING to the *N. Y. Medical News* a systematic plan for the extermination of mosquitoes has been inaugurated by the residents on the north shore of Long Island from Roslyn to Huntington. The immediate work to be undertaken will be in charge of Messrs. A. C. Weeks and F. E. Lutz, of the University of Chicago, who will work in conjunction with Dr. Chas. B. Davenport, director of the Biological Laboratory of Cold Spring Harbor.

It has been decided that the commission to be sent out by the Liverpool, Manchester and London Chambers of Commerce to investigate the conditions of health and sanitation in West Africa shall consist of one member from each of the three chambers of commerce and of a sanitary engineer. In addition, Major Ronald Ross has been requested to attach himself to the commission as expert in tropical medicine.

WE learn from the *Lancet* that legal authority has been given for the creation of a fund for scientific research in France. It is divided into two sections, and its object is the promotion of purely scientific work relative (1) to the discovery of new methods of treatment of the diseases which attack man, domestic animals, and cultivated plants; and (2) to the discovery, apart from the medical sciences, of the laws which govern natural phenomena (mechanics, astronomy, natural history, physics and chemistry). The income of the fund will be derived from the following sources: (1) Grants made by the government, by the departments, by the communes, by the colonies, and by other sections of the population. (2) Gifts and bequests. (3) Individual or collective subscriptions. (4) Grants deducted from the proceeds of the *pari-mutuel* assigned to philanthropic or charitable purposes locally; the annual amounts of these grants, which will not be less than 125,000 francs, will be fixed each year on the application of the council of management by the special commission held at the Ministry of Agriculture. (5) Interest of money invested in government securities or deposited with the treasury. The fund is subject to the authority of Ministry of Public Instruction, and is managed by a council assisted by a technical commission concerned with the grants.

Nature states that a committee has been appointed by the president of the Board of Trade to inquire and report as to the best means by which the state or local authorities can assist scientific research as applied to problems affecting the fisheries of Great Britain and Ireland. The members of the committee are as follows: The Right Hon. Sir Herbert Maxwell, Bart.; Mr. Walter E. Archer, Mr. Donald Crawford, Rev. William Spotswood Green, Professor William Abbott Herdman, the Hon. Thomas H. W. Pelham, Mr. Stephen E. Spring-Rice, C.B., and Professor J. Arthur Thomson.

THE daily papers report the death from yellow fever of two men and one woman who permitted themselves to be bitten by infected mosquitoes in order to become immune. It should be understood that the trials were not made in order to test the communication of yellow fever by mosquitoes, but they are certainly very convincing evidence. It is further reported that the yellow fever commission regards the experiments with the Caldas serum as having demonstrated its uselessness and will not supervise any further experiments conducted by Dr. Caldas.

THE *Lancet* states that the proposal to establish a central pathological laboratory in connection with the lunatic asylums of Ireland has taken practical shape by the insertion of a permissive clause in the lunacy bill which has just passed. According to it the committees of any two or more district asylums may, with the consent of the county council, agree to unite 'in providing and maintaining a laboratory for pathological research in connection with insanity and nervous diseases,' and the committees of those institutions may defray the expenses incurred.

A GOVERNMENT laboratory for experimenting with explosives is to be built at Sandy Hook at a cost of \$10,000.

REUTER'S Agency announces that the expedition under Captain Stoekken arrived at Christiania on August 17, after having explored the south coast of Franz Josef Land. The expedition found no trace of the three lost members of the Duke of the Abruzzi's expedition. The memorial presented by the Duke was erected on Cape Flora.

ACCORDING to the daily papers the steamer *Frithjof* arrived at Hammerfest on August 29 and reported that the Baldwin-Ziegler arctic expedition had been landed at Camp Ziegler, in latitude 90.24° north and longitude 55.52° east, on Alger Island. All the members of the expedition were in good health. Mr. Baldwin intended to start northward on August 24, by the interchannel route, across Markham Sound. We record the movements of this arctic expedition with some hesitation, as it has but little claim to be called scientific. Mr. Baldwin contributes to the last number of *McClure's Magazine* what is said to be the only authorized account of the aims of the expedition. He enlarges on his intention to reach the pole and describes in detail the number of tons of provisions of different kinds provided by the liberality of Mr. Ziegler, but does not mention the names of the members of the scientific staff. Still valuable scientific knowledge may be secured, and even voyages of adventure have some relation to the advancement of science.

THE Italian government has established laboratories of micrography and bacteriology and chemistry as dependencies of the Sanitary Bureau. According to the *British Medical Journal* a department of the bacteriological laboratory is to be devoted to the preparation and control of serums and similar products. The professional staff of the bacteriological laboratory consists of a director, with a salary of \$1,200; a coadjutor, with \$800; and two assistants, with \$500 each. For the serum department there are medical and veterinary coadjutors, each with a salary of \$800 and three assistants at \$500 each. The staff of the chemical laboratory is paid on the same scale.

THE National Good Roads Association of the United States has called an International Congress of Good Roads, to be held in Buffalo, September 16-21. All sessions of the congress will be held during the Pan-American Exposition. It is designed to devote a portion of the time included in the dates above named to demonstrate the scientific methods of modern road construction by building sections of the various classes of roads, including earth, oil, gravel, stone, tar-macadam, vitrified brick, etc.

A railroad train equipped with modern road-making machinery will be on exhibition, and practical road experts and engineers will have charge of the work. The scope of the deliberations of the congress will include general discussion and exemplification of the science of road construction and maintenance, together with experimental tests and experience of the several countries of the world and the states of the Union. Addresses will be made by prominent statesmen and officials, competent engineers, and scientific road experts from various nations.

According to the *Medical News* several members of the Chicago Sanitary District Board are said to have suppressed the reports showing the self-purification of running streams. After having appropriated \$2,500 for the preparation of the report and after having authorized its publication, they are said to have taken steps to keep it from being made public. The circumstance was brought to the surface when President Alexander J. Jones was asked to permit access to the report by several expert chemists who spent months making an examination of the waters of the drainage canal and the Illinois river. The experts are Professor E. O. Jordan, of the University of Chicago, Professors Palmer and Burrill, of the University of Illinois, and Professor Adolph Gehrmann, of the city laboratory. Political jealousy, lest the publication should reflect too much credit upon city officials, is alleged to have been the chief motive which actuated the suppression. The suggestion as to this motive comes from officials of the City Health Department. President Jones declares that the report was suppressed so that the material in it could be used by the sanitary district in its defense against the attempts of the city of St. Louis to have the drainage canal closed by the courts. Should the report become public, says President Jones, its value as a defense would be injured. The suppressed report is said to show that the waters of the drainage canal are not polluting the waters of the Illinois River and that the alarm of St. Louis is unfounded. Before the waters of the river reach Peoria they are said to be absolutely pure. At that point they are contaminated by the Peoria distilleries. The river again becomes perfectly pure many miles

north of the junction with the Mississippi River. Trustees of the sanitary district are pleased with the action of the War Department in issuing orders to allow a swift flow of water through the canal during eight hours of the day. The hours specified are between 4 p. m. and midnight, and the flow allowed is 300,000 cubic feet a minute, instead of 200,000 cubic feet, as is allowed during the remainder of the day.

THE Report on the Observatory Department of the National Physical Laboratory for the year 1900 has been published in the *Proceedings* of the Royal Society. According to an abstract in *Nature* the magnetographs have been in constant operation throughout the year, but the curves have been quite free from any large fluctuations. The mean westerly declination for the entire year was $16^{\circ} 52'.7$. The automatic and tabulated records of the various meteorological instruments have been transmitted, as usual, to the Meteorological Office, to be dealt with in its publications, and special cloud observations have been made each month in connection with the international scheme of balloon ascents. Seismological observations have been regularly made; two noticeable disturbances occurred during the year, on January 20 and October 29. A detailed list of the movements of the seismograph will be published in the Report of the British Association for the present year. As regards experimental work, the observation of distant objects during mist and fog and researches upon atmospheric electricity, referred to in previous reports, have been regularly continued. The list of the various instruments tested is a very long one. Some of the cases in which a considerable increase has occurred are: Aneroids and marine barometers (number tested in year 1900), 336 (increase 69); compasses, 963 (increase 559); rain gauges, 1,345 (increase 784); clinical thermometers, 20,476 (increase 4,456); total number of instruments tested, 27,569 (increase 5,518). The principal addition to the staff during the year has been the appointment of Dr. J. A. Harker as an assistant in the laboratory.

In an interview with a representative of the *London Times*, Professor Otto Nordenskjöld, who is at present staying at Malmö in order to

make arrangements for his antarctic expedition, made the following statement: "As soon as the *Antarctic* returns from the expedition which she has made to Spitzbergen for meridian measurements—and it is calculated that she must be on her homeward journey by September 15—we start from Göteborg. The time of our departure cannot, of course, be definitely fixed, for unforeseen hindrances may arise; but we shall certainly be able to weigh anchor by about October 1. From Göteborg we shall proceed to England, and thence to Buenos Ayres and Tierra del Fuego, whence we shall make our way to the antarctic regions. We shall endeavor to push as far south as possible with the *Antarctic*; and, when winter comes on, we shall send a party on shore to winter. That party will probably consist of six persons, of whom I shall be one. We shall build a small hut for ourselves, and engage in meteorological, magnetic, hydrographic and other scientific observations. As soon as we have landed, the *Antarctic* will return to Tierra del Fuego; and a scientist, who will sail with her, will conduct the researches in that hitherto little explored country. In this way we shall be able to work in two detachments, and make as much use of our time as possible. As is well known, an English and a German South Polar expedition are also being sent out at the same time. In order to avoid clashing with one another, these three expeditions have come to an agreement whereby we explore the region south of the Atlantic Ocean, the Germans that south of the Indian Ocean, and the British that south of the Pacific Ocean. Naturally we cannot advance so far towards the South as towards the North Pole, but the scientific results must be great, and we are well equipped for scientific research. I shall have some able scientists with me. Professor Ohlin, of Lund, the well-known explorer, and M. K. A. Andersson will accompany me as zoologists. Dr. Bodman will come as hydrographer and magnetician, M. Skottoberg as botanist, and Dr. E. Ekolof as medical officer. The Norwegian, Captain Larsin, who has already made several voyages to South Polar regions, will be in charge of the *Antarctic*."

A CORRESPONDENT of the *London Times* reports that a discovery of flint implements has lately

been made on the estate of the Marquis of Ailesbury at Knowle Farm, on the borders of Savernake Forest. A gravel pit was opened a short time ago close to the farm buildings, and the implements have been found at various depths, some embedded in coarse gravel and silt and others in dark red clay, at a depth in some instances of 8 feet to 10 feet from the surface. The ground is at least 450 feet above sea-level, and it would seem that at the particular place where the gravel occurs two or three streams must have met which had had their courses through the forest and were making their way to the valley of the Kennet, some three or four miles to the southeast. There is now no stream of water in any part of the forest, and besides this there is nothing to indicate in the present configuration of the ground the source from whence the water by means of which the valleys were eroded could have come. It is only by imagining an entirely different face to the country (such as might have been if the valleys had been eroded before the formation of the Pewsey Vale, some three or four miles to the southwest) that an origin for the streams in these forest valleys can be conceived. Between 200 and 300 implements have already been found, many of them of beautiful workmanship, while others are very rude and apparently unfinished. Whether these latter belong to the earlier 'Eolithic' period and have been washed out of earlier beds of gravel and deposited with implements of a later date (as appears to have taken place on the plateaus in Kent) is a point to be decided hereafter; but it is very difficult to imagine those rude implements to have been manufactured by the same race of people as have made and finished with so much care those apparently lying by their side. Most of the implements are of very superior flint, extremely hard in texture; one or two may be of chert, and one appears to be of 'Sarsen' stone, and they bear a marked similitude to those found at St. Acheul in the valley of the Somme. Many have been rolled and have lost all their sharp edges, while others appear to have been made on the spot and to have had but little use before they were embedded in the stiff clay where they are now found. Some are

very finely polished, as if from the constant rubbing of blown sand, and have an appearance as if coated with glass. They are of all sizes and shapes, some from 5 in. to 6 in. long, generally of a rough, unfinished type; others 3 in. to 4 in. long, of the common spear-shaped form; others of the well-known ovoid form; and others pointed as if to be used as drills. One or two paleolithic implements have been previously found in the locality; but the occurrence of them in such large numbers as these at Knowle is quite new to the district.

UNIVERSITY AND EDUCATIONAL NEWS.

THE University of Edinburgh receives £5,000 by the will of the late Miss Eleanor Omerod, the entomologist.

THE *Educational Review*, which each year carefully compiles a black list of the institutions that offer the degree of Ph.D. *honora causa*, finds this year only two such institutions—Bethany College and Dickinson College.

DR. J. W. BASHFORD, president of the Ohio Wesleyan University, who, as we reported last week, has been offered the presidency of the Northwestern University, has decided to remain with the former institution at the urgent request of the trustees.

DR. A. W. HARRIS, president of the University of Maine, has resigned in order to accept the position of director of the Jacob Tome Institute at Fort Deposit, Md.

DR. A. P. OHLMACHER, director of the pathological laboratory of the Ohio Hospital for Epileptics at Gallipolis, Ohio, has been appointed professor of pathology in the Medical School of Northwestern University.

ALBERT HENRY YODER, A.B. (Indiana), has been appointed professor of pedagogy at Washington University.

MR. R. K. McCLUNG has been awarded an exhibition scholarship of 1851 by McGill University. He will go to Cambridge University to study under Professor J. J. Thomson.

AT Hartley College, Southampton, Dr. J. T. Jenkins has been appointed lecturer in biology and geology, and Mr. J. D. Coates assistant lecturer in physics and electrical engineering.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

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FRIDAY, SEPTEMBER 13, 1901.

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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 CARNEGIE TECHNICAL SCHOOL.*

It was the intention of your vice-president to prepare an address on the Evolution of the Mechanics of the Telescope for pre-

*Address of the vice-president and chairman of Section D, Mechanical Science and Engineering, of the American Association for the Advancement of Science, Denver meeting, August, 1901.

sentation before Section D of this Association, but a new and important theme has been brought before me by reason of intimate association therewith, and to which a number of the members of this Section have contributed most valuable data. I therefore beg to present to you a few notes upon this subject, namely, the technical school for which Mr. Andrew Carnegie has most generously proposed to furnish the means to build, equip and endow in the city of Pittsburg. When Mr. Carnegie gave to the city its library, its art gallery, its temple of music and its museum, neither the donor nor the citizens had the remotest dream of what they would develop into, nor how far their influence would reach and be felt. I need not tell you what potent factors these institutions have been as educators in the realms of art, science and literature. Suffice it to say, that every department of the great institute has proved itself worthy of its name and is doing marvelous work for the betterment of the people. So marked has been this development during the six years of the existence of the Pittsburg Institute that Mr. Carnegie has given over three million dollars to enlarge its boundaries and increase its influence.

But Mr. Carnegie had promised even greater things for the city of his adoption. He knew as well as any man the need, the great value of a school of technology in

Pennsylvania's great hive of industry ; and with but little preliminary discussion of the subject, with full confidence in the commission that had been entrusted with the building, care and development of the Pittsburgh Institute, he proposed to furnish the means to build, equip and endow a school of technology on the broadest possible basis, whose doors should be open not only to students from western Pennsylvania, but eventually to students from any part of the world.

President Frew of the Carnegie Commission appointed two committees : (A) A committee to confer with the city officials in reference to a site for the building, etc. (B) A committee on 'Plan and Scope' of the proposed technical school. On this latter committee President Frew appointed the following gentlemen :

President Wm. McConway, of the McConway, Torley Manufacturing Co. ; Chas. M. Schwab, president Carnegie Steel Co. ; Wm. A. Magee, 'Times Publishing Co.' ; Hon. Wm. A. Diehl, Mayor of Pittsburgh, and John A. Brashear.

After a series of important meetings in which the best plan of procedure was carefully discussed, Mr. Schwab found it necessary to resign as a member of the committee, as he had been called to the position of president of the United States Steel Co. The resignation of Mr. Schwab was greatly regretted, as he has had large personal experience in technical and manual training schools, having built and endowed a splendid school in Homestead, Pennsylvania, in the very center of the great steel industries. Mr. W. Lucien Scaife was appointed to fill the place made vacant by the resignation of Mr. Schwab. He is a graduate of the Sheffield Scientific School and has studied in the technical schools of France and Germany, and his technical and practical knowledge has proved of great value in the deliberations of the committee.

After a careful discussion of the plan of procedure it was decided to call to our assistance a number of the best men on technical lines in the country, rather than one man, no matter how thoroughly he might be posted in technical school matters, for the one man might have a bias, either of education or environment, which, while it possibly would be in the direction of the very best plan and scope for the new school, might be detrimental to its highest development ; and in this important matter it was concluded that in the 'multitude of counselors' there ought to be wisdom. The committee therefore called to its assistance, Dr. Robert H. Thurston, Professor J. B. Johnson, Dr. Thomas Gray (all members of Section D of the Association) and Dr. Victor Alderson, acting president of the Armour Institute of Chicago. These gentlemen were to come to Pittsburgh last spring to study the conditions and environment which would necessarily be important factors in formulating the plan and scope of the new school and, after several pleasant meetings with our own committee, arranged to return to Pittsburgh on the 24th of June to make at least a preliminary, if not comprehensive and final report. In the meantime the original committee found much work to do, for communications were coming from eminent technologists, technological societies, domestic art associations, educators in manual training schools and mechanical engineers, all of which contained much good grain, with here and there a hobbyist whose theories were mixed with a good deal of chaff ; but on the whole we found a widespread interest in the development of what, let us hope, will eventually become one of the best institutions for technical instruction in this good land of ours. It is for the purpose of leading the members of this Section of the American Association to take an interest in the new school, that this paper is written. It contains no new

thought, no new theories, but calls for your help in a project which we believe will be for the betterment of a large class of students, whose means are necessarily limited, but who will be, let us profoundly hope, mighty factors in the future development of American technological and allied industries.

If we are to keep fast hold of the prestige we have gained in the industrial world by hard work and persistent effort, we must open the storehouse of knowledge to our future mechanics, engineers, etc., give them an opportunity to partake of the treasures stored therein, and we shall have no fear of the position we are to occupy in the coming years.

Our advisory committee, having studied the problem from many points of view, met with us in Pittsburg on the twenty-fourth of Junelast, each member having formulated his plans without consultation with other members of the committee, yet it is a matter of interest to know that the expressed views of the advisory board as individual members were so nearly in accord on the general principles formulated for the great school of technology. Of course with such a field to work upon, there were a number of most valuable suggestions made by the individual members of the board, all of which will be of use to our committee in making up its report to the commission.

With your permission, and I am sure with that of the several members of the advisory board, I will give as briefly as possible an outline of the scheme for the new technical school.

First, as to site. The Carnegie Institute is situated in Schenley Park; and it was thought desirable by Mr. Carnegie and members of the commission to secure, if possible, enough ground near the Institute for the technical school. A tract of eleven acres was the only available land in the Park, but this was at once pronounced far

too limited in extent for the new school; indeed the first plan of buildings, campus, etc., submitted by Mr. Emil Swensson, of the Carnegie Steel Co., covered 40 acres and this for not more than one thousand students. The advisory board suggested that not less than 50 acres be secured, and as a tract of 65 acres is available not far distant from the Carnegie Institute, the board strongly recommended its purchase, or a similar piece of land as near by as it is possible to obtain it. A potent reason for placing the technical school near the Carnegie Institute is the fact that its library is rich in technical and other valuable works, which need not be duplicated in the technical school library; indeed the association of the school with the great and increasingly valuable library, museum, art gallery and Academy of Science and Art is certainly to be desired. In this connection it may be well to state that it was the intention of the donor that the city should furnish the land upon which the school of technology should be built, but it is the unanimous opinion of the advisory board that, as Mr. Carnegie not only proposes to build and equip but fully to endow it, it would be far better to purchase the land and thus, while bringing to the city of Pittsburg all the honor such a school of technology would bring, keep it forever free from baneful political influences. Dr. Gray says in summing up his report: "Such an institution properly managed, could in my opinion do much more to advance the science which underlies our industries than any national or State institution is ever likely to do, hampered as all of them are by political association. I may in conclusion express the opinion that for the best work, independence of city or other politics should if possible be insured by avoiding all kinds of public financial support."

As to the buildings for the technical school but little has been suggested; indeed,

this part of the problem, important as it is, may well be left open until the 'scope' of the great work to be done is well in hand. Dr. Thurston in his report has given an interesting résumé of the space occupied by the student in the various German technical schools, remarking that the German motto 'Viel Platz, Viel Licht, Viel Luft,' would be an excellent guide in determining this question. He says: "Ample space, good light and plenty of fresh air are essential, although the architect who should be the most earnest and intelligent of them all is often woefully deficient in appreciation of their importance when brain work is going on." Dr. Thurston further states that taking figures from the best German technical schools, which are based on the largest experience, the school of architecture at Berlin has 150 feet floor space per student, the engineering school 35 feet, but this latter school is so much over-crowded that arrangements are being made to give the student in this department at least 75 feet of floor space. In marine engineering 111 feet are provided and in metallurgy and the chemical departments each student has 426 square feet of space. Professor Thurston advises not less than 30 square feet per student in class rooms, in drawing rooms about 100 and in laboratories from 150 to 500 feet, according to character of the work to be done and magnitude of the space required for machinery and apparatus.

The Brunswick school has 410 feet floor space per student in all departments. At Karlsruhe 450 square feet is provided in the department of electrotechnics. The cost of the Berlin building is placed at \$1,000 per student, of the Brunswick buildings \$2,000 per student. From this data it can be seen that an institution which may be called upon to provide for a thousand students at once, and perhaps three or four times that number in the near future, must be planned upon a most liberal scale to

meet the demands which will be made upon it, and here we shall be confronted with the cost of such buildings. With the knowledge that Mr. Carnegie would not be satisfied with buildings devoid of architectural beauty, I feel morally certain that he would not be willing to invest his millions in buildings not properly constructed for the specific purpose for which they are intended, and with all regard to the society of architects, it is to be hoped that utility will be the first question solved in this important undertaking.

In a recent communication from Dr. Barker, of the University of Pennsylvania, upon this subject he says: "I hope the mistake will not be made of spending too much money upon buildings. The order of expenditure should be as follows: (a) Instruction; (b) endowment; (c) equipment; (d) building; by this I mean that the securing of the very best ability in the men in all the departments is an absolute desideratum, not only as teachers but investigators, for technical science is advancing so rapidly that abstract research in pure science cannot keep up with it and so applied science has to enter upon research work to supply the data it needs.

"Next comes endowment. In far too many cases, all the money given has been expended upon building and equipment, leaving nothing for maintenance." Dr. Barker then refers to a number of our noted American universities which have splendid buildings and some of them fine equipment, but with little or no funds to carry on research work. The members of this Association know this fact too well, many of them from unpleasant personal experience. Shall we steer clear of these shoals in the new technical schools?

Brainy men do not need a palace in which to make discoveries. Place a Newton, a Napier, a Faraday or an Edison, a Watt or an Ericson in a hovel and the discoveries

will come whether we will or not. Fortunately we are assured that the man who has given this great technical school for the glorious purpose it is sure to subserve will see to it that the endowment does not suffer, even if the buildings are constructed on a generous scale, but I know it to be his desire that the best technological knowledge shall be united with architectural design, so that the buildings may combine utility with beauty and reflect honor on all associated with the work.

And now as to the scope of the new school. That American schools of technology have done magnificent work for two or three decades goes without saying. Shall the new schools follow in the footsteps of the best of them, shall it unite the best features of one school with the best of another, or shall it venture upon entirely new fields to push outward the borders of human knowledge? The American, German, English, French and Swiss schools have been studied by the members of the advisory board (as well as by some members of our committee), and we have been greatly helped in formulating our plans of what the new school should be, by the generous data given in their report.

A summary of Professor Johnson's proposed scheme for the Carnegie School of Technology is as follows:

A. Colleges. Courses of four years with a high school preparation.

1. College of Science.
2. College of Engineering.
3. College of Commerce.

All the above of university grade, with degrees conferred at graduation.

B. Schools. Courses three years with a grammar school preparation.

1. Manual Training School.
2. Domestic Science School.
3. School of Industrial Design.
4. School of Commerce.

All the above of high school grade. Diplomas given at graduation.

C. Artisan Day School. Courses of three years with a preparation in reading, writing and arithmetic.

To include courses of instruction in subjects of essential importance in the practice of the various trades.

D. Night School for day workers. Preparation same as C.

Regular courses, and also special instructions of practical value to day workers of all sorts and all employments.

Professor Johnson, Dr. Alderson and Dr. Gray studied a number of the industries of our city, and in all their reports they emphasized the value of the secondary schools. The question of monotechnic or trade schools, *i. e.*, where a young man or woman can learn at least the rudiments of the trade by which they propose to make their living, was also discussed by Professor Johnson and Dr. Alderson with the writer, and it is the opinion of both committee and advisory board that in due time this part of the problem should be given earnest consideration. A summary of Dr. Alderson's recommendations as to the various departments that could advantageously be established in the school are:

First—Department of Engineering, comprising

- (a) Mechanical Engineering.
- (b) Electrical Engineering.
- (c) Civil Engineering.
- (d) Chemical Engineering.
- (e) Electro-chemical Engineering.
- (f) Foundry Practice.
- (g) Metallurgy (iron and steel).

Second—Department of Secondary Education.

1. Work preparatory to the College of Engineering.
2. Secondary Technical Education.

Courses in

- (a) Machine Tool Work.
- (b) Stationary Engineering.
- (c) Elementary Electrical Engineering.
- (d) Elementary Mechanical Engineering.
- (e) Foundry Practice.
- (f) Surveying.
- (g) Drafting.
- (h) Machine Design.
- (i) Glass Making.
- (j) Blacksmithing.
- (k) Pattern Making.

- (1) Brass Making.
- 3. Department of Library Economy.
- 4. Department of Domestic Arts and Sciences.
- (a) Normal Course.
- (b) Courses in cooking, sewing, dressmaking, millinery and household economy.
- 5. Department of Art.
- 6. Department of Evening Instruction.

Dr. Alderson closes his summary with these words of sterling advice: "The Carnegie School of Technology should be a protest against *surface education*; it should educate the hand and eye as well as the mind; it should emphasize the *doing* element in education; it should be essentially a school of applied sciences; and finally it should enter the broad field of technical education, supplying useful knowledge to boys and girls, young men and young women. The Carnegie School of Technology, located in a center of industrial activity, on grounds naturally beautiful and attractive, carefully planned and thoughtfully administered, can be made to bear the same relation to the great work of technical education that Columbia College does to university education, and thus become a technical school second to none.

Dr. Gray recommends that the institute should offer a course of instruction covering the whole nine years of study; that it be divided into two distinct schools, a secondary and upper secondary, and a higher college or professional school. He advises that the secondary school commence above the grade schools with a minimum age limit of 14 years, and that the course of instruction should include all the subjects commonly given in the best high schools, with the possible exception of Latin and Greek, and in addition the subjects more commonly given in business schools or colleges; along with this course of classroom instruction, provision should be made for practical instruction, either manual or otherwise, bearing upon the particular branch of industry which the scholar in-

tends to enter. The duration of this course should be about four years, as at present in city schools, but should be freed from a number of subjects that are of little use to the ordinary artisan class. Dr. Gray recommends a good sound course in English for students of the secondary school, but does not recommend a study of foreign languages.

One of the most important, if not the most important, recommendations made by Dr. Gray is that in regard to the upper school. I quote his language:

"This school can be made to fill the place which the present technical colleges have failed to do, namely, provide a college education for men of the rank of shop foremen, superintendents, etc. In this course, which should be of two years' duration, instruction can be given in such subjects as the design of structures and machinery, the properties of materials and machines, the design and management of power stations, telegraphy, and train signal systems, the surveying and construction of railway beds, civil engineer's and architect's office work, finer kinds of machine work and a host of other subjects, the understanding being that these subjects be treated in such a manner that *practical* information shall be the object rather than fundamental mathematical principles."

Other matters of importance are suggested in this part of Dr. Gray's report, one of which is that as there would probably be those in this course who would find it impossible to take the higher or technical college education, this upper secondary school would serve as a most excellent preparation for the same.

Dr. Gray recommends that the technical college or professional school be open only to a selected small number of students who have shown special fitness for the work, and that the entrance requirements should be considerably higher than is usual in existing

technical colleges. For this department extensive laboratory practice is recommended and thorough drill in the methods of testing properties of matter and in investigational work. Dr. Gray—as indeed every member of the advisory board—thoroughly agrees with Dr. Barker that apparatus should not be merely toys, that they must subserve some real purpose in the activities of life. As Dr. Barker puts it: “Where shall we draw the line between a testing machine and a cohesion apparatus—between a calorimeter of a pint capacity (an apparatus) and one of 100 gallons (a machine),” etc.

Dr. Gray suggests that this course might be of three years' duration and that fees be charged. Deserving students unable to bear the expense could possibly be provided with scholarships. Original research should be a prominent feature in this higher college.

Dr. Thurston's report to the committee is an exhaustive one, covering every phase of technical education, and as the commission will have it printed in full with the reports of other members of the board, I shall only give a few of the salient points in his paper.

Dr. Thurston assumes that the purpose of the institute will be primarily the useful education and technical training of the young people of Pittsburg, and especially of those belonging to the great body of wage earners, and that both sexes are, if practicable, to be equally well cared for. He divides these into two classes: (*a*) Those who can come to the instructor and give their time as required to study, to lectures and to recitations, and (*b*) those who are compelled to work during the working hours of the establishments in which they are employed and can only be given instruction outside during the evening hours, usually in evening classes.

Dr. Thurston asks: “Is it practicable to carry into effect that ambition of every tech-

nical education, so admirably pictured by Scott Russell, ‘the Technical University on the lines of which Ezra Cornell would have approved, where any man could secure instruction in any study in such departments as are capable of being utilized practicably in the sequel of life. It is obvious that could such an institution be founded, and thus the noble example be furnished in full perfection, and a standard thus provided by which to measure, the establishment of this complete and perfect model would, very probably, advance the cause of useful education of the people, for the life and work of the people for many years. It is possible that the opportunity is here and now presented, and that, lost, it may not recur again.’”

The opportunity is one not simply to provide education of the most imperatively needed sort for the youth of Pittsburg, but it is an opportunity to establish a model of the most perfect and most widely useful institution of learning that has been conceived, and that shall, by force of example establish a standard and promote the most complete and perfect system of technical and liberal education anywhere.

The general scheme laid out for the great technical school by Dr. Thurston is as follows:

(*a*) The college of mechanical engineering and the mechanic arts, with eight different departments of mechanical engineering.

(*b*) The college of civil engineering—with six departments.

(*c*) The college of architecture with three departments.

(*d*) The college of mines and metallurgy with two departments.

(*e*) The college of agriculture with six departments.

(*f*) The college of applied chemistry with four departments.

(*g*) The college of physics with two departments.

(*h*) The college of fine arts with three departments.

(*i*) The college of the business man with four departments.

(j) The college of navigation and marine transportation with two departments.

(k) The college of mathematics with two departments.

(l) The college of politics and economics with four departments.

(m) The college of languages and literature with four departments.

(n) The college of philosophical science and ethics.

(o) The college of biology.

(p) The preparatory college (standard curriculum).

"This scheme appears an ambitious one, but it so appears simply because we are in the very inception of educational work, and few persons have the slightest idea of the need or the opportunity for promoting the highest interests of the nation through a thoroughly systematized education."

Dr. Thurston refers with just pride to the Massachusetts Institute of Technology, the Armour Institute, the Pratt and Drexel institutes, as well as to others of a similar character, giving the curriculum of that sterling school of technology, the Massachusetts Institute, as well as much valuable data regarding the faculty, equipments and graduate students, all of which is compared with the Royal Technical College at Berlin. Dr. Thurston, with every other member of the commission, lays particular stress upon the value of the secondary school which he chooses to call the technical high school and which it is evident will meet the needs of the largest number of people. He chooses for a typical illustration of this division of the scheme the splendid work of the Pratt Institute of Brooklyn. Dr. Thurston also emphasizes the great value of such a secondary school to the young men and women of Pittsburg particularly, and believes it is only carrying out Mr. Carnegie's wishes to develop this department to its fullest extent.

As to the higher departments of the new school he expresses himself most charmingly in the language of John Russell on the occasion of the latter's visit to a German

technical university: "A technical university abroad was to me a surprise, a profound lesson, a delight. It was a dream of my youth suddenly embodied in living substance, and, unlike other realized dreams, the reality excelled the fiction. It was one of my early dreams that highly educated men should engage in teaching skilled workmen the profound philosophical principles which underlie all material work, and I hoped so to make their work their pleasure, excellence their ultimate aim and truth of execution and perfection of finish their highest ambition."

Dr. Thurston proceeds to discuss the higher branch of technical education with special reference to the needs of Pittsburg, then gives us some valuable information as to the status of the faculty of the great school, quoting precedents in home and foreign institutions. Endowments are also discussed with a freedom that has opened our eyes to the vital importance of this part of the scheme, and to which I have already referred in this paper. Summarizing, Dr. Thurston says:

"The first step considered advisable in preparing to supply Pittsburg and its environs with an institution of high efficiency for technical instruction should be to make a plan of that final educational structure which is taken to represent the limit toward which progress is expected to advance. The actual construction of the scheme should be commenced with the most essential elements; the less immediately and imperatively needed parts should be arranged for later. In the present case it would probably be justifiable to assume that the aim of the school should be, first, to provide for the young people of Pittsburg needing elementary technical educational instruction, and to organize for this purpose a technical high school with evening classes for pupils unable to attend regularly the day classes. This foundation being laid,

the various developments which have been considered in the preceding pages may be added, each as the preceding element is completed, working continually toward the technical university and the highest ultimate divisions of the scheme, the department of experimental engineering and research.

"The method of organization would be that which best insures the management of the whole of the great scheme and of each of its subdivisions by men expert each in his own field, whether that of director of the technical university, principal of one of its schools, or professor or instructor, or workman in shop, drawing-room or laboratory. Such an organization of a staff of experts being provided, the administration will be certain to work smoothly and efficiently, without special attention to detail on the part of the trustees. Their largest problem will be the matter of securing the endowment and its income from deterioration in later years and consequent impediment or interruption of the enterprise.

"Every division of the institution, from lowest to highest and first to last, should be so planned as to work in concert with the public schools of similar grade as far as practicable. The technical high school might accept certificates from the academic high schools of the city and from other academies of similar rank; the pupils of the city schools might be given admission to the classes of the technical school in the shops and technical departments; a half-time school, as advocated by Professor Higgins, of Worcester, might possibly come of such mutual aid of city and technical schools. The technical school would be able, in some cases probably, to promote the initiation of special instruction in manual training and in the kindergarten forms of technical work in the public schools. Every possible means of allying the technical and the common school work should

be availed of, and the cardinal principle should be constantly proclaimed and enforced: the purpose of the whole movement is to advance the best interests of the people of Pittsburg and its vicinity. It should be made distinctly understood that it is desired to make use of all possible ways to that end and to cooperate with every other educational movement."

In closing this far too lengthy paper I must acknowledge the great interest taken in the development of the scheme for the new technical school by the Engineers' Society of Western Pennsylvania, by the Women's Domestic Arts Association and by a number of eminent engineers, physicists and technologists at home and abroad; and the sole purpose of my paper is to ask the further cooperation and kindly advice of the members of this Association in formulating our plans, in steering clear of 'derelects' and in making the Pittsburg Carnegie School of Technology what its generous patron wishes it to be and what the demands of this great industrial nation require it to be. Any communication sent Mr. Wm. McConway, chairman of our committee, Pittsburg, Pa., will be received and acknowledged with great pleasure.

J. A. BRASHEAR.

SECTION A (MATHEMATICS AND ASTRONOMY) OF THE AMERICAN ASSOCIATION.

THE officers of this section were: vice-president, James McMahan; secretary, G. A. Miller; councilor, G. B. Halsted; sectional committee, James McMahan, G. A. Miller, H. A. Howe, Florian Cajori, F. H. Loud; member of the general committee, C. A. Waldo. The meetings of the section were well attended and most of the papers aroused discussion. With the exception of the anniversary meeting at Boston, the program was the most extensive in the recent history of this section. It consisted of the following twenty-five papers. As

the last six are of special interest to section B, they were presented at a joint session of sections A and B.

'Supplementary Report on Non-Euclidean Geometry': Professor G. B. HALSTED, University of Texas.

This is a supplement to the report read at the Columbus meeting. It will be published in SCIENCE.

'Kepler's Problem for High Planetary Eccentricities': Professor H. A. HOWE, University of Denver.

The solution of the equation $M = E - e \sin E$ is commonly called Kepler's problem. The known quantities e and M are respectively the eccentricity and the mean anomaly. E is to be found.

The purpose of this paper is to develop a direct method of solving Kepler's problem for planetary orbits of high eccentricity, which shall be more expeditious than any heretofore discovered, and shall be sufficiently accurate to meet the most exacting requirements of astronomers. This method is an outgrowth of one published by the author several years ago.

Let E' be an approximate value of E found by the well-known equation

$$\tan(E' - \frac{1}{2}M) = \frac{1+e}{1-e} \tan \frac{1}{2}M. \quad (1)$$

Let $2\eta = E' - M - \sin(E' - M)$, and

$$2\epsilon = \frac{1}{2}(E' - E) - \sin \frac{1}{2}(E' - E).$$

Then

$$E' - E = \frac{2\eta}{1 - e \cos \frac{1}{2}(E' + E)} - \frac{e \cos \frac{1}{2}(E' + E)}{1 - e \cos \frac{1}{2}(E' + E)} 4\epsilon. \quad (2)$$

But the unknowns, E and 4ϵ , are in equation (2), and must be made to disappear. In the most eccentric of the asteroid-orbits the value of the last term of equation (2) does not reach 0."0006; this term is therefore rejected, and we write with sufficient accuracy

$$E' - E = \frac{2\eta}{1 - e \cos \left\{ E' - \frac{\eta}{1 - e \cos(E' - \eta)} \right\}}. \quad (3)$$

E' may be found from (1), and $E' - E$ from (3); then $E' - (E' - E) = E$, the quantity desired. The paper was illustrated by large charts and will be published in the *Astronomical Journal*.

'The Great Fireball of December 7, 1900': Professor H. A. HOWE and Miss L. L. STINGLEY.

On December 7, 1900, at about 3:20 p.m., mountain time, there passed over the north-western quarter of Colorado a magnificent fireball, which exploded with startling detonations in the vicinity of the Bow Range near the north boundary-line of the state. The director of the Chamberlin Observatory prepared circulars of inquiry, containing a number of questions, which were lavishly distributed over the region from which the meteor was visible. The local press was also largely utilized for a dissemination of the queries. About 150 letters came in reply. Miss Stingley, of the class of 1903 in the College of Liberal Arts of the University of Denver, made a digest of these letters, and determined the meteor's path across the state. It passed nearly through the zenith of La Salle, and the main body came to earth in the vicinity of the town of Pearl. Its distance from the earth's surface, when near La Salle, was about 25 miles, and about 12 miles at the time of bursting. When the fireball was near Pearl an observation made by Mr. Thomas, of Manassa, a civil engineer, who was 250 miles away, gave it a height of 7 miles. Mr. Godshall, manager of a copper mining company, who was in Wyoming, about 40 miles beyond Pearl, saw the body come down in a curve somewhere in the general direction of Pearl.

Several observers thought that they saw fragments fall before the meteor reached Pearl, but on account of the wildness of the country none of the pieces have yet been found, though they have been searched for. The orbit has been computed on the

usual hypothesis that the path is a parabola. The body was moving nearly in the plane of the ecliptic, and caught up with the earth, which was traveling less rapidly in the same general direction. The search for fragments will continue. The paper will be illustrated by a large map showing the meteor's path across the country, and by a drawing exhibiting the relation of its orbit to that of the earth. It will be published in *Popular Astronomy*.

'Divergent and Conditionally Convergent Series whose Product is Absolutely Convergent': Professor F. CAJORI, Colorado College.

In an article on 'Divergent and Conditionally Convergent Series whose Product is Absolutely Convergent,' in the *Trans. of the Am. Math. Soc.*, Vol. II., pp. 25-36, were given special cases in which an absolutely convergent series is obtained as a result of multiplying two conditionally convergent series together, or one conditionally convergent series by a divergent series. But the sum of one of the two factor-series of each pair given in that article is zero. In the present paper it is shown that this is not a necessary property of conditionally convergent series whose product is absolutely convergent, and that the n th sum of such series may be of the degree $-r$, with respect to n , where $\frac{1}{2} < r \leq 1$.

'The Application of the Fundamental Laws of Algebra to the Multiplication of Infinite Series': F. CAJORI.

The behavior of infinite series with respect to the laws of algebra may be considered under two heads: An inquiry into the validity of the laws; (1) when applied to the terms of an infinite series; (2) when applied to the infinite series themselves.

The second inquiry, when made for the multiplication of series, leads to the conclusion that in this operation (assuming Cauchy's definition for the product of two infinite series), the asso-

ciative, commutative, and distributive laws are obeyed.

The two series obtained by removing the parentheses from the series,

$$S_1 \equiv \sum_{p=0}^{p=\infty} \left(\frac{1}{4p^r + 1} - \frac{1}{4p^r + 4} + \frac{1}{4p^r + 1} - \frac{1}{4p^r + 4} \right),$$

$$S_2 \equiv \sum_{p=0}^{p=\infty} \left(\frac{1}{4p^r + 4} + \frac{1}{4p^r + 4} - \frac{1}{4p^r + 1} - \frac{1}{4p^r + 1} \right),$$

where $\frac{1}{2} < r \leq 1$, are conditionally convergent, but their product is absolutely convergent.

Hence,

$$(S_1 S_2)(S_1 S_2)(S_1 S_2) \text{ is abs. convergent.}$$

But

$$(S_1 S_2)(S_1 S_2)(S_1 S_2) = S_1^3 \cdot S_2^3, \text{ and}$$

S_1^3 and S_2^3 are each divergent when $r < \frac{2}{3}$. Hence, when $\frac{1}{2} < r < \frac{2}{3}$, S_1^3 and S_2^3 are two divergent series whose product is absolutely convergent.

'On Systems of Isothermal Curves': Professor L. E. DICKSON, University of Chicago.

The object of this paper is to give an elementary geometrical definition of a system of isothermal curves in the plane. The definition is readily extended to families of curves on any algebraic surface. Two families of curves are discussed at length. From these the general definition is apparent.

'The Plane Geometry of the Point in Space of Four Dimensions': C. J. KEYSER, Columbia University.

The space under investigation is the point (in 4-space) regarded as the assemblage of all the lineoids (*i. e.*, ordinary 3-fold spaces), planes and lines containing it. This space is 3-dimensional in lineoids and in lines, the lineoid and the line being reciprocal elements; it is 4-dimensional in planes, the plane being *self-reciprocal*. The plane being

taken as element, a theory results which is in its analytical aspect identical with the Plücker line theory of the lineoid, while the two theories are geometrically disparate. It is seen that, while neither of these geometries has a correlate in its own domain, each is in the domain of 4-space the perfect correlative of the other. Naturally, therefore, in the geometry of 4-space, whether it be the point-lineoid theory or the line-plane theory, the two doctrines in question play indispensable and precisely coordinate rôles. The subject is treated under the following six headings: Introductory considerations, concerning certain metric relationships, homogeneous coordinates of the plane, the linear complex plane, linear congruences of planes, projective transformations by means of complexes.

'The Next Opposition of Eros': Professor H. A. HOWE and Miss M. C. TRAYLOR.

The planet Eros, to which astronomers have recently given so much attention, is now too near the sun for observation. As it is evident that the observatories near the equator will have a better chance to rediscover the planet than those in the United States, computations have been made for Manila, where the Jesuit Fathers have a large telescope, and for Arequipa, Peru, where the Bruce 24-inch star camera is stationed. To represent the United States Denver has been chosen, its latitude being $39^{\circ} 41'$. For each of the three dates, May 1, June 1 and July 1 of 1902 have been computed the times of sunrise, of the beginning of the morning twilight, and of the rising of Eros. From these computations it appears that the conditions for early rediscovery are most favorable at Arequipa, excellent at Manila, and unpropitious at Denver. But before July 1 it should certainly have been observed in the United States.

In order to have a secure basis for a theory about the causes of the planet's

variability, it is suggested that a table of standard magnitudes be computed for the entire period of visibility (May, 1902–October, 1903), on the assumption that the changes of brightness depend only on the relative positions of the sun, the earth and Eros. A comparison of the measured magnitudes with these will give data for theorizing.

A chart giving the path of Eros through the sky was exhibited, and also a pasteboard model of the orbits of the earth and the planet, showing their positions at favorable oppositions. This paper will appear in *Popular Astronomy*.

'On the Dimensions, Masses and Densities of the Satellites': Professor T. J. J. SEE, U. S. Naval Observatory.

The author points out the difficulty of measuring the angular diameters of very small bodies, on account of the tremors of the atmosphere, and then takes up the densities of the great planets as found in his recent investigations. He concludes that the average density of the four inner planets is 4.25, that of the outer planets 1.50. It is mentioned that the smaller inner planets have less density than the larger because the matter is less compressed by the action of gravity.

He then considers the diameters of the four large satellities of Jupiter; and, after analyzing the masses found by various investigators since the days of Laplace, adopts finally the masses used by Professor J. C. Adams. These masses, with the author's diameters, lead to the following densities for the several satellites:

Satellite I.	2.80	(Water = 1.)
Satellite II.	3.57	
Satellite III.	2.62	
Satellite IV.	0.76	

An investigation of Titan, the largest satellite of Saturn, shows its probable mass to be $\frac{1}{4700}$ that of Saturn, and the density 2.03. Thus Titan appears to be solid, and

less dense than the planet Mercury (3.00), which is the rarest of the inner planets. Professor See concludes that on the average the satellites are of the density 2.36, about the same as the matter which compresses the crust of the earth (2.55); and that the small satellites which cannot be measured are of about the same density as those which can be investigated, such as the four satellites of Jupiter, and Titan, the largest satellite of Saturn.

'Photometric Observations of Eros': HENRY M. PARKHURST, New York City.

These observations, extending from September 13 to March 22, comprised 382 double extinctions, in comparison with a large number of standard stars, including four other asteroids. From these observations the constant of brightness, reducing the distances to unity, was ascertained to be 9.78 mag., and the constant factor for phase angle .037. The phase correction, additional to the correction for defect of illuminated surface, was found to be uniform through the whole variation up to 58°. The observations confirm the discovery of the rapid change of brightness, undoubtedly due to rotation. The author's conclusion is that this change is probably due to the spheroidal form of Eros, the amount of the change depending upon the direction of the axis of rotation with regard to the earth.

'On the History of Several Fundamental Theorems in the Theory of Groups of Finite Order': Dr. G. A. MILLER, Cornell University.

This paper will appear in a future number of SCIENCE.

'On Certain Methods in the Geometry of Position': Professor ARNOLD EMCH, University of Colorado.

In this paper the author attempts to outline those methods which seem to be best adapted for an introductory study of projective geometry. Particular stress is laid upon the study of homology in advanced

plane geometry and descriptive geometry. It is shown that the principles of homology result naturally from the orthographic and also central projection, and that their application is conversely the best means for the construction of projective figures.

'The Parallaxes of 54 Piscium and Weisse 17^h, 322': Professor F. L. CHASE, Yale Observatory.

This paper was supplementary to a paper read by the same author before this section a year ago under the title, 'The Series of Parallaxes of Large Proper Motion Stars made with the Yale Heliometer,' a research begun in 1892, the observational part of which was finished the present year. In that paper the author had stated that the results of a preliminary solution indicated two of the 97 stars under investigation to possess a parallax of nearly 0''.25, which values, if confirmed by further observation, would place them among the first ten or twelve nearest stars so far as at present known. These two stars have been further investigated, two additional pairs of comparison stars being selected for each of them, and the observations with the original pairs repeated at the same time.

Altogether there were 56 observations on 54 Piscium and 54 on Weisse 17^h, 322, distributed as follows:

54 Piscium, Mag. 6.2.

Series I. 12 obs. with a & b Mags. 7.5 & 7.3 (orig.)
 Series II. 12 obs. with a & b (rep.)
 Series III. 16 obs. with c & d Mags. 8.7 & 8.7
 Series IV. 16 obs. with e & f Mags. 7.5 & 5.5

Weisse 17, 322 Mag. 8.0.

Series I. 10 obs. with a & b Mags. 7.0 & 8.0 (orig.)
 Series II. 12 obs. with a & b (rep.)
 Series III. 16 obs. with c & d Mags. 7.2 & 5.5
 Series IV. 16 obs. with e & f Mags. 8.6 & 7.2

The observations treated in the customary way and the equations derived therefrom being solved, the following results were obtained:

for 54 Piscium from

Series I.	$\pi = + 0''.241 \pm 0''.026$	Wt. 36.10
Series II.	$\pi = + 0.081 \pm 0.017$	Wt. 42.26
Series III.	$\pi = + 0.183 \pm 0.035$	Wt. 59.53
Series IV.	$\pi = + 0.055 \pm 0.023$	Wt. 51.40

for Weisse 17, 322,

Series I.	$\pi = + 0''.218 \quad 0''.030$	Wt. 33.60
Series II.	$\pi = + 0.189 \quad 0.034$	Wt. 35.08
Series III.	$\pi = + 0.198 \quad 0.022$	Wt. 45.87
Series IV.	$\pi = - 0.047 \quad 0.031$	Wt. 38.92

The author then goes on to discuss the disparity between some of the results, which are rather amazing in view of the size of the probable errors found. He investigates the question of a possible large systematic error and concludes that any such error, if it exists, must arise from the employment of different comparison stars, and is not due to changes dependent on the time. He finds only one of the comparison stars to possess any appreciable proper motion, viz., star *c* in the first table, which amounts to $- 0''.01$ in R.A. and $0''.3$ in Decl. the proper motion of 54 Piscium, according to Porter, being $- 0''.034$ in R.A. and $- 0''.38$ in Decl., and of Weisse 17^a, 322, $- 0''.040$ in R.A. and $- 1''.22$ in Decl.

He finally concludes by combining the various solutions, first, by their weights, and second, by the magnitude of the probable errors, and finds the following values :

for 54 Piscium,

I.	$\pi = + 0''.137 \pm 0''.014$	Prob. error 1 Ob. = $\pm 0''.193$
II.	$\pi = + 0.117 \pm 0.011$	

for Weisse 17, 322,

I.	$\pi = + 0''.132 \pm 0''.013$	Prob. error 1 Ob. = $\pm 0''.166$
II.	$\pi = + 0.140 \pm 0.014$	

But the author remarks that it has been considered worth while to make still another series on Weisse 17^a, 322, with the third set of comparison stars *e. f.* where there is a great difference in brightness, using screens in various ways to see if difference of brightness could account for the anomalous results obtained. Meanwhile the results above

given must be considered as only provisional.

'The Distance of the New Star in Perseus': Professor F. L. CHASE.

When the new star in Perseus first appeared last February it at once became the great desire of the author to determine, if possible, the parallax of this most remarkable object. So far as is known to the author, no one has as yet succeeded in determining the distance of one of these new stars. In 1892 he began a series of observations on Nova Aurigæ for the same purpose, but it will be remembered this star rapidly diminished in brilliancy, though with several fluctuations, and was not observable with the Yale heliometer for more than two or three months, which would not give a very sensible parallax factor. With Nova Persei conditions have been much more favorable, and even now the star is conspicuously brighter than the brightest comparison star employed, which was, according to Argelander, of the 7.4 magnitude.

There was but a single pair of comparison stars suitable for the purpose, viz., B.D. + 43°, 720 Mag. 7.4 and B.D. + 43°, 766 Mag. 8.0. Calling the first *a* and the second *b*, the position angles were respectively about 252° and 94°, and the distances, 2900" and 2700" from the Nova.

The plan was to make the observations in the usual symmetrical order *Na, Nb, Nb, Na*, so as to eliminate, as far as possible, the effect of refraction and other effects which may vary with the time. Since the distance, *ab*, was not beyond the range of the heliometer it was thought expedient to measure this distance also each night, and thus have besides the sums of the distances, an independent basis for correcting the changes in the scale value from night to night. Each night's work, then, consists of six observations of distance each of four pointings in reversed positions of the instrument, as follows: *Na, Nb, ab, ab, Nb,*

Na. Such observations were secured on five nights from February 26 to March 18, and seven from July 19 to August 4. These treated in the usual manner by the differences *Na* — *Nb*, corrected for scale value furnish seven equations of condition of the form :

$$+ 1.0x - 1.88y + 0.15z = -0.003 \text{ or } -0.004,$$

the equation derived from the observations of February 26, where *x* = the correction to the scale value, *y* = the parallax, and *z* = the proper motion.

A solution of the normals derived from these equations gives :

$$y = -0.0003 \pm 0.0013 = -0.003 \pm 0.017 \text{ Wt. } 38.85$$

or,

$$-0.0002 \pm 0.0013 \quad -0.003 \quad 0.017 \quad \text{“} \quad \text{“}$$

But since the distance *ab* furnishes an independent scale value, it was thought in the beginning that with this independent value we might solve the parallax from each comparison star separately, and thus see if there is any marked difference in the parallaxes of the comparison stars themselves. A closer investigation later, however, showed that this method would involve the parallaxes of the comparison stars in precisely the same manner as before, and hence would furnish nothing further than another value of the parallax relative to that of the mean parallax of the two comparison stars, differing from that already found simply by the difference in the scale value used.

The value found by this method was :

$$\pi = -0.006 \pm 0.022$$

as compared with

$$\pi = -0.003 \pm 0.017$$

given above ; which agrees with the uncertainty of the computations.

The author was able to find only one of the comparison stars in any other catalogues than the A. G. Zone Catalogue for 1875,

and this one shows no appreciable proper motion.

Of course the result here given must be considered as only provisional, inasmuch as nothing is known as to the proper motion of the Nova and it is barely possible that this may be such as to have just neutralized the effect of parallax. Should the star remain sufficiently bright for another six months, however, it will then be possible to determine the effect of proper motion and hence give a definitive result.

‘Hyperbolic Curves of the *n*th Order’ : Mr. A. C. SMITH, University of Colorado.

In a plane are given *n* straight lines with Cartesian equations. Any point in the plane is taken as origin and through this a line is drawn intersecting the *n* lines in *n* points. In this manner *n* segments, measured from the origin, are obtained on the line through the origin. The algebraic sum of these segments taken on this same line will determine a point, *P*, which will describe a curve of the *n*th order as the ray through the origin rotates through 360°. It was shown how the general equation of the locus could be obtained and some linear transformations were considered.

‘A Uniform Method of determining the Elements of Orbits of all Eccentricities from three Observations of Apparent Position’ : Dr. F. R. MOULTON, University of Chicago.

The methods of determining orbits which are in most general use were devised by Gauss one hundred years ago. They are different for orbits in which the eccentricities are less than, equal to, and greater than, unity, although there is no singularity, which is essential to the problem, for the eccentricity equal to one. The method of this paper is uniform for all orbits, it is considerably more convenient than that of Gauss, and the radius of convergence of the series employed is examined in each case.

The longitude of the node and the inclination are computed by the usual methods,

which are satisfactory, and the heliocentric distances and the arguments of the latitude at the epochs of the three observations are computed as in the method of Gauss.

Let $u_1, u_2, u_3, r_1, r_2, r_3$ represent the arguments of the latitude and the heliocentric distances at the epochs of the three observations. Then the parameter, p , is defined by the equation

$$k \sqrt{p}(t_3 - t_1) = \int_{u_1}^{u_3} r^2 du,$$

where r^2 is expressed as a series in u whose radius of convergence is determined as a function of u_2 and e . It is shown how the coefficients are to be found. The eccentricity, e , and the longitude of the perihelion from the node, ω , are given by

$$\left\{ \begin{array}{l} e \sin (u_1 - \omega) = \left\{ \begin{array}{l} \frac{p - r_1}{r_1} \cos (u_3 - u_1) \\ - \frac{p - r_3}{r_3} \end{array} \right\} \operatorname{cosec} (u_3 - u_1), \\ e \cos (u_1 - \omega) = \frac{p - r_1}{r_1}. \end{array} \right.$$

The time of perihelion passage is determined from the law of areas.

'On the Modular Functions associated with the Riemann Surface

$$s^3 = z(z - 1)(z - x)(z - y)';$$

Dr. J. I. HUTCHINSON, Cornell University.

The object of the present paper is to extend the results obtained by Picard in his memoir 'Sur des fonctions de deux variables independantes analogues aux fonctions modulaires' (Acta Math., II., p. 114). Picard considers in the first place the integrals of the first kind, and in particular the moduli of periodicity of the normal integrals. By changing the values of x, y in a continuous manner so as to return finally to their initial values, the moduli undergo a linear transformation, which can be represented by a linear transformation on two parameters, u, v , in terms of

which all the moduli are rationally expressible.

These transformations forming an infinite group G can be generated by five special ones $S_1 S_2 \dots S_5$, the explicit equations for which were given by Picard in a subsequent paper (Acta Math., V.).

The two variables x, y are then automorphic functions of u, v , and all functions belonging to the group can be rationally expressed in terms of these.

According to theorems previously obtained by Picard, there exist functions possessing a pseudo-automorphic character, exactly analogous to the fuchsian theta functions which Poincaré uses in connection with the automorphic functions of a single variable.

These functions can be constructed out of the theta constants. In order to do this it is necessary to determine the effect of the transformations of the group G on the latter, which is accomplished by means of the transformation theory of the theta functions. A table is constructed by means of which pseudo-automorphic functions can readily be constructed.

'Some Future Solar Eclipses, in particular that of June 8, 1918, total at Denver': Professor F. H. LOUD and Mr. L. R. INGER-SOLL, Colorado College.

The tables used in computing the circumstances of the eclipses herein discussed are those 'On the Recurrence of Solar Eclipses' published by Professor Simon Newcomb in 1879. After some remarks upon the limits within which the errors of such a computation may be expected to fall, the results of what seems the preferable combination of Professor Newcomb's tabulated data are stated as follows:

On June 8, 1918, the moon's shadow passes across the United States from northwest to southeast, covering Denver from 4^h 22^m 59^s P.M. to 4^h 24^m 23^s—a period of 1^m 24^s; while on the central line the duration is 1^m 33^s.

The width of the shadow-path is about 59.3^m and the velocity of the shadow 2900^m an hour. The eclipse will be visible from Chamberlin Observatory, Denver, and Mt. Arapahoe, Grand Co.

Sept. 10, 1923. An eclipse of duration $3^m 24^s$ is total from San Diego, Cal., eastward along a line near the United States and Mexican boundary. Width of shadow-path 102 miles.

Jan. 24, 1925. An eclipse visible (as total) from northern Michigan to New Haven, Ct., reaching the latter point at $9^h 5^m$ A.M., and lasting $2^m 8^s$.

Two maps of the Denver eclipse were shown.

'Bibliography of Quaternions and Allied Systems of Mathematics': Professor ALEXANDER MACFARLANE, Lehigh University.

The association for the promotion of quaternions and allied mathematics has in preparation a bibliography of all the literature of the subject. The field embraces all that has been written on what is called geometric algebra, or space analysis, and its three main subdivisions are quaternions, Ausdehnungslehre, and geometric algebra previous to Hamilton and Grassmann. The extent of this literature is not so small as is commonly supposed. As regards the first branch, the papers of Hamilton himself are numerous, and he has been followed by about one hundred writers. The writings of Grassmann are also numerous, and he has been followed by about the same number of writers.

It is desired to make the bibliography as complete as possible, and the writer desires mathematicians to cooperate by sending to him the necessary data about their own writings, or any rare writings in their possession.

'The Bruce Micrometer': Professor C. J. LING, Denver Manual Training High School.

The filar micrometer attached to the

telescope at the Chamberlin Observatory at University Park, Colorado, is the gift of the late Miss Caroline W. Bruce. It is especially adapted to rapid work and work on faint objects. Instead of being screwed to the tail piece of the telescope, it is so attached that it slides off, thus leaving the zero of the position circle unchanged. The position circle is furnished with a system of solid stops which enable it to be turned exactly 90° when micrometric measures of both $\Delta\alpha$ and $\Delta\delta$ are being made. These stops can be rapidly thrown back, enabling the circle to be turned any desired angle, and so rapidly thrown exactly to their former position. The circle can also be clamped at any position and adjusted by the use of a tangent screw.

The eye piece can be moved rapidly in both R. A. and Decl., admitting of the use of exceptionally long and a large number of spider webs. It is possible to observe objects differing in declination by more than $30'$, and this with a comparatively small motion of the micrometer. A micrometer screw of 20 threads to the inch makes rapid work possible. This is provided with three heads which are graduated so as to be read rapidly, two of which may be clamped in position.

The field is illuminated by two pairs of two candle power electric lamps whose intensities are regulated by a rheostat and mechanical shades, making it possible to rapidly adjust the illumination or to throw it off entirely. The observer can also illuminate at will either or both of the verniers of the position circle.

The results obtained from many hundreds of observations demonstrate that the micrometer is admirably adapted to combine rapidity and accuracy, making it an extremely efficient instrument, and this is all the more worthy of mention since it is accomplished without undue haste on part of the observer.

'The Metric System in the United States': Mr. JESSE PAWLING, Jr., Central High School, Philadelphia.

A brief history of the action of Congress in the subject of weights and measures is given. This includes the passage by the House and failure to pass by the Senate of the bill of 1796; the petitions urging legislation in uniformity of weights and measures from various states; the bills of 1866 to legalize the metric system and to allow it for the use of the post-offices; the failure to consider the bills of 1892 for the adoption of the metric system for the exclusive use in the customs service, though urged by 150 petitions; the passage of the bill of 1896 and its reconsideration, which referred it back to the committee from which it was not reported, and the bills following this for the same purpose, the adoption of the metric system for the use of the Departments of the Government, none of which were considered.

The work of the English Decimal Association has advanced the interests of the metric system. The association has among its members, members of Parliament and business people of England. It has secured the pledges of members of Parliament to vote for the metric system. It has secured the teaching of the metric system in the schools. It circulates literature and has a lecturer who addresses audiences wherever a meeting can be secured in England. It circulates reports of consuls on the metric system in other countries. It has secured the cooperation of the labor organizations, Chamber of Commerce, and National Union of Teachers: It has no dues and any one can become a member.

A similar organization may do good work in this country for the interests of the metric system. It could secure the cooperation of Congressmen. It might aim at having the metric system taught in the schools. It could educate the people by literature and

lectures like the English Decimal Association. It might secure advertisements of foreign goods in the metric system and in many other ways popularize the metric system with nominal or no dues.

'The New National Bureau of Standards': Mr. JESSE PAWLING, Jr.

The new Bureau is to be located in the suburbs of Washington, where it is free from disturbance. It has an appropriation of \$300,000 and a laboratory costing about \$200,000 is to be erected. Great care is to be exercised in selecting the personnel, and none but those trained for the work will be employed, as it is under civil service laws. Members of the Bureau are traveling to inspect laboratories of Europe. When established the Bureau will employ a number of young men just graduated from universities, giving them opportunities to develop along the lines which they wish to follow. It will invite specialists to do work in their line.

The Bureau standardizes three grades of weights and measures:

1. Those for commercial use.
2. Those for manufacturing and technical processes and professions; and
3. Those for extreme accuracy for scientific purposes.

'A Summary of the Salient Effects due to Secular Cooling of the Earth': Professor R. S. WOODWARD, Columbia University.

The effects summarized in this paper are:

(a) The slow process of heat conduction in the earth's crust, leading to the conclusion that nothing less than a million years is a suitable time unit for recording the historical succession of events.

(b) The insignificant modification of the process of conduction arising from the hydrosphere, leading to the conclusion that secular cooling goes on substantially as if the earth had neither atmosphere nor ocean.

(c) The resultant effect on the litho-

sphere of secular contraction and the process of isostasy.

(d) The effects of secular contraction on the length of the sidereal day.

'The Energy of Condensation of Stellar Bodies': Professor R. S. WOODWARD.

The problem considered in this paper is that of the energy due to the gravitational condensation of gaseous matter from a state of infinite diffusion to a finite spherical mass in which Laplace's law of density holds. The problem is worked out in its generality, formulas specifying the distribution of density, pressure, and potential in the mass being given. Special attention is given to the probable case of the fixed stars of a vanishing surface density.

'The Physical Basis of Long Range Weather Forecasts': Professor CLEVELAND ABBE, U. S. Weather Bureau.

In the absence of the author and of the member who was to present it this paper was read by title. The papers by Professor See and Dr. Moulton were presented by Professor Howe. Those by Professor Dickson, Mr. Keyser, Mr. Parkhurst, Dr. Hutchinson and Professor Macfarlane were read by the secretary. All the other papers were presented by their authors. Several other papers were read before the joint session of Sections A and B. These will be included in the report of Section B.

G. A. MILLER,
Secretary of Section A.

ON THE STABILITY OF VIBRATIONS.

Observations.—The following experiment seems to me to be an interesting illustration of the equation of the damped harmonic oscillation. It also presents a striking illustration of the stability of a given type of vibration.

The necessary apparatus is very simple, consisting of an ordinary open organ pipe (say c'' of the one foot octave) and a cylindrical tin box, 4–5 cms. in diameter and 5–6

cms. long, with a central hole at one end about 1 cm. in diameter. This is adjusted so as to be of the same period as the organ pipe. A König's resonator will do equally well, but if the box has a slightly loose lid, it brings out other phenomena also deserving notice.

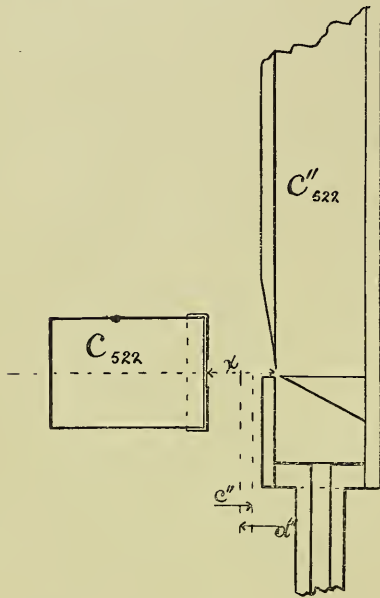
The experiment is as follows: Using a resonator giving b' to e'' , depending on the intensity of the blast and with a loose (not sealed) lid, let it be placed symmetrically to the slit of the pipe at a distance, x , from it, as shown in the figure. Then as x decreases from a large distance, to say 3 cms., the resonator trembles violently (felt with the finger), but neither raises nor depresses the note. As x decreases further to 1.7 cms., no marked effect occurs, but pressure in the influx of the organ pipe will force out the octave, which it did not do before. Between $x = 1.7$ and $= 1.5$ there is destructive interference; a mere whiffing is heard from the combined instrument, but an impure octave may be forced out by pressure. Finally, when x decreases further to say 1.1 cms., a clear d'' suddenly breaks forth and is the chief feature of the experiment. For smaller distances (1.1 to .7 cms.) the d'' flattens again to e'' .

The same sharpening is produced when the resonator is placed on top of the open organ pipe, mouth inward. If two resonators are used, one as in figure, the other on top, the sharpened note of the one is further sharpened by the other.

When the so-called destructive interference occurs there is no vibration in the resonator; but on pressing the finger against its bottom, the c'' may again be heard.

If the lid of the resonator be cemented on with wax, or if a round König resonator be used, there is no whiffing. The interval, x , of instability is then very small (about .2 cm.) so that the note passes very suddenly from c'' to d'' . Too loose a lid merely depresses the tone at short distances.

The rise of the sharpened note will naturally depend on the pitch of the resonator. For a shorter one giving d'' to e'' with increasing blast, the above effect on the organ pipe is an e'' flat. A resonator of pitch d''



to f'' raises the organ pipe to e'' or depresses it to b' , as follows: c'' at long ranges, b' at $x = 1.2$, about; b' flat at $x = 1.0$ cm., then suddenly e'' at $x = .9$ cm. Here I thought I had detected two modes of vibration of a system of two degrees of freedom; yet as the butt end of the resonator produced like depressions of tone, this is probably referable to increased friction.

A resonator of pitch $a'-c''$, definitely below that of the pipe, depressed the tone from c'' to c'' flat. With the butt end the depression was a whole tone. The same resonator on top of the pipe showed just perceptible sharpening. The effect seemed to be the same whether the pitch of the resonator was depressed by lengthening or by reducing the size of the mouth.

Remarks in Explanation.—As the note of the organ pipe is always depressed when the butt end of the resonator or any other

obstacle is brought up to the lip, I think that a rough explanation in terms of a system of one degree of freedom will be admissible. Thus the organ pipe is vibrating throughout under more or less resistance. Its period may therefore be given by $T = 2\pi m / \sqrt{ma - b^2}$, where m is the inertia of the vibrating body, a is Hooke's constant and $2b$ the coefficient of friction. From another point of view, $T = 2\lambda m / b$, if $\lambda = Tb / 2m$ is the logarithmic decrement.

If the friction is increased by presenting an obstacle at the lip, b is increased and therefore T is increased or the tone is depressed. If, however, the friction is decreased by presenting a negative obstacle—i. e., the mouth of a resonator—near the lip, which initially tugs and pushes synchronously with the vibration of the lamina of air from the lip, then b is decreased and T is decreased. In other words, the tone is sharpened. It is in this way that I have presented this very striking phenomenon as an illustration of the given equation, though the full explanation cannot of course stop with a single degree of freedom.

As to the reasons for the absorption of the organ-pipe note in the resonator, if its lid is somewhat loose, it is clear that this cannot be a case of ordinary interference; for in such a case there should be vibration in the resonator, whereas none is manifest to the touch at least. In other words, each successive vibration of the organ pipe is quenched in the resonator, being completely damped out. Hence the effective friction in the resonator considered alone for the given conditions is so large as to change the harmonic type of decay in the exponential type, the period becoming imaginary. Now it is interesting to note that this takes place at a particular distance, x , from the lip within narrow limits, the resonator responding strongly to c'' for larger values of x , and to d'' for smaller values. The whiffing suggests the impure octave b'' , while

increased pressure at the organ pipe brings out the strong octave c'' .

Stability of vibration. Vibrational hysteresis.— Finally, the peculiar phenomenon observed in connection with the stability of vibration deserves special mention. A König resonator mounted on a graduated slide, x , is convenient for the purpose. If the mouth of this apparatus is approached slowly from a large distance, x , to within 2.2 cm. of the lip, c'' is strongly resounded. On passing these limits, d'' breaks forth almost suddenly. With this d'' sounding from the combined system, withdraw the resonator slowly again; d'' will be retained until x has increased to 2.8 cm., about. Hence, within 6 mm. of approach, the note is either c'' or d'' , depending upon whether the position has been reached from large or from small values of x , within the limits given. See figure. With a carefully regulated slow influx, 9 or even 10 mm. of range were attained with a sharp clicklike breakdown at each end. The change from c'' to d'' is usually more sudden, that from d'' to c'' more gradual, perhaps, but the *hysteresis-like* character of the phenomenon is unmistakable. As I have recently been studying hysteresis* from different points of view (cf. forthcoming paper in the *Physical Review*, on temporary set), the present purely vibrational case of it is to me strikingly interesting.

CARL BARUS.

BROWN UNIVERSITY.

THE FIFTH INTERNATIONAL ZOOLOGICAL CONGRESS.

THE Fifth International Zoological Congress held its sessions in Berlin from August 12 to August 16, under the gracious protection of His Highness the Crown Prince of Germany and the presidency of Professor K. Möbius, and, so far as concerns the attendance, was the most successful of

all that have so far been held. Most of the countries of Europe were well represented, delegates were present from Canada, Brazil, Mexico and the United States, the total number of those present being considerably over six hundred. The members in attendance from the United States were: Professors E. B. Wilson, of Columbia University, and Patten, of Dartmouth College; Dr. Stejneger, of the Smithsonian Institution; Dr. C. W. Stiles, of the National Museum; Mr. W. A. Murrell, of Cornell University; Mr. J. Hunter, of St. Louis, and Professor J. Playfair McMurrich, of the University of Michigan. Owing to the large number of papers to be presented, seven sections were established, namely, general zoology, experimental zoology, vertebrata (biology and systematic), vertebrates (anatomy and embryology), evertabrata (exclusive of arthropoda), arthropoda and nomenclature; and while such a separation of subjects was undoubtedly necessary and the grouping as satisfactory as might be, it made it impossible to attend the reading of many of the papers in which one might be interested.

The papers read were very varied in character, some being on special subjects, some, indeed, altogether too special for such a meeting, and others on the more general problems of zoology. If a single subject is to be selected as that which awakened the greatest interest, the new or rather the rekindled struggle between vitalism and mechanism must be the one chosen. Driesch, who has precipitated the renewal of the struggle, presented his views to a well-attended meeting of the section of experimental zoology, upholding, in a forcible and clearly stated argument, the vitalistic side of the question, while, in the discussion which followed, Ziegler, Roux and Rhumbler took the opposite side, maintaining that it is too early yet to admit the existence of vitalism or to postulate an active purpose-

* *American Journal of Science*, XI., 1901, p. 97.

fulness for the vital processes. That we cannot explain certain phenomena exhibited by living organisms on the mechanical or better the physical, hypothesis does not necessarily require the postulation of a vital force; it may rather be due to our ignorance of the physico-chemical and mechanical factors at work, and the progress of modern investigation has steadily tended towards the elucidation of more and more of the vital phenomena as chemico-physical or mechanical processes. In one of the general sessions of the Congress the same problem was the topic of a lecture by Bütschli, of Heidelberg, whose work on the structure of protoplasm necessarily inclines him towards the mechanical side. The problem, of course, cannot as yet be settled, but the opinion of the majority who took part in the discussion seemed to be in favor of the physical theory, holding that the neo-vitalists had not demonstrated the existence of a special life force or a necessity for such a force.

One of the most interesting and instructive of the lectures before the entire Congress was that given by Professor Poulton, of Oxford, on 'Mimicry and Natural Selection.' His thesis was the defense of Darwin's theory of mimicry, and in a clear and convincing manner he showed that many of the peculiarities exhibited by mimicking animals can be explained plausibly and satisfactorily on no other hypothesis. His lecture was illustrated by lantern slides, photographed in colors, showing numerous cases of mimicry in insects collected, with a special view to the study of this question, in Mashonaland, South Africa. Other lectures in the general sessions were given by Professor Grassi of Rome on 'The Malaria Problem from the Zoological Standpoint'; Professor Delage, of Paris, on 'The Theories of Fertilization'; Professor Forel, of Morges, on 'The Psychic Peculiarities of Ants'; Professor Branco, of Berlin,

on 'The Fossil Remains of Man,' the last named making the rather startling suggestion that *Pithecanthropus* may have been neither man nor ape nor yet a connecting link between the two, but a cross between pliocene man and an ape!

Of the papers read before the various sections there were but few which call for special notice. One of the most important was the announcement by Professor Patten that he had been able to detect the existence of a series of three-jointed appendages in specimens of *Cephalaspis* preserved in the British Museum, a fact which, taken along with the structure of the shell and the arrangement of organs which may be identified with median and lateral eyes, seems to indicate a close affinity of these supposed fishes with the merostomatous crustacea. In the section for vertebrate anatomy and embryology, Hubrecht presented the results of his studies of the development of *Tarsius*, which seem to explain the significance of the belly-stalk of the higher mammals, and Kopsch demonstrated by interesting experiments upon the blastoderm of the chick that Balfour's view that the primitive streak lay entirely posterior to the body of the embryo required considerable modification. Papers were also presented by Schauinsland on the development of the skull of *Hatteria* and of *Callorhynchus* and by Mitrophanow in the early development of the ostrich.

In the section for experimental zoology in addition to the paper by Driesch already mentioned, Herbst contributed an interesting communication on the influence of the nervous system on regenerated parts, having found that the regeneration of the eye-stalk of a crab resulted in the formation of an antennule, provided the optic ganglion had been destroyed by the operation. Other interesting papers presented to this section were by Spemann, of Würzburg, on the formation of double embryos by constricting

the eggs of *Triton* in the two-celled stage, his method permitting of different degrees of constriction and of constriction in different planes, as well as a thorough study of the resulting abnormalities; and by E. B. Wilson, who gave the results of his studies on the cytological changes in the eggs of *Toxopneustes* developing parthenogenetically by the Loeb method.

In the section for systematic zoology of the vertebrates one of the most interesting exhibits was that by Sclater of the skull and a portion of the skin of the newly discovered *Okapia*, a giraffine animal closely related to the extinct *Helladotherium* and obtained in the Uganda district by Sir Harry Johnston. The papers and demonstrations in the section for invertebrata were numerous, and it is impossible to refer to more than a few of them. Most noteworthy was perhaps a magnificent collection of Hexactinellid sponges obtained from the Japanese seas and exhibited by Professor Iijima, of Tokyo, while other papers of interest were by McBride on the development of *Echinus esculentus*, Apathy on the visual cells of the Herudinea (both these with demonstrations), Hoyle on intrapallial luminous organs in the Cephalopoda and Simroth on the digestive canal of the Mollusca. The section on nomenclature devoted a considerable portion of its time to a consideration of the report of the commission proposed at the last Congress and appointed a committee to codify the rules as they now exist.

The arrangements for the meeting were admirably carried out. Through the courtesy of the president of the Reichstag the sessions of the Congress were held in the Reichstag building and everything was done to make the meeting enjoyable in every way. The death of the Empress Frederick naturally cast a gloom over the city and entailed considerable alterations in the program of excursions and festivities which had been planned by the com-

mittee, but withal they were fully successful in their efforts to make the meeting both intellectually and socially enjoyable for all those in attendance.

The next Congress will be held in Berne, Switzerland, in 1904, and Professor Studer, of Basel, was unanimously chosen as president-elect.

J. P. McM.

SCIENTIFIC BOOKS.

Annals of the Astrophysical Observatory of the Smithsonian Institution. Vol. I. By S. P. LANGLEY, Director, aided by C. G. ABBOT. Washington, Government Printing Office.

During the ten years of its existence the Smithsonian Astrophysical Observatory has been almost entirely devoted to the prosecution of a single research—a continuation of one begun some years ago by Professor Langley at Allegheny—namely, the production of a map of the absorption lines in the infra-red solar spectrum which would be in some measure comparable as regards completeness and precision with those of the visible region produced photographically with the aid of the grating. Besides this main research—and carried out largely since its completion—several subsidiary researches have been undertaken, one of which, to be mentioned later, is of particular importance.

If we represent the solar radiation by an energy curve, in the usual manner, in which ordinates are proportional to radiant energy, and abscissæ to wave-lengths, the selective absorption of the solar and terrestrial atmospheres will be indicated by depressions in the curve, whose depth and width will show the intensity of the absorption and the extent of the spectral region affected by it. In the visible region, of course, the absorption will be indicated by a great number of more or less sharp, close-packed depressions, corresponding to the great number of visible 'lines.' It has been found that, besides broad regions of general absorption previously noted by Langley and others, the infra-red spectrum is also affected by similarly sharp selective absorption, producing 'lines,' and as has been said, this main research is devoted to the mapping of

these 'lines'—that is, to the accurate determination of the details of the infra-red energy curve. It is noticeable that most of the effort has been put upon the measurement of the abscissæ of the curve (*i. e.*, wave-lengths), the ordinates being considered for the present of secondary importance; and no determination of the radiant energy in absolute measure has been attempted.

The problem can be considered as made up of two distinct parts: first, the production of a sufficiently intense, pure and well-defined solar spectrum by means which permit of the direct or indirect measurement of wave lengths; second, the detection of absorption lines in a region of this spectrum quite beyond the range of visual or even special photographic processes, and in a manner which will result in the precise location of these lines in the spectrum and in the approximate determination of their intensity and character. As a means of producing the spectrum the grating, on account of loss of energy, was necessarily discarded in favor of the prism; of glass for the shorter wave lengths, of rock salt for the longer. The observatory possesses undoubtedly the finest specimens known of the latter substance; one in particular, from the salt mines of Russia, in the form of a 60° prism with faces 13 cm. wide and 19 cm. high, having been used in the present research. The spectroscope as finally used was of the extremely convenient fixed-arm type described by Wadsworth (*Phil. Mag.*, '94) combined with a very ingenious collimating system of cylindrical mirrors, due to Mr. Abbot, which enabled a slit of sufficiently small angular width to be used, while at the same time the linear width could be so great (over 0.2 mm.) that the loss of energy by diffraction at the slit was avoided. The refinement of the apparatus is shown by the fact that in the region of wave-lengths $\lambda < 2.5\mu$, a slit image of angular width 1''.5 could be used with a bolometer of angular width 1''.2, while for longer wave-length the values 4''.5 or 9'' and 3''.4 respectively were necessary to obtain proper deflections. The Rayleigh formula for visual spectroscopic resolving power indicates that with the prism used some 1,300 lines might be detected in the region between $\lambda = .76\mu$ and $\lambda = 5.3\mu$. It is here shown that by

the use of instruments of detection other than the eye the resolving power might be different and possibly greater than that given by Rayleigh's formula; and apparently this limit has been exceeded in practice. With the prism spectroscope, in order that the wave-length corresponding to a particular position in the spectrum may be known, the angle of the prism and its dispersion curve must be known; the former was determined with great care from time to time during the progress of this work, and a full discussion is given of the methods used, and of the precautions necessary when—as seems usually to be the case with rock-salt—the prism faces are curved; while the determination of the dispersion curve formed the principal subsidiary research.

As regards the method of detecting the lines, the instrument chosen was, naturally, the bolometer which for such purposes, where a linear form is essential, possesses decided advantages over any other form of radiation measurer yet devised. Instead of the usual visual observation of the motion of the spot of light reflected from the galvanometer mirror, produced by changes in the radiant energy falling on the exposed bolometer strip, a method of photographic registration was used. The spot of light fell upon a vertical photographic plate which was given vertical motion so connected mechanically with the motion of the spectrometer that each position of the plate corresponded to a definite position of the bolometer in the spectrum. The spot of light therefore occupied at any instant a position on the plate such that its one coordinate was proportional to the radiation striking the bolometer, and its other to the position of the bolometer in the spectrum; it therefore traced out the energy curve above referred to, except that the abscissæ were proportional not to the wave-length, but to the deviation produced by the particular prism used. In the form of fixed-arm spectroscope here used, the only moving part is the central table carrying the prism and a pane mirror suitably placed; if the table is given a uniform rotation, the angular motion of the spectrum past the fixed bolometer strip will be uniform also, and twice as rapid, and the particular wave-length in focus on the bolometer at any instant will have

passed through the prism at minimum deviation. The rotation of the prism corresponding to the entire range of wave-lengths here studied is less than 1° with the rock-salt prism—and hence it is necessary to be able to determine the angular position of the prism with rather unusual accuracy if the position of the bolometer in the spectrum (*i. e.*, the wave-length) is to be accurately known. The aim has been to have the maximum error in a single determination of the position of the bolometer in the spectrum not greater than $0''.6$, corresponding in the usual case to 0.1 mm. on the photographic plate. The critical part of the mechanical connection between the spectrometer and plate is a worm and wheel-segment by Warner and Swasey, which is so good that the above rigorous conditions can probably be nearly satisfied. When in use the spectrometer and plate are moved uniformly by clockwork which is, however, quite independent of the accurate mechanical connection between them, so that its errors do not enter. The photographic energy curve thus obtained by the motion of the spectrum past the bolometer strip will show besides the depressions due to the absorption lines sought, many other depressions and irregularities due to disturbances of a mechanical, electrical, magnetic or thermal nature, and a large part of the work has been an attempt to reduce to a minimum these accidental disturbances in order that the depressions in the curve due to real lines might be more clearly identified. It is impossible to consider here the causes of these irregularities—some coming from the bolometer circuit, some from the galvanometer, some from the battery, or the steps which have led to the gradual reduction of them, though these fill what is in some ways the most interesting chapter. Suffice it to say that careful comparison of a number of the best curves, or bolographs as they are called, has resulted in the more or less certain identification of over 700 lines in the region from $\lambda = 0.76\mu$ to $\lambda = 5.3\mu$ whose wave-lengths are determined with a mean probable error of two or three Ångstrom units, the results being given in tables, containing also indications as to the character and grouping of the lines. A graphic representation is also given in the form of line spectrum maps, both

normal and prismatic, either drawn by hand from the tabulated results, or transformed in a semi-automatic way from some of the curves themselves. This process seems of doubtful value, however, as the line-spectrum conveys in reality less information than the curves themselves, while it is apt to produce a false impression of authenticity. Curves and tables are also given illustrating the changes which occur, seasonal and otherwise, in the intensity of many infra red absorption lines; changes whose existence is here definitely fixed, but which will have to be further investigated before their cause can be assigned.

The most important subsidiary research has been the determination of the dispersion curves of rock-salt and fluorite; the former by direct comparison (so to speak) with a grating, the latter by comparison of fluorite bolographs with rock-salt bolographs of the solar spectrum, and measurements of the deviation of the same lines in both. Langley's early method was substantially repeated here in the work with rock-salt, and is briefly as follows:

Radiation from whatever source is used falls first upon the slit of a Rowland concave grating spectroscope, the eyepiece of which is replaced by a second slit; the radiation passing this second slit, from the grating, goes through the optical train of the prism spectroscope and is brought to focus at the proper place in the dispersion spectrum of the particular prism used. If the grating is set so as to let through the second slit light of a known (visible) wave-length in (say) the 3d order spectrum, waves of $\frac{2}{3}$ and 3 times this length will also pass through, belonging to the 2d and 1st order spectra. Hence in the dispersion spectrum of the prism there will be three distributions of energy, more or less sharp according to the widths of the two slits; and if a bolograph of this spectrum is taken in the usual way, three maxima will appear, separated by regions indicating no radiation. If on the same plate a record of the 'A' line is made, the relative deviation of the maxima (due to known wave-lengths) with respect to the 'A' line, can be determined by measurement of the plates. Such records, combined with the determination of the absolute deviation of the 'A' line, and of the angle

of the prism, gave the data for plotting the dispersion curve of rock-salt. The results, exceeding in accuracy any heretofore obtained, and which will be of the greatest value to other investigators using rock-salt dispersion for infrared work—are given in several convenient forms, most conveniently, perhaps, in the shape of a very large scale curve, extending between the limits $\lambda = 0.5 \mu$ and $\lambda = 6.5 \mu$, from which indices of refraction can be read off to 0.000002, and for which the probable error lies usually between 0.000009 and .000018. The dispersion curve of fluorite is given on the same scale between the limits $\lambda = .75 \mu$ and $\lambda = 3.5 \mu$. From the data for rock-salt have been calculated the five constants of the Ketteler dispersion formula, which differ quite noticeably from those calculated by Rubens and Trowbridge for a longer wave-length interval; but the differences between the observed and computed values of index of refraction are hardly greater than the probable errors of deviation, except for the longest wave-lengths. Accurate comparisons have also been made of the dispersion of three rock salt prisms which confirm the view that rock-salt as found in nature is in one respect of great optical uniformity, so that accurate determinations of indices of refraction for one prism can be safely applied to another for the purpose of determining wave-lengths; an extremely fortunate circumstance.

It is impossible to do more than mention some of the lesser pieces of work here recorded—such as the determination of the energy curves of various incandescent mantles; tests of the accuracy or constancy of the bolometer, which unfortunately do not touch the most difficult point, *i. e.*, constancy as regards sensibility for long time intervals; and a study of the minute structure of the infra red absorption band ' ω_1 .' A considerable space is, appropriately, devoted to the discussion of errors, and to methods for overcoming difficulties inherent in bolometric work; of which the most troublesome are undoubtedly 'drift,' or the continuous change in the zero position of the galvanometer spot of light, and the more or less rapid periodic changes of zero, or 'wiggle.' The various precautions taken, which have finally almost eliminated the drift and greatly reduced

the 'wiggle,' are dealt with in full; few of them altogether new perhaps, but certainly applied here with greater completeness and care than has been done elsewhere. The detailed consideration of manipulation and construction will be of great value to others engaged in similar work. In particular should be mentioned the study of the behavior of rock-salt prisms under conditions of rising temperature; the question of the construction of linear bolometers, in which such skill has been attained, and of the design of balancing bridges; and the full discussion of the adjustments of the fixed-arm spectroscope. In the chapter on the galvanometer will be found a useful table of the computed axial magnetic force produced by galvanometer coils of various resistances, wound either with a single size of wire or with different combinations of three sizes, which not only shows clearly the advantage of sectional winding, but will be a valuable aid in the design of galvanometers. The use of the Ayrton-Mather scale for expressing galvanometer sensibilities, now so generally adopted, would have rendered easier the comparison of the observatory instrument with others.

The valuable and interesting material, which it has been here attempted briefly to summarize, is the result of about nine years of work, involving the labors, successively, of Dr. Hallock, Mr. Wadsworth, Mr. Child and, for a longer time, of Mr. Abbot and Mr. Fowle, all under the direction of Professor Langley. From time to time statements of the progress of the work have been made by Professor Langley, and some special points considered in papers of Mr. Wadsworth, Mr. Abbot and Mr. Fowle, but the results now made public are so interesting and so important to all engaged in similar work that it is to be hoped that in the future conditions affecting publication by the government may allow more frequent and less delayed reports from this observatory, which is unique in its possibilities for the highest class of work with radiant energy.

C. E. MENDENHALL.

Dynamo Electric Machinery. Its construction, design, and operation. Direct current machines. By SAMUEL SHELDON, A.M., Ph.D.

Assisted by HOBART MASON, B.S. 12 mo. Pp. 281. Price, \$2.50, net.

The appearance of a promising new text-book on a subject relating to electrical engineering in any of its phases is a matter of much interest in the engineering schools; but Dr. Sheldon's book on 'Dynamo Electric Machinery' may justly receive special attention on account of the author's experience as a teacher and writer, his reputation for vigor, and the evident care with which he has constructed the book. Covering a field in which there are many books, the new comer finds an ample demand which is unfulfilled; for none of the older books are completely satisfactory as text-books and few are more successful as reference books. The demand for a really successful college text-book on applied electromagnetism and the construction of dynamos is therefore large and crying, and the new comer was assured of a certain effusiveness of welcome from technical college circles.

It then becomes a matter of interest to scrutinize the book and learn whether it fulfills those important requirements that are yet unfulfilled by existing literature; and it is a satisfaction to say that in many respects it bears the scrutiny well. In order of treatment and clearness of exposition the book is admirable, as it also is in typography and in much of the illustrative matter. The book has characteristics which are excellent in one designed for classes of trained mechanics, and perhaps the shorter and in some respects more superficial 'information courses' of instruction, which are given in our engineering schools to classes of men who are not following the professional course in electrical engineering and for whom the allotment of time to the subject of dynamos is insufficient for the most approved scientific instruction.

Dr. Sheldon's book was thus used during the past year in the University of Wisconsin as the text-book for a short course of study in dynamos required of mechanical engineering students. In this place the book proved successful, though several predecessors that presumably occupy a similar field had failed to give satisfaction. It is also expected that Dr. Sheldon's book will give good results in the

better classes of the Summer School for Apprentices and Artisans which has just completed its first session at the University of Wisconsin.

For the longer course in applied electromagnetism and the construction of dynamos that should be presented to the men pursuing a college course in electrical engineering, this book does not appear to be so well adapted. Such a course should deal in principles, principles, principles; and it should be remembered that good results involve much labor on the part of the student, however much interested he may be. In the small compass of Dr. Sheldon's book, so much space is occupied by descriptions and illustrations of the commercial apparatus of the day that the principles of electromagnetism and the modes of their application cannot be adequately treated.

We have no text-book on this subject which satisfactorily meets the requirements of a thorough treatise for the 'electrical engineering students' of our colleges, and we may justly say that it is better to use as a syllabus for these classes some book which deals sensibly and with reasonable adequacy in the theory of electromagnetism, than to use a book like Dr. Sheldon's which is of the so-called 'more practical' character. This choice of the preferable plan casts much labor on the teacher; but where the best teaching is the object, labor cannot be shirked.

To meet the requirements of the college classes to which I refer, a book is required of much greater scope than Sheldon's and much greater volume. One may doubt whether Sheldon's book was seriously planned for such classes, as the author's intention is stated in his preface to be to write a book 'to be used primarily in connection with instruction on courses of electrical engineering in institutions for technical education'; and also to meet the wants of '*the general reader, who is seriously looking for information concerning dynamo electric machinery of the types discussed, * * **' The object which I have set forth in italics has been well attained. It is obviously impossible to attain this object, and also to meet the requirements of extended scientific instruction, in the subject of this book, all within the covers of a duodecimo volume of 281 pages.

One object well attained is success, and it is to be hoped that the book will reach sufficient sales through the reasonable accomplishment of this object, so that the author may be encouraged to write another and more extended volume which may meet the needs of the electrical engineering students.

The author is to be congratulated upon the remarkable freedom of his first edition from typographical errors. In other respects he is perhaps not always so fortunate, as in some of his definitions, which are not always adapted to give a proper physical conception to the student. Also, in certain parts of the book, the descriptive matter is inexact or inadequate—especially is this true in the chapter on armature windings, where no attempt is made to present the rational laws of windings, and the short descriptions are inadequate and the diagrams too small to be thoroughly serviceable. Such faults, however, may be readily corrected in another edition, the compliment of an early demand for which we cordially wish for the author.

All in all, we heartily welcome the book to a useful sphere and compliment the author on his success. But we must regret that he did not make a book which might occupy the more important place of a scientific college textbook on applied electromagnetism and the construction of dynamos.

DUGALD C. JACKSON.

DISCUSSION AND CORRESPONDENCE.

A NEW FIELD FOR KITES IN METEOROLOGY.

TO THE EDITOR OF SCIENCE: Although kites carrying recording instruments to a height exceeding three miles have rendered great services to meteorology at Blue Hill and elsewhere, they have been subject to the limitation of requiring a wind that blows at least twelve miles an hour. In certain types of weather—notably anti-cyclones—the winds are light and consequently observations with kites can rarely be obtained at these times. It also happens frequently that, while the wind at the ground is sufficient to raise the kites, it fails completely above the cumulus clouds so that the kites are unable to penetrate this calm zone.

By installing the kites and apparatus on a steamship, not only can kites be flown in calm weather, but observations may be made above the oceans where little is known about the conditions of the upper air. It is evident that a vessel steaming twelve knots an hour through a calm atmosphere will raise the kites to the height they would attain in a favorable natural wind, while the force of strong winds can be moderated by steaming with the wind. In this way, kites can be flown on board a steamer, under almost all conditions and probably more easily than on land, since the steadier winds at sea facilitate launching them. Wherever these observations in the upper air may be made, there is always a station at sea-level and not far distant horizontally with which to compare them.

To test the practicability of this method of flying kites, experiments were undertaken on August 22, 1901, with the aid of my assistants, Messrs. Fergusson and Sweetland, upon a tow-boat chartered for this purpose to cruise in Massachusetts Bay. Anti-cyclonic weather conditions prevailed, and a southeast wind blew from 6 to 10 miles an hour, but at no time with sufficient velocity to elevate the kites, either from sea-level or from the summit of Blue Hill. With the boat moving 10 miles an hour toward the wind, and within an angle of forty-five degrees on either side of its mean direction, the resultant wind easily lifted the kites and meteorograph with 3,600 feet of wire to the height of half a mile.

While it is desirable to have a vessel that can be started, stopped and turned at the will of the meteorologist, as was the case in the experiments described, it is nevertheless probable that soundings of the atmosphere can often be made from a steamship pursuing its regular course, and such are about to be attempted by me on a steamer eastward bound across the North Atlantic. Although observations above all the oceans are valuable, the exploration of the equatorial region is the most important, since, with the exception of a few observations on the Andes and on mountains in central Africa, we know nothing of the conditions existing a mile or two above the equator. The need of such data to complete our theories of the thermo-

dynamics and circulation of the atmosphere was urged by the Russian meteorologist, Woeirof, at the Meteorological Congress in Paris last year. North and south of the equator, within the trade-wind belts, kites might be employed to determine the height to which the trades extend, and also the direction and strength of the upper winds, concerning which the high clouds, rarely seen in those latitudes, furnish our only information. In order to deduce the velocity of the upper current from the resultant velocity recorded at the kite, it is necessary to ascertain the direction of this latter force, which could be done from the orientation of the kite.

A. LAWRENCE ROTCH.

BLUE HILL METEOROLOGICAL OBSERVATORY, August 24, 1901.

GRADUATE COURSES IN SCIENCE.

At the request of the editor, I have drawn up a list of the graduate courses in pure science offered by several of our leading universities during the academic year 1901-1902. Chicago, Columbia, Cornell, Harvard, Johns Hopkins, Pennsylvania and Yale have been chosen because during the past four years each of these universities has almost invariably conferred from 20 to 40 doctorates of philosophy, whereas no other university in our country has on the average conferred more than eight.

This information has been collected from the most recently issued announcements of graduate courses to be given by the respective universities during the ensuing academic year, and has been made as complete as the material at command will permit. In some instances the announcements of courses fail to distinguish clearly between primarily undergraduate courses and purely graduate courses, and the compiler has in such cases endeavored to discriminate as carefully as possible. Wherever the information has been obtainable, there is added in parenthesis to the announcement of each course the number of hours a week for which that course is scheduled. Unless otherwise stated, the common denominator employed is the unit hour per week during the entire academic year. Laboratory hours are distinguished by italics. The graduate courses given at the University of Chicago during the summer quarter of 1901

have been omitted, as also the graduate courses given at the recent summer sessions of several of the universities.

ANATOMY.

(Consult also Zoology.)

Chicago.

Professor Barker: Seminar; Advanced work and original research.

Columbia.

Professor Huntington: Laboratory courses in animal morphology.

Harvard.

Professors Dwight and Dexter: Research course in anatomy.

Johns Hopkins.

Professors Mall, Harrison and Bardeen: Advanced work and original investigation (daily).

Professors Mall, Harrison, Drs. Sudler, Lewis: Systematic instruction in gross human anatomy (afternoons).

Professor Bardeen, Drs. Knower, MacCallum: Systematic instruction in histology, microscopic anatomy, neurology, and embryology (mornings).

Pennsylvania.

Professor Jayne: Research in human anatomy.

Yale (see Zoology).

ANTHROPOLOGY.

Chicago.

Professor Starr: Physical anthropology, lab. (4); Laboratory work in anthropology (4); Japan (4, 6 wks.); Pueblo Indians of New Mexico (4, 1 qr.).

Columbia.

Professor Boas: Ethnography of America (2); Statistical study of variation (2); Physical anthropology (2); American languages (2).

Professor Farrand: General introductory course (2); Ethnology, primitive culture (2).

Professors Boas and Farrand: Research work in physical anthropology, ethnology and North American languages (daily).

Harvard.

Professor Putnam: American archeology and ethnology (research).

Drs. Woods, Dixon: General anthropology (3).

Dr. Dixon: Primitive religions (1½); Special ethnology (1½).

Yale.

Professor Sneath: Philosophical anthropology (2).

Professor Sumner: (See Sociology and statistics.)

ASTRONOMY.

Chicago.

Professor Hale: Solar physics (8); Stellar spectroscopy (8); *ditto* (4).

Professor Frost: Astronomical spectroscopy (4); Stellar spectroscopy (4); Celestial photometry (4, 1 qr.).

Professor Laves : Theory of absolute perturbations (4, 1 qr.); Theory of attractions and figures of the heavenly bodies (4, 1 qr.).

Professor Moulton : Theory of orbits and special perturbations (4, 1 qr.); Lunar theory (4, 1 qr.).

Professors Hale, Barnard, Frost : Astronomical and astrophysical research.

Columbia.

Professor Rees : General astronomy (2); Spherical and practical astronomy (2+2); Geodesy, theory (1); Advanced spherical and practical astronomy (2+4).

Professor Jacoby : Geodesy, applications (1); Summer school in practical geodesy (6 wks.); Theoretical astronomy (1); Theory and method of reduction of photographic star plates (1).

Professors Rees and Jacoby : Geodesy (1); The method of least squares, with applications to astronomy and to geodesy (1).

Dr. Mitchell : Astronomical spectroscopy (1).

Cornell.

— : Descriptive and theoretical astronomy (2).

Harvard.

Professor Pickering : Practical observatory work.

Professor Wilson : Practical astronomy (3).

Johns Hopkins.

Dr. Huff : Elements of astronomy (1).

Pennsylvania.

Professor Doolittle : Method of least squares (1); Reduction of stellar coordinates (1); History of astronomy (1); Observatory practice (6); Practical astronomy (3).

Mr. Eric Doolittle : Theoretical astronomy (2 and 3); Secular perturbations (3).

Yale.

Professor Beebe : Practical astronomy (2).

BACTERIOLOGY AND PATHOLOGY.

Chicago.

Professor Jordan : Research in bacteriology.

Drs. Hektoen, Wells : Research in pathology (4 or 8).

Columbia.

Professor Prudden and Drs. Hiss, Leaming : Advanced bacteriology with research (*afts.*, 3 mos.).

Dr. Hiss : Advanced bacteriology (*afts.*, 3 mos.).

Harvard.

Professor Ernst : Research courses.

Johns Hopkins.

Professor Welch and assistants : Bacteriology (laboratory), (3 *hlf. days a wk.*, 3 mos.); Infection and immunity (1 or 2, 3 mos.); General pathology, pathological anatomy and pathological histology (3 *afts a wk.*, 5 mos.); Advanced work and special research.

Dr. MacCallum : Demonstrations in gross morbid anatomy (1); Conduct of autopsies.

BOTANY.

Chicago.

Professors Coulter, Barnes, Drs. Davis, Chamberlain : Research in Morphology (4 or 8).

Professor Coulter, Dr. Chamberlain : Special morphology of the pteridophytes (8, 1 qr.).

Professor Barnes : Special morphology of bryophytes (8, 1 qr.).

Professor Barnes, Mr. Livingston : Plant physics (4, 1 qr.); Plant chemics (4, 1 qr.); Growth and movement (4, 1 qr.).

Dr. Davis : Organic evolution (4, 1 qr.); General morphology of the bryophytes and pteridophytes (4, 1 qr.); General morphology of the spermatophytes (4, 1 qr.); Special morphology of the algæ (4, 1 qr.).

Dr. Chamberlain : Elementary histology (4, 1 qr.); Field botany (4, 1 qr.); Cytology (4, 1 qr.).

Dr. Cowles : Ecological anatomy (4, 1 qr.); Geographic botany (4, 1 qr.); Physiographic ecology (4, 1 qr.); Seminar in ecology (4 or 8); Research in ecology (4 or 8).

Columbia.

Professor Underwood : Morphology of fungi (10); Morphology of bryophyta (10); Morphology of pteridophyta (10); Taxonomy of fungi (10); Taxonomy of bryophyta (10); Taxonomy of pteridophyta (10).

Professors Underwood, Britton : Regional botany (10).

Professor Lloyd : Experimental morphology (10); Embryology of spermatophyta (10); Ecology (10).

Professor Britton : Taxonomy of spermatophyta (10).

Dr. Curtis : Plant physiology (2); General physiology (10); Physiological anatomy (10).

Dr. Howe : Morphology of algæ (10); Taxonomy of algæ (10).

Dr. MacDougal : Physiology of the cell (10); Ecological physiology (10).

Dr. Richards : Physiology of nutrition (10).

Dr. Rydberg : Morphology of spermatophyta (10).

Mr. Nash : Taxonomy of gramineæ (10).

Cornell.

Professor Atkinson and assistants : Comparative morphology and embryology (3); Mycology (3); Taxonomy of the bryophytes and pteridophytes (3); Methods of research in morphology and embryology (4); Plant physiology (4); Seminary in embryology, mycology, physiology etc. (1).

Professor Rowlee and Dr. Wiegand : Taxonomy and phylogeny of angiosperms (3); Comparative histology of plants (3); Dendrology (3); Research in taxonomy and phylogeny of the angiosperms (4); Research in comparative histology and cytology (4).

Harvard.

Professor Goodale : Morphology, histology and physiology of flowering plants (2); Principles of botanical classification, ecology and plant distribution (3); Structure and development of phanerogams (research).

Professor Thaxter : Cryptogamic botany (1½); Structure and development of cryptogams (research).

Johns Hopkins.

Dr. Johnson : Comparative morphology of the vegetable kingdom (2+2); Physiology and histology

of plants (2); Botanical journal club (1); Botanical seminary (1).

Pennsylvania.

Professor MacFarlane: Comparative histology of plants (1+2); Plant irritability and nutrition (1+5); Comparative morphology of the gymnosperms (2+4).

Dr. Harshberger: Comparative taxonomy of plants (1+2); Comparative morphology of the myxomycetes and fungi (1+4).

Yale.

Professor Evans: Botany of the flowering plants (1½); General morphology of plants (4); Advanced morphology and taxonomy of plants.

Dr. Coe: Cytology and general embryology (2).

CHEMISTRY.

Chicago.

Professor Nef: Organic chemistry (4); Organic preparations (10 or 20); Research in organic chemistry (30 to 40); Special chapters of organic chemistry (4 hrs., 6 wks.); Journal meetings.

Professor Smith: Advanced general chemistry (4 hrs., 1 qr.); Research in general chemistry (30 to 40).

Professor Lengfeld: Inorganic preparations (10 or 20); Research in inorganic chemistry (30 to 40); Advanced inorganic chemistry (2 hrs., 1 qr.); Physico-chemical methods (5 hrs., 6 wks.).

Professor Stieglitz: Advanced qualitative analysis (10 or 20); Advanced quantitative analysis (10 or 20); Special methods in quantitative analysis; Research in organic chemistry (30 to 40); The aromatic series (2).

Dr. Jones: Elementary spectrum analysis (qualitative) (2 hrs., 1 qr.).

Columbia.

Professor Pellew: Industrial chemistry, special applications, laboratory (3½); Industrial chemistry, preparation of chemicals (1); Industrial chemistry, advanced course.

Professor Bogert: Advanced organic chemistry, laboratory (12); *ditto*, research.

Professor Bogert and Dr. Caspari: Chemistry of methane and its derivatives (3); Chemistry of the carbocyclic and heterocyclic compounds (3); Organic chemistry, general laboratory course.

Professor Miller: Quantitative analysis, special methods (16); Advanced inorganic analysis (2+lab.); Assaying, ores and metallurgical products (2); Special methods of assaying ores, alloys and furnace products (4).

Professor Morgan: Physical chemistry (3+lab.); Physical chemistry, advanced (2+12).

Dr. Wells: The spectroscopy as applied to qualitative and quantitative analysis (20).

Dr. Jouët: Quantitative analysis.

Dr. Sherman: Proximate organic and sanitary analysis, quantitative (4+12 or 18); Advanced proximate organic analysis (2+lab.).

Cornell.

Professor Caldwell: Agricultural qualitative and quantitative analysis, advanced course; Beverages and foods (1).

Professor Dennis: General inorganic and ultimate organic analysis, advanced; Spectroscopic chemical

analysis and colorimetry (1½); Qualitative and quantitative gas analysis (½); Technical gas analysis; Inorganic chemistry, advanced (3); *ditto* (laboratory); Inorganic chemistry, seminar (1).

Professor Trevor: Mathematical chemistry (3); Advanced mathematical chemistry (1).

Professor Bancroft: Physicochemical methods (3); Advanced physical chemistry (3); Advanced laboratory work, physical chemistry.

Professor Orndorff: Organic chemistry (3+3); Special chapters in organic chemistry (2); Advanced organic chemistry, laboratory; The coal tar dye-stuffs (½); Stereochemistry (½); Seminar in organic chemistry (1).

Dr. Chamot: Food and water analysis (3); Microchemical analysis (3); Potable water (1); Toxicology (1); Toxicological chemistry (½).

Dr. Carveth: Introductory physical chemistry (2).

Mr. Cushman: Technical and engineering analysis; Assaying (3).

Harvard.

Professor Hill: Carbon compounds (3); Organic chemistry (research).

Professor Jackson: Organic chemistry (research).

Professor Richards: Historical development of chemical theory (1); Advanced quantitative analysis (1½); Gas analysis (1½); Physical chemistry, (3); Inorganic chemistry, including determination of atomic weights (research); Physical chemistry (research).

Professor Sanger: Applied chemistry (research).
 _____: Electrochemistry (1½.)

Johns Hopkins.

Professor Remsen: Compounds of carbon (3); Historical topics in chemistry (12 lectures).

Professor Morse: Advanced inorganic chemistry (2).

Professor Jones: Physical chemistry (3); Elements of physical chemistry (1).

Pennsylvania.

Professor Smith: Advanced inorganic chemistry (2); History of chemistry (½); Electrochemistry (1); Mineral analysis (½); Analytical chemistry (½); Seminary (1).

Dr. Lorenz: Organic chemistry (2); Gas analysis (lab.); Physical chemistry (lab.).

Dr. Shinn: Industrial chemistry (1).

Yale.

Professor Mixer: Chemical physics.

Professor Wells: Qualitative analysis (1+lab.); Quantitative analysis; Inorganic preparations; Advanced quantitative analysis; Metallurgy and assaying; Technical gas analysis; Investigations in inorganic chemistry.

Professor Gooch: Quantitative analysis (6); Chemical theory (1); Special methods; Research in inorganic chemistry.

Professor Wheeler: Advanced organic chemistry; Organic preparations.

Professor Browning: The rare elements (1); Inorganic preparations (2).

Dr. Locke: Systematization of inorganic compounds; Advanced inorganic chemistry; Application of the ionic theory to analytical chemistry; Constitution of chemical compounds.

Dr. Foote: Physical and electro chemistry (1); Physico chemical measurements (lab.); Electro-chemistry (lab.).

Dr. Phelps: The carbon compounds (2); Organic synthesis (lab.).

Mr. Comstock: Elementary organic chemistry; Organic chemistry (1).

GEOLOGY (INCLUDING GEOGRAPHY).

Chicago.

Professor Chamberlin: Principles and theories of geology (6).

Professors Chamberlin and Salisbury: Special geology, selected themes.

Professor Iddings: Petrology (4 or 8); Special petrology (4 or 8).

Professor Weller: Special paleontologic geology (4 or 8).

Columbia.

Professor Kemp: Economic geology ($1\frac{1}{2}$); Petrology (2 + 4); Geological examinations and surveys (1).

Professor Dodge: Elementary physical geography, and geography of the United States (3).

Dr. Hollick: Paleobotany (1 + 4).

Dr. Jubin: Geology of building-stones (1); Metamorphism (1).

Dr. Grabau: Invertebrate paleontology (2 + 4).

Cornell.

Professor Tarr and assistants: Dynamic, structural and physiographic geology (2 + $2\frac{1}{2}$); Physical geography (3 +); Elementary meteorology (1); Glacial geology (3); Geological investigation; Seminar (2).

Professor Harris: Geological research in America (2); Conchology (2); Paleontological illustration ($\frac{1}{2}$); Field and laboratory work.

Dr. Ries: General economic geology (3); Clay investigation; Advanced economic geology.

Harvard.

Professors Shaler, Davis, Wolff, Smyth, Woodworth, Dr. Jaggard: Geological investigation in the field and laboratory.

Professors Shaler and Jackson: General paleontology (3); Historical geology (1); Advanced paleontology.

Professor Davis: Physiography of Europe ($1\frac{1}{2}$); Physiography, advanced (2).

Professor Smyth: Mining geology (3); Economic geology ($1\frac{1}{2}$); Mining geology, advanced (2).

Professor Jackson: General paleontology (1 + 4).

Professor Woodworth: General critical geology (3); Glacial geology ($1\frac{1}{2}$).

Professor Ward: General climatology ($1\frac{1}{2}$); Climatology of the United States ($1\frac{1}{2}$).

Dr. Jaggard: Advanced geological field work (2); Structural and dynamical geology of the United States (1).

Johns Hopkins.

Professor Clark and assistants: General geology (4); Paleontology (2); Historical geology (2).

Professor Reid: Experimental geology (1); Geological physics (1); Exploratory surveying (1).

Professor Abbe: Meteorology.

Dr. Shattuck: Physiographic geology (1).

Dr. Fassig: Climatology (1).

Mr. Willis: Stratigraphic and structural geology (1).
Dr. Bauer: Terrestrial magnetism.

Pennsylvania.

Professor Brown: Historical geology (1 + 4); Petrography (1 + 4); Chemical geology (1 + 4).

Dr. Ehrenfeld: Physical geology and physiography (1 + 3).

Professor Brown and Dr. Ehrenfeld: Paleontology of the invertebrates (5).

Yale.

Professor Williams: Historical geology (4); Evolution theories (2); Geological surveys; Practical geology.

Professor Beecher: General invertebrate paleontology (1); Invertebrate paleontology, faunal; Invertebrate paleontology, special; Research in invertebrate paleontology; Organic evolution; Taxology; Historical geology.

Professor Pirsson: Petrology; Elementary petrology ($\frac{1}{2}$); Elementary structural and dynamical geology ($1\frac{1}{2}$).

Dr. Gregory: Physiography.

MATHEMATICS.

Chicago.

Professors Moore, Bolza, Maschke: Mathematical reading and research.

Professor Moore: Theory of functions of real variables (4, 1 qr.); General arithmetic (4, 2 qr.); Seminar, Theory of functions of real variables (4, 2 qr.).

Professor Bolza: Abelian functions (4, 1 qr.); Seminar, Theory of abelian functions (4, 1 qr.).

Professor Maschke: Twisted curves and surfaces (4, 1 qr.); Theory of invariants (4, 1 qr.); Theory of functions (4, 2 qrs.); Seminar, differential geometry (4, 1 qr.).

Professor Dickson: Theory of numbers (4, 1 qr.).

Columbia.

Professor Fiske: Advanced calculus (3); Functions defined by linear differential equations (3).

Professor Cole: Theory of groups (3).

Professor Maclay: Theory of functions of a complex variable (3).

Mr. Keyser: Modern theories of geometry (3).

Cornell.

Professor Wait: Advanced analytic geometry (1); Advanced calculus, differential (3).

Professor Jones: Higher algebra and trigonometry (3); Theory of probabilities and least squares (2).

Professor Tanner: German mathematical reading (2); Algebraic invariants (2).

Professor McMahon: Quaternions and vector analysis (2).

Dr. Snyder: Projective geometry (3); General theory of algebraic curves and surfaces (3); Theory of functions (3).

Dr. Hutchinson: Advanced integral calculus (2); Theory of function (3).

Mr. Fite: Theory of groups (3); Theory of numbers (3).

—: Differential equations, advanced (3).

Harvard.

Professor J. M. Peirce: Calculus of quaternions (3); Theory of triangular coordinates and algebraic

plane curves (3); Application of quaternions to the theory of curves and surfaces ($1\frac{1}{2}$); Selected topics in quaternions ($1\frac{1}{2}$).

Professor Byerly: Advanced differential and integral calculus (3); Trigonometric series, spherical harmonics, potential function (3); Research, Picard's *Traité d'Analyse*, Vol. I.

Professor B. O. Peirce: Trigonometric series, spherical harmonics, potential function (3).

Professor Osgood: Infinite series and products ($1\frac{1}{2}$); Theory of functions (3); Research, calculus of variations.

Professor Bôcher: Higher algebra, polynomials and invariants ($1\frac{1}{2}$); Partial differential equations ($1\frac{1}{2}$); Linear differential equations of the second order (3).

Dr. Bouton: Theory of numbers ($1\frac{1}{2}$); Elementary theory of differential equations ($1\frac{1}{2}$).

Mr. Coolidge: Theory of equations, invariants ($1\frac{1}{2}$); Non-Euclidean geometry (3); Research, projective geometry.

Mr. Whittemore: Modern methods in geometry, determinants (3).

Johns Hopkins.

Professor Morley: Advanced geometry (3); The differential equations of physics (1); Mathematical seminar (1).

Dr. Cohen: Advanced differential equations (2); Theory of algebraic numbers (2); Elementary theory of functions (2).

Dr. Franklin: Probability.

Pennsylvania.

Professor Crawley: Plane analytic geometry (2); Higher plane curves (3).

Professor Fisher: Differential equations (2); Invariants and covariants (3); Theory of functions of a real variable ($1\frac{1}{2}$); Theory of functions of a complex variable ($1\frac{1}{2}$).

Professor Schwatt: Infinite series and products (3); Definite integrals and the functions of Bessel, Laplace and Lamé (3).

Dr. Hallett: Theory of substitutions (2); Theory of groups (2).

Department officers: Mathematical seminar.

Yale.

Professor Clark: Determinants (1); Differential equations (1).

Professor Gibbs: Vector analysis ($1\frac{1}{2}$); Advanced vector analysis ($1\frac{1}{2}$).

Professor Pierpont: Higher algebra ($1\frac{1}{2}$); Differential equations and function theory (3); Theory of functions (3).

Professor Smith: Advanced differential geometry (2); Foundations of geometry (1).

Dr. Porter: Advanced calculus (3); selected topics in differential equations ($1\frac{1}{2}$).

Dr. Granville: Differential geometry ($1\frac{1}{2}$).

Mr. Wilson: Projective geometry ($1\frac{1}{2}$).

MECHANICS.

Chicago. (Consult also Physics.)

Professor Maschke: Theory of the potential (4, 2 qr.).

Dr. Gale: Dynamics (4, 1 qr.).

Columbia.

Professor Woodward: Analytical mechanics (3); Advanced theoretical mechanics (2); Theory of the

potential function (2); Geodynamics (2); Mathematical theory of elasticity (2); Theory of the conduction of heat in solids (2).

Professor Pupin: Thermodynamics ($1\frac{1}{2}$); Theory of dynamo and motor ($1\frac{1}{2}$); Theory of direct-current dynamo ($1\frac{1}{2}$); Theory of alternators and transformers ($1\frac{1}{2}$); Theory of variable currents ($1\frac{1}{2}$); Maxwell's theory of electricity and magnetism (2); Theory of Bessel's functions and spherical harmonics (1); Electro-magnetic theory of light ($1\frac{1}{2}$); Advanced thermodynamics (2); Theory of oscillations (2).

Mr. Pfister: Theoretical mechanics (2).

Cornell.

Professor Trevor: Mathematical theory of thermodynamics (2).

Professor McMahon: Theoretical mechanics (2); Potential function, Fourier's series and spherical harmonics (2); Mathematical theory of sound (2).

Professor Merritt: Electricity and magnetism; Theoretical physics, mechanics and thermodynamics (4).

—————: Mathematical theory of fluid motion; Mathematical theory of electricity and magnetism.

Harvard.

Professor Hall: Elements of thermodynamics ($1\frac{1}{2}$); Modern developments and applications of thermodynamics ($1\frac{1}{2}$).

Professors Byerly and B. O. Peirce: The potential function (3).

Professor Byerly: Dynamics of a rigid body (3).

Professor B. O. Peirce: Mathematical theory of electricity and magnetism (3).

Mr. Whittemore: Hydrostatics and hydrokinematics (3).

Johns Hopkins.

Professor Morley: Kinematics (1).

Pennsylvania.

Professor Goodspeed: Theory of the potential (1); Analytic statics (1); Rigid dynamics (2); Thermodynamics (1); Dynamics of a particle (1).

Dr. Richards: Application of harmonic series to physical problems.

Yale.

Professor Clark: Electricity and magnetism (1); Thermodynamics and properties of matter (2).

Professor Beebe: Celestial mechanics (3).

Professor Bumstead: Problems in mathematical physics (2).

Mr. Wilson: Analytical mechanics ($1\frac{1}{2}$).

MINERALOGY.

Chicago.

Professor Iddings: Advanced petrology (4 or 8); Special petrology (4 or 8).

Columbia.

Professor Moses: Descriptive and determinative mineralogy (2 + 3); Physical crystallography (1 + 4); Physical crystallography, advanced (6); Mineralogy, special (research).

Dr. Luquer: The minerals of building-stones (2); Optical mineralogy (2 + 3, 2 mos.); Optical mineralogy, advanced (12).

Cornell.

Professor Gill: Physical crystallography (1½); Petrography (1½); Seminar (1); Research work in mineralogy and petrography.

Harvard.

Professor Wolf: Petrography (3).
Professor Wolf and Dr. Palache: Physical crystallography; Mineralogical and petrographical research.
Dr. Palache: Crystallography.

Johns Hopkins.

Professor Mathews: General mineralogy (4); Advanced mineralogy (3); Petrography (3).

Pennsylvania.

Professor Brown: Mathematical and physical crystallography (1 + 4); Systematic mineralogy (1 + 4); Chemical and synthetic mineralogy (1 + 3); Determination of minerals (4).

Yale.

Professor Penfield: Determinative mineralogy (3); Crystallography (1); Descriptive mineralogy (1½); Descriptive mineralogy, advanced (1); Experimental work in crystallography and mineralogy; Research courses.

PHYSICS.

(Consult also Mechanics.)

Chicago.

Professor Michelson: Theoretical physics (4, 1½ qr.); Experimental physics, advanced (10); Research course (20); Spectrum analysis (4, 6 wks.); Interference methods and their application (4, 6 wks.).

Dr. Mann: Development of physical ideas (4, 1 qr.).

Columbia.

Professor Rood: Magnetism and electricity, sound (2 + 2 or 6); Light, heat (3 + 2 or 4).

Professor Hallock: Units and measurements, exact electrical measurement (2 + 2 to 3).

Professors Rood, Hallock, Dr. Tufts, Mr. Trowbridge: Laboratory courses in physics.

Cornell.

Professor Nichols: Physical seminar (2).

Professor Merritt: Theoretical physics (4); Recent advances in experimental physics (1).

Professors Nichols and Merritt: Advanced laboratory practice in general physics (research).

Professor Moler: Advanced photography (2).

Mr. Shearer: Theory of light (4); Wave motion (2).

Mr. Ambler: Theory of alternating currents (1).

Harvard.

Professor B. O. Peirce: Electrostatics, electrokinematics, electromagnetism (1, 6 to 8); Electricity and magnetism (research).

Professor Hall: Heat and electricity (research).

Professor Trowbridge: Electrodynamics (2); Light and electricity (research).

Professors Trowbridge and Sabine: Electrodynamics, magnetism, electromagnetism (2 + lab.).

Professor Sabine: The theory of the microscope (1½); Light and heat (2 + 6 to 8); Research courses in light and heat.

Johns Hopkins.

Professor Ames: General physics (3).

Professor Wood: Physical optics (1½); Recent progress in physics (3).

Mr. Whitehead: Applied electricity.

Pennsylvania.

Professor Goodspeed (see Mechanics).

Professor Goodspeed and Dr. Richards: Absolute physical measurements (3 to 9); Theory and practice of spectroscopy (3); Seminary (1).

Dr. Richards: Electricity and magnetism (2); Theory of sound (1); Radiation, electromagnetic theory (2).

Yale.

Professor A. W. Wright: Physics [heat, light, electricity, magnetism] (2); Advanced physics (2).

Professor Hastings: Theory of observation, method of least squares, theory of electricity, electrical measurements (3 + 6).

PHYSIOLOGICAL CHEMISTRY.

Chicago.

Professor Mathews: Physiological chemistry (4 or 6, 1 qr.).

Columbia.

Professor Chittenden, Dr. Gies, Messrs. Richards and Cutter: General physiological chemistry (2 + 6).

Dr. Gies, Mr. Cutter: Advanced physiological chemistry, laboratory (6).

Dr. Gies, Mr. Richards: Special physiological chemistry, laboratory (12).

Cornell.

Professor Orndorff, Mr. Teeple: Physiological chemistry (2 + 2).

Professor Orndorff: Advanced physiological chemistry (laboratory).

Harvard.

Dr. Koch: Chemical physiology (1½).

Yale.

Professor Chittenden: Physiological chemistry (2).

Professors Chittenden and Mendel: Physiological chemistry (4 + 4).

PHYSIOLOGY.

Chicago.

Professor Loeb: The physiological effects of ions (4, 1 qr.); Physiology of space sensations (4, 1 qr.); Physiological morphology and theory of tropisms (4, 1 qr.); Seminar (1); Research work (8).

Columbia.

Professor Curtis: Laboratory course in special physiology (3).

Professors Curtis, Lee, Dr. Green: The physiology of man as related to that of other mammals and of lower vertebrates (4).

Professor Lee: General physiology (1).

Professor Lee, Mr. Budington: Laboratory course in general physiology (5).

Cornell.

Professor Wilder, Dr. Stroud, Mr. Reed: Research in physiology (daily); Fortnightly conference.

Harvard.

Professor Bowditch : Experimental physiology (research).

Johns Hopkins.

Professor Howell : Research courses ; Physiological journal club (1) ; Physiological seminar (1).

Professor Howell, Drs. Dawson, Erlanger, Mr. Stiles : Advanced research ; Regular medical course ($1\frac{1}{2} + 3$) ; Special course (3).

Yale.

Professor Chittenden : Elementary physiology (1) ; Experimental toxicology (1) ; Physiology of nutrition (1).

Professors Chittenden, Mendel : Experimental physiology (3) ; Seminary (2).

PSYCHOLOGY.

Chicago.

Professor Dewey : Seminar, mental development (4, 2 qr.).

Professor Angell, Dr. Fite : Experimental psychology, training course (4, 3 qr.) ; Experimental psychology, research (4, 3 qr.).

(See also Sociology and Statistics.)

Columbia.

Professor Cattell : Experimental psychology, introductory (2) ; Problems in experimental psychology (2) ; Research in experimental psychology (daily).

Professor Cattell, Mr. Davis : Experimental psychology, laboratory (2 or 4).

Professor Starr : Diseases of the mind and nervous system (1).

Professor Farrand : Physiological psychology (3) ; Abnormal and pathological psychology (1) ; Research in physiological and abnormal psychology.

Professor Thorndike : Genetic psychology, advanced (2) ; Research in genetic and comparative psychology.

Mr. Strong : Analytic psychology (1) ; Philosophy of mind (1) ; Research in analytic psychology and the philosophy of mind.

Cornell.

Professor Titchener, Drs. Bentley, Whipple, Mr. Baird : Systematic psychology (3) ; Laboratory exercises in psychology ; Seminar in psychology, and advanced laboratory work.

Dr. Bentley : History of psychophysics ($\frac{1}{2}$).

Dr. Washburn : Social psychology.

Harvard.

Professor James : The psychological elements of religious life ($\frac{1}{2}$).

Professor Münsterberg : Psychological seminar, The theory of the will (2).

Professor Münsterberg, Dr. MacDougall : Experimental psychology, advanced research.

Dr. MacDougall : Advanced psychology ($1\frac{1}{2}$) ; Experimental psychology, elementary (5).

Pennsylvania.

Professor Witmer : Fundamental processes (1) ; Physiological psychology (1) ; Complex mental processes (1) ; Experimental psychology (1) ; Modern psychological theory ($1\frac{1}{2}$) ; Seminar in child psychology ($1\frac{1}{2}$) ; Research.

Yale.

Professor Duncan : General psychology, advanced (2).

Professor Scripture : Physiological and experimental psychology (2) ; Experimental psychology, elementary (2) ; Experimental phonetics (1) ; Theory of statistics and measurements (1) ; Technical course in experimental psychology (1) ; Research.

SOCIOLOGY AND STATISTICS.

Chicago.

Professor Small : The ethics of sociology (4, 1 qr.) ; Seminar, Problems in methodology and classification (4) ; The premises of general sociology (4, 1 qr.) ; An outline of general sociology (4, 1 qr.).

Professor Henderson : The group of industrials (4, 1 qr.) ; Seminar, Methods of social amelioration (4) ; Urban communities (4, 1 qr.) ; Philanthropy in its historical development (4, 1 qr.).

Professor Talbot : Seminar in sanitary science (4).

Professor Thomas : Art and the artist class (4, 2 qrs.) ; Development of mind in the race (4, 1 qr.) ; Primitive social control (4, 1 qr.).

Professor Vincent : Public opinion (4, 1 qr.) ; Education as a social function (4, 1 qr.).

Dr. Mitchell : Training course in statistics (4, 1 qr.).

Columbia.

Professor Giddings : Principles of sociology (2) ; Social evolution (1) ; Progress and democracy (1) ; Pauperism, poor laws and charities (1) ; Crime and penology (1) ; Seminar in sociology (1).

Professor Mayo-Smith : Statistics and sociology (1) ; Statistics and economics (1) ; Theory of statistics (1) ; Laboratory work in statistics.

Dr. Ripley : Racial demography.

Dr. Bayles : The civil aspect of ecclesiastical organizations (1).

Cornell.

Professor Willcox : Elementary social economics (2) ; Elementary statistics (2 + 2) ; Advanced statistics (2).

Professor Fetter : Methods of modern philanthropy (2).

Professor Powers : The modern régime (2) ; Social interpretation of art (1) ; Seminar, The evolution of society (2).

Harvard.

Professor Ashley : Statistics (1).

Professor Carver : Principles of sociology (3) ; Socialism and communism (1).

——— : Seminar (1).

Johns Hopkins.

Dr. Brackett : Public aid, charity and correction (1, 3 mos.) ; Conferences on charitable legislation and custom in England and the United States (1).

Pennsylvania.

Professor Lindsay : Structure of modern society (2) ; Social-debtor classes (2) ; Seminar in sociology.

Yale.

Professor Sumner : The mental reactions (2) ; The beginnings of industrial organization (2) ; The science of society, elementary (2) ; The science of society, advanced (2).

ZOOLOGY (INCLUDING NEUROLOGY).

Chicago.

Professors Whitman, Lillie, Dr. Child : Zoological problems, research (1 + 18).

Professor Davenport : Experimental and statistical zoology (8).

Professors Whitman, Davenport, Lillie, Dr. Child : Seminar in zoology (2).

Professor Donaldson : The growth of the brain and its physical characters as related to intelligence (2 + 4, 1 qr.); Seminar in neurology (2); Research, the study of neurological problems (8).

Professor Donaldson, Dr. Hardesty : The architecture of the central nervous system (2 + 4, 1 qr.); Gross and microscopic anatomy of the human central nervous system and sense organs (3 + 6, 1 qr.).

Dr. Hardesty : The architecture of the central nervous system (2 + 10, 6 wks.); Comparative histology of the central nervous system and sense organs (2 + 9).

Columbia.

Professor Wilson : Comparative embryology (1 + lab.); Cellular biology (3).

Professor Osborn : Mammals, living and fossil (6). Professors Wilson, Osborn : Comparative zoology, advanced (10).

Professor Dean : Classification and comparative anatomy of the vertebrates (1 + 2); Embryology of fishes (1), Embryology of vertebrates ($\frac{1}{2}$ + 1).

Professor Crampton : Experimental embryology ($\frac{1}{2}$).

Dr. Calkins : General zoology of invertebrates, advanced (1 $\frac{1}{2}$ + 3); The protozoa ($\frac{1}{2}$ + 1); Sanitary biology (1 $\frac{1}{2}$).

Dr. Strong : Comparative neurology (1 + 4); The human brain and spinal cord (1 + 4).

Dr. McGregor : Mammalian dissection.

Professor Osborn, Dr. McGregor : Readings and conferences in Gegenbaur's *Vergleichende Anatomie* (1).

_____ : Practical histology; Practical embryology; Seminar; Journal Club.

Cornell.

Professor Wilder, Dr. Stroud, Mr. Read : Research in vertebrate zoology and neurology (daily); Department conference.

Professor Comstock : Research in entomology (daily); Morphology and development of insects (2).

Professor Gage : Research in histology and embryology (8); Advanced microscopy (2 $\frac{1}{2}$); Seminar in microscopy, histology and embryology.

Harvard.

Professor Mark : Anatomy and development of vertebrates and invertebrates (research).

Professor Mark, Dr. Rand : Microscopical anatomy (1 $\frac{1}{2}$); Embryology of vertebrates (1 $\frac{1}{2}$).

Professor Jackson : Fossil invertebrates (1 $\frac{1}{2}$); Fossil invertebrates, special groups (1 $\frac{1}{2}$).

Professor Parker : Introduction to the study of the nervous system (1 $\frac{1}{2}$); The nervous system and its terminal organs (1 $\frac{1}{2}$).

Dr. Rand, Mr. Carpenter : Comparative anatomy of vertebrates (3).

Dr. Castle : Experimental morphology, phylogenesis (2).

Johns Hopkins.

Professor Brooks, Drs. Andrews, Johnson : Advanced laboratory work (daily); Journal club (1); Seminar (1).

Pennsylvania.

Professor Jayne : Human anatomy (research); Mammalian osteology (research).

Professors Conklin, Montgomery, Dr. Calvert : Comparative anatomy and embryology of the invertebrata (1 + 5); Zoological seminar (1).

Dr. Moore : Recent and fossil vertebrata (2 + 2).

Yale.

Professor Verrill : Zoology, comparative anatomy, morphology, histology, systematic zoology.

Professor Smith, Dr. Coe : Elementary anatomy and histology (2); Comparative anatomy and general biology (3); Advanced comparative anatomy and general biology (daily).

Professor Ferris : Comparative morphology of the vertebrate brain (1).

Dr. Coe : Cytology and general embryology (2).

GEO. B. GERMANN.

PRIZE-SUBJECTS IN APPLIED SCIENCE.*

THE program of subjects for which prizes will be awarded by the Société industrielle de Mulhouse next year has been issued, and copies can be obtained upon application to the secretary of the Society. In general chemistry, medals will be awarded for the best memoirs or works on the theory of the manufacture of alizarin reds; the synthesis of the coloring matters of cochineal; theoretical and practical study of the carmine of cochineal; study of the coloring matter of cotton; the composition of aniline blacks; physical and chemical modifications which occur when cotton fiber is transformed into oxycellulose; action of chlorine and its oxygen compounds upon wool; constitution of coloring matters employed in linen fabrics; synthesis of a natural coloring matter used in industries; and theory of the natural formation of an organic substance and preparation of the substance by synthesis.

In connection with dyeing, medals will be awarded for the best works presented on the following subjects: A new mordant which admits of practical use; metallic solutions which give up their bases to textile fibers, and the conditions in which they are most effective; iron mordants and the part they play in dyeing according to their condition of oxidation and hydration; an aniline black which will not de-

* From *Nature*.

teriorate in the presence of other colors or affect these colors, especially those of albumin; a soluble black for dyeing, which will resist the action of light and soap as much as aniline black; a light blue cheap enough to be used to dye wools and not affected by boiling or by light; a blue similar to ultramarine which can be fixed upon cotton by a chemical process; a pure yellow which behaves like alizarin as regards its dyeing properties; a lake-red; a purple; a coloring matter to supersede logwood in its various applications; an assistant especially applicable to wool, capable of being cleared by simple washing, and composed of substances other than tin salts, hydrosulphites, sulphites, and bisulphites; new method of fixing aniline colors; a means of making colors resist the action of soap or of prolonged boiling; a means of producing the sheen of gold and silver upon materials by metallic powders; a manual containing tables showing the densities of as many inorganic and organic compounds as possible, in the crystallized state and in cold saturated solution; the synthesis of a substance having the essential properties of Senegal gum; a substance to supersede egg-white in the dyeing of linen; a colorless blood albumin which can be used instead of egg-white; a manual on the analysis of compounds employed in fabric printing and in dyeing; an indelible ink for marking cotton and similar materials; a practical method of removing grease spots from materials; a memoir on the use of resins in bleaching cotton fiber; a memoir on the bleaching and dyeing of various kinds of cotton; also memoirs dealing similarly with wool and silk; use of hydrogen peroxide for bleaching; improvements in the bleaching of wool and silk; and manuals on the bleaching of cotton, wool, silk, hemp and other fibers.

In connection with fabric printing, medals are offered for an alloy or other substance which has both the elasticity and durability of steel and also the property of not causing any chemical action in the presence of acid colors and colors containing certain metallic salts; a new cylinder machine capable of printing at least eight colors at once; and an application of electricity to bleaching, dyeing or fabric printing.

Among the prize subjects in mechanical arts are: A means of recording by a graphical method the work done by steam engines in a given period (ordinary indicator diagrams do not fulfil the conditions); memoir on the spinning of combed wool; on the force required to start spinning machines; a motor for driving machines used in printing fabrics.

In electricity medals will be awarded for an electric motor the power and driving rate of which can be easily varied; a memoir on the comparative cost of electricity and gas for lighting a town having a population of at least 30,000; and comparative costs of electricity, gas, acetylene and water-gas for lighting an industrial establishment.

Money prizes as well as medals are awarded for some of the subjects, and all the competitions are open to every one, irrespective of nationality. The memoirs, designs or models submitted for the awards should be sent to the president of the Société industrielle de Mulhouse before February 15, 1902.

SCIENTIFIC NOTES AND NEWS.

A ROYAL commission has been appointed in Great Britain to study the relation of bovine and human tuberculosis, consisting of Sir Michael Foster, Dr. Sims Woodhead, Dr. Harris Cox Martin, Professor J. McFadyean and Professor R. W. Boyce.

DR. W. J. MCGEE and Dr. W. H. Holmes were at St. Louis recently to advise in regard to the exhibit of anthropology and ethnology at the exposition in 1903. Very comprehensive exhibits were recommended, of which we hope to give later a detailed account.

PROFESSOR WILLIS L. MOORE, chief of the Weather Bureau, visited the Yellowstone Park last week, with a view to studying the desirability of establishing there a weather station.

MR. H. D. HUBBARD, private secretary to President Harper, of the University of Chicago, has been appointed, as the result of a civil service examination, secretary of the National Bureau of Standards, at a salary of \$2,000 a year.

THE Dutch Academy of Sciences at Harlem has elected to membership H. Haga, professor

of physics at Gröningen; Ed. Verschaefelt, professor of botany and pharmacognosy at Amsterdam, and S. G. De Vries, of Leiden. Foreign members have been elected as follows: H. Becquerel, professor of physics at the *École Polytechnique*, Paris; Max Planck, professor of mathematical physics and director of the Institute for Theoretical Physics at the University of Berlin, and Heinrich Dubois, associate professor of physics at the same university.

JOSEPH Y. BERGEN, the author of well-known text-books on botany, has resigned his position in the English High School of Boston. With his family he sailed on September 3 for Naples, Italy, where for the future he will make his home.

THE officers of the Society for the Promotion of Agricultural Science elected at the recent Denver meeting, to serve for next year, are:

President, W. H. Jordon, director of the New York State Experiment Station, Geneva.

Secretary-Treasurer, F. M. Webster, Wooster Ohio.

Members of the Executive Committee, to serve with the president and secretary, W. J. Beal, Agricultural College, Mich.; W. R. Lazenby, Columbus, Ohio; C. S. Plumb, Lafayette, Indiana.

DR. ADOLF FICK, the eminent physiologist, died on August 21, at the age of seventy-one years. He was born at Cassell, and after studying at Zurich became professor at that University in 1876. In 1868 he removed to Würzburg, where he made the laboratory of physiology one of the most important in Germany. He published a well-known compendium of physiology, the third edition of which appeared in 1882, and was also the author of books on the physiology of the senses and on muscular contraction, to which subjects his researches contributed in an important degree.

THE death is announced of Admiral Jonquières, the well-known French geometer.

PROFESSOR SAMUEL PORTER, a widely known teacher of the deaf and dumb, died at his home in Farmington, Conn., on September 2, at the age of ninety-one. He was a son of President Noah Porter, of Yale College, and graduated from that institution. He began the instruction of the deaf and dumb at Hartford, where he

remained till 1836. In 1846 he went to New York and in 1866 was made professor of mental science and English philology at Gallaudet College, Washington. He became professor emeritus in 1884.

DURING the present season the biological laboratory of the United States Fish Commission at Wood's Holl, Massachusetts, has been under the personal direction of Dr. H. M. Smith, of the Commission staff. The former director, Dr. H. C. Bumpus, owing to his new duties at the American Museum of Natural History, was unable to continue his services, much to the regret of Commissioner Bowers. Among those who have occupied tables and pursued investigations during the summer are Dr. Robert P. Bigelow, Massachusetts Institute of Technology; Dr. Gary N. Calkins, Columbia University; Dr. Otto Folin, McLean Hospital (Waverly, Mass.); Dr. Caswell Grave, Johns Hopkins University; Mr. Karl Kellerman, U. S. Department of Agriculture; Dr. F. T. Lewis, Harvard Medical School; Dr. H. R. Linville, DeWitt Clinton High School; Professor W. J. Moenkhaus, Indiana University; Professor George H. Parker, Harvard University; Dr. H. W. Rand, Harvard University; Dr. R. M. Strong, Harvard University; Dr. F. B. Sumner, College of the City of New York; Dr. W. T. Swingle, U. S. Department of Agriculture, and Professor R. W. Tower, Brown University.

Two vacancies in the position of assistant computer in the Nautical Almanac Office will be filled by civil service examination on October 8 and 9.

A NEW YORK State civil service examination will be held on or about September 28, to fill certain positions, including that of electrical engineer, at a salary of \$900, and of instructor in various manual arts in the State reformatories and institutions.

AT the approaching annual reception and opening of the American Museum of Natural History, New York, the Tiffany collection of gems, recently presented to the museum by Mr. J. Pierpont Morgan, will be on exhibition; part of the Bement collection of minerals will also be exhibited.

THE library of natural history, which the Park Department has fitted up in the Swedish schoolhouse on the West Drive near the Metropolitan Museum, is used by fifty to one hundred people daily. It will be kept open during the winter, and it is expected that it will be used by children from the schools. The library is dependent on gifts, and books or journals bearing on natural history will be gladly received.

MR. ANDREW CARNEGIE has offered \$20,000 and \$15,000, respectively, to Riverside, Cal., and Chatham, N. Y., for public libraries.

THE New York City Board of Health has adopted resolutions requiring public institutions to report cases of malaria and requesting physicians to do the same.

IN harmony with the vote of the executive committee, the eighteenth annual meeting of the Association of Official Agricultural Chemists will be held in Washington, D. C., beginning Thursday, November 14, and continuing over Friday and Saturday, 15 and 16, or until the business of the Association is completed. The authorities of the Columbian University have extended the courtesy of the use of the University lecture hall for the various sessions. The following order of business will be observed: The president's address; reports of the referees on nitrogen, on potash, on phosphoric acid, on soils, on ash, on foods and feeding stuffs, on liquor and food adulteration, on dairy products, on sugar, on tannin, on insecticides; reports of special committees (abstract committee, food standards, fertilizer legislation, volumetric standards).

THE following preliminary program of subjects for the proposed International Conference on Plant Breeding and Hybridization, to be held in the fall of 1902, is announced by the Horticultural Society of New York. The exact dates for the meetings are not yet decided upon, and the program as given is subject to alteration:

Results of Hybridization and Plant Breeding in Canada. (Illustrated by specimens.) William Saunders, director of the Central Experimental Farm, Ottawa, Canada.

Notes on Plant Breeding in California. E. J. Wick-

son, horticulturist, Agricultural Experiment Station, University of California.

Plant Breeding in New Jersey. (Illustrated by specimens.) B. D. Halsted, professor of botany in Rutgers College, New Brunswick, N. J.

Hybrid Plums. F. A. Waugh, horticulturist, Vermont Agricultural Experiment Station.

Variations in Hybrids not appearing in the First Generation, but Later. E. S. Goff, horticulturist, Agricultural Experiment Station, University of Wisconsin.

Results in the breeding of Species of Ricinus. E. Mead Milcox, botanist, Oklahoma Agricultural Experiment Station.

On Orchid Hybrids. (Illustrated by specimens of the parents and progeny.) Oakes Ames, Ames Botanical Laboratory, North Easton, Mass.

The Wild Hybrids of the North American Flora. (Illustrated by specimens of the parents and progeny.) David George, museum aid, New York Botanical Garden.

Hybrid Beans. R. A. Emerson, horticulturist, Agricultural Experiment Station, University of Nebraska.

Cytological Aspects of Hybrids. W. A. Cannon, Columbia University, New York City.

Correlation between the Fruit and other Parts of the Plant in Form, Color and other Characteristics. (Illustrated by specimens.) S. A. Beach, horticulturist, New York State Experiment Station, Geneva, N. Y. Other papers, the titles of which have not yet been communicated, are also promised from the following: Delegates representing the Royal Horticultural Society of England; Luther Burbank, Santa Rosa, Cal.; J. Craig, Cornell University, Ithaca, N. Y.; K. C. Davis, West Virginia Agricultural Experiment Station; S. B. Green, Agricultural Experiment Station, University of Minnesota; H. C. Price, Iowa Agricultural Experiment Station; W. van Fleet, M. D., Little Silver, N. J.; J. C. Whitten, Agricultural Experiment Station, Columbia, Mo.; C. W. Ward, Queens, N. Y.; H. J. Webber and others representing the United States Department of Agriculture.

THERE was held at Glasgow last week an international engineering congress under the auspices of the leading British engineering societies. Lord Kelvin was the honorary president and Mr. James Mansergh the president. The sections in which the congress met were as follows:

Section I.—Railways. Chairman, Sir Benjamin Baker.

Section II.—Waterways and Maritime Works. Chairman, Sir John Wolfe Barry, K.C.B., F.R.S.

Section III.—Mechanical Engineering (Institution of Mechanical Engineers). Chairman, Mr. W. H. Maw.

Section IV.—Naval Architecture and Marine Engineering (Institution of Naval Architects). Chairman, the Right Hon. the Earl of Glasgow.

Section V.—Iron and Steel (Iron and Steel Institute). Chairman, Mr. William Whitwell.

Section VI.—Mining (Institution of Mining Engineers). Chairman, Mr. James S. Dixon.

Section VII.—Municipal Engineering (Association of Municipal and County Engineers). Chairman, Mr. E. George Mawbey.

Section VIII.—Gas Engineering (Institution of Gas Engineers). Chairman, Mr. George Livesey.

Section IX.—Electrical (Institution of Electrical Engineers). Chairman, Mr. W. E. Langdon.

THE Department of State has received from the Russian Embassy, Washington, under date of August 12, 1901, notice of the International Exposition and Congress of Fisheries, to be held in St. Petersburg in 1902. An invitation is extended to the United States to participate in the exposition and to send official delegates and experts to the congress. The exhibition is open to Russian and foreign exhibitors. Its objects consist in: (a) Determining the actual condition of sea and fresh-water fisheries, and of other similar pursuits; (b) acquainting producers and consumers with the various products of fisheries and with methods of preparing and preserving the same; (c) exhibiting the gradual development and actual state of artificial fish breeding, as likewise the various aspects of amateur fishing and angling; (d) promoting scientific research pursued in the interests of fisheries.

DR. CALMETTE, the director of the Pasteur Institute at Lille, and the discoverer of a curative serum for the effect of snake-bite, was, as a correspondent to the *Lancet* reports, recently severely bitten on the hand by a trigonoccephalus. Dr. Calmette without delay gave himself an injection of his anti-venomous serum, but nevertheless the hand swelled up and acute fever set in; but by the afternoon of the same day Dr. Calmette was sufficiently recovered to attend a sitting of the Conseil-Général of the

Department, at which he argued in favor of a grant in aid of the sanatorium which he has undertaken to found at Lille. On the following day he was perfectly well, having thus afforded in his own person, albeit unwillingly, a convincing proof of the efficacy of his excellent remedy.

UNIVERSITY AND EDUCATIONAL NEWS.

IT appears that German soldiers are still occupying the buildings of the University at Tien-Tsin, and the question has been brought to the attention of our Department of State, the institution being conducted under American auspices.

THOMAS L. WATSON, Ph.D. (Cornell), assistant state geologist of Georgia for the past four years, has been elected professor of geology and botany at Denison University, Granville, Ohio.

PROFESSOR F. C. VAN DYCK, who holds the chair of electricity and mechanics at Rutgers College, has been made dean of the faculty.

E. B. HOLT, M.A. (Columbia), Ph.D. (Harvard), has been appointed instructor in psychology in Harvard University, succeeding Dr. Robert MacDougall, recently called to the chair of psychology in the School of Pedagogy, New York University.

MR. FRANK NICHOLAS SPINDLER has been elected professor of psychology and pedagogy in the State Normal College, at Stevens Point, Wisconsin.

MR. A. H. YODER, of the University of Indiana, has been appointed professor of pedagogy at the University of Washington.

A. L. KROEBER, Ph.D. (Columbia), has been appointed instructor in Indian anthropology in the University of California.

AT Brown University, Mr. G. F. Parmenter and Dr. N. A. Dubois have been appointed instructors in chemistry.

MR. S. Y. WARA has been awarded a teaching fellowship in chemistry in the University of Missouri.

DR. RUDOLPH ZUBER has been promoted to a full professorship of geology at the University at Lemberg.



WILLIAM MCKINLEY, twenty-fifth President of the United States, universally beloved and honored by a Nation whose greatness he maintained and advanced, died on September 14, 1901.



SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

EDITORIAL COMMITTEE: S. NEWCOMB, Mathematics; R. S. WOODWARD, Mechanics; E. C. PICKERING, Astronomy; T. C. MENDENHALL, Physics; R. H. THURSTON, Engineering; IRA REMSEN, Chemistry; CHARLES D. WALCOTT, Geology; W. M. DAVIS, Physiography; HENRY F. OSBORN, Paleontology; W. K. BROOKS, C. HART MERRIAM, Zoology; S. H. SCUDDER, Entomology; C. E. BESSEY, N. L. BRITTON, Botany; C. S. MINOT, Embryology, Histology; H. P. BOWDITCH, Physiology; J. S. BILLINGS, Hygiene; WILLIAM H. WELCH, Pathology; J. MCKEEN CATTELL, Psychology; J. W. POWELL, Anthropology.

FRIDAY, SEPTEMBER 20, 1901.

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the great Queen, in whose reign nearly all the meetings of the British Association have been held, has passed to her rest.

To sovereigns most honors and dignities come as of right; but for some of them is reserved the supreme honor of an old age softened by the love and benedictions of millions; of a path to the grave, not only magnificent, but watered by the tears both of their nearest and dearest, and of those who, at the most, have only seen them from afar.

This honor Queen Victoria won. All the world knows by what great abilities, by what patient labor, by what infinite tact and kindness, the late Queen gained both the respect of the rulers of nations and the affection of her own subjects.

Her reign, glorious in many respects, was remarkable, outside these islands, for the growth of the Empire; within and without them, for the drawing nearer of the Crown and the people in mutual trust; while, during her lifetime, the developments of science and of scientific industry have altered the habits and the thoughts of the whole civilized world.

The representatives of science have already expressed in more formal ways their sorrow at the death of Queen Victoria, and the loyalty and confident hope for the future with which they welcome the accession of King Edward. But none the less, I feel

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.

ADDRESS OF THE PRESIDENT OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.*

THE first thought in the minds of all of us to-night is that since we met last year

* Glasgow meeting, 1901.

sure that at this, the first meeting of the British Association held in his reign, I am only expressing the universal opinion of all our members when I say that no group of the King's subjects trusts more implicitly than we do in the ability, skill and judgment which His Majesty has already shown in the exercise of the powers and duties of his august office; that none sympathize more deeply with the sorrows which two great nations have shared with their sovereigns; and that none cry with more fervor, 'Long live the King!'

But this meeting of the British Association is not only remarkable as being the first in a new reign. It is also the first in the new century. It is held in Glasgow at a time when your International Exhibition has in a special sense attracted the attention of the world to your city, and when the recent celebration of the ninth jubilee of your University has shown how deeply the prosperity of the present is rooted in the past. What wonder, then, if I take the chair to which you have called me with some misgivings? Born and bred in the south, I am to preside over a meeting held in the largest city of Scotland. As your chosen mouthpiece I am to speak to you of science when we stand at the parting of the centuries, and when the achievements of the past and present, and the promise of the future, demand an interpreter with gifts of knowledge and divination to which I cannot pretend. Lastly, I am president of the British Association as a disciple in the home of the master, as a physicist in a city which a physicist has made forever famous. Whatever the future may have in store for Glasgow, whether your enterprise is still to add wharf to wharf, factory to factory and street to street, or whether some unforeseen 'tide in the affairs of men' is to sweep energy and success elsewhere, fifty-three years in the history of your city will never be forgotten while civilization lasts.

More than half a century ago, a mere lad was the first to compel the British Association to listen to the teaching Joule, and to accept the law of the conservation of energy. Now, alike in the most difficult mathematics and in the conception of the most ingenious apparatus, in the daring of his speculations and in the soundness of his engineering, William Thomson, Lord Kelvin, is regarded as a leader by the science and industry of the whole world.

It is the less necessary to dwell at length upon all that he has done, for Lord Kelvin has not been without honor in his own country. Many of us, who meet here to-night, met last in Glasgow when the University and city had invited representatives of all nations to celebrate the jubilee of his professorship. For those two or three days learning was surrounded with a pomp seldom to be seen outside a palace. The strange middle-age costumes of all the chief universities of the world were jostling here, the outward signs that those who were themselves distinguished in the study of Nature had gathered to do honor to one of the most distinguished of them all.

Lord Kelvin's achievements were then described in addresses in every tongue, and therefore I will only remind you that we, assembled here to-night, owe him a heavy debt of gratitude; for the fact that the British Association enters on the twentieth century conscious of a work to do and of the vigor to do it is largely due to his constant presence at its meetings and to the support he has so ungrudgingly given. We have learned to know not only the work of our great leader, but the man himself; and I count myself happy because in his lifelong home, under the walls of the university he served so well, and at a meeting of the Association which his genius has so often illuminated, I am allowed, as your President, to assure him in your name of the

admiration, respect, nay, of the affection, in which we all hold him.

I have already mentioned a number of circumstances which make our meeting this year noteworthy; to these I must add that for the first time we have a Section for Education, and the importance of this new departure, due largely to the energy of Professor Armstrong, is emphasized by the fact that the Chair of that Section will be occupied by the Vice-President of the Committee of Council on Education—Sir John Gorst. I will not attempt to forecast the proceedings of the new Section. Education is passing through a transitional stage. The recent debates in Parliament; the great gifts of Mr. Carnegie; the discussion as to university organization in the north of England; the reconstitution of the University of London; the increasing importance attached to the application of knowledge both to the investigation of nature and to the purposes of industry, are all evidence of the growing conviction that without advance in education we cannot retain our position among the nations of the world. If the British Association can provide a platform on which these matters may be discussed in a scientific but practical spirit, free from the misrepresentations of the hustings and the exaggerations of the partisan, it will contribute in no slight measure to the national welfare.

But amid the old and new activities of our meeting the undertone of sadness, which is never absent from such gatherings, will be painfully apparent to many of us at Glasgow. The life-work of Professor Tait has ended amid the gloom of the war-cloud. A bullet, fired thousands of miles away, struck him to the heart, so that in their deaths the father and the brave son, whom he loved so well, were not long divided. Within the last year, too, America has lost Rowland; Viriamu Jones, who did yeoman's service for education and for sci-

ence, has succumbed to a long and painful illness; and one who last year at Bradford seconded the proposal that I should be your president at Glasgow, and who would unquestionably have occupied this chair before long had he been spared to do so, has unexpectedly been called away. A few months ago we had no reason to doubt that George Francis FitzGerald had many years of health and work before him. He had gained in a remarkable way not only the admiration of the scientific world, but the affection of his friends, and we shall miss sadly one whom we all cared for, and who, we hoped, might yet add largely to the achievements which had made him famous.

THE SCIENCE OF THE NINETEENTH CENTURY.

Turning from these sad thoughts to the retrospect of the century which has so lately ended, I have found it to be impossible to free myself from the influence of the moment and to avoid, even if it were desirable to avoid, the inclination to look backward from the standpoint of to-day.

Two years ago Sir Michael Foster dealt with the work of the century as a whole. Last year Sir William Turner discussed in greater detail the growth of a single branch of science. A third and humbler task remains, *viz.*, to fix our attention on some of the hypotheses and assumptions on which the fabric of modern theoretical science has been built, and to inquire whether the foundations have been so 'well and truly' laid that they may be trusted to sustain the mighty superstructure which is being raised upon them.

The moment is opportune. The three chief conceptions which for many years have dominated physical as distinct from biological science have been the theories of the existence of atoms, of the mechanical nature of heat, and of the existence of the ether.

Dalton's atomic theory was first given to the world by a Glasgow professor—Thomas Thomson—in the year 1807, Dalton having communicated it to him in 1804. Rumford's and Davy's experiments on the nature of heat were published in 1798 and 1799 respectively; and the celebrated Bakerian Lecture, in which Thomas Young established the undulatory theory by explaining the interference of light, appeared in the *Philosophical Transactions* in 1801. The keynotes of the physical science of the nineteenth century were thus struck, as the century began, by four of our fellow-countrymen, one of whom—Sir Benjamin Thompson, Count Rumford—preferred exile from the land of his birth to the loss of his birthright as a British citizen.

DOUBTS AS TO SCIENTIFIC THEORIES.

It is well known that of late doubts have arisen as to whether the atomic theory, with which the mechanical theory of heat is closely bound up, and the theory of the existence of an ether have not served their purpose, and whether the time has not come to reconsider them.

The facts that Professor Poincaré, addressing a congress of physicists in Paris, and Professor Poynting, addressing the Physical Section of the Association, have recently discussed the true meaning of our scientific methods of interpretation; that Dr. James Ward has lately delivered an attack of great power on many positions which eminent scientific men have occupied; and that the approaching end of the nineteenth century led Professor Hæckel to define in a more popular manner his own very definite views as to the solution of the 'Riddle of the Universe,' are perhaps a sufficient justification of an attempt to lay before you the difficulties which surround some of these questions.

To keep the discussion within reasonable limits I shall illustrate the principles under

review by means of the atomic theory, with comparatively little reference to the ether, and we may also at first confine our attention to inanimate objects.

THE CONSTRUCTION OF A MODEL OF NATURE.

A natural philosopher, to use the old phrase, even if only possessed of a most superficial knowledge, would attempt to bring some order into the results of his observation of nature by grouping together statements with regard to phenomena which are obviously related. The aim of modern science goes far beyond this. It not only shows that many phenomena are related which at first sight have little or nothing in common, but, in so doing, also attempts to explain the relationship.

Without spending time on a discussion of the meaning of the word 'explanation,' it is sufficient to say that our efforts to establish relationships between phenomena often take the form of attempting to prove that, if a limited number of assumptions are granted as to the constitution of matter, or as to the existence of quasi material entities, such as caloric, electricity and the ether, a wide range of observed facts falls into order as a necessary consequence of the assumptions. The question at issue is whether the hypotheses which are at the base of the scientific theories now most generally accepted are to be regarded as accurate descriptions of the constitution of the universe around us, or merely as convenient fictions.

Convenient fictions be it observed, for even if they are fictions they are not useless. From the practical point of view it is a matter of secondary importance whether our theories and assumptions are correct, if only they guide us to results which are in accord with facts. The whole fabric of scientific theory may be regarded merely as a gigantic 'aid to memory'; as a means for producing apparent order out of dis-

order by codifying the observed facts and laws in accordance with an artificial system, and thus arranging our knowledge under a comparatively small number of heads. The simplification introduced by a scheme which, however imperfect it may be, enables us to argue from a few first principles, makes theories of practical use. By means of them we can foresee the results of combinations of causes which would otherwise elude us. We can predict future events, and can even attempt to argue back from the present to the unknown past.

But it is possible that these advantages might be attained by means of axioms, assumptions and theories based on very false ideas. A person who thought that a river was really a streak of blue paint might learn as much about its direction from a map as one who knew it as it is. It is thus conceivable that we might be able, not indeed to construct, but to imagine, something more than a mere map or diagram, something which might even be called a working model of inanimate objects, which was nevertheless very unlike the realities of nature. Of course, the agreement between the action of the model and the behavior of the things it was designed to represent would probably be imperfect, unless the one were a facsimile of the other; but it is conceivable that the correlation of natural phenomena could be imitated, with a large measure of success, by means of an imaginary machine which shared with a map or diagram the characteristic that it was in many ways unlike the things it represented, but might be compared to a model in that the behavior of the things represented could be predicted from that of the corresponding parts of the machine.

We might even go a step further. If the laws of the working of the model could be expressed by abstractions, as, for example, by mathematical formulæ, then, when the formulæ were obtained, the model might be

discarded, as probably unlike that which it was made to imitate, as a mere aid in the construction of equations, to be thrown aside when the perfect structure of mathematical symbols was erected.

If this course were adopted we should have given up the attempt to know more of the nature of the objects which surround us than can be gained by direct observation, but might nevertheless have learned how these objects would behave under given circumstances.

We should have abandoned the hope of a physical explanation of the properties of inanimate nature, but should have secured a mathematical description of her operations.

There is no doubt that this is the easiest path to follow. Criticism is avoided if we admit from the first that we cannot go below the surface; cannot know anything about the constitution of material bodies; but must be content with formulating a description of their behavior by means of laws of nature expressed by equations.

But if this is to be the end of the study of nature, it is evident that the construction of the model is not an essential part of the process. The model is used merely as an aid to thinking; and if the relations of phenomena can be investigated without it, so much the better. The highest form of theory—it may be said—the widest kind of generalization, is that which has given up the attempt to form clear mental pictures of the constitution of matter, which expresses the facts and the laws by language and symbols which lead to results that are true, whatever be our view as to the real nature of the objects with which we deal. From this point of view the atomic theory becomes not so much false as unnecessary; it may be regarded as an attempt to give an unnatural precision to ideas which are and must be vague.

Thus, when Rumford found that the

mere friction of metals produced heat in unlimited quantity, and argued that heat was therefore a mode of motion, he formed a clear mental picture of what he believed to be occurring. But his experiments may be quoted as proving only that energy can be supplied to a body in indefinite quantity, and when supplied by doing work against friction it appears in the form of heat.

By using this phraseology we exchange a vivid conception of moving atoms for a colorless statement as to heat energy, the real nature of which we do not attempt to define; and methods which thus evade the problem of the nature of the things which the symbols in our equations represent have been prosecuted with striking success, at all events within the range of a limited class of phenomena. A great school of chemists, building upon the thermodynamics of Willard Gibbs and the intuition of Van't Hoff, have shown with wonderful skill that, if a sufficient number of the data of experiment are assumed, it is possible, by the aid of thermodynamics, to trace the form of the relations between many physical and chemical phenomena without the help of the atomic theory.

But this method deals only with matter as our coarse senses know it; it does not pretend to penetrate beneath the surface.

It is therefore with the greatest respect for its authors, and with a full recognition of the enormous power of the weapons employed, that I venture to assert that the exposition of such a system of tactics cannot be regarded as the last word of science in the struggle for the truth.

Whether we grapple with them, or whether we shirk them; however much or however little we can accomplish without answering them, the questions still force themselves upon us: Is matter what it seems to be? Is interplanetary space full or empty? Can we argue back from the

direct impressions of our senses to things which we cannot directly perceive; from the phenomena displayed by matter to the constitution of matter itself?

It is these questions which we are discussing to-night, and we may therefore, as far as the present address is concerned, put aside, once for all, methods of scientific exposition in which an attempt to form a mental picture of the constitution of matter is practically abandoned, and devote ourselves to the inquiries whether the effort to form such a picture is legitimate, and whether we have any reason to believe that the sketch which science has already drawn is to some extent a copy, and not a mere diagram, of the truth.

SUCCESSIVE STEPS IN THE ANALYSIS OF MATTER.

In dealing, then, with the question of the constitution of matter and the possibility of representing it accurately, we may grant at once that the ultimate nature of things is, and must remain, unknown; but it does not follow that immediately below the complexities of the superficial phenomena which affect our senses there may not be a simpler machinery of the existence of which we can obtain evidence, indirect indeed but conclusive.

The fact that the apparent unity which we call the atmosphere can be resolved into a number of different gases is admitted; though the ultimate nature of oxygen, nitrogen, argon, carbonic acid and water vapor is as unintelligible as that of air as a whole, so that the analysis of air may be said to have substituted many incomprehensibles for one.

Nobody, however, looks at the question from this point of view. It is recognized that an investigation into the proximate constitution of things may be useful and successful, even if their ultimate nature is beyond our ken.

Nor need the analysis stop at the first step. Water vapor and carbonic acid, themselves constituents of the atmosphere, are in turn resolved into their elements, hydrogen, oxygen and carbon, which, without a formal discussion of the criteria of reality, we may safely say are as real as air itself.

Now at what point must this analysis stop if we are to avoid crossing the boundary between fact and fiction? Is there any fundamental difference between resolving air into a mixture of gases and resolving an elementary gas into a mixture of atoms and ether?

There are those who cry halt at the point at which we divide a gas into molecules, and their first objection seems to be that molecules and atoms cannot be directly perceived, cannot be seen or handled, and are mere conceptions, which have their uses, but cannot be regarded as realities.

It is easiest to reply to this objection by an illustration.

The rings of Saturn appear to be continuous masses separated by circular rifts. This is the phenomenon which is observed through a telescope. By no known means can we ever approach or handle the rings; yet everybody who understands the evidence now believes that they are not what they appear to be, but consist of minute moonlets, closely packed indeed, but separate the one from the other.

In the first place Maxwell proved mathematically that if a Saturnian ring were a continuous solid or fluid mass it would be unstable and would necessarily break into fragments. In the next place, if it were possible for the ring to revolve like a solid body, the inmost parts would move slowest, while a satellite moves faster the nearer it is to a planet. Now spectroscopic observation, based on the beautiful method of Sir W. Huggins, shows not only that the inner portions of the ring move the more

rapidly, but that the actual velocities of the outer and inner edges are in close accord with the theoretical velocities of satellites at like distances from the planet.

This and a hundred similar cases prove that it is possible to obtain convincing evidence of the constitution of bodies between whose separate parts we cannot directly distinguish, and I take it that a physicist who believes in the reality of atoms thinks that he has as good reason for dividing an apparently continuous gas into molecules as he has for dividing the apparently continuous Saturnian rings into satellites. If he is wrong it is not the fact that molecules and satellites alike cannot be handled and cannot be seen as individuals that constitutes the difference between the two cases.

It may, however, be urged that atoms and the ether are alleged to have properties different from those of matter in bulk, of which alone our senses take direct cognizance, and that therefore it is impossible to prove their existence by evidence of the same cogency as that which may prove the existence of a newly discovered variety of matter or of a portion of matter too small or too distant to be seen.

This point is so important that it requires full discussion, but in dealing with it, it is necessary to distinguish carefully between the validity of the arguments which support the earlier and more fundamental propositions of the theory; and the evidence brought forward to justify mere speculative applications of its doctrines which might be abandoned without discarding the theory itself. The proof of the theory must be carried out step by step.

The first step is concerned wholly with some of the most general properties of matter, and consists in the proof that those properties are either absolutely unintelligible, or that, in the case of matter of all kinds, we are subject to an illusion similar to that, the results of which we admit in the

case of Saturn's rings, clouds, smoke, and a number of similar instances. The believer in the atomic theory asserts that matter exists in a particular state; that it consists of parts which are separate and distinct the one from the other, and as such are capable of independent movements.

Up to this point no question arises as to whether the separate parts are, like grains of sand, mere fragments of matter; or whether, though they are the bricks of which matter is built, they have, as individuals, properties different from those of masses of matter large enough to be directly perceived. If they are mere fragments of ordinary matter, they cannot be used as aids in explaining those qualities of matter which they themselves share.

We cannot explain things by things themselves. If it be true that the properties of matter are the product of an underlying machinery, that machinery cannot itself have the properties which it produces, and must, to that extent at all events, differ from matter in bulk as it is directly presented to the senses.

If, however, we can succeed in showing that if the separate parts have a limited number of properties (different, it may be, from those of matter in bulk), the many and complicated properties of matter can, to a considerable extent, be explained as consequences of the constitution of these separate parts; we shall have succeeded in establishing, with regard to quantitative properties, a simplification similar to that which the chemist has established with regard to varieties of matter. The many will have been reduced to the few.

The proofs of the physical reality of the entities discovered by means of the two analyses must necessarily be different. The chemist can actually produce the elementary constituents into which he has resolved a compound mass. No physicist or chemist can produce a single atom separated

from all its fellows, and show that it possesses the elementary qualities he assigns to it. The cogency of the evidence for any suggested constitution of atoms must vary with the number of facts which the hypothesis that they possess that constitution explains.

Let us take, then, two steps in their proper order, and inquire, first, whether there is valid ground for believing that all matter is made up of discrete parts; and secondly, whether we can have any knowledge of the constitution or properties which those parts possess.

THE COARSE-GRAINEDNESS OF MATTER.

Matter in bulk appears to be continuous. Such substances as water or air appear to the ordinary observer to be perfectly uniform in all their properties and qualities, in all their parts.

The hasty conclusion that these bodies are really uniform is, nevertheless, unthinkable.

In the first place the phenomena of diffusion afford conclusive proof that matter when apparently quiescent is in fact in a state of internal commotion. I need not recapitulate the familiar evidence to prove that gases and many liquids when placed in communication interpenetrate or diffuse into each other; or that air, in contact with a surface of water, gradually becomes laden with water vapor, while the atmospheric gases in turn mingle with the water. Such phenomena are not exhibited by liquids and gases alone, nor by solids at high temperatures only. Sir W. Roberts-Austen has placed pieces of gold and lead in contact at a temperature of 18° C. After four years the gold had traveled into the lead to such an extent that not only were the two metals united, but, on analysis, appreciable quantities of the gold were detected even at a distance of more than 5 millimeters from the common surface, while within a distance of three-quarters of a millimeter from the

surface gold had penetrated into the lead to the extent of 1 oz. 6 dwts. per ton, an amount which could have been profitably extracted.

Whether it is or is not possible to devise any other intelligible account of the cause of such phenomena, it is certain that a simple and adequate explanation is found in the hypothesis that matter consists of discrete parts in a state of motion, which can penetrate into the spaces between the corresponding parts of the surrounding bodies.

The hypothesis thus framed is also the one which affords a rational explanation of other simple and well-known facts. If matter is regarded as a continuous medium the phenomena of expansion are unintelligible. There is, apparently, no limit to the expansion of matter, or, to fix our attention on one kind of matter, let us say to the expansion of a gas; but it is inconceivable that a continuous material which fills or is present in every part of a given space could also be present in every part of a space a million times as great. Such a statement might be made of a mathematical abstraction; it cannot be true of any real substance or thing. If, however, matter consists of discrete particles, separated from each other either by empty space or by something different from themselves, we can at once understand that expansion and contraction may be nothing more than the mutual separation or approach of these particles.

Again, no clear mental picture can be formed of the phenomena of heat unless we suppose that heat is a mode of motion. In the words of Rumford, "it is extremely difficult, if not quite impossible, to form any distinct idea of anything capable of being excited and communicated in the manner the heat was excited and communicated in [his] experiment [on friction] except it be motion."* And if heat be mo-

tion, there can be no doubt that it is the fundamental particles of matter which are moving. For the motion is not visible, is not motion of the body as a whole, while diffusion, which is a movement of matter, goes on more quickly as the temperature rises, thereby proving that the internal motions have become more rapid, which is exactly the result which would follow if these were the movements which constitute sensible heat.

Combining, then, the phenomena of diffusion, expansion and heat, it is not too much to say that no hypotheses which make them intelligible have ever been framed other than those which are at the basis of the atomic theory.

Many other considerations also point to the same conclusion. Many years ago Lord Kelvin gave independent arguments, based on the properties of gases, on the constitutions of the surfaces of liquids, and on the electric properties of metals, all of which indicate that matter is, to use his own phrase, coarse-grained—that it is not identical in constitution throughout, but that adjacent minute parts are distinguishable from each other by being either of different natures or in different states.

And here it is necessary to insist that all these fundamental proofs are independent of the nature of the particles or granules into which matter must be divided.

The particles, for instance, need not be different in kind from the medium which surrounds and separates them. It would suffice if they were what may be called singular parts of the medium itself, differing from the rest only in some peculiar state of internal motion or of distortion, or by being in some other way earmarked as distinct individuals. The view that the constitution of matter is atomic may and does receive support from theories in which definite assumptions are made as to the constitution of the atoms; but when, as is

* *Phil. Trans.*, 1798, p. 99.

often the case, these assumptions introduce new and more recondite difficulties, it must be remembered that the fundamental hypothesis—that matter consists of discrete parts, capable of independent motions—is forced upon us by facts and arguments which are altogether independent of what the nature and properties of these separate parts may be.

As a matter of history the two theories, which are not by any means mutually exclusive, that atoms are particles which can be treated as distinct in kind from the medium which surrounds them, and that they are parts of that medium existing in a special state, have both played a large part in the theoretical development of the atomic hypothesis. The atoms of Waterston, Clausius and Maxwell were particles. The vortex-atoms of Lord Kelvin, and the strain-atoms (if I may call them so) suggested by Mr. Larmor, are states of a primary medium which constitutes a physical connection between them, and through which their mutual actions arise and are transmitted.

PROPERTIES OF THE BASIS OF MATTER.

It is easy to show that, whichever alternative be adopted, we are dealing with something, whether we consider it under the guise of separate particles or of differentiated portions of the medium, which has properties different from those of matter in bulk.

For if the basis of matter had the same constitution as matter, the irregular heat movements could hardly be maintained either against the viscosity of the medium or the frittering away of energy of motion which would occur during the collisions between the particles. Thus, even in the case in which a hot body is prevented from losing heat to surrounding objects, its sensible heat should spontaneously decay by a process of self-cooling. No such phenomenon

is known, and though on this, as on all other points, the limits of our knowledge are fixed by the uncertainty of experiment, we are compelled to admit that, to all appearance, the fundamental medium, if it exists, is unlike a material medium, in that it is non-viscous; and that the particles, if they exist, are so constituted that energy is not frittered away when they collide. In either case we are dealing with something different from matter itself in the sense that, though it is the basis of matter, it is not identical in all its properties with matter.

The idea therefore that entities exist possessing properties different from those of matter in bulk is not introduced at the end of a long and recondite investigation to explain facts with which none but experts are acquainted. It is forced upon us at the very threshold of our study of nature. Either the properties of matter in bulk cannot be referred to any simpler structure, or that simpler structure must have properties different from those of matter in bulk as we directly knew it—properties which can only be inferred from the results which they produce.

No *à priori* argument against the possibility of our discovering the existence of quasi-material substances, which are nevertheless different from matter, can prove the negative proposition that such substances cannot exist. It is not a self-evident truth that no substance other than ordinary matter can have an existence as real as that of matter itself. It is not axiomatic that matter cannot be composed of parts whose properties are different from those of the whole. To assert that even if such substances and such parts exist no evidence, however cogent, could convince us of their existence is to beg the whole question at issue; to decide the cause before it has been heard.

We must therefore adhere to the stand-

point adopted by most scientific men, *viz.*, that the question of the existence of ultra-physical entities, such as atoms and the ether, is to be settled by the evidence, and must not be ruled out as inadmissible on *à priori* grounds.

On the other hand, it is impossible to deny that, if the mere entry on the search for the concealed causes of physical phenomena is not a trespass on ground we have no right to explore, it is at all events the beginning of a dangerous journey.

The wraiths of phlogiston, caloric, luminiferous corpuscles and a crowd of other phantoms haunt the investigator, and as the grim host vanishes into nothingness he cannot but wonder if his own conceptions of atoms and of the ether

‘shall dissolve,

And, like this insubstantial pageant faded,

Leave not a wrack behind.’

But though science, like Bunyan’s hero, has sometimes had to pass through the ‘Valley of Humiliation,’ the spectres which meet it there are not really dangerous if they are boldly faced. The facts that mistakes have been made, that theories have been propounded, and for a time accepted, which later investigations have disproved, do not necessarily discredit the method adopted. In scientific theories, as in the world around us, there is a survival of the fittest, and Dr. James Ward’s unsympathetic account of the blunders of those whose work, after all, has shed glory on the nineteenth century, might *mutatis mutandis* stand for a description of the history of the advance of civilization. “The story of the progress so far,” he tells us, “is briefly this: Divergence between theory and fact one part of the way, the wreckage of abandoned fictions for the rest, with an unattainable goal of phenomenal nihilism and ultra-physical mechanism beyond.”*

* James Ward, ‘Naturalism and Agnosticism,’ Vol. I., p. 153.

“The path of progress,” says Professor Karl Pearson, “is strewn with the wreck of nations. Traces are everywhere to be seen of the hecatombs of inferior races, and of victims who found not the narrow way to the greater perfection. Yet these dead peoples are, in very truth, the stepping-stones on which mankind has arisen to the higher intellectual and deeper emotional life of to-day.”*

It is only necessary to add that the progress of society is directed towards an unattainable goal of universal contentment, to make the parallel complete.

And so, in the one case as in the other, we may leave ‘the dead to bury their dead.’ The question before us is not whether we too may not be trusting to false ideas, erroneous experiments, evanescent theories. No doubt we are; but, without making an insolent claim to be better than our fathers, we may fairly contend that, amid much that is uncertain and temporary, some of the fundamental conceptions, the root-ideas of science are so grounded on reason and fact that we cannot but regard them as an aspect of the very truth.

Enough has, perhaps, now been said on this point for my immediate purpose. The argument as to the constitution of matter could be developed further in the manner I have hitherto adopted, *viz.*, by series of propositions, the proof of each of which is based upon a few crucial phenomena. In particular, if matter is divided into moving granules or particles, the phenomenon of cohesion proves that there must be mutual actions between them analogous to those which take place between large masses of matter, and which we ascribe to force, thereby indicating the regular, unvarying operation of active machinery which we have not yet the means of adequately understanding. For the moment, I do not wish

* Karl Pearson, ‘National Life from the Standpoint of Science,’ p. 62.

to extend the line of reasoning that has been followed. My main object is to show that the notion of the existence of ultra-physical entities and the leading outlines of the atomic theory are forced upon us at the beginning of our study of nature, not only by *à priori* considerations, but in the attempt to comprehend the results of even the simplest observation. These outlines cannot be effaced by the difficulties which undoubtedly arise in filling up the picture. The cogency of the proof that matter is coarse-grained is in no way affected by the fact that we may have grave doubts as to the nature of the granules. Nay, it is of the first importance to recognize that, though the fundamental assumptions of the atomic theory receive overwhelming support from a number of more detailed arguments, they are themselves almost of the nature of axioms, in that the simplest phenomena are unintelligible if they are abandoned.

THE RANGE OF THE ATOMIC THEORY.

It would be most unfair, however, to the atomic theory to represent it as depending on one line of reasoning only, or to treat its evidence as bounded by the very general propositions I have discussed.

It is true that as the range of the theory is extended the fundamental conception that matter is granular must be expanded and filled in by supplementary hypotheses as to the constitution of the granules. It may also be admitted that no complete or wholly satisfactory description of that constitution can as yet be given; that perfection has not yet been attained here or in any other branch of science; but the number of facts which can be accounted for by the theory is very large compared with the number of additional hypotheses which are introduced; and the cumulative weight of the additional evidence obtained by the study of details is such as to add greatly

to the strength of the conviction that, in its leading outlines, the theory is true.

It was originally suggested by the facts of chemistry, and though, as we have seen, a school of chemists now thrusts it into the background, it is none the less true, in the words of Dr. Thorpe, that 'every great advance in chemical knowledge during the last ninety years finds its interpretation in [Dalton's] theory.'*

The principal mechanical and thermal properties of gases have been explained, and in a large part discovered, by the aid of the atomic theory; and, though there are outstanding difficulties, they are, for the most part, related to the nature of the atoms and molecules, and do not affect the question as to whether they exist.

The fact that different kinds of light all travel at the same speed in interplanetary space, while they move at different rates in matter, is explained if matter is coarse-grained. But to attempt to sum up all this evidence would be to recite a text-book on physics. It must suffice to say that it is enormous in extent and varied in character, and that the atomic theory imparts a unity to all the physical sciences which has been attained in no other way.

I must, however, give a couple of instances of the wonderful success which has been achieved in the explanation of physical phenomena by the theory we are considering, and I select them because they are in harmony with the line of argument I have been pursuing.

When a piece of iron is magnetized its behavior is different according as the magnetic force applied to it is weak, moderate or strong. When a certain limit is passed the iron behaves as a non-magnetic substance to all further additions on magnetic force. With strong forces it does and with very weak forces it does not remain mag-

* Thorpe, 'Essays on Historical Chemistry,' 1849, p. 368.

netized when the force ceases to act. Professor Ewing has imitated all the minute details of these complicated properties by an arrangement of small isolated compass needles to represent the molecules. It may fairly be said that as far as this particular set of phenomena is concerned a most instructive working model based on the molecular theory has not only been imagined but constructed.

The next illustration is no less striking. We may liken a crowd of molecules to a fog; but while the fog is admitted by everybody to be made up of separate globules of water, the critics of scientific method are sometimes apt to regard the molecules as mere fictions of the imagination. If, however, we could throw the molecules of a highly rarefied gas into such a state that vapor condensed on them, so that each became the center of a water-drop, till the host of invisible molecules was, as it were, magnified by accretion into a visible mist, surely no stronger proof of their reality could be desired. Yet there is every reason to believe that something very like this has been accomplished by Mr. C. T. R. Wilson and Professor J. J. Thomson.

It is known that it is comparatively difficult to produce a fog in damp air if the mixture consists of air and water-vapor alone. The presence of particles of very fine dust facilitates the process. It is evident that the vapor condenses on the dust particles and that a nucleus of some kind is necessary on which each drop may form. But electrified particles also act as nuclei; for if a highly charged body from which electricity is escaping be placed near a steam jet, the steam condenses; and a cloud is also formed in dust-free air more easily than would otherwise be the case if electricity is discharged into it.

Again, according to accepted theory, when a current of electricity flows through a gas some of the atoms are divided into

parts which carry positive and negative charges as they move in opposite directions, and unless this breaking-up occurs a gas does not conduct electricity. But a gas can be made a conductor merely by allowing the Röntgen rays or the radiation given off by uranium to fall upon it. A careful study of the facts shows that it is probable that some of the atoms have been broken up by the radiation, and that their oppositely electrified parts are scattered among their unaltered fellows. Such a gas is said to be ionized.

Thus by these two distinct lines of argument we come to the conclusions: 1st, that the presence of electrified particles promotes the formation of mist, and 2d, that in an ionized gas such electrified particles are provided by the breaking-up of atoms.

The two conclusions will mutually support each other if it can be shown that a mist is easily formed in ionized air. This was tested by Mr. Wilson, who showed that in such air mist is formed as though nuclei were present, and thus in the cloud we have visible evidence of the presence of the divided atoms. If then we cannot handle the individual molecules we have at least some reason to believe that a method is known of seizing individuals, or parts of individuals, which are in a special state, and of wrapping other matter round them till each one is the center of a discrete particle of a visible fog.

I have purposely chosen this illustration, because the explanation is based on a theory—that of ionization—which is at present subjected to hostile criticism. It assumes that an electrical current is nothing more than the movement of charges of electricity. But magnets placed near to an electric current tend to set themselves at right angles to its direction; a fact on which the construction of telegraphic instruments is based. Hence if the theory be true, a similar effect ought to be produced by a

moving charge of electricity. This experiment was tried many years ago in the laboratory of Helmholtz by Rowland, who caused a charged disc to spin rapidly near a magnet. The result was in accord with the theory; the magnet moved as though acted upon by an electric current. Of late, however, M. Crémieu has investigated the matter afresh, and has obtained results which, according to his interpretation, were inconsistent with that of Rowland.

M. Crémieu's results are already the subject of controversy,* and are, I believe, likely to be discussed in the Section of Physics. This is not the occasion to enter upon a critical discussion of the question at issue, and I refer to it only to point out that though, if M. Crémieu's result were upheld, our views as to electricity would have to be modified, the foundations of the atomic theory would not be shaken.

It is, however, from the theory of ions that the most far-reaching speculations of science have recently received unexpected support. The dream that matter of all kinds will some day be proved to be fundamentally the same has survived many shocks. The opinion is consistent with the great generalization that the properties of elements are a periodic function of their atomic weights. Sir Norman Lockyer has long been a prominent exponent of the view that the spectra of the stars indicate the reduction of our so-called elements to simpler forms, and now Professor J. J. Thomson believes that we can break off from an atom a part, the mass of which is not more than one-thousandth of the whole, and that these corpuscles, as he has named them, are the carriers of the negative charge in an electric current. If atoms are thus complex, not only is the *à priori* probability increased that the different structures which

we call elements may all be built of similar bricks, but the discovery by Lenard that the ease with which the corpuscles penetrate different bodies depends only on the density of the obstacles, and not on their chemical constitution, is held by Professor Thomson to be 'a strong confirmation of the view that the atoms of the elementary substances are made up of simpler parts, all of which are alike.'* On the present occasion, however, we are occupied rather with the foundations than with these ultimate ramifications of the atomic theory; and having shown how wide its range is, I must, to a certain extent, retrace my steps and return to the main line of my argument.

THE PROPERTIES OF ATOMS AND MOLECULES.

For if it be granted that the evidence that matter is coarse-grained and is formed of separate atoms and molecules is too strong to be resisted, it may still be contended that we can know little or nothing of the sizes and properties of the molecules.

It must be admitted that though the fundamental postulates are always the same, different aspects of the theory, which have not in all cases been successfully combined, have to be developed when it is applied to different problems; but in spite of this there is little doubt that we have some fairly accurate knowledge of molecular motions and magnitudes.

If a liquid is stretched into a very thin film, such as a soap bubble, we should expect indications of a change in its properties when the thickness of the film is not a very large multiple of the average distance between two neighboring molecules. In 1890 Sohncke † detected evidence of such a

* For the most recent account of this subject see an article on 'Bodies Smaller than Atoms,' by Professor J. J. Thomson in the *Popular Science Monthly* (The Science Press), August, 1901.

† *Wied. Ann.*, 1890, XL., pp. 345-355.

* See *Phil. Mag.*, July, 1901, p. 144; and *Johns Hopkins University Circulars*, XX., No. 152, May-June, 1901, p. 78.

change in films of average thickness of 106 millionths of a millimeter ($\mu\mu$), and quite recently Rudolph Weber found it in an oil-film when the thickness was 115 $\mu\mu$.*

Taking the mean of these numbers and combining the results of different variants of the theory we may conclude that a film should become unstable and tend to rupture spontaneously somewhere between the thicknesses of 110 and 55 $\mu\mu$, and Professor Reinold and I found by experiment that this instability is actually exhibited between the thicknesses of 96 and 45 $\mu\mu$.† There can therefore be little doubt that the first approach to molecular magnitude is signalled when the thickness of a film is somewhat less than 100 $\mu\mu$, or 4 millionths of an inch.

Thirteen years ago I had the honor of laying before the Chemical Society a résumé of what was then known on these subjects,‡ and I must refer to that lecture or to the most recent edition of O. E. Meyer's work on the kinetic theory of gases§ for the evidence that various independent lines of argument enable us to estimate quantities very much less than 4 millionths of an inch, which is perhaps from 500 to 1,000 times greater than the magnitude which, in the present state of our knowledge, we can best describe as the diameter of a molecule.

Confining our attention, however, to the larger quantities, I will give one example to show how strong is the cumulative force of the evidence as to our knowledge of the magnitudes of molecular quantities.

We have every reason to believe that though the molecules in a gas frequently collide with each other, yet in the case of the more perfect gases the time occupied in

collisions is small compared with that in which each molecule travels undisturbed by its fellows. The average distance traveled between two successive encounters is called the mean free path, and, for the reason just given, the question of the magnitude of this distance can be attacked without any precise knowledge of what a molecule is, or of what happens during an encounter.

Thus the mean free path can be determined, by the aid of the theory, either from the viscosity of the gas or from the thermal conductivity. Using figures given in the latest work on the subject,* and dealing with one gas only, as a fair sample of the rest, the lengths of the mean free path of hydrogen as determined by these two independent methods differ only by about 3 per cent. Further, the mean of the values which I gave in the lecture already referred to differed only by about 6 per cent. from the best modern result, so that no great change has been introduced during the last thirteen years.

It may, however, be argued that these concordant values are all obtained by means of the same theory, and that a common error may affect them all. In particular, some critics have of late been inclined to discredit the atomic theory by pointing out that the strong statements which have sometimes been made as to the equality, among themselves, of atoms or molecules of the same kind may not be justified, as the equality may be that of averages only, and be consistent with a considerable variation in the sizes of individuals.

Allowing this argument more weight than it perhaps deserves, it is easy to show that it cannot affect seriously our knowledge of the length of the mean free path.

Professor George Darwin † has handled the problem of a mixture of unequal spher-

* *Annalen der Physik*, 1901, IV., pp. 706-721.

† *Phil. Trans.*, 1893, 184, pp. 505-529.

‡ *Chem. Soc. Trans.*, LIII., March, 1888, pp. 222-262.

§ 'Kinetic Theory of Gases,' O. E. Meyer, 1899. Translated by R. E. Baynes.

* Meyer's 'Kinetic Theory of Gases' (see above).

† *Phil. Trans.*, 180.

ical bodies in the particular case in which the sizes are distributed according to the law of errors, which would involve far greater inequalities than can occur among atoms. Without discussing the precise details of his problem it is sufficient to say that in the case considered by him the length of the mean free path is $\frac{7}{11}$ of what it would be if the particles were equal. Hence were the inequalities of atoms as great as in this extreme case, the reduction of the mean free path in hydrogen could only be from 185 to 119 $\mu\mu$; but they must be far less, and therefore the error, if any, due to this cause could not approach this amount. It is probably inappreciable.

Such examples might be multiplied but the one I have selected is perhaps sufficient to illustrate my point, *viz.*, that considerable and fairly accurate knowledge can be obtained as to molecular quantities by the aid of theories the details of which are provisional, and are admittedly capable of improvement.

IS THE MODEL UNIQUE?

But the argument that a correct result may sometimes be obtained by reasoning on imperfect hypotheses raises the question as to whether another danger may not be imminent. To be satisfactory our model of nature must be unique, and it must be impossible to imagine any other which agrees equally well with the facts of experiment. If a large number of hypotheses could be framed with equal claims to validity, that fact would alone raise grave doubts as to whether it were possible to distinguish between the true and the false. Thus Professor Poincaré has shown that an infinite number of dynamical explanations can be found for any phenomenon which satisfies certain conditions. But though this consideration warns us against the too ready acceptance of explanations of isolated phenomena, it has no weight

against a theory which embraces so vast a number of facts as those included by the atomic theory. It does not follow that, because a number of solutions are all formally dynamical, they are therefore all equally admissible. The pressure of a gas may be explained as the result of a shower of blows delivered by molecules, or by a repulsion between the various parts of a continuous medium. Both solutions are expressed in dynamical language; but one is, and the other is not, compatible with the observed phenomena of expansion. The atomic theory must hold the field until another can be found which is not inferior as an explanation of the fundamental difficulties as to the constitution of matter, and is, at the same time, not less comprehensive.

On the whole, then, the question as to whether we are attempting to solve a problem which has an infinite number of solutions may be put aside until one solution has been found which is satisfactory in all its details. We are in a sufficient difficulty about that to make the rivalry of a second of the same type very improbable.

THE PHENOMENA OF LIFE.

But it may be asked—nay, it has been asked—may not the type of our theories be radically changed? If this question does not merely imply a certain distrust in our own powers of reasoning, it should be supported by some indication of the kind of change which is conceivable.

Perhaps the chief objection which can be brought against physical theories is that they deal only with the inanimate side of nature, and largely ignore the phenomena of life. It is therefore in this direction, if in any, that a change of type may be expected. I do not propose to enter at length upon so difficult a question, but, however we may explain or explain away the characteristics of life, the argument for the truth of the atomic theory would only be

affected if it could be shown that living matter does not possess the thermal and mechanical properties, to explain which the atomic theory has been framed. This is so notoriously not the case that there is the gravest doubt whether life can in any way interfere with the action within the organism of the laws of matter in bulk belonging to the domain of mechanics, physics, and chemistry.

Probably the most cautious opinion that could now be expressed on this question is that, in spite of some outstanding difficulties which have recently given rise to what is called Neovitalism, there is no conclusive evidence that living matter can suspend or modify any of the natural laws which would affect it if it were to cease to live. It is possible that though subject to these laws the organism while living may be able to employ, or even to direct, their action within itself for its own benefit, just as it unquestionably does make use of the processes of external nature for its own purposes; but if this be so, the seat of the controlling influence is so withdrawn from view that on the one hand its very existence may be denied, while, on the other hand, Professor Haeckel, following Vogt, has recently asserted that "matter and ether are not dead, and only moved by extrinsic force; but they are endowed with sensation and will; they experience an inclination for condensation, a dislike for strain; they strive after the one and struggle against the other."*

But neither unproved assertions of this kind nor the more refined attempts that have been made by others to bring the phenomena of life and of dead matter under a common formula touch the evidence for the atomic theory. The question as to whether matter consists of elements capable of independent motion is prior to

and independent of the further questions as to what these elements are, and whether they are alive or dead.

The physicist, if he keeps to his business, asserts, as the bases of the atomic theory, nothing more than that he who declines to admit that matter consists of separate moving parts must regard many of the simplest phenomena as irreconcilable and unintelligible, in spite of the fact that means of reconciling them are known to everybody, in spite of the fact that the reconciling theory gives a general correlation of an enormous number of phenomena in every branch of science, and that the outstanding difficulties are connected, not so much with the fundamental hypotheses that matter is composed of distinguishable entities which are capable of separate motions as with the much more difficult problem of what these entities are.

On these grounds the physicist may believe that, though he cannot handle or see them, the atoms and molecules are as real as the ice crystals in a cirrus cloud which he cannot reach; as real as the unseen members of a meteoric swarm whose death-glow is lost in the sunshine, or which sweep past us, unentangled, in the night.

If the confidence that his methods are weapons with which he can fight his way to the truth were taken from the scientific explorer, the paralysis which overcomes those who believe that they are engaged in a hopeless task would fall upon him.

Physiology has specially flourished since physiologists have believed that it is possible to master the physics and chemistry of the framework of living things, and since they have abandoned the attitude of those who placed in the foreground the doctrine of the vital force. To supporters of that doctrine the principle of life was not a hidden directing power which could perhaps whisper an order that the flood-gates of reservoirs of energy should now be opened

* 'Riddle of the Universe' (English translation), 1900, p. 380.

and now closed, and could, at the most, work only under immutable conditions to which the living and dead must alike submit. On the contrary, their vital force pervaded the organism in all its parts. It was an active and energetic opponent of the laws of physics and chemistry. It maintained its own existence not by obeying but by defying them; and though destined to be finally overcome in the separate campaigns of which each individual living creature is the scene, yet like some guerilla chieftain it was defeated here only to reappear there with unabated confidence and apparently undiminished force.

This attitude of mind checked the advance of knowledge. Difficulty could be evaded by a verbal formula of explanation which in fact explained nothing. If the mechanical, or physical, or chemical causes of a phenomenon did not lie obviously upon the surface, the investigator was tempted to forego the toil of searching for them below; it was easier to say that the vital force was the cause of the discrepancy, and that it was hopeless to attempt to account for the action of a principle which was incomprehensible in its nature.

For the physicist the danger is no less serious though it lies in a somewhat different direction. At present he is checked in his theories by the necessity of making them agree with a comparatively small number of fundamental hypotheses. If this check were removed his fancy might run riot in the wildest speculations, which would be held to be legitimate if only they led to formulæ in harmony with facts. But the very habit of regarding the end as everything, and the means by which it was attained as unimportant, would prevent the discovery of those fragments of truth which can only be uncovered by the painful process of trying to make inconsistent theories agree, and using all facts, however remote, as the tests of our central generalization.

"Science," said Helmholtz, "Science, whose very object it is to comprehend Nature, must start with the assumption that Nature is comprehensible." And again: "The first principle of the investigator of Nature is to assume that Nature is intelligible to us, since otherwise it would be foolish to attempt the investigation at all." These axioms do not assume that all the secrets of the universe will ultimately be laid bare, but that a search for them is hopeless if we undertake the quest with the conviction that it will be in vain. As applied to life they do not deny that in living matter something may be hidden which neither physics nor chemistry can explain, but they assert that the action of physical and chemical forces in living bodies can never be understood, if at every difficulty and at every check in our investigations we desist from further attempts in the belief that the laws of physics and chemistry have been interfered with by an incomprehensible vital force. As applied to physics and chemistry they do not mean that all the phenomena of life and death will ultimately be included in some simple and self-sufficing mechanical theory; they do mean that we are not to sit down contented with paradoxes such as that the same thing can fill both a large space and a little one; that matter can act where it is not, and the like, if by some reasonable hypothesis, capable of being tested by experiment, we can avoid the acceptance of these absurdities. Something will have been gained if the more obvious difficulties are removed, even if we have to admit that in the background there is much that we cannot grasp.

THE LIMITS OF PHYSICAL THEORIES.

And this brings me to my last point. It is a mistake to treat physical theories in general, and the atomic theory in particular, as though they were parts of a scheme

which has failed if it leaves anything unexplained, which must be carried on indefinitely on exactly the same principles, whether the ultimate results are, or are not, repugnant to common sense.

Physical theories begin at the surface with phenomena which directly affect our senses. When they are used in the attempt to penetrate deeper into the secrets of nature it is more than probable that they will meet with insuperable barriers, but this fact does not demonstrate that the fundamental assumptions are false, and the question as to whether any particular obstacle will be forever insuperable can rarely be answered with certainty.

Those who belittle the ideas which have of late governed the advance of scientific theory too often assume that there is no alternative between the opposing assertions that atoms and the ether are mere figments of the scientific imagination, or that, on the other hand, a mechanical theory of the atoms and of the ether, which is now confessedly imperfect, would, if it could be perfected, give us a full and adequate representation of the underlying realities.

For my own part I believe that there is a *via media*.

A man peering into a darkened room, and describing what he thinks he sees, may be right as to the general outline of the objects he discerns, wrong as to their nature and their precise forms. In his description fact and fancy may be blended, and it may be difficult to say where the one ends and the other begins; but even the fancies will not be worthless if they are based on a fragment of truth, which will prevent the explorer from walking into a looking-glass or stumbling over the furniture. He who saw 'men as trees walking' had at least a perception of the fundamental fact that something was in motion around him.

And so, at the beginning of the twentieth century, we are neither forced to abandon

the claim to have penetrated below the surface of nature, nor have we, with all our searching, torn the veil of mystery from the world around us.

The range of our speculations is limited both in space and time: in space, for we have no right to claim, as is sometimes done, a knowledge of the 'infinite universe'; in time, for the cumulative effects of actions which might pass undetected in the short span of years of which we have knowledge, may, if continued long enough, modify our most profound generalizations. If some such theory as the vortex-atom theory were true, the faintest trace of viscosity in the primordial medium would ultimately destroy matter of every kind. It is thus a duty to state what we believe we know in the most cautious terms, but it is equally a duty not to yield to mere vague doubts as to whether we can know anything.

If no other conception of matter is possible than that it consists of distinct physical units—and no other conception has been formulated which does not blur what are otherwise clear and definite outlines—if it is certain, as it is, that vibrations travel through space which cannot be propagated by matter, the two foundations of physical theory are well and truly laid. It may be granted that we have not yet framed a consistent image either of the nature of the atoms or of the ether in which they exist; but I have tried to show that in spite of the tentative nature of some of our theories, in spite of many outstanding difficulties, the atomic theory unifies so many facts, simplifies so much that is complicated, that we have a right to insist—at all events till an equally intelligible rival hypothesis is produced—that the main structure of our theory is true; that atoms are not merely helps to puzzled mathematicians, but physical realities.

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*A NOTABLE FACTOR OF SOCIAL DEGENERATION.**

THE subject to which I propose to call your attention cannot be said to be a new one, though I do not think that it has ever been presented before this Section. I wish to speak for a short time on one of the phases of social anthropology, in which I am very greatly interested. My theme is the problem of the feeble-minded. This term is now generally used to include all persons from those with weak minds to the most abject idiot. Perhaps most of us have met with a few individuals of this class. Almost every community contains one or more of these degenerates. The aggregate for our country, however, makes a mighty host. We do not know how many feeble-minded persons there are in the United States. The census of 1890 gives 95,571 individuals of that kind. From Pennsylvania there were reported that year 8,753; Ohio, 8,035; Indiana, 5,568; Iowa, 3,319; Kansas, 2,039; Colorado, 192. What the increase since then has been we do not know. The present census does not give any figures on this point; therefore any effort to ascertain the number can be but an estimate. These feeble-minded persons are distributed throughout our land, not in the same proportion everywhere. They are not so notable in some localities as in others. In some places they are so few or inconspicuous as scarcely to be recognized. On the contrary, elsewhere their presence is strikingly manifest, and they, in one way or another, make a deep impression upon society that must endure through succeeding generations. The feeble-minded are found under many conditions. There are children and men and women. It is as children and as adults in their more active years that most of us

know them best. Our social organization is made up of many factors. Some are constructive, some destructive. The feeble-minded are a disturbing element. Their life is a degenerating social force.

Some of the children with stronger mental powers enter the public schools. They may make some progress for a time, but whether they do or not, they must soon drop behind because they are unable to keep up with the work. Others roam the streets; the boys become the butt of the neighborhood, they are led into pranks, too often into vices, and seem to possess a peculiar tendency to immorality. The girls, many of them strong, well-appearing, with no one to teach them aright, and without strength of mind to protect themselves against the temptations which surround them, too early and too often fall into vice. "It is impossible to think of the evil of feeble-mindedness without heeding the curse of vice and illegitimacy which are its inevitable accompaniments. In the feeble-minded person the animal passions are usually present and are often abnormally developed, while will and reason, which should control and repress them, are absent. The feeble-minded woman, thus lacking the protection which should be her birthright, falls easily into vice. She cannot in her weakness resist the persuasions and temptations which beset her. When her baser passions are strong, she must oppose not only the influences from without but her own dominating desires. She is not to be condemned and punished, but rather to be pitied and helped in every possible manner." (Bicknell, Proc. Fourth Indiana State Conf. of Char. & Corr., 1895, p. 64.) Many of these poor creatures are easily attracted by an immoral life. Once begun, the pace is rapid, the course is always the same. It is impossible to tell or even to conceive of the depths of degradation to which they go. Dr. Kerlin, in

* Address of the Vice-President and Chairman of Section H, Anthropology, of the American Association for the Advancement of Science, Denver meeting, August, 1901.

1884, in his report to the National Conference of Charities and Correction speaks of moral imbecility, showing its blighting and demoralizing effects. He shows how crime, vice and depravity are spread by neglected feeble-minded or imbecile persons. He says, "There is no field in political economy which can be worked to better advantage for the diminution of crime, pauperism and insanity than that of idiocy." (Proc. Nat. Conf. of Char. and Cor., 1884, pp. 257 and 258.)

One perverted feeble-minded woman can spread throughout a community an immoral pestilence which will affect the homes of all classes, even the most intelligent and refined. The sight of such conditions or a knowledge of them must have a deadening effect upon the finer sensibilities of all.

These defectives usually also become dependents for a part of, if not all, the time. They may depend upon private charities or, when possible, upon the overseer of the poor. They frequently live in the poorest quarters of our towns and cities amid squalor and dirt, or occupy miserable huts in the least desirable localities of rural communities. It is not unusual for two or more families to live near each other or associate together. Marital ties are often lightly regarded. Frequently such bonds have not been entered into.

When these feeble-minded persons become helpless or learn the habit of regular public dependence, they find their way to poor asylums, the children being placed in such orphans' homes as will accept them. To one who visits the poor asylums and orphans' homes where they are received, the idiotic and feeble-minded are striking objects. In every one of the ninety-two poor asylums in my own State, Indiana, there are to be found inmates of this class, the greatest number in any one institution being 25; the lowest, 2. In

many, their presence is emphasized by pitiable cases, individuals who are almost uncontrollable, or by infants, the offspring—in most cases the illegitimate offspring—of parents, one or both of whom are feeble-minded. The records at hand show that there are 970 feeble-minded persons in the Indiana poor asylums. (Rept. Board of State Char. of Indiana, 1900, p. 73.) Almost all these are adults. Many are in some degree helpless and all require more or less care. They have grown up without discipline; they lack such training as is possible with their dwarfed minds or strong hands; they are not only incapable of earning their own support, but, in a large number of instances, are the objects of continual anxiety to those in charge. This is particularly the case with feeble-minded women. Four hundred and eighty unfortunates of this sex are to be found in our county asylums, comprising 49.5 of their total feeble-minded population. Under our system of care it is only by the utmost watchfulness that the sexes are kept apart. Where proper facilities for sex separation are wanting, or the overwatch is not strict, there is to be found a continual increase of feeble-mindedness. This brings an increasing burden of expense upon the tax-payers in such counties.

I am compelled to speak specifically of Indiana, because we know more of the facts concerning conditions that exist there than we do of those elsewhere.

From information received, however, it is believed that they are not materially different from those existing in other States similarly situated. Perhaps in a general way the conditions there may be said to be the average of what is true of all our States.

To quite a large number of our poor asylums the inmates often come and go at will. The absence of the feeble-minded is especially noted during the summer season. They then go to visit friends or wander

about the country. Any kind of shelter will answer their purpose and food is easily obtained. Quite a number of the women return to the poor asylum to become mothers.

In a certain county in the southern part of the State is a family of sixteen persons, representing three generations. Twelve of its members are the direct descendants of a feeble-minded blind man and his feeble-minded, partially blind, wife. The husband and wife have been inmates of the poor asylum off and on for thirty-five years. Generally wintering in the institution, they spend the summer roaming about the country, living in the woods. In unfavorable weather they seek an old hut or rail pen for shelter. They are said to make a bed of leaves or straw and live on what they can beg, supplemented by wild fruits and nuts. They have a feeble-minded daughter who is also partially blind. She has been twice married and has borne two feeble-minded daughters and three feeble-minded sons. Another feeble-minded and partially blind daughter has spent the greater part of the last twenty-two years in the poor asylum of an adjacent county and has been the mother of four illegitimate children. In this family of sixteen persons, nine are feeble-minded (three of these being also partially blind) and four are known to be illegitimate.

In an adjoining county are a husband and wife, both degenerates, who make the poor asylum their home in winter and live elsewhere in summer. It is no uncommon thing, in the spring following these wanderings, to have the family increased by a little mite of humanity which does not seem as if it could live. Many such children do live, however. This woman has borne eleven children and six of them are alive. One summer the family lived in a little shed built of short boards obtained from dry-goods boxes, old tin and carpets, along the railroad right-of-way, and obtained its liv-

ing principally from begging. This family has just made a beginning. How extensive it may become depends upon what measures are taken. It has probably been an expense of \$1,000 per year to the county.

Occasionally the children of normal parents are feeble-minded. As Mr. Bicknell has well said, there is no method of diverting the course. While it is easily possible for parents of normal faculties through dissipation, vice or disease to produce feeble-minded offspring, there seems to be no method by which the tendency can be reversed and the degeneration, thus easily accomplished, displaced by regeneration and restoration in succeeding generations. (Fifth Rept. of Indiana Board of State Charities, 1894, page 51.)

Usually, and in a large number of cases, feeble-minded children are the offspring of feeble-minded parents. It is equally true that in the majority of cases the children of feeble-minded parents are feeble-minded.

From what has been said may be gathered that the question before us presents two notable evils:

- (a) The increasing number of illegitimate children of feeble-minded parents.
- (b) The inheritance of feeble-mindedness.

In the office of the Board of State Charities of Indiana there has been collected, from every reliable source, during the past twelve years, a great mass of material relating to this group of defectives. It embraces much that has been gathered by the Indiana School for Feeble-minded Youth especially through the efforts of Mr. Alexander Johnson, its able superintendent. In addition, it contains such information as could be obtained from the Poor Asylum and Orphans' Home records and from the township trustees who are *ex-officio* overseers of the poor. I know of no such a series of records nor one so conveniently arranged. Mr. Ernest P. Bicknell, formerly the Secre-

tary of the Board of State Charities, some years ago prepared two papers based upon a part of this material. (Proc. Indiana State Conf. of Char. and Cor., 1895, p. 60. Proc. National Conf. of Char. and Cor., 1887, p. 219.)

With the fuller amount of data from these records at hand I have thought to present some illustrations obtained from it at this time.

Perhaps I may say a word as to the method of registration used in this work. From all our institutions regular reports are required. Some of these are made monthly, others quarterly. They are arranged with headings for all the principal facts in the individual and family history of each inmate. It is desired to have them filled as fully as the information obtained will permit. In addition to the regular institution records, information is sought as to the age, nativity, sex, color, mental and physical condition, and whether illegitimate. If parents are known we ask for their names and specific information as to whether either is affected with insanity, feeble-mindedness, deafness, blindness, paralysis, or whether either was a pauper, criminal or drunkard. This information, when obtained, is transferred to a card registration, where the cards are kept in duplicate; one series arranged alphabetically, the other by institutions. To the information at hand every fragment that is learned is added.

I have taken from these records some information concerning 511 families in which there is known to be feeble-mindedness. If there was any question regarding any family it was omitted. No such collection of these families has heretofore been reported upon. The number of persons known to be represented in them is 1,924. This is an average of 3.76 persons in each family. 1,343 of these persons are supported in public institutions. It is known, how-

ever, that these are not all the family representatives. They are the family members of whom we have accurate information. In it are included not only direct descendants, but those related by marriage.

Of this number of persons, 889, 46.2 per cent., were men; 1,035, 53.7 per cent., were women. 1,249—64.9 per cent., 532 men and 717 women, were feeble-minded; 54, 21 men and 33 women, were insane; 44, 25 men and 19 women, were otherwise defective. These last include blind, deaf, paralytics and epileptics. 577, 311 men and 268 women, were normal or their defectiveness was unknown. Every person known concerning whom positive information was not included in this latter group. In a number of cases there are combinations of defectiveness. One was insane and deaf, another feeble-minded, deaf and epileptic. Consequently, if we undertake to separate them we find there are 79 epileptics, 31 men and 48 women; 35 blind, 17 men and 18 women; 21 deaf, 6 men and 15 women; 19 paralytics, 8 men and 11 women; with combined mental and physical defects 101, 34 men and 67 women. Of these family members, 267, 13.8 per cent., 141 men and 126 women, are known to have been illegitimate.

What about the parentage of these individuals? In a large number of cases the characteristics are unknown. It is a matter of record that in 1,042 cases (over 54 per cent. of the whole) either one or both parents were defective. Of these in the cases of 666—348 males and 318 females, the mother was defective. In the case of 151, 83 males and 68 females, the father was defective, the mother unknown or normal. Both parents were defective in 225 instances, 122 males and 103 females. It will be seen that the records show the mother defective in 34.6 per cent. of the total number of cases noted herein, while only 7.8 per cent. of the fathers were defective, and both parents were defective

A TABLE OF 511 FEEBLE-MINDED FAMILIES CONTAINING 1,924 PERSONS.

	Whole number.	In public institutions.	Feeble-minded.	Insane.	Epileptic.	Blind.	Deaf.	Feeble-minded and epileptic.	Feeble-minded, paralytic and epileptic.	Feeble-minded and blind.	Feeble-minded and paralytic
Males.	889	617	499	20	8	10	3	21	1	6	3
Females.	1,035	726	652	31	10	2	5	31	3	14	7
Total.	1,924	1,343	1,151	51	18	12	8	52	4	20	10

	Feeble-minded and deaf.	Feeble-minded, deaf and epileptic.	Feeble-minded, blind and epileptic.	Blind and paralytic.	Paralytic.	Blind and epileptic.	Insane and epileptic.	Insane and deaf.	Unknown or normal.	Illegitimate.	Total.
Males.	1	1		1	3			1	311	141	889
Females.	8	1	1		1	1	1	1	266	126	1,035
Total.	9	2	1	1	4	1	1	2	577	267	1,924

PARENTAGE OF ABOVE 1,924 PERSONS.

	Mother f. m. Father unk. or normal.	Mother f. m. and ep. Father unk. or normal.	Mother f. m. and bl. Father unk. or normal.	Mother f. m. Father f. m. and ep.	Mother f. m. and ep. Father f. m.	Mother f. m. and df. Father unk. or normal.	Mother f. m. and par. Father unk. or normal.	Mother f. m. Father par.	Mother f. m. Father bl.	Mother f. m. Father insane.	Mother f. m. and bl. Father unk. or normal.	Mother insane. Father unk. or normal.	Mother blind. Father unk. or normal.	Mother ep. Father unk. or normal.	Mother insane. Father f. m.
Males.	307	4	2	3	1	1	1		8	3	2	23	4	4	14
Females.	289	7	3	7		1	1	2	7	2	2	14		2	9
Total.	596	11	5	10	1	1	2	2	15	5	2	37	4	6	23

	Mother ep. Father f. m.	Mother unk. or normal. Father f. m.	Mother unk. or normal. Father ep.	Mother ins. and ep. Father unk. or normal.	Mother unk. or normal. Father par.	Mother unk. or normal. Father f. m. and bl.	Mother unk. or normal. Father insane.	Mother unk. or normal. Father blind.	Mother ep. Father f. m. and bl.	Parents insane.	Parents f. m. and bl.	Parents related.	Parents D. and D.	Parents unknown or normal.	Parents f. m.
Males.	1	75	2	1		2	3	1	1	5		10	1	326	85
Females.		61	1	1	2		3	1	1	2	2	12	1	534	70
Total.	1	136	3	2	2	2	6	2	2	7	2	22	2	860	155

FEEBLE-MINDEDNESS AND RELATED DEFECTS, TOGETHER WITH ILLEGITIMACY IN FIVE HUNDRED AND ELEVEN FAMILIES.

	Whole number.	Feeble-minded.	Epileptic.	Insane.	Blind.	Deaf.	Paralytic.	Illegitimate.
Males.	889	532	31	21	17	6	8	141
Females.	1,035	717	48	33	18	15	11	126
Total.	1,924	1,249	79	54	35	21	19	267
Number of families.	511							
Average number of persons to each family.	3.76	1.54						
Percent. of whole number		64.9	4.1	2.8	1.8	1.	.9	13.8
Percentage of males.		59.8	3.5	2.3	1.9	.6	.9	15.8
Percentage of females.		69.3	4.6	3.1	1.7	1.4	1.	12.1

in 11.6 per cent. instances. One cause of this difference, perhaps the chief one, is that the mothers, for various reasons which will occur to you, are often known when the fathers are not. The parents of 860 of the 1,924 children, 326 men and 534 women, an aggregate of 44.6 per cent., were either unknown or were known to be normal. In but 22 instances (1.1 per cent.) were the parents reported to be relatives. This was true in the case of 10 men and 12 women.

The physical and mental condition of the parents of these 889 males is more specifically given as follows :

Mother defective, father unknown or normal.....	348 or 39.1%
Father defective, mother unknown or normal.....	83 or 9.3%
Both parents defective.....	122 or 13.7%
Parents unknown or normal.....	326 or 36.6%
Parents related.....	10 or 1.1%
	889 99.8%

141, or 15.8 per cent., of the males are illegitimate.

The physical and mental condition of the parents of these 1,035 females more particularly stated is as follows :

Mother defective, father normal or unknown.....	318 or 30.7%
Father defective, mother normal or unknown.....	68 or 6.5%
Both parents defective.....	103 or 9.9%
Parents unknown or normal.....	534 or 51.5%
Parents related.....	12 or 1.1%
	1,035 99.7%

(' Defective ' in the above means either mentally or physically defective.)

Of the 717 feeble-minded women, 163, or 22 per cent., have had illegitimate children. These 163 women have had 248 children, an average of 1.52 each. They range in number from 1 to 8 to the mother.

Perhaps it is well to refer to a few illustrations of the ancestors of the persons whom we have been discussing.

In one of the county poor asylums of Indiana, years ago, were a man and his

wife, who are reported to have been of a low grade of intelligence, if not actually feeble-minded. The direct descendants of this couple, with those who entered the family through marriage, number 67, comprising three generations. One of the men, who is fairly bright, has raised a good family; another is an intelligent barber; two men have served in the army, but the majority of the family are feeble-minded, illiterate and of low morals, and their history is one of drunkenness, prostitution and crime. The marriage relation has been lightly regarded, and doubtless many of the unions were those of common law. Some of these persons are self-supporting, but a much larger number of them are or have been supported by the public in county or state institutions.

One woman I recall is the mother of eleven children, ten of them by one husband, one by another. A feeble-minded man whose history is known to us, was father of twenty children but was married several times.

Another group of 241 families in which there are two or more generations of feeble-mindedness has 970 persons who are blood relations, that is an average of 4.02 to each family. Of these families, 221 have two generations of feeble-mindedness, sixteen have three generations, three have four generations and one has five generations. The number of direct descendants who are feeble-minded is known to be 726. That is to say, 74.8 per cent. are feeble-minded. Does anything else reproduce itself so surely? In addition to this there are 25 who show other evidences of defectiveness. But 197 are normal or their mental and physical condition is unknown.

In the first generation 103 men and 203 women (306) were the parents of 248 children. Of these 84 were males and 164 were females. It is observed that almost twice as many women as men were known

as parents in the first generation. The reason is the women were principally poor asylum inmates who were permitted to leave the institution and either live among relatives of a similar stage of mentality or roam the country. They returned to the poor asylum as a maternity house and nothing was learned or recorded of the paternity of many of the children.

persons, 304 males and 224 females. Of these, 26 were parents of the third generation. Of the latter seven were parents of the fourth generation. From it came the single parent of the fifth generation. In the first generation there were 267 individuals of 306, or 87 per cent., who were feeble-minded; in the second generation 386 of 548, or 70 per cent., were so recorded; in the

A TABLE OF 241 FAMILIES EACH CONTAINING TWO OR MORE GENERATIONS OF FEEBLE-MINDEDNESS REPRESENTED BY 970 INDIVIDUALS.

No. families of 2 generations of feeble-mindedness	221
“ “ “ 3 “ “ “	16
“ “ “ 4 “ “ “	3
“ “ “ 5 “ “ “	1

241

Total No. of persons 970. Average to each family 4.02.

	Total No. of persons.		F. M.		Ins.		Ep.		Df.		Bl.		F. M. & Df.		F. M. & Ep.		F. M. & Par.		F. M. & Bl.		F. M. Bl. & Ep.	
	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.
1st generation.	103	203	84	164	5	17	1	1			3	1		1		3	1	3	3	6		
2d “	304	244	199	157	4	5	2	1	1	2			3	8	11		1		3		1	
3d “	48	47	25	31			1							2					1			
4th “	9	11	7	6																		
5th “	1		1																			
Total.	465	505	316	358	9	22	4	2	1	5	1		4	10	14	1	4	3	10			1

	F. M., Par. & Ep.		F. M., Df. & Ep.		Par.		Ins. & Ep.		Ins. & Df.		Unk. or Normal.		Illegit.		
	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	
1st generation.		1		1	1			1			5	4		3	Parents of 3d generation, 26 “ “ 4th “ “ 7 “ “ 5th “ “ 1
2d “	1	1	1						1	87	59	46	26		
3d “										20	15	15	15		
4th “										2	5	1	1		
5th “												1	1		
Total.	1	2	1	1	1		1		1	114	83	63	44		

Most of the families obviously are of two generations. The child and parent are reported, and often nothing has been learned of an earlier ancestor. Where there are three or four generations some of the older members are dead, so that the amount of information concerning them is scant. On the other hand the later generation is represented by one or more children, many of them so young that their mental state cannot be determined.

In the second generation there were 548

third generation 59 of 95, or 62 per cent., were so noted; in the fourth generation 13 of 20 cases, or 65 per cent., were given as feeble-minded. In the fifth generation the single representative is reported as feeble-minded. The aggregate showing, as noted, is that 74.8 per cent. of the descendants of these feeble-minded ancestors are feeble-minded. Other defects among the children are noted as follows: insane, 3.4 per cent.; epileptic, 3.8 per cent.; blind, 2 per cent.; deaf, 8 per cent.; paralysis, 9 per cent.;

both mentally and physically defective, 5.5 per cent. 107 or 11 per cent. were reported as illegitimate.

It will be observed that the feeble-minded and blind are more common than any other combination in the first generation, while in the second and third generations there are more feeble-minded and epileptics.

In one neighboring county a feeble-minded woman, who, according to the records in our office, has been in the poor asylum over twenty years, was the mother of two daughters, to whom she transmitted her mental defect. One of these feeble-minded daughters, Rachel, has been twice married, and has borne eleven children, three of whom are now dead. Her second union was with a negro. Her children are very ignorant, but so far our records do not show that they have been inmates of any public institution, with the exception of one son, who has been in prison. The other daughter,

sons have been the result of this marriage. One of the daughters is feeble-minded. One of the sons, also feeble-minded, is a natural criminal. The direct descendants of the feeble-minded woman first mentioned number twenty-nine, and in the past ten years twelve of these persons have spent an aggregate of twenty-two years in the poor asylum and orphans' home of the county. The total family members reported number forty-seven and extend over five generations.

One group of 13 feeble-minded families is recorded containing 68 individuals. Of these there were 18 in the first generation; 26 in the second; 24 in the third. With these degenerates it is not always true that when there is a little child there are three persons in a family. The paternity is not always known and in many cases we are compelled to count two persons, the mother and child. All the members of the first generation were feeble-minded; twenty

A RECORD OF THIRTEEN FAMILIES OF THREE GENERATIONS EACH.

	No. of persons.		Feeble-minded		Insane.		F. M. & Ep.		F. M. & Df.		Deaf & Dumb.		Unk. or normal.		Illegitimate.	
	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.
First generation.	7	11	6	9		1	1	1								
Second generation*	7	19	6	14					1		2		1	2		2
Third generation.	14	10											14	10	5	6

Kate, had four children, all girls, two feeble-minded and two illegitimate. The two feeble-minded daughters have spent much of their lives in the county poor asylum. One of them, Nancy, became the third wife of a feeble-minded, paralytic man, and one son and three feeble-minded daughters were born to her. Her husband's second wife had a feeble-minded daughter, who married an insane man, and they have one child, a son. Nancy's feeble-minded sister, Lou, married a feeble-minded man, and three daughters and two

of the second generation showed the same defect. The mental condition of the third generation is not given. The reason is that they were reported when they were at an age at which it could not be determined. Eleven of its members, however, are reported as illegitimate. The 11 women in the first generation were the mothers of 26 children. The 24 members of the third generation are the children of 12 of these. It will be noted that when the younger members of a generation are born in an institution, or become inmates very young, their mental condition cannot be reported and often is not known unless they are readmitted when

*No. of persons in 2d generation who had children = 12.

they become older and the psychosis can be determined. Neither the husbands nor the wives of the members of this group are counted in this table. Those enumerated are the direct descendants of the persons in the preceding generation.

It is not unusual to find in a poor asylum three generations of feeble-mindedness. Not long since, the speaker had grouped before him, at a poor asylum in the southern part of the State, four generations of feeble-minded persons—father born in 1817, daughter, granddaughter and great-grandson. There are nineteen members of this family; nine are feeble-minded and four are illegitimate. Most of them have been inmates of the institution where they were seen. Some of them recur to it from time to time yet. This is not a single instance, for in other poor asylums an equal number of generations, similarly afflicted, can be found, and in fact there are instances where five generations have at one time or another been inmates of such a county institution.

Years and years ago a single man here and there—a prophet in a strange land—began to call attention to the condition of the idiot. They were treated as animals in confinement. At the beginning of the present century the first institution was built for their care.

Dr. Walter E. Fernald tells us that the first recorded attempt to educate an idiot was made about the year 1800 by Itard, the celebrated physician-in-chief to the National Institution for the Deaf and Dumb at Paris, upon a boy found wild in a forest in the center of France, and known as the 'Savage of Aveyron.' This boy could not speak any human tongue, and was devoid of all understanding and knowledge. Believing him to be a savage, for five years Itard endeavored with great skill and perseverance to develop at the same time the intelligence of his pupil and the theories of the materialistic school of philosophy.

Itard finally became convinced that this boy was an idiot, and abandoned the attempt to educate him. (Proc. Nat. Conf. Char. and Cor., 1893, page 203.)

In 1818 the American Asylum for the Deaf and Dumb, at Hartford, Conn., the first institution of its kind in this country, gave the first instruction offered in the United States to idiotic children. Following this several attempts were made in teaching such children in France, Switzerland and Germany. But a few could be cared for. Slowly the thought of the possibility of their improvement spread. The progress of the work was slow. Individuals were interested and pressed into it. Finally a state took some interest.

In 1846 the first effort was made for legal provision for the instruction of idiots in this country in New York. This was unsuccessful; but a few days later in the same year action looking to similar results was begun in Massachusetts. This culminated in legislation in 1848, providing for the education of 'ten indigent idiots.' Thus began our public institutions for idiotic or feeble-minded children. In New York efforts providing for such a school were repeatedly made, but it was not until 1851 that they were entirely successful and the act passed in that State. Pennsylvania was the third State to begin the work in 1852. It was followed by Ohio in 1857. One after another of our States has recognized the duty of providing education, training and care for these unfortunates. In a number of States institutions of the highest standing have been developed. Dr. Fernald tells us the early history of these pioneer State institutions in many respects was very similar. They were practically all begun as tentative experiments in the face of great public distrust and doubt as to the value of the results to be obtained.

At last it became recognized that those who had given years of study to the idiot

had a right to have an opinion and to express it. Then it came to be believed and advocated that in this class of defectives were many who were amenable to instruction if it were only of the right kind and taught in the right way. The children might be reached and helped.

First it was thought that many of these children could be educated to make their own way in the world. Finally it was decided that while many of them could be taught to be self-supporting under direction, but very few could ever leave the fostering care of the institution. Children they are and children they will be as long as they live. For, though they become old in years, mentally they will still be children.

More and more came the conviction that there should be custodial institutions. These were especially advocated for feeble-minded women under forty-five years of age. They would be safe and with no prospect of reproducing their kind. Now it has come to be regarded as the proper right and duty to retain control over these grown-up children during life. Some states have made a beginning for this purpose.

Never did we appreciate so strongly as we do to-day the untold misery and accumulating expense caused by the lack of control of our feeble-minded population. Their fecundity and animal instincts make them fit subjects for consideration, both on financial and moral grounds, to say nothing of the dangers that beset those of strong minds who have weaker bodies.

The problem presented to us is the manner in which these conditions shall be met. Its solution lies in an intelligent and general knowledge of the subject by the public, preventive measures by legal marriage restrictions and other means, the education of feeble-minded children and the custodial care of feeble-minded women.

AMOS W. BUTLER.

INDIANAPOLIS, IND.

SCIENTIFIC BOOKS.

Anatomy of the Cat. By JACOB REIGHARD, Professor of Zoology in the University of Michigan, and H. S. JENNINGS, Instructor in Zoology in the University of Michigan. 173 original figures by LOUISA BURRIDGE JENNINGS. Henry Holt & Co. 1901. 8vo. Pp. ix+498.

Teachers and students alike will welcome the appearance of this admirable text-book because it is practically the only work which treats of the entire macroscopic anatomy of the cat, the mammal most generally available for class-room study. Of the books on the cat hitherto published none unites in itself all the requirements of a satisfactory text-book; they are either inaccurate and diffuse or accurate and meager, while another class which covers parts of the subject exhaustively is not available because incomplete. We believe that, with the aid of this present work, a teacher will find no difficulty in conducting a thorough laboratory course and can cover the entire ground in a college year. The authors are to be congratulated, not only upon producing a book which will secure a higher grade of class-room work, but also upon the completion of an important scientific contribution which cannot fail to stimulate and encourage a wider teaching of elementary anatomy. In one sense this is not an elementary work; the descriptions are scientific and concise, without attempt at popular writing. Moreover, it presupposes a knowledge on the part of the student of such general matters as the nature of tissues, the functions of organs and the meanings of scientific terms. Hence its use would seem to call for accompanying lectures or for previous preparation in courses on histology and general biology.

We are glad to see that the authors have not cast the book in the form of a laboratory guide; structures are described in their proper order and relation, the amount of space devoted to the different systems of organs being determined not only by their relative importance, but also by the amount of work on each which can be expected from the average student. Thus, for example, almost one-half of the entire work is devoted to a description of the bones and muscles, and but one-eighth to the viscera.

The descriptive portion of the book is followed by an appendix of practical directions, covering forty-three pages. Herein are given general directions for study and for the preparation of material, together with special directions for the dissection of each group of organs—as they present themselves to the student and not in the order in which they are studied in the descriptive portion of the work. The separation of these notes from the body of the book of course preserves continuity to the descriptions and enhances the value of the book as a work of reference; on the other hand, it necessitates such an amount of turning of pages by the student that it would have been wiser to have brought the practical directions into closer relation with the text—at the beginning or at the end of each section or chapter.

In the matter of nomenclature, as the authors maintain, and properly, that the primary purpose of such a work is not to illustrate or defend any particular system of nomenclature, but to aid in obtaining a knowledge of the structures themselves, and as they hold that the time has not come for an absolutely uniform nomenclature, they have adopted such terms as they judge likely to be measurably permanent. As a basis, therefore, they use, as far as possible, the Latin terms (and their English equivalents) proposed by the German Anatomical Society, but freely substitute for these other terms, either when those proposed are not appropriate for the cat, as, for example, the names for the cerebral sulci or gyri, or when the substitutes are better known to English anatomists and are not likely to be given up, as, for example, *trapezoid* for *os multangulum minus*. In cases of substitution the Latin name proposed by the German Society is given as a synonym. Whenever a structure has two names, equally well-known, both names are given. It is certainly most desirable that each structure should have a single name; if however, there be two, the student should learn them.

As terms of direction the authors properly use, almost exclusively, such intrinsic terms as *dorsal* and *ventral*; *cranial* and *caudal*; *proximal* and *distal*; *medial* and *lateral*, and they discard the older extrinsic terms *anterior* and *posterior*; *superior* and *inferior*; *inner* and *outer*. *Dorsal*

and *ventral* are also applied, less happily we think, to surfaces of the limbs; the dorsal side being indicated by the convexity of the joint, elbow or knee, the ventral side by the concavity of the joint. The constant use of adverbial forms such as *dorsad*, *cranialad*, *proximalad*, etc., certainly gives brevity and directness to the text; they do not add, however, to its elegance—nor does the use of *onto* for *on*.

We have examined the greater part of the book with care and find it to be well planned, clearly written and based on accurate original study. Some things are omitted which, from the general thoroughness of the work, one would have expected to find, as, for example, an account of the interesting arrangement of the tendons and ligaments attached to the terminal phalanges. To reduce the book to a convenient size, omissions, of course, are necessary; what shall be omitted must remain a matter of personal opinion. The drawings by Mrs. Jennings which illustrate the work are excellent; they show clearly what the student is expected to see and are not burdened with unnecessary detail. A few diagrams from frozen sections to show the relations of organs would have been instructive. The book is well made; type, paper, printing and binding are all good; and there is a capital index.

HORACE JAYNE.

Zell- und Protoplasmastudien. By F. DOFLEIN. 1900.

Under the above title Dr. F. Doflein publishes in brochure form a reprint of his paper in Spengel's 'Zoolog. Jahrbücher,' XIV. This contribution is the first Heft of the author's studies on the morphology and physiology of nuclear and cell-division. It deals, in the main, with the process of nuclear division in *Noctiluca miliaris*. The author gives a very detailed account of his work on preserved material. He differs in several particulars from the results of previous writers, the most important differences being his failure to identify the centrosome in any part of the astrophere, and his denial of a longitudinal splitting of the chromosomes as described by Calkins. The latter author has shown, from the arrangement of the chromatin threads at a certain phase in the division that

it is probable that a longitudinal splitting of the chromosomes takes place. Doflein does not find any evidence of such in process. In the absence of conclusive proof it is impossible to decide which of these two accounts is correct.

SCIENTIFIC JOURNALS AND ARTICLES.

The Plant World for August contains, besides short articles, notes and reviews, 'August Days,' by John Burroughs; 'Notes from Western Kentucky,' by Sallie F. Price, and, under the caption 'A Scanty Flora, a description of that of Bird Rock, Gulf of St. Lawrence,' by Henry E. Baum. But three species of plants are found on this islet: *Poa compressa*, *Achillea borealis* and *Plantago maritima*. Pauline Kaufman continues 'Orchids in Central Park,' and John Gifford describes 'The Dwarf Mistletoe, *Razoumofskya Prusilla*.' L. H. Pammel discusses 'Rare Plants and their Disappearance,' the drying up of sloughs and the overpasturing of the woodlot being accountable for the small numbers of the plants mentioned. In the supplement devoted to 'The Families of Flowering Plants,' Charles Louis Pollard describes the Trigoniaceæ and other families of the Germinales and begins the description of the Sapindales.

The News Bulletin of the Zoological Society of New York appeared in new form with its last (July) issue, having been reduced to a small quarto about the size of *SCIENCE*. Besides a number of views of animals living in the park, there is a cut showing the state of the monkey house in June. The completion of a restaurant and of the Service Building is announced, and many improvements in the buildings and grounds are noted. Six species of mammals, twelve of birds and eight of reptiles were born in the park this present season. A special feature of the New York Zoo is its collection of reptiles, and the additions to this have been numerous during the first six months of the year.

The Osprey for July brings this periodical nearly down to date, and the August number is promised at an early day. The present issue contains besides shorter articles 'Camping on the Old Camp Grounds,' by Paul Bartsch;

'Stephen's Whip-poor-will,' by J. H. Riley; 'The Malar Stripe of Young Flickers and the Moults,' by William Palmer; 'The Blue Grosbeak in Eastern Kansas,' by Walter S. Colvin, and the sixth instalment of 'The Osprey or Fish-hawk; its Characteristics and Habits,' by Theodore Gill.

SCIENTIFIC journals are not often sold, and it is consequently a matter of interest that the market value of a special journal has been ascertained by the sale of the *Botanisches Centralblatt* to the International Association of Botanists. According to the *Compte Rendu* of the recent congress the price was 37,500 Marks, and the present editor, Dr. Uhlworm retains his position for five years, and if subsequently superseded receives an indemnity. About half the amount has been subscribed, and the balance has been advanced by the publisher, J. E. Brille, of Leipzig, who is to be paid 4 per cent. interest.

DISCUSSION AND CORRESPONDENCE.

DISCORD AND PSYCHOLOGY.

TO THE EDITOR OF *SCIENCE*: In the issue of *SCIENCE* for August 30 Mr. Max Meyer calls attention, in a discussion of 'Discords and Beats,' to a supposed error in my review of a recent book on physics, where I referred to Mayer's law expressing the duration of the residual auditory sensation as a function of vibration frequency. He is right in thinking it rare to find physicists well up with current psychological literature, a fact necessitated by the immense mass of literature now in all departments. This fact excuses Mr. Meyer for having apparently failed to read the investigations of Professor Mayer on this subject, which were published in the *American Journal of Science* (Oct., 1874, April, 1875, and Jan., 1894). This physicist did not assume that discord was necessarily due exclusively to beats. His own conclusions were tested in 1875 by a trained musician whose deliverances were given without considering anything else than the perception of discord. This was a purely psychological investigation, therefore, so far as musical sensation was concerned. If the psychologists have some time since agreed that discord cannot be defined by beats, this negative conclusion does not estab-

lish the proposition that all discord is wholly independent of beats. Whether it be due wholly or partly to beats or to something else quite unknown as yet, Mayer's curve is sufficient to disprove the statement that the maximum of discord is due to always the same number of beats, whatever may be the pitch.

It was not my intention to publish any detailed criticism of the point to which I took exception in my review of the book of physics under examination. But Mr. Meyer will probably agree with me in objecting to the following sentences, which may now be quoted: "One cause of discord is the presence of beats between the two notes, and the greatest discord results when the beats are about 32 per second. If the number of beats is fewer than 10 per second, they are not agreeable, but do not produce discord. Discord is caused by sounding together notes that give more than 10 and less than 70 beats per second." Whatever may be the cause of discord now agreed upon among psychologists, Mayer's law comes nearer to being a statement of the truth than the sentences just quoted. The author is creditably cautious in assigning the presence of beats as 'one cause.' Presumably it may not be the only cause. But his quantitative statements warranted my criticism that he had "defined 'discord' more sharply than the facts warrant by failure to recognize Mayer's law."

If Mr. Meyer will criticise the quoted sentences from the standpoint of the psychologist he will doubtless confer a favor upon physicists who have not kept up with recent advances in psychology.

W. LE CONTE STEVENS.

WASHINGTON AND LEE UNIVERSITY,
August 31, 1901.

MAGAZINE ENTOMOLOGY.

It has been the habit to charge newspapers with the dissemination of scientific misinformation, and undoubtedly with considerable justice. But they are not the sole sinners. In the September number of *McClure's Magazine* there is a paper entitled 'Next to the Ground; Stories and Scenes of Farm Life,' by Martha McCulloch Williams. The amount of misinformation it conveys cannot be equalled by any bit of

newspaper writing, and for ignorance on the part of the author it is certainly entitled to the palm. First, we have information about the dragon fly, and the superstition concerning snakes that is connected with it; that is all right; but we are immediately afterward informed that it begins its early life as a fat white grub, variously known as Hellgrammite, dobson, etc. Now, in the first place, the hellgrammite is neither white, nor fat, nor is it a grub; and in the second place, it has absolutely no connection with the dragon fly.

From any elementary work on entomology, national or foreign, the writer could have obtained an accurate life history of the dragon fly, and also information as to the adult stages of the hellgrammite. She may have seen a dragon fly; she certainly never saw a hellgrammite to know it. Then we learn something about the locusts, and most interesting, we are told that the eggs are laid in the pith of dying twigs. So much has been written about these insects that it does seem as if the authoress might have known better than to make an assertion of this kind. Pithy stems are rarely used by locusts, if at all, and dying twigs are never attacked. The eggs are always laid in growing shoots, and in the wood itself. I wonder where she saw the black beetles or 'Betty bugs' that were three inches long? She speaks of them as 'Scarabs,' and the largest of these, occurring in the United States entitled to that name, are not more than one inch in length.

More marvelous than anything else is the description of the change from the tumble bug, black and loutish, into a 'June bug,' green all over, with copper yellow tints on the legs, etc. Where in the world this information came from, if it was not the product of overstrained imagination, seems incomprehensible. In fact, reading the entire paper, which covers eight pages, there is more dense ignorance and absolute misinformation crowded into it than I have seen anywhere on a similar subject within the last decade. And what there was in it anywhere, to recommend to the editor its publication, seems almost beyond finding out. There has been of late years a great revival of interest in natural history. We have had many useful and accurate books, including the topics on which Martha

McCulloch Williams writes. It would seem as if anyone intending to publish concerning natural history would at least familiarize himself or herself with the subject. It is discouraging to find a magazine like *McClure's* accepting and printing an article of this character.

JOHN B. SMITH.

NEW BRUNSWICK, September 12, 1901.

CURRENT NOTES ON PHYSIOGRAPHY.

THE RANGES OF THE GREAT BASIN.

THE mountain ranges of the Great basin in Utah and Nevada have been explained, chiefly by Gilbert and Russell, as due to block faulting, but without sufficient statement concerning the form of the region before faulting or of the amount of erosion since faulting. Hence the ranges have sometimes been imagined as presenting long, gentle back slopes where the pre-faulting surface has been tilted up, and abrupt frontal cliffs where the fault scarp is revealed; and in the absence of statement to the contrary it has been sometimes supposed that the faults by which the blocks are limited were determined by ordinary stratigraphic evidence.

Spurr now offers a new interpretation of these ranges ('Origin and Structure of the Basin Ranges,' *Bull. Geol. Soc. Amer.*, XII., 1901, 217-270, pl. 20-25). Finding monoclinical structure not persistent, finding much dissection on both slopes of the ranges, and finding no stratigraphic evidence of faulting along the base of the ranges, he discards the theory of block faulting and explains the mountains as residuals of a disordered and greatly denuded mass, the intermont depressions being regarded as valleys of erosion produced under a former greater rainfall and now clogged with waste since a drier climate has set in.

Attention is here called to the different values given by Spurr to the stratigraphic evidence of faults where both members of the faulted series are seen, and to the physiographic evidence where only one member is visible. Faults determined by ordinary stratigraphic evidence are spoken of as 'actually observed' (266), while faults announced by previous observers on physiographic evidence are altogether rejected, apparently because they are not confirmed by

stratigraphic proof. As a matter of fact, no faults (meaning thereby surfaces of fracture on which movements of dislocation have taken place) have been actually observed as such in the Great basin; faulting is there as elsewhere a matter of inference. In the case of faults proved by stratigraphy, the termination of one series of strata against another may be more or less closely observed; and then instead of believing that both sets of strata were 'made so' in the beginning, it is reasonably inferred that they both originally had greater extension, that they were brought into their present relations by dislocation, and that the dislocated mass has been carved into its present form by greater or less erosion. This demonstration is commonly accepted as so compulsory and all other explanations seem so infinitely improbable, that faulting proved by stratigraphic evidence is often treated as if it were a matter of first-hand observation, and given an equal order of verity with the plain facts of strike and dip.

In the case of faults proved by physiographic evidence, the outcrops of a series of strata in an escarpment or on a mountain side are directly observed; and then instead of believing that they were made so, it is inferred that the invisible parts of the series have been in some way removed. On finding that their removal cannot be reasonably accounted for by erosion alone, the aid of faulting is invoked, a greater or less amount of erosion being supposed to precede and to follow. This argument of course involves such a knowledge of the observable facts of structure and form, and such an understanding of the processes of erosion and of the forms resulting therefrom, that, while certain forms (such as the Appalachian ridges of Pennsylvania) may be reasonably ascribed to erosion alone acting on a deformed structure, certain other forms (such as the Basin ranges) may as reasonably be held to be beyond production by erosion, without relatively recent faulting. This demonstration of faulting may be just as logical as that based on stratigraphy alone, but it is somewhat more complicated and it is much less commonly employed.

Now inasmuch as the block faulting of the Basin ranges has been determined in nearly every case by the physiographic method alone,

it is certainly desirable that discussions of the Basin range structure should include a consideration of the criteria for the demonstration of faults by this means, when only one member of the faulted series is visible. Yet no such consideration of the problem is given by Spurr. He confirms earlier work by finding that marginal faults are not to be determined along the base of the ranges (except in rare instances) by ordinary stratigraphic evidence. He reiterates the undisputed fact that great erosion has occurred since the ancient folding and faulting within the body of the ranges, and he illogically infers from this that recent faulting, marginal to the ranges, has not taken place. Instead of dealing with the problem at issue—the sufficiency of physiographic evidence to prove block faulting—he asserts without adequate discussion the sufficiency of erosion to produce

upon it to attest its elevation. The block faulting of the Basin ranges may perhaps be some day disproved, but not until the evidence of faulting accepted by Gilbert and Russell has been shown to be valueless.

PHYSIOGRAPHIC EVIDENCE OF FAULTING.

The essential elements in the physiographic evidence of faulting in the Great basin are the impossibility of accounting for the presence of the mountain ranges if the intermont depressions have been produced by erosion alone, and the ease of accounting for them if the rough form of the region has been blocked out by faulting, leaving erosive processes only the smaller work of trimming the mountains into their present shape. The difficulty of dispensing with faulting is both qualitative and quantitative. In the first place, the structure of the

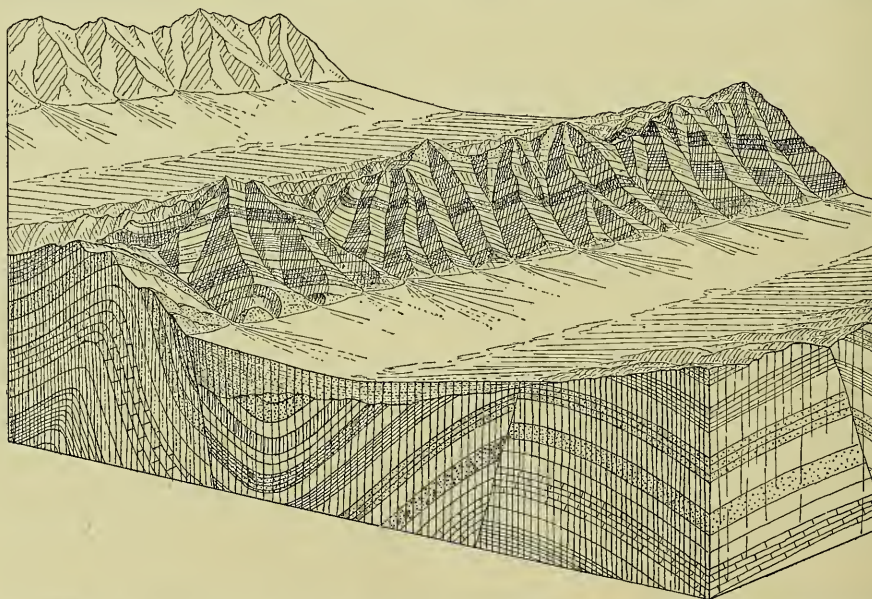


FIG. 1. Diagram of a mountain carved on a faulted block of previously deformed and denuded strata.

existing forms, and after the briefest consideration he denies the peculiar faulting that has been reasonably inferred on physiographic grounds to be essential for the production of the ranges. This is very much as if one should deny the modern uplift of the Appalachian Piedmont district after its broad denudation, because no strata containing marine fossils lie

ranges is commonly oblique to their border, so that the faulted margin passes indifferently from one structure to another, as in the accompanying figure; if the ranges were the residuals of a long period of undisturbed erosion, such a lack of correlation between border and structure would not be looked for; but if the ranges are limited by faults at one side or both, the

indifference of border to structure is natural enough. In the second place, the body of each range is usually continuous, although it may be incised by sharp-cut valleys; if the ranges were the residuals of a period of undisturbed erosion long enough to have permitted the excavation of broad intermont valley-lowlands, each range should be divided into isolated mountain groups by the opening of wide branch-valleys in its mass; but if the depressions and the ranges are blocked out by recent faulting, the continuity of the ranges is to be expected.

Both these tests are best met in southern Oregon, where the ranges as described by Russell are very little affected by erosion after faulting. Neither test is well met by certain ranges in southeastern California described by Fairbanks as almost worn down to grade. In Utah and Nevada both tests are well borne; but no definite statement has yet been published concerning the amount of erosion that has taken place in this district since the block faulting; nor has any careful inference been made as to the form that the region had before faulting, some remnants of which may perhaps still be detected on the lower back slope of the ranges. The absence of steep scarps along the faulted border of a range does not bear closely on the problem, although Spurr attaches much importance to it. Recent and rapid faulting would produce a scarp; but similar scarps produced less recently would now be more or less completely dissected and destroyed. Gradual faulting, even if continued into the historic period, would produce only a low basal scarp; the upper part of the fault face would be battered back and ravined. The truncated ends of certain spurs of the Wahsatch range near Prevo, Utah, seem to result from faulting of this kind, the fresh scarp that follows the base of the range being the product of the most recent episode of faulting.

No features due to recent faulting are seen in the Appalachians. The ridges there are intimately dependent upon the harder strata, the base of a ridge always follows the strike of the individual ridgemaker, and the lowlands between the ridges are demonstrably excavated by erosion on weak rocks. All these are conditions which no one has shown to obtain in

the Great basin; yet Spurr says: "Suppose the Appalachians, which likewise consist of parallel ridges eroded along lines of folding, should become arid, so that the rivers were unable to remove the detritus and the valleys become choked. There would develop in the course of time exactly what exists in the Basin region, namely, a nearly level desert, containing a series of parallel, synclinal, and anticlinal ranges" (p. 255). The strongest dissent from this unwarrantable comparison must be expressed.

THE KENTUCKY MOUNTAINEERS.

AN article that might serve as the type of many more is a description of the Kentucky mountaineers by Ellen C. Semple ('The Anglo-Saxons of the Kentucky Mountains: a Study in Anthropogeography,' *Geogr. Journ.*, XVII., 1901, 588-623). The dissected Alleghany plateau, which is of mountainous ruggedness in Kentucky and West Virginia, shares with the mountains of North Carolina the unenviable distinction of being less affected by civilization than any equal area east of the Rockies. So many old customs are there preserved that the people have been well named 'our contemporary ancestors.' Miss Semple's account of these primitive Americans is based on personal observation and affords many excellent illustrations of the consequences of living in a region too rough for easy movement and too poor to attract immigrants.

W. M. DAVIS.

THE UNIVERSITY OF CHICAGO'S FIELD WORK IN BOTANY, GEOLOGY AND ZOOLOGY.

PRESIDENT HARPER, of the University of Chicago, in his last quarterly statement gives the following details in regard to field work:

The work in biology at the Marine Biological Station at Wood's Holl, Mass., is largely in charge of University of Chicago men, the director and the majority of the staff being from this institution. The director of the Laboratory of the Brooklyn Institute at Cold Spring Harbor, Long Island, and one of the botanical staff this summer were members of this faculty. The work at both these

laboratories may be looked upon as field work of a somewhat permanent type. The courses are credited at the University of Chicago, although not formally under its charge.

Besides the local field work in connection with residence courses in botany, zoology and geology, field work during the past summer has been conducted at a distance from the University by the departments of geology and botany.

I. GEOLOGY.

1. A course in elementary field geology was given by Mr. R. D. George for four weeks of the second term of the summer quarter, the remainder of the term being devoted to the preparation of a report on the field work. A party of eleven traversed a region in the Mississippi valley between Prairie du Chien, Wis., and Muscatine, Ia. They devoted themselves to a study of (a) Paleozoic strata and fossils, (b) the topographic features of the driftless area in Iowa and Wisconsin, (c) the stratified drift of the valleys, (d) the loess, and (e) the lead and zinc deposits of the Dubuque region.

2. Professor R. D. Salisbury is in charge of several parties in Montana, Idaho and Utah. These parties consist of advanced students and are working somewhat independently, Professor Salisbury visiting the different parties at intervals and making suggestions regarding the work. A party of two is at Kipp, Mont., a second party of two at Kalispell, Mont. These two parties are investigating the phenomena of local glaciation in the Rocky mountains. Another party of two is at work in the Santa Fé mountains of New Mexico, studying their structural and stratigraphic features. A party of six, under the immediate direction of Mr. W. W. Atwood, is at work on the Wahsatch mountains, studying similar problems.

BOTANY.

1. A party of eight, under the direction of Mr. S. M. Coulter, of Washington University, spent the first part of the second term of the summer quarter at North Manitou Island, passing over later to the mainland in the vicinity of Petoskey and Charlevoix, studying the ecological relations of the flora in these regions. This work is essentially an examination of the way

in which plants associate themselves and an investigation of the determining factors of environment for each society.

2. Similar but more extended work has been undertaken by a party of eighteen in charge of Dr. H. C. Cowles. This party has a car on the Great Northern Railroad, and is stopping at various favorable localities through Montana and Washington. Two weeks were spent at Flat Head Lake, Montana, the site of the biological station of the University of Montana, whose facilities were put at the disposal of the party; another week was spent at Belton, Mont.; and other stops were made at Leavenworth and Seattle, Wash. This is the most extended field trip yet offered in the department of botany and has certainly presented unusual advantages to the students for a study of widely different floras under most varied climatic conditions.

NEW YORK BOTANICAL GARDEN.

THE Misses Olivia E. Phelps Stokes and Caroline Phelps Stokes have recently contributed the sum of \$3,200 to the Garden, of which \$200 is to be added to the Special Book Fund, the remainder is to constitute a fund, the income of which is to be devoted to the protection and preservation of native wild flowers. This will increase the effectiveness of the Garden in a very desirable direction, and enable it to do much in the promotion of a healthy public sentiment in the matter.

Dr. M. A. Howe, assistant curator, accompanied by Mr. William Lange, museum aid, and Mr. Clifton D. Howe, of the University of Chicago, made an exploration of Nova Scotia. Special attention was paid to the collection of marine algæ, of which several thousand specimens, preserved in fluid and dried condition were secured. About 8,000 sheets of herbarium specimens of land plants were secured. The exploration reached New York on September 9. The expenses of the expedition were chiefly defrayed from funds contributed by Mr. George W. Perkins, of the Board of Managers.

Dr. D. T. MacDougal, first assistant, spent a portion of the summer in Montana in cooperation with the biological expedition of the State University. Dr. MacDougal was accom-

panied by Mr. Wilson P. Harris, as voluntary assistant, and secured a large number of plants for the outdoor plantations, many kinds of seed for growing additional species and over 900 numbers of herbarium and museum specimens, collectively including more than 3,000 specimens. In addition to these, all the duplicates of the collections of the University of Montana were obtained. Attention was also given to climatological observations. Mr. Harris devoted his attention chiefly to lichens. The exploration extended along the Mission range of mountains and into the southern Kootenais, and regions were reached which had never been touched by such an expedition. The expenses of this work were paid from funds contributed by Mr. W. E. Dodge, of the Board of Managers.

Dr. MacDougal is acting director-in-chief during the absence of Dr. Britton.

Professor L. M. Underwood, of the scientific directors, recently returned from a tour of Porto Rico, bringing with him a nice collection of cacti from the arid southern part of the island, some 75 species of seeds, many of which have already germinated in the propagating houses, a number of museum specimens and about 1,000 specimens for the herbarium. He will spend a month now in the Rocky Mountains of Colorado, continuing the exploration begun by Dr. P. A. Rydberg. A recent gift from Mr. Adrian Iselin has made the extension of the important work possible.

Professor N. L. Britton, director-in-chief, left for St. Kitts, and other of the Windward Islands, on August 30, accompanied by Mr. John H. Cowell, director of the Buffalo Botanic Gardens. The object of their expedition is to obtain living tropical plants and seeds for the conservatory collections, specimens for the public museums, and as complete a collection of herbarium specimens of these islands as can be obtained during a month or six weeks' residence there. This work is in continuation of the botanical exploration of the West Indies and Central America instituted in 1899, when Mr. A. A. Heller and Mr. Samuel Henshaw were sent to Porto Rico by means of funds contributed by Mr. Cornelius Vanderbilt, and of Professor Underwood's recent work in Porto

Rico made possible by funds contributed by Mr. W. E. Dodge.

Mr. Percy Wilson, museum aid, who was sent to the East Indies in March, accompanying Professor Todd, of Amherst College, on the total eclipse of the sun expedition, has returned, bringing with him ten large cases of museum specimens illustrating economic products, a number of living orchids, a collection of seeds for growing in the propagating houses, and a valuable set of books and pamphlets treating of the botany and agriculture of that region. He visited the botanical gardens at Singapore and at Buitenzorg, Java, where he was most kindly received, and arranged with these institutions for important exchanges of plants, books and specimens.

SCIENTIFIC NOTES AND NEWS.

THE French Institute will make the first award of the Osiris prize in 1903. It is of the value of 100,000 francs, and is awarded to the one who in the preceding three years accomplishes the most important work for science, industry or literature.

THE city of Berlin will contribute \$25,000 toward the Virchow foundation for research, now being enlarged in honor of Professor Virchow's eightieth birthday.

THE Austrian Emperor has addressed an appreciative autograph letter to Professor Ed. Suess, the eminent geologist, on the occasion of his retirement from the University at Vienna.

As the newspapers fully report, the steamship *Erik* reached North Sydney, Cape Breton, on August 14, with news from Lieutenant Peary. During the eighteen months in which no news had been received from him, he had succeeded in rounding the northern limit of the Greenland Archipelago, and in reaching the highest latitude gained by an American, 83° 50'' north. Lieutenant Peary remains at Payer Harbor, and will attempt to reach the most northerly point possible in the spring of next year. Messrs. Stein and Warmbath are returning on the *Windward*, but no news is brought of Captain Sverdrup on the *Fram*.

MEMBERS of the British Geological Association visited France last month. They were

met at Clermont by MM. Glangeaud and Giraud, and after visiting the department of Puy de Dôme explored Le Cantal under the guidance of M. Boule.

DR. A. W. NIEUWENHUIS has returned from a two years' expedition across the unexplored regions of Borneo, made under the auspices of the Dutch government. Dr. Nieuwenhuis's previous expeditions to Borneo have yielded results of much zoological, geographical and ethnographic interest.

DR. H. F. KNOWLTON, of the U. S. Geological Survey, has just returned from a trip, made in company with Dr. John C. Merriam, of the University of California, through the John Day Basin, Oregon. The special object of the investigation was to secure collections of fossil plants from the rich beds of the region, and also of the vertebrate fauna of the recently differentiated rattlesnake beds. Much valuable material was secured.

DR. GEORGE A. DORSEY, curator of the department of anthropology at the Field Columbian Museum, Chicago, has returned from a trip among the Hopi Indians of Arizona.

PROFESSOR F. W. PUTNAM, professor of American archeology and ethnology in Harvard University, is at present in California, where, as last summer, he is looking into the case of the Cavalaras skull.

DR. E. W. ALLEN, of the Office of Experiment Stations, Department of Agriculture, has recently returned from an extended tour of the agricultural experiment stations in the Northwest and Alaska. He finds that the Alaska stations are meeting with encouraging success in demonstrating the entire feasibility of growing the vegetables necessary to supply the needs of the local population, and in maturing the cereal grains. He will recommend the taking up of experiments in raising and feeding farm animals to determine the extent to which this is practicable with Alaska-grown products.

REPORTS received from Professor C. C. Georgeson, the officer in charge of the Alaska experiment stations, who has just returned from a trip to the interior and down the Yukon, are exceedingly encouraging. New potatoes, cab-

bage, cauliflower and other vegetables were ready for the table early in August, and gardens planted with a variety of annual flowers were in full bloom. Rye and barley were ripened this year at the station at Rampart on the Yukon, with a fair prospect for oats and wheat. Extensive tracts of land were found on the lower Yukon which were covered with a luxuriant growth of grasses, often six feet in height, and apparently well suited to agriculture.

PROFESSOR JOHN B. SMITH, of Rutgers College, is devoting a good portion of the present season to the study of the mosquito question in New Jersey. The occurrence of these insects in great swarms along the coast, lessens the value of shore property by many millions of dollars, and some localities farther inland are rendered almost uninhabitable. The object of the present inquiry is chiefly to establish the distribution of the various species that occur in the state, their relative abundance and the general character of the breeding places. It is intended to make the facts so ascertained the basis of the report to go to the Legislature, which will probably be asked to make a substantial appropriation to carry on the work in a more thorough and comprehensive manner. It seems probable that by cooperation of the state and municipal authorities, aided by individual effort in some cases, the pest can be very materially reduced. It will require, however, a very careful study of the problem before a comprehensive plan of campaign can be formulated.

MR. WILLIAM CAMPBELL, B.Sc., F.G.S., a graduate of and former instructor in metallurgy and geology in Durham College of Science, England, has been honored for the third time by the award of an 1851 Exhibition Research Scholarship. For the past two years Mr. Campbell has been engaged in researches upon the constitution of alloys, working in the laboratories of Sir William Roberts-Austen, at the Royal School of Mines (London University), and at the Royal Mint. Mr. Campbell, at the request of the commissioners by whom the award is made, proposes to continue his researches at Columbia University in Professor Henry M. Howe's laboratory.

IN view of the resignation of Dr. Thomas L. Watson, assistant geologist of the Survey of Georgia, to accept a chair at Denison University, the State Geologist, Dr. W. S. Yeates, Atlanta, will be glad to enter into correspondence with geologists seeking such a position.

DR. EIJI AOYAGI, of the University of Kioto, is at present in the United States investigating methods for the application of electricity.

PROFESSOR A. C. HADDON, of Cambridge University, is to visit the United States, reaching New York on the steamship *Campania* of the Cunard Line about September 28 and remaining in this city until about October 7. While in this country he will deliver lectures, illustrated by excellent stereopticon views, at various educational institutions upon some of the following subjects:

The House and Family Life of the Natives of Sarawak.

Ceremonial and Secular Dances of the Papuans.

A Trip into the Interior of Borneo.

The Papuans.

Evolution in Art.

The Descriptive Art of Primitive Peoples.

The Life of a Torres Straits Islander.

As is well known, Professor Haddon is an authority on 'The Evolution of Art' and kindred subjects. He has worked for many years among the tribes of New Guinea, Borneo, Torres Straits and the adjacent territory, conducting the recent Cambridge expedition to that region.

MR. WALDRON SHAPLEIGH, a well-known industrial chemist of Philadelphia, died in Maine on August 30. He was born in Philadelphia in 1848, and was assistant professor of chemistry at Lehigh University from 1868 to 1872. He then studied abroad, and was connected first with the King's County Sugar Refinery and later with the Welsbach Company. He was an authority on the rare earths.

DR. CHARLES MELDRUM, F.R.S., formerly director of the observatory in Mauritius, died on August 28, at the age of eighty years.

THE Rev. Moses Harvey died at St. Johns, Newfoundland, on September 3, at the age of eighty-two years. He retired from active work

in the Presbyterian church in 1878, and has since been engaged in literary and scientific work.

THE death is also announced of Professor Alwin von Coler, surgeon-general of the Prussian medical service, at the age of seventy years.

THE German Geological Society will hold its forty-sixth meeting at Halle during the first week in October.

THE astronomical instruments 'conveyed' by the German soldiers from the Pekin Observatory have reached Germany, and it is said will be placed in the park of Sans Souci. Many of the German newspapers protest against the detention of these instruments.

THE director of the Paris Jardin des Plantes, M. Perrier, has asked the French government for the sum of \$2,000,000, which he claims is required for the buildings and collections.

A MAGNETIC observatory is being constructed by the government at Sitka, Alaska, under the direction of Dr. H. W. M. Edmonds, of the U. S. Coast and Geodetic Survey.

AN interesting and useful pamphlet, says *Nature*, has recently been issued by Mr. A. Hilger, containing full description and details of manipulation of the Michelson Echelon grating. Many of the principal universities of Europe have been provided with this very powerful means of spectroscopic determination, and the experience gained has been sufficient to permit the designing of a standard type of instrument. In this the thickness of each plate is 10 mm., and the width of each step 1 mm. The progressive precision in the working of the plates has enabled Mr. Hilger to avoid the considerable loss of light which was caused in the original instruments by the plates not being mechanically clamped together. They are now held in position by a screwed frame, which can be so adjusted that no distortion is perceptible, while the increase in brilliancy of the spectra is very noticeable.

MAJOR RONALD ROSS, Royal Army Medical Corps, landed at Plymouth on September 2 on his return from West Africa. He gave a press

representative an account of the work which is being done in Freetown and Lagos under his direction as leader of the expedition sent out by the Liverpool School of Tropical Medicine, in the course of which he said it was too early to speak of the sanitary work at Freetown, but the number of the mosquitoes in the center of the town had certainly been largely reduced. There were hardly any to be found in Dr. Logan Taylor's house, where formerly they used to swarm, and the same state of affairs prevailed at Government House, where Major Ross stayed with the Governor. Dr. McKendrick, of the Indian Medical Service, who had been deputed to watch over the operations of the expedition on behalf of the Government of India, was not bitten once during a whole month. In former days he would certainly have been bitten at least five or six times a day. Major Ross said he had no doubt that the expeditions would be successful and that they would be continued as long as necessary. At Lagos the measures adopted by Sir William Macgregor were admirable and he was confident of success. The Governor of Accra, Major Nathan, was anxious to start similar work there at once, and doubtless experts would be sent out immediately by the Liverpool School of Tropical Medicine. On the whole, Major Ross expressed himself as being well satisfied with his tour. Personally he did not think the health of the Coast was as bad as was painted. He believed that by minute attention to details the place would be made as healthy as India for Europeans. Old West Africans are sober and careful and generally live in very good health. It was the improvident newcomer who generally seemed to suffer. He had been informed that there was a high rate of mortality amongst such on the Cape Coast.

UNIVERSITY AND EDUCATIONAL NEWS.

MRS. PHOEBE HEARST has agreed to pay all the expenses of a department of anthropology at the University of California, which will be devoted especially to the study of Indians of the Pacific coast.

MR. AARON FRENCH, the Pittsburg manufacturer, who has made large gifts to the

Georgia School of Technology, has established a third scholarship in that institution.

SYRACUSE UNIVERSITY receives about \$40,000 by the will of the late Justice George N. Kennedy.

By the death of Mrs. Henrietta Cramp, Wesleyan College, at Bloomington, Ill., has received \$50,000, bequeathed to it by the late Rev. Samuel Cramp.

WE recently had occasion to call attention to the great development of the universities of the Central and Western States during the past ten years. There is every reason to suppose that in the course of the next ten years a great advance will be made in the Southern States. Tulane University has recently made great progress, and the University of South Carolina, under the presidency of Dr. F. P. Venable, will have this year about 600 students. This university should be included among those competent to carry on advanced work, though it was omitted from our summary of the universities awarding the degree of Doctor of Philosophy. There were, as a matter of fact, two doctorates of philosophy awarded last year, as follows :

Archibald Henderson, Mathematics : 'The Cone of the Normals and an Allied Cone for Central Surfaces of the Second Degree.'

James E. Mills, Chemistry : 'Some Molecular Changes caused by Rise in Temperature.'

As a result of the recent troubles in the Storrs Agricultural College, Mr. George W. Flint has been dismissed from the presidency. Professor R. W. Stimson, who holds the chair of English at the College, has been appointed acting president.

PROFESSOR E. M. WOOD, of Baker University, at Baldwin, Kansas, is to succeed the late Professor Henry Benner, as professor of mathematics and astronomy in Albion (Mich.) College.

PROFESSOR THOMAS C. ESTY, of Amherst, has succeeded Professor Baker in the chair of mathematics at the University of Rochester.

PAUL ARNOLD, M.A., of Los Angeles, has been appointed professor of mathematics in the University of Southern California.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

EDITORIAL COMMITTEE : S. NEWCOMB, Mathematics ; R. S. WOODWARD, Mechanics ; E. C. PICKERING, Astronomy ; T. C. MENDENHALL, Physics ; R. H. THURSTON, Engineering ; IRA REMSEN, Chemistry ; CHARLES D. WALCOTT, Geology ; W. M. DAVIS, Physiography ; HENRY F. OSBORN, Paleontology ; W. K. BROOKS, C. HART MERRIAM, Zoology ; S. H. SCUDDER, Entomology ; C. E. BESSEY, N. L. BRITTON, Botany ; C. S. MINOT, Embryology, Histology ; H. P. BOWDITCH, Physiology ; J. S. BILLINGS, Hygiene ; WILLIAM H. WELCH, Pathology ; J. MCKEEN CATTELL, Psychology ; J. W. POWELL, Anthropology.

FRIDAY, SEPTEMBER 27, 1901.

PROBLEMS AND POSSIBILITIES OF SYSTEMATIC BOTANY.*

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THESE annual summer meetings of our Society, occurring as they do between the close of one year's academic activity and the beginning of the next, offer an excellent opportunity not merely for profitable retrospects, but for such interchange of ideas as may stimulate renewed effort. The summary of results achieved, although a natural and desirable part in the proceedings of an assembly of this sort, is subject to a growing difficulty from the ever-increasing technicality of modern research. We live in an age of great detail and at a time when our subject has branched into many narrowing paths of investigation. Thus, even at a meeting of highly trained botanists, there is less common ground than we could wish, and it is scarcely possible, without the certain ennui of most of our colleagues, to present the finer results in those particular researches which may have stirred us individually to great enthusiasm. On the other hand, the aims and methods in our varying lines are by no means so unlike, and afford an ever-fertile field for discussion and comparison. It may be further maintained, in defiance of any suspicion of prejudice, that the aims and methods of systematic botany should command an especial and very gen-

* Delivered at Denver, August 28, as an address by the retiring President of the Botanical Society of America.

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.

eral interest. No department of our subject is more intimately associated with every other. No other branch of botany so completely underlies all phases of botanical work. For what botanical investigation does not depend for its value upon a correct identification of the plants with which it deals? An accurate, lucid and complete classification of plants is thus the only secure basis upon which botany as a whole can rest. What is the present strength of this all-important foundation? Is it built upon rational principles? Should we build on or tear down and reconstruct? Is it nearing completion or does it represent as yet only the earliest stages of the desired structure? These are questions scarcely less significant to the physiologist, ecologist, pathologist, horticulturist or pharmacist than to the systematic botanist.

In surveying the taxonomic work of the last decade we see on every hand evidences of great and increasing activity. Small genera have become large; easy groups have become intricate. Thin periodicals have grown marvelously fat—in pages, not, alas! in pecuniary receipts. The number of regular and irregular publications has vastly increased. Species have been made by the thousand. No previous period of similar length has turned out such a bulk of systematic literature. It is true that this copious and now decentralized publication is of all degrees of merit, yet no one would wish to deny to it a reasonably high average of excellence. I speak, of course, of those papers which aim at the record of serious research. From these considerations and in the presence of this extraordinary activity there can be no doubt that systematists are making flattering progress in at least one direction; they are, namely, recording a huge number of facts.

Facts, however, can be accumulated much faster than they can be sorted and arranged. They are, to carry out our figure, only the

bricks for the structure, and to be effective building material must be laid in a firm mortar of law, organization and proper association. The chief difficulty which now besets our subject is the overwhelming accumulation of uncorrelated facts, unmonographed species, disjointed observations, preliminary and fragmentary records. The summit of our structure, instead of presenting a fairly clear and firm surface for further construction, seems to be buried at many points mountain-deep by disorderly heaps of loose bricks, in their way excellent building material, but so carelessly piled together as to impede rather than assist those who are earnestly endeavoring to bring order into this threatened chaos. Let no one understand me as discouraging the accumulation of facts—even very small facts—relating to the classification of plants. We do not know half enough even about the commoner species. I would merely urge that those who publish should take far greater pains to present their facts in an orderly and lucid way, with reasonable terseness and in such a manner as to show clearly their relation to preceding observations in the same field. This is the first possibility for advance in systematic botany and, if I mistake not, many other branches of research are in like case.

In this matter of presentation the natural sciences seem to be at a peculiar disadvantage. In belles-lettres a work of crude literary form is damned. Authors, if they would be read, must cultivate a good style. But in the natural sciences, if a work only presents some new and valuable facts it must, in spite of the crudest form, be purchased, read, reviewed, quoted, and the author is often flattered by the seeming success of a paper which may have been little better than an imposition upon his colleagues. Some improvement may undoubtedly be accomplished if the scientific public, especially editors and reviewers, can be

stirred to a more critical attitude toward work defective in form. But important advance can only emanate from the authors themselves. They should take a greater pride in the style of their publications, should realize that lucidity of exposition goes far to carry conviction, while obscurity is positive injustice to their coworkers.

Let us take, for instance, the publication of a new species. The requisites of a good description are generally known. There should be the habitual picture, giving in a few words an idea of the general form, size and nature of the plant as a whole; then a considerable number of features should be tersely described; special care should be taken to point out the differential characteristics by which the plant is distinguished from its nearest relatives; and finally full information should be given with regard to the occurrence of the species, its type, locality, collector, date and exsiccation-number of the type-specimen, with a mention of the herbarium in which it is to be found. These are usually simple matters, and their business-like statement in relation to every new species is a generally-recognized obligation of its author to his colleagues, yet it is safe to say that not one-half of the species published during the last year have received descriptions which fulfilled these simple conditions.

On the one hand insufficient characterizations still occur. A well-known botanist has recently described a new leafy-stemmed phanerogam, without mentioning root, stem, branches, leaves, pubescence, calyx or fruit. However, this sort of insufficient description is becoming rare. The need of fullness is widely recognized, and great improvement in this regard has been manifested in recent years. *Enough* is generally said. Quantity in the description is no longer such a desideratum as proper arrangement, judicious selection, and especially some form of emphasis by which the really im-

portant, invariable, and therefore diagnostic, features may stand out in high relief. As I have said, the author of a new species owes clarity to his colleagues. This obligation is not fulfilled by a page and a half of description in which, without particular emphasis, all manner of characteristics are given, ranging from those which concern a group or even family down to others so detailed as to apply only to the single specimen in hand. Here is another possibility for advance, namely, the discrimination and proper emphasis of differential characteristics in description.

Here authors can bring to bear all the keenness of insight which they possess. To estimate correctly the value of plant differences is by no means easy. To a great extent their permanence and consequent taxonomic significance can only be a matter of inference based upon a knowledge of similar differences in other groups. This fact seems to have discouraged some of our systematists to such an extent that they wish to escape all responsibility in relation to the matter. They give what is called a good full description without the slightest effort to show the relative importance of the points they mention. They trust that a future monographer will somehow extract from their miscellaneous statements or find upon their so-called types certain significant differences which will serve to distinguish their plants from all others.

It may be doubted, however, whether a writer is justified in publishing a species until he sees with clearness its differential characteristics, and certainly when he sees them he has no right to hide them without any mark of distinction in a mass of other details of little or no taxonomic significance. Let us hope that, in this regard, the coming decade may see the same improvement which the last has witnessed in the increased fullness of descriptions, and that a systematist's work may be estimated, not by the

number of plants he publishes nor by the pages of descriptions he writes, but by the clearness with which he ascribes true differential characters and the actuality of his species in nature.

Regarding the citation of the type, there is in some quarters still a carelessness or indifference which is little short of astonishing. Species are still, in some cases, and even by persons prominent in systematic botany, published with no more definite information as to habitat, collector or type than the bald statement that the plant appears to be common from Vermont to Michigan and southward to Virginia.

I have heard certain attempts to justify this sort of thing. It is said, for instance, that the citation of a type-number is likely to mislead; that even the best collectors occasionally distribute unlike plants under the same number; that Pringle's 1507 at the Philadelphia Academy of Natural Sciences may not be just the 1507 at the Arnold Arboretum; that a species is more than an individual, and if a single type is cited there will be danger that some will narrow the interpretation of the species until it is artificially confined by those individual characteristics which the type-specimen chances to exhibit. But these are weak excuses. The probability is that Pringle's 1507 will be the same species wherever found, and if by any chance this is not the case a well-drawn description will go far to remove the danger of error. It is, furthermore, always possible, indeed desirable, to state the particular herbarium in which the type is preserved and thus remove all ambiguity. The other objection to the citation of type-specimens has quite as little force, for persons given to such fine-haired discriminations that they separate so-called species on individual traits are bound to interpret a described species in the light of some supposed representative of it, and in the interests of accuracy it is

much better that this individual should be the type rather than some specimen which from its characters or presence in the author's herbarium is merely assumed to represent the species in question. It would seem, then, that an author who does not cite his types is careless or unduly timid, and it is to be hoped that negligence in this matter, of which drastic examples might be given, may be regarded with increasing disfavor. Happily, here, as in the other matters mentioned, there are hopeful signs of improvement, and some of our most important botanical establishments, for instance the United States Department of Agriculture under its present direction, have been exemplary in this regard.

On many accounts it is to be regretted that the commendable custom of describing new species in Latin has been so generally abandoned in America. Still common in England, it is almost universal in continental Europe, and as a means of uniformity it is a source of much convenience. The Latin language by its high inflection and wealth of terse adjectival expressions lends itself exceptionally to the clear and compact presentation of details, and the formal description in Latin undoubtedly requires added attention to subject matter as well as form, while the running characterization, so easily dashed off in the vernacular, is to some extent a temptation to verbosity and hasty publication. The habit of writing descriptions in Latin would also exercise a chastening influence upon nomenclature. An author who could produce an intelligible Latin characterization would scarcely name his plant *pseudolongifolia* or *pulcherrima* or *nationalparkensis*, and these are scarcely overdrawn illustrations of the crudities into which some fall who have utterly abandoned Latin in the presentation of systematic botany. In regard to this matter of names, it may not be remarkable that there are some beginners whose enthu-

siasm in publication far outstrips their general scholarship; but one may express genuine surprise that the heads of important botanical departments and editors of prominent journals let these nomenclatorial solecisms see light in print. Here is another opportunity for easy improvement in the methods of systematic botany.

To this point I have dealt chiefly with the form of presentation. Let us now consider the subject matter. Here the difficulties of improvement are naturally greater.

The first feature of this subject which demands attention is the artificiality which still lingers in our so-called natural system. It is true that the natural arrangement of orders and families has been much improved in recent years. The clues derived from the varying degrees of adnation, conation and zygomorphy of floral parts in the dicotyledons have suggested the first system in which groups of such obvious affinity as the *Caryophyllaceae*, *Aizoaceae*, *Scleranthaceae* and *Amaranthaceae* are found in natural proximity. But much artificiality still remains in the details of modern classification. For instance, we are commonly treating as equivalents in our system things which in nature have widely different values.

There is an old question always coming up, ever fresh for discussion, never very clearly settled, regarding the objectivity of species. Do they exist in nature or are they artificial categories? Much may be said on both sides. It takes, however, no very profound study of plants and their descriptions to reveal the fact that so-called species are of both kinds. Many thousands exist as well-marked entities in nature, but, alas! there are many hundreds more which scarcely extend beyond the subjective. They represent not permanent lines of more or less independent development in nature, but chance combinations of inconstant characters analogous to cross-sections

through some plastic and still unsolidified material.

The cause of this lies partly in the author of the species and is partly inherent in nature. On the one hand, such so-called species may result from the hasty description of plants whose differences, observed in a few herbarium specimens, have not been sufficiently verified in the field. On the other hand, they may come from the simple fact that there are no formed or settled species in the group concerned. The forms of that particular affinity are still in a state of free intergradation and the species *im Werden begriffen*.

There seems to be a wish upon the part of many systematists to ignore this fact; to maintain that this or that form is, in hackneyed phrase, a 'perfectly good species' because it shows certain differences from its slightly removed although copiously intergrading neighbors; in fact, to asseverate that all plants which show differences worthy of remark should, irrespective of their constancy, be classed as species. But notwithstanding these unhappy ideas, nothing can be more certain than that fortuitous cross-sections in the nebulous places of nature are not species in the sense that *Ranunculus pennsylvanicus*, *Juncus trifidus*, *Malva rotundifolia* or *Potentilla tridentata* are. Nor can we hope to escape great artificiality in any system which assigns to like rank and groups in the same category things of such diverse nature and significance.

Species as now recognized are not equivalent things. The category, called specific, is itself a complex, in the same need of critical study, of subdivision, of segregation, as many of its elements. There are species marked by pronounced morphological features, which they never lose and which may always serve to identify them. There are others with characters subject to concomitant variations, in which if one feature varies in a particular direction the change

is regularly accompanied by certain other modifications affecting other members. Such species may be subdivided, and have good subspecies or varieties. On the other hand, there is a totally different type of species in which variation is not concomitant, in which one feature changes without apparent connection with any other, in which, for instance, thorns may be developed or be absent, while leaflets may be few or many irrespective of the presence or absence of thorns, and again, the inflorescence may show further variation quite independent of leaflets and thorns. Such species, exhibiting what Dr. Gray called promiscuous variation, are well illustrated by *Acacia filicina*, *Mimosa asperata*, certain *Aquilegias*, *Delphiniums* and *Lupines*. In these cases segregation or even varietal subdivision, although often attempted, has little or no significance, for the segregates exhibit only kaleidoscopic combinations of ever-changing characters. There are, on the other hand, especially as the result of preponderating close fertilization or vegetative reproduction, species which exhibit a wonderful constancy of small characters, a remarkable fidelity in transmitting from one generation to the next the most obscure traits. Such are the segregates of *Draba verna*, elaborated by Jordan, studied with such keen interest by de Bary during the last months of his life and critically reviewed in the later work of Rosen. Such are also the newly recognized *Alchemillas* of the Alps and our own *Antennarias*.

From these illustrations it is easy to see that species as now recorded in literature are by no means alike and that they cannot be regarded as equivalents in any complete or logical system of classification. Curiously enough, however, the term 'species' seems to be growing more and more popular as it means less and less. Often and on all sides we hear lengthy arguments, and emphatic asseverations to

the effect that this or that plant is a 'perfectly good species'; and if in the course of monographic work a so-called species is let down to varietal rank it rarely fails to find somewhere its ardent defenders, who appear to hold the curious view that the monographer has not merely expressed a scientific opinion, but has somehow perpetrated an injustice upon the plant or its describer. How anxious most discoverers of new forms are that their plants may prove species, not mere varieties, and finally what a fascination the mere binomial appears to exert upon certain minds! Is it any wonder under these circumstances that the specific category has been overcrowded and made to include such widely different elements that the word species has lost nearly all its taxonomic significance?

However, no thoughtful botanist who can rise above a merely subjective attitude toward the few species in which he chances to be particularly interested and take a broader, more objective survey of the whole field, will be satisfied that the present hodgepodge of non-equivalent forms in the specific category represents the finished result of a natural system of classification.

Species must be subjected to a gradual reclassification along more definite lines. Overwhelming as the task may at first appear, it is fortunately one which can be taken up little by little, a work in which every systematist, every collector, every amateur, who will, may take part. The first step is evident enough. Each species must be examined in the light of vastly more copious material than at present exists even in our largest herbaria. Has there ever been a conscientious monographer who has not seen the pressing need of further material in his group, who has not felt that ten or even a hundred times as many specimens would have been necessary to yield a satisfactory knowledge of the directions and limits of variation? Let

us, then, proceed with the accumulation of material, with the collection of specimens which may illustrate each species at every stage of development, in every part of its range, in every environment in which it occurs. In this matter we are much behind zoologists. They often work with hundreds or even thousands of specimens while we try to draw like inferences from dozens. An entomologist recently told me, quite as a matter of course, that he had just completed a monographic examination of more than fifteen hundred specimens representing a single species of orthopterous insect, together with three or four of its varieties. When may we expect that botanists will take similar pains in the interpretation of the limits and variations of a single species?

While on this subject of collection I may be permitted to emphasize an often neglected obligation of the collector to the monographer—that of reasonably full field notes. I realize that this is a wearisome subject, well known and thoroughly appreciated by many conscientious botanists and as persistently disregarded by others. I am acquainted, for instance, with several expert systematists, most scrupulous in all other ways, who appear on this subject of labels to have a curious mental defect. They never seem to have grasped the art of writing them, nor realized in this matter any obligation whatever toward their colleagues. From one of them I recently received some excellent specimens with no data but ‘White Mountains.’ Repeatedly, when working upon a particular species at the Gray Herbarium, I have examined dozens of specimens from many different collectors in the vain hope of learning from the field notes upon the labels such simple facts as the color of the corolla, height of the plant, or nature of the soil where it grows. Here is another opportunity for advance in which nearly every one con-

nected with systematic botany can cooperate.

We have seen, then, that the first requisite for a more thorough proving of species is a much greater and more representative accumulation of material and data. Then, of course, will come the difficult task of interpreting this material and especially of determining for general guidance more definite standards of variation. Regarding this latter possibility I have heard some scepticism expressed; but it seems to offer no greater difficulty than many other problems which have been successfully settled in the natural sciences. It must be admitted, of course, that while our knowledge of particular species is derived from a dozen, or in some instances from only one or two, specimens, no satisfactory standards of variation can be devised or applied. But were we to work with a hundred times this amount of material, it is more than probable that the degrees of natural intergradation could be fairly approximated. It would at least become evident which lines of specific development had attained what may be called a normal distinctness, a condition in which intergrades would be so exceptional as to suggest atavistic reversions, while, on the other hand, many of our so-called species would doubtless be found to be connected by regular, normal and fairly numerous natural intergrades, their lines of development would still be in a state of anastomosis, not having attained habitual distinctness. The interesting question would then arise whether the intergradation were geographically general or local, whether it were morphologically concomitant or promiscuous.

To interpret these matters satisfactorily will require not only the vast accumulation of material the need of which has just been emphasized, but a cautious and judicial attitude of mind, great impartiality, and an

unswerving desire to find out and record the exact truth. I do not mean to imply that systematists to-day have not this desire. Unfortunately, however, many of them, perhaps all, seem never to escape a certain hypnotism caused by particular interests. Trifling matters assume undue importance. Little differences seem so great as to obscure the preponderating similarities, or, on the other hand, superficial likeness blinds the observer to every differing detail. An opinion is quickly formed and perhaps hastily published. It then becomes a matter of personal pride to maintain it, and if any one expresses a doubt concerning its accuracy he is promptly called out to a controversial duel.

Now these things have their bright side and are in their milder form diverting, for somehow after the scrimmage which follows, truth, for the time hidden by the dust of combat, usually shines forth in victory, or more often becomes evident as the result of compromise. Indeed controversy is perhaps the only means which will successfully dispel the narrowing and perverting influence proceeding from the intensive examination of small details, and so often blinding the systematist to the real perspective of his own observations.

If we now turn from the matter of variation to that of distribution, it is equally evident that only a beginning has been made, that inferences are drawn from very insufficient material and that a vast accumulation of further data is requisite to accurate results. Let any one who doubts try to bound the range of some common species, to draw upon a map the sinuous line connecting the outermost recorded stations. The gaps are astonishing. Great lacunæ quickly appear in our knowledge of plant distribution.

No one can doubt the value of much fuller records in this department of our subject, nor maintain that our knowledge

of any plant is satisfactory until the limits of its natural occurrence are accurately determined. While plant distribution, studied from the ecological side, has become a popular subject, comprising many useful observations and theories both valuable and fascinating, the actual record of plant-ranges is on the whole regarded as rather dry business and is a field of investigation in which laborers are few. Mention should be made, however, of Professor A. S. Hitchcock's admirable work in this direction upon the flora of Kansas. What notable advance might be made if each State of our Union could have an equally well-trained systematist similarly interested in this matter of plant distribution!

Could we but know the actual curving boundaries of a few hundreds of our best-defined species, what a wealth of new generalizations could be drawn from them, and how much new information they would yield concerning the factors which govern distribution in general! For, irregular as these lines would be, I can but think that they would in many cases stand in definite relation to lines of other kinds, to isothermals, to altitudinal contours, to degrees of humidity, to the boundaries of geological formations, the limits of glaciation, the ranges of animals, especially pollen-bearing insects, to the paths of bird-migration, and finally, to the course of human traffic. What a field for further investigation is thus suggested by our still very imperfect knowledge of plant boundaries! It is a field, too, which the careful amateur can cultivate almost as easily and as well as the professional botanist. Every one lives near the assumed limits of some plants and might, by directing his attention to the subject, do much to change these as yet vague and hypothetical boundaries into accurately determined and carefully recorded lines.

Not only would these lines be likely to

disclose new and as yet unsuspected relations to forces controlling distribution in general, but they would give us our first accurate landmarks for the observation of plant migration, thus greatly facilitating a study of progressive changes in our flora.

While the accurate determination of plant boundaries has thus great interest it may be remarked that research in this field, as in others, to be successful, must be conducted with care. Reports of occurrence, especially extra-limital stations, should be taken with much caution. In this as in many other matters of science it is impossible to make too sharp a distinction between facts actually observed and those taken on hearsay. In mapping a plant the recorder will do well to indicate this difference. If, for instance, he shows by an umbra the range which rests upon specimens personally examined, let him record unverified reports only by a penumbra. Furthermore, any work of this kind to be of permanent value must rest, at least in great part, upon specimens which are carefully preserved, for segregation is progressing rapidly and no one can foresee its subjects. A plant of supposedly uniform character may at any time prove, upon more critical observation, to be two or more distinguishable species. In such a case it is easy to see that any previous study or records of the composite plant must lose nearly all their value unless specimens have been preserved so that a re-examination will show to which of the segregates the records applied. Similarly, the disappearance of a plant from a given region may lead to a justifiable scepticism as to the accuracy of the records relating to its occurrence in that place. In this case, practically the only valid proof is a preserved specimen accompanied by the original data of collection.

In interpreting and recording this matter of plant boundaries opinions will doubtless differ as to what may be called continuous

range and what is to be regarded as an extra-limital station, or, so to speak, an island in a sea of non-occurrence. This is, of course, all a matter of degree, since in reality no plant has a continuous range, for it is represented by more or less isolated individuals. Yet this offers no serious obstacle. The meteorologist maps the analogous course and limits of a rain-storm composed of separate drops, and the biologist has long recognized the practical continuity of plant and animal ranges which, in a generalized form, are the basis of his so-called 'life-zones.'

Turning now to quite a different field which seems to offer great possibilities, I would call attention to recent researches in plant ontogeny: the investigation of embryonic development, the comparative study of seedlings, and such observations as have been recently made by Professor R. T. Jackson upon the reappearance of juvenile and ancestral traits in offsets and runners. Systematic zoologists have long made use of ontogeny in determining group affinities, but botanical taxonomists have been much less successful in drawing from the early stages of plants like inferences. There are several reasons for this. In the first place, there can be no doubt that plants in their early development do not exhibit such a continuous and complete series of phylogenetic stages as many animals do. In plants some stages seem to have dropped out by a sort of morphological and physiological elision or ellipsis. Again, while the classification of animals rests upon general morphology often well suggested even in very early stages of development, the classification of plants is based chiefly upon the mode of reproduction—that is to say, upon a series of structures produced so late in the life of the individual that no suggestion of their character is afforded by embryo or seedling.

But, after all, there can be no doubt that

ontogeny has for the plant taxonomist a wealth of information as yet unrevealed regarding the affinities of genera within the family and species within the genus. In these matters of more intimate relationship, the form, position and venation of leaves, the nature of the petioles, stipules, pubescence and glandularity, all shown in the seedling, are significant.

Here, however, as in the other subjects of which I have spoken, the real obstacle to further inference at present is an astonishing lack of material and data. It is safe to say that of the one hundred and fifty thousand flowering plants recorded in the recently issued *Index Kewensis* not one fiftieth part has been carefully traced through the earlier stages of development. Enough is known, however, to show that species even of the same genus often possess striking differences, and in other cases remarkable similarities, in the seedling stages, that these particular differences and similarities often become lost or obscured as the plants advance to maturity, and the conclusion is unavoidable that these juvenile characteristics must, at least in many cases, show ancestral traits, and, if properly studied, yield even better clues to real affinities than any which we now possess.

By way of summary, it may be said that systematic botany is very far from being a completed subject, that from our present standpoint we can see in various directions long vistas of further possibilities for fascinating exploration and profitable discovery, that among the subjects which seem to invite immediate attention the most important are: (1) The determination of the modes and degrees of variation, an investigation which alone can yield data for a more critical discrimination of plant categories; (2) far more complete study of plant ranges, which can scarcely fail to throw much new light upon the forces controlling distribution; and (3) a further examination of plant

ontogeny as the most hopeful source of information regarding the more intimate affinities and proper arrangement of plants.

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*THE CHANGE OF FRONT IN EDUCATION.**

DR. SAMUEL JOHNSON considered education as useful to the 'embellishments of life.' In his day very few were educated at all, and those few for society or public service. The toiling masses had no education, were supposed to need no education, and while discussing details educators and scholars took no thought of what we call the common people.

Said Johnson (in his 'Life of Milton'):

"The truth is, that a knowledge of external nature, and the sciences which that knowledge requires or includes, are not the great or the frequent business of the human mind. Whether we provide for action or conversation, whether we wish to be useful or pleasing, the first requisite is the religious and moral knowledge of right and wrong; the next is an acquaintance with the history of mankind, and with those examples which may be said to embody truth, and prove by events the reasonableness of opinions. Prudence and justice are virtues and excellences of all times and of all places. We are perpetually moralists, but we are geometricians only by chance. Our intercourse with intellectual nature is necessary; our speculations upon matter are voluntary and at leisure. Physiological learning [by which he means a knowledge of the laws and phenomena of the external world] is of such rare emergency, that one may know another half his life without being able to estimate his skill in hydrostatics or astronomy; but his moral and prudential character immediately appears.

* Address of the Vice-President and Chairman of Section I, Social Science and Statistics, of the American Association for the Advancement of Science, Denver meeting, August, 1901.

“Those authors, therefore, are to be read at schools that supply most axioms of prudence, most principles of moral truth, and most materials for conversation; and those purposes are best served by poets, orators and historians.”

This statement was, no doubt, entirely adequate to the demands of Johnson's time. Polite conversation and elegant manners were the chief characteristics of an age in which Chesterfield was a bright and shining light. With the dull, hard-working, unlettered crowds, that plodded on in the steps of their grandfathers, educators had nothing to do; for such they had no educational theories.

How wonderfully conditions have changed, both as to the curriculum and as to the constituency of education. It is interesting to picture, in fancy, the bewilderment of a Sam Johnson in the learned circles of this scientific and industrial age. Imagine him attempting to join in the discussions of our British and American Associations for the Advancement of Science, in our educational conferences, or in the halls of exchange, where the active minds of our generation do mostly congregate. He would find it difficult, in spite of the wonderful vigor of his intellect, to be either useful or ornamental, though he could easily be amusing.

From the days of John Milton, in 1608, to the end of the eighteenth century, university training culminated in a preparation for the professions of law, medicine and theology, and in the training of the nobility for the duties and responsibilities of government and elegant society.

But when alchemy developed into chemistry; when physics became an experimental science; when Leibnitz and Newton elaborated the infinitesimal calculus; when Watts invented an efficient steam engine; when Fulton built a successful steamboat; when Stephenson devised the locomotive and constructed a road with smooth rails;

and finally when Siemens and Gramme produced the electric motor—vast fields of fascinating and useful material were opened for study and research. Mathematical analysis and the principle of mechanics, which had previously been devoted to the problems of physical astronomy, were now directed to the study of the transformation and transmission of energy, the theory of structures, and the phenomena of electricity. The theory of evolution gave a new meaning to all vital phenomena; and the doctrine of the conservation of energy permeated all study of motion and force.

In the earlier days, Alexander Pope voiced the popular notion that ‘the proper study of mankind is man.’ ‘Nature Study,’ which to-day is the bright, attractive feature of the primary school, and equally the inspiring field of the savant, was not countenanced by polite society. For centuries it was held to be little short of blasphemy to wound the earth by digging for ores which were intended to be hidden away from our sight and touch, or to attempt in any way to improve upon God's workmanship. When in 1680 a Spanish engineer proposed to deepen the channels of certain rivers and to restrain their overflows in the interest of navigation, the Spanish Council decreed as follows: “If it had pleased God that those rivers should have been navigable, He would not have needed human assistance to make them so; but as He has not done it, it is plain that He does not want it done”; and the improvements were forbidden. This decree reminds me of a bit of Mrs. Eddy's logic which you may remember in substance as follows: Had the Almighty intended that drugs should be used in treating sick people, He would have placed drugs in the hands of Jesus and his disciples; Jesus and his disciples used no drugs; it is therefore evident that the Almighty does not wish drugs to be used upon people who are sick.

But, putting aside pseudo science, the modern thought of the creation is that it was and is a part of the all-wise plan to fill the earth with unsolved problems, the study and solution of which should develop our best powers, and at the same time cultivate our highest instincts of reverence for the Creator and of love and devotion for His creatures.

It has taken many centuries for the world to discover that the great forces of nature are neither sacred nor profane, neither kind nor cruel, that they neither love nor hate, and that they are more unchangeable than the stars; that shrines and temples, priests and priestesses, tripods and oracles, have been in vain, except so far as they reacted upon the human heart and satisfied its natural craving for the worship of the Superior Being. Instead of building a temple to the far-darting Apollo or to Zeus, the Thunderer, we now stretch over our cities a network for artificial lighting; and all the winds that blow and all the waters that flow are made to furnish their tribute to our comfort and pleasure. We tap the sources of endless energy and transmit it through all the ramifications of our social order, relieving mankind from heavy burdens and creating hundreds of occupations hitherto unknown.

Out of this vast extension of the horizon of human activities, and a corresponding multiplication of occupations, has come an imperative demand for more education and for technically educated men. In our industrial system the crying want has been and is for men who can both plan and execute. The secret of our unparalleled commercial and industrial success lies in the fact that we have put educated brains into our work. Hence a score of professions unthought of 100 years ago have been called into being, and the standards of these new professions are of the highest order.

It is this grand movement towards a

study of the materials and the forces of nature and the problems of modern life, sociological, commercial and industrial, that constitutes the change of front in education. This does not mean that we must abandon altogether the old education. We must preserve all that is permanently fine and essential to high thinking and well doing. The great epics of Homer, like the book of Job and the Psalms of David, will live forever, imperishable monuments of the youth of the world, but we shall not perpetually care for Aristotle's speculations about the origin of matter, or the conceited discussions of Cicero at Tusculum. Modern life in all its details has so far departed from the ancient that neither the moralizings nor the tragedies have a lively and sustained interest for us. We are deeply interested in the affairs of to-day, in a civilization not based upon human slavery, nor upon a blooded aristocracy buttressed and supported by millions of laborers ground down in ignorance, poverty and superstition, but based upon the principle of human equality before the law, and of equal rights to life, liberty and the pursuit of happiness.

In turning from an inherited scheme of education which faced backward, which concerned itself largely with the thought, the deeds and the theories of the past, and in proclaiming the universal need, as well as the universal opportunity, of education, we must not fail to preserve the dignity and the nobility of our educational standards. In spite of frequent assumptions to the contrary, modern education is becoming more and more 'liberal.' The defenders of the Johnsonian programs delight in the use of unworthy epithets with which to characterize the tendency of modern education; they plead for 'humanities' as though anything human was foreign to our curriculum. What can be more human than human life as we see it

and as we share in it? What problems can be more human than those which face nine out of ten of the people who reach the age of individual responsibility?

More and more we are considering the many and not the few, when we draw up our schemes of study and training. As wealth increases, as the hours of labor become shorter, as luxuries multiply, and a taste for literature and art and science becomes general, the number of students entering upon some form of higher education greatly increases. The number of such students to-day per million of people has doubled several times in fifty years.

It is, therefore, not surprising that there should arise, in the minds of many less familiar with the content and the method of a modern technical university, a fear that the standards of character as well as the standards of scholarship should suffer, and, in being less 'select,' that the content of education should be at the same time less fine. Whether this fear be well grounded or not, we must all sympathize with its spirit. We can have no quarrel with those who wish the first fruit of education to be character. I cannot forbear quoting a few sentences from the late president of the Massachusetts Institute of Technology, Gen. Francis A. Walker, upon the tendencies of modern technical education, in reply to certain strictures as to its dignity and unselfishness. In his remarks at the dedication of new science and engineering buildings at McGill University, Montreal, General Walker said:

"The notion that scientific work was something essentially less fine and high and noble than the pursuit of rhetoric and philosophy, Latin and Greek, was deeply seated in the minds of the leading educators of America a generation ago. And it has not even yet wholly yielded to the demonstration offered by the admirable effects of the new education in training up young

men to be as modest and earnest, as sincere, manly and pure, as broad and appreciative, as were the best products of the classical culture, and, withal, more exact and resolute and strong. We can hardly hope to see that inveterate prepossession altogether disappear from the minds of those who have entertained it. Probably these good men will have to be buried with more or less of their prejudices still wrapped about them, but from the new generation scientific and technical studies will encounter no such obstruction, will suffer no such disparagement.

"Another objection which the new education has encountered is entitled to far more of consideration. This has arisen from the sincere conviction of many distinguished and earnest educators that the pursuit of science, especially where its technical applications are brought strongly out, loses much of that disinterestedness which they claim, and rightly claim, is of the very essence of education. I differ from these honorable gentlemen. I believe that the contemplated uses of science, whether in advancing the condition of mankind, or even in promoting the ulterior usefulness, success and pecuniary profit of the student of a technical profession, do not necessarily impair that disinterestedness. These gentlemen appear to me to have an altogether unnecessary fear of the usefulness of science.

"The strong desire to become a useful man, well equipped for life, capable of doing good work, respected and entitled to respect, constitutes no breach of disinterestedness in any sense of that word."

Finally he says:

"I boldly challenge comparison between the scientific men of America, as a body, and its literary men or even its artists, in the respect of its devotion to truth, of simple confidence in the right, of delight in good work for good work's sake, of indis-

position to coin name and fame into money, of unwillingness to use one thing that is well done as a means of passing off upon the public three or four things that are ill done. I know the scientific men of America well, and I entertain a profound conviction that as regards sincerity, simplicity, fidelity and generosity of character, in nobility of aims and earnestness of effort, in everything which should be involved in the conception of disinterestedness, they are surpassed, if indeed they are approached, by no other body of men."

Of like import are these words from a recent address of Hon. F. W. Lehmann, of St. Louis. Speaking of the breadth of the modern university, he said :

"The university of to-day has abdicated none of its old functions, but it has taken on many new. Not disdaining mere scholarship, making, indeed, the standard always a higher one, it widens its domain and adapts its teachings to the after-work of life. Its graduates are not simply conventional finished gentlemen, but beginners in the serious business of life, scholars as before, but artists, engineers and artisans as well. The sciences lose nothing because they become utilities. Physics and mathematics gain in interest by application to the building of bridges, and the very sewers of a city become classic to the scholar because one of the means to the classic excellence of a sound mind in a sound body."

Perhaps the characteristic most dreaded by the opponents of the new education is usefulness. They have but to learn that a certain branch of study, course of training or line of culture is useful, and its value is at once compromised. One of the few foolish things that Lowell ever wrote or said was that, 'a university is a place where nothing useful is taught.' I will not discuss a statement which, after all, may not do justice to Lowell's thought, but I will define a university as a place where every-

thing useful in a high and broad sense may be taught. Matthew Arnold would have defined a university as a place where is taught and illustrated 'the best that has been thought and done in the world.'

Supt. Gilbert, of Rochester, N. Y., said at Buffalo last month : "The exalted character of a man's work is to be measured by its usefulness to mankind ; I believe in the universality of service."

It has often been assumed that this new education is not liberal. Liberality consists not so much in the subject as in the method of study. The liberal method is broad, deep, generous, comprehensive. It recognizes infinite uses, both far and near. It aims at the artist rather than the artisan ; the engineer, not the craftsman ; the freeman, not the slave. Liberal culture deals with fundamental principles, typical phenomena, general results, not special applications. It is liberal to study the laws of manufacture, trades, commerce, finance and social progress ; it is not liberal to seek merely the conditions of a successful business, whether it be law, medicine or manufacture. It is liberal to demand the *raison d'être* of dogma, canon, rule, dictum, formula or usage ; it is illiberal to blindly follow authority, to put facts and processes above principles and reasons, to prefer echoes to living voices.

A recent reviewer said that mathematics and electricity are becoming less valuable for general education on account of their increasing usefulness in technical pursuits. The maximum of educational value (he held) appertains to a sort of knowledge which falls short of such a mastery as makes it useful. Of course, I accept no such statements. That man's notion of a liberal education is not yours nor mine.

The list of liberal branches of study is ever increasing. For four years Harvard compelled me to give one-sixth of my time to Greek and one-fourth to Latin ; to-day

one may go through Harvard and take his degree without giving one moment to either Greek or Latin, while in Cambridge. The same thing is true at many universities. Are we, therefore, less liberal than formerly? Can we not answer that we are more liberal? People now read Demosthenes and Quintilian and Horace, analytic geometry, physics, thermodynamics and the like, because they wish to be familiar with those authors or to master those subjects, not because they are compelled to by a traditional canon. Does any one suppose that there is not a decided gain in the quality of the result?

Through the technical schools, some of the most valuable educational studies have been developed. How few people realize the surpassing mental discipline that comes from the study of descriptive geometry, laboratory physics and the mechanic arts. I knew nothing of the study of descriptive geometry till years after I left college, and yet no subject I had in college could compare with it as a mental stimulus and a cultivator of the scientific imagination. It ought to have place in every liberal course of study. Modern courses of study contain, of necessity, extensive allowances of laboratory work of one sort and another. Our idea of all such work is that the method shall be unfailingly rational; that facts, though essential, shall be rated as far less important than the principles which underlie them. Where this idea is realized, the study becomes truly liberal.

In spite of the old claim of preeminent liberality, the old college curriculum, when examined historically, is found to have been adopted for reasons of utility. People learned Latin because they wanted to use Latin. All books and state papers were written in Latin, and one needed to both read it and write it, as we must English prose. The physician must read Galen in the original; the clergyman needed the Greek Testament; the lawyers must read

the Institutes of Justinian, and the man of leisure and the orator must be able to quote Aristotle and Homer, Virgil and Horace. The first American colleges were organized for the training of clergymen. Every feature of the course was directly useful to the end in view.

It is easy to see the source of a widespread prejudice against technical training. The history of civilization has been the history of masters and slaves, of castes, of contempt for labor and for all useful arts. Every one of the technical professions had its beginning in the crafts and the present technical expert and engineer had as a prototype a man in overalls, with horny hands and a soiled face, who presided over some enginery which was not authorized by the ancients and which at best was generally regarded as ungenteeled. Milton placed Memnon, the first ante-tellurian engineer, among the fallen angels, and sent him

‘With his industrious crew to build in hell.’

The engineer is by nature an iconoclast. He has small respect for the traditions. He bows not down to the ‘tyranny of the ancients.’ His glories are in the future. He looks forward, not back. He does not hesitate to smile at the puerile fancies of people who created gods and demi-gods in order to account for phenomena which to-day submit to mathematical analysis and which bear no comparison with the exploits of modern engineering. The accomplished engineer generally reciprocates the prejudice I have mentioned, for he cannot understand how the worship of the ancients can be really serious; it seems to him three-fourths affectation. This mutual prejudice was fostered by the high wall of separation which at first kept the technical and the liberal branches of study far apart. That wall, I am happy to say, is fast tumbling down, and men are rapidly scrambling over it in both directions. It becomes us, from our various vantage grounds of influence,

to encourage this evolution of a better feeling, a more intimate acquaintance, a mutual respect, and a common zeal for whatever is broad and high and fine.

While we may for many reasons congratulate ourselves on the decided change of front we have achieved in education, we must not be blind to the fact that much remains to be done. We must still devise a scheme of secondary and higher education for a stage of progress in which secondary and higher education may become approximately universal. As Sir Walter Besant put it, the twentieth century must not only "open up all intellectual careers to lads [and lasses] who are capable, clever and ambitious, but we must have a system of education broad enough and elastic enough to include the children who are destined for crafts, industries and arts of all kinds; one that will make them good citizens, not ignorant of their civic rights, and alive to their civic duties."

I do not at all assume that we have yet discovered the true system for universal secondary education. The manual-training high school with its opportunities for training and culture along many lines, industrial, commercial, civic, artistic and literary, seems to come near the ideal, but it is by no means generally accepted, and when accepted it is at once exposed to serious dangers.

In our most advanced communities only a small minority of children enter upon the secondary stage of education. In my own city of St. Louis, only about one boy in seven takes a course in a school of high-school grade. In many communities the proportion in secondary schools is greater—in others it is less. There must be some reason for this; either the training and culture are not what they ought to be or our people are so ignorant that they do not know the value of education. I will not admit that poverty offers a sufficient explanation. In

either case, it is evident that we have much to do and much to learn.

Of the dangers to which the manual-training high school is exposed, I have spoken elsewhere at length. I will at present only refer to the strong tendencies of 'practical' people, who are more intimate with the old system of apprenticeship than they are with the art of education, to introduce the teaching of special trades. I think we shall be able to stem this unfortunate tendency, but it is well to be forewarned that we may be forearmed. The advocates of the introduction of trade work make three serious mistakes:

1. They assume that the graduate of the manual-training school is unfitted to enter an industrial shop to advantage.

2. They would begin trade work with pupils who are too young.

3. They do not realize that only about 50 boys in 100 are so constructed mentally and physically that they can and ought to learn what are known as the industrial trades.

In my paper already referred to, I have at some length defended the natural right of a boy to the privilege of choice of occupation at an age of some maturity and after a training which enables him to substitute a rational judgment for a boyish whim.

In this connection, I fail to endorse at least one feature in the Report of the Advisory Committee of the Carnegie Technical School. The full report was published in *SCIENCE* for July 12, 1901. For a variety of excellent reasons, the Committee reaches the conclusion 'that some new kind of preparation for the work of life must be introduced into the school training of both boys and girls.' It then proceeds to outline a technical college, a technical high school and an artisan day and evening school, which are to meet this demand. Here we have a clear recognition of a twentieth-century problem and an attempt to solve it.

The artisan day and evening school is somewhat on the order of German and English low-grade technical schools. I earnestly hope that the suggestion of this school may be adopted and that the experiment may be fairly tried in America. The plan for a technical college is in complete harmony with our best engineering schools, and needs no discussion here.

The scheme for a technical high school, however, seems to me faulty. This school would be of high-school grade, taking pupils from the grammar schools and covering presumably four years. The normal ages of entrance and graduation would accordingly be 14 and 18.

Three things in the Committee's outline of this technical high school deserve more attention than I can give them at this time :

1. The elective principle is to be recognized, the student selecting the required number of courses under the direction of the director of the school. Here the pupil at a tender age (only 14 or 15) is asked to surrender his birthright to the privilege of choice when he is 18.

2. The course in mathematics—which begins with elementary algebra—is to include the *elements of calculus*! Of course, it must include solid geometry, higher algebra, trigonometry and analytical geometry! One rarely meets with such an astounding proposition from engineers who are supposed to have studied mathematics and to know what they are talking about. They might as well propose that the pupils shall take thermodynamics in a short course of lectures. To be sure, similar ambitious schemes have been proposed elsewhere for boys just out of the grammar school, but they came from people who could have known very little mathematics, and nothing of the uses of the calculus. This criticism may seem trivial, but in more than one place the scheme attempts too much.

3. The technical studies suggested take the form of trade work or special employments, with well-equipped shops and experimental laboratories under the direction of expert artisans.

What Mr. Carnegie will do with this last suggestion remains to be seen, but any attempt to embody it in a real technical high school of secondary grade will be full of interest to the educational world. If any man was well prepared to give the scheme a fair trial that man is Andrew Carnegie; but it will cost a vast amount of money and its experience will teach us how not to do many things.

I have high respect for the members of the Advisory Committee, but I think a less ambitious scheme would be more successful. You cannot teach the higher mathematics in a high school, and I have no great faith in the value of attempts to teach employments, commercial or industrial, within the limits of any secondary school. Such attempts are certain to mislead and ultimately hinder those they aim to help. Any trade or special employment must be dwarfed and narrowed before it can be brought down to the grasp of an untrained boy, and its very narrowness unfits it for the best educational uses.

The school is the place where one should learn the fundamental unchanging laws and manifestations of force and materials. Special occupations, like special constructions, should be analyzed in their elements, and pupils should become expert in such analyses, in so far as they involve universal elements that pupils can comprehend. But there are many things essential to a business employment which cannot even be apprehended in school. As William Mather, M.P., says :

“There is no possibility of teaching in a school that sort of knowledge which practical work carried out on commercial principles, within restrictions as to time of

execution, etc., can alone make any one familiar with." ('*Technical Ed'n in Russia*,' p. 12.)

As to values, let us teach intrinsic values, not market values; the latter are fluctuating with time and place, the former are permanent.

No scheme of American education is complete without a careful study of the duties and responsibilities of citizenship. The tramp, like the political leech, assumes that the world owes him a living; the good citizen knows that he owes it to the state to earn his own living, to support his family and to contribute his share to the necessary expenses of the city, state and nation. Hence the youth must learn how the city, state and nation are respectively organized and what their proper functions are; and when he is a man he must to the extent of his ability see to it that those functions are placed in the hands of public servants who are both capable and honest. The corrupting influence of a politician who fosters selfishness in his neighborhood, that he and his neighbors may profit at the expense of other neighborhoods, must be counteracted by a generous education which shall cultivate a love of justice and plant the seeds of manly and noble ideals. If democratic governments are to survive, the whole people must be educated to the highest standards of citizenship, and the new education must face and solve the problem of securing those results.

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SECTION C (CHEMISTRY) OF THE AMERICAN ASSOCIATION.

In accordance with the recent custom, the meetings of Section C were held conjointly with those of the American Chemical Society, the officers of the latter presiding on Monday and Tuesday and those of the former during the remainder of the ses-

sion. The meetings proved to be of unusual interest, a large number of valuable papers being presented. Eighty persons, representing twenty-three different States, were in attendance.

The Section was first called to order Monday, August 26, at 11:30 a. m., by Vice-president, Jno. H. Long. Mr. Franklin Guiterman was introduced and welcomed the members on behalf of the chemists and metallurgists of Colorado. Brief responses were made by F. W. Clarke, President of the American Chemical Society and Vice-president Long. Section C was then organized in accordance with the provisions of the constitution. The following were the officers for the Denver meeting:

Vice-president, Jno. H. Long.

Secretary, Wm. McPherson.

Sectional Committee: J. L. Howe, Vice-president, Section C, 1900; A. A. Noyes, Secretary, Section C, 1900; Jno. H. Long, Vice-president, Section C, 1901; Wm. McPherson, Secretary, Section C, 1901; W. D. Bancroft, C. S. Palmer, A. Lachman.

Member of General Committee, H. W. Hillyer.

Member of Council, C. S. Palmer.

Press Secretary, C. L. Parsons.

After the organization of Section C, the officers of the American Chemical Society took charge of the meeting. With the exception of Wednesday afternoon, two sessions were held daily until the final adjournment on Friday. Wednesday afternoon was given up to a visit to the Denver Smelting Works, under the direction of Mr. Franklin Guiterman. A special train conveyed the visitors to the Argo, Grant and Globe Works, successively. In the evening a subscription dinner was given at the University Club by the courtesy of the House Committee. After the final adjournment on Friday a number of the chemists accepted the invitation of Mr. J. D. Hawkins to visit the works of the various smelting companies at Colorado City.

At the meeting of the General Commit-

tee on Thursday evening, Professor H. A. Weber, Ohio State University, and Professor Francis C. Phillips, University of Western Pennsylvania, were elected respectively Vice-president and Secretary of Section C for the Pittsburg meeting, 1902.

The following is a complete list of papers presented at the meeting, together with brief abstracts whenever it was possible to secure these from the authors.

1. 'Report of the Census Committee of the American Chemical Society': CHAS. BASKERVILLE, *Chairman*.

The report included a detailed résumé of improved conditions in the teaching of chemistry in the United States; of the establishment of agricultural colleges, technical institutions, standard bureaus; comparative statements of the training of chemists and chemical engineers in the United States and indications of directions for even greater improvement and extension of the work of the larger institutions; suggestions for the guidance of growth of the smaller colleges.

The complete report will be published in the memorial volume of the twenty-fifth anniversary of the American Chemical Society.

2. 'A Summary of the Analyses of some Massive and Eruptive Rocks of Boulder County, Colorado': CHAS. SKEELE PALMER.

The paper included a condensed statement of the analyses of typical or characteristic rocks of Boulder county. The work was done largely by seniors in the chemical laboratory of the University of Colorado, with the view of training the individual student in the accuracy and independence necessary for original work; also with the further view of adding to the general knowledge of the composition of the rocks of this region. The paper will be published in the *Journal of the American Chemical Society*.

3. 'Recent Developments in Physical Chemistry': WILDER D. BANCROFT.

A résumé was given of the important work done recently in physical chemistry in the various laboratories both in the United States and foreign countries.

4. 'On the Optical Rotation of Certain Tartrates in Glycerol': J. H. LONG.

The rotation of the ordinary tartrates in water is well known, and it has been shown that in dilute solutions the molecular rotations are nearly constant. In this paper the rotations of the following bodies in glycerol are discussed: Potassium sodium tartrate, ammonium tartrate, ammonium hydrogen tartrate, potassium antimonyl tartrate, ammonium antimonyl tartrate and potassium boryl tartrate.

In the cases of the antimony compounds, the molecular rotations agree very well with each other, and also with the rotations in water solution for the same salts; their molecular rotations are therefore very different from those of the simple salts of tartaric acid, which suggests, possibly, that the active acid ion here is no longer that of tartaric acid. Following the suggestion of Clarke, it may be that we have here to deal with salts of tartrantimonious acid ($C_4H_4O_6Sb$)OH, the properties of which are very different from those of the dibasic tartaric acid.

The behavior of the borotartrate in glycerol is very different from that in water, and also different from that of the antimony compound. It is likely that the assumed analogy between these bodies does not hold. There is nothing especially noteworthy in the behavior of the simpler tartrates in glycerol. For Rochelle salt the rotation is larger than that in water and in marked degree variable with the concentration.

5. 'The Atomic Volume Curve in Relation to the Periodic Sequence': CHAS. SKEELE PALMER.

The author proposes a new form of Lothar Meyer's curve which seems to indicate the form in short and long independ-

ent series as the more natural one for the periodic sequence.

The paper will be submitted to the American Chemical Society for publication.

6. 'Report on some of the Mineral Waters of the Philippine Islands': G. B. FRANKFORTER.

The author called attention to the occurrence of lithium in many of the samples. Rubidium and cæsium were also found in some cases.

7. 'Proper Methods of Teaching Physical Chemistry': WILDER D. BANCROFT.

According to the author, an introductory lecture course in physical chemistry should begin with the physics of one-component systems, the formation, separation, properties and identification of phases. Next should come the corresponding study of two-component systems, stress being laid on the variation of properties with concentration and the resulting analytical methods. With three-component and four-component systems, chemical methods of analysis become necessary. The general theory of separation by fractional crystallization and distillation comes in at this point. An outline was given of the laboratory course now offered at Cornell University, which is designed to supplement the lecture course and which calls for thirty-three afternoons' work.

8. 'Some Observations on the Teaching of Chemistry': CHAS. SKEELE PALMER.

The paper emphasized: (1) The value of the thorough study of oxidation and reduction tables as a systematic basis for general inorganic chemistry; (2) the conservative use of the periodic sequence in the form of short and long independent series; (3) the lack of an easy, natural and thoroughly satisfactory introduction to general systematic inorganic chemistry after the consideration of the typical elements and the atomic theory; (4) the use of qualitative reactions in the laboratory work of elemen-

tary organic chemistry, pending the use of the necessary but more complicated synthetic work of organic chemistry proper.

9. 'Some Suggestions for the Improvement in Instruction in Technical Chemistry': ARTHUR LACHMAN.

This paper will be published in full in SCIENCE.

10. 'Discussion of Methods used in Different Universities for giving Instruction to Large Classes in Elementary Laboratory Work': WM. MCPHERSON.

11. 'Chemistry in the High School': FREDUS N. PETERS.

12. 'Chemistry in Manual Training Schools': ARMAND R. MILLER.

In this paper the writer gave a description of the method of teaching the subject in the Manual Training High School of Kansas City, Mo. In harmony with the spirit of the school, the practical applications of the subject are prominently brought out and the facts linked, so far as possible, to the things of every-day life. With this same end in view, the pupils are shown through smelters, soap factories, acid works, gas works, etc.

In the study of the metals careful attention is given to the ways in which these occur in nature, the metallurgical processes by which the metals are obtained, and their physical properties, upon which their adaptation to various uses depend. The value of the stereopticon as an aid in arousing and holding an interest in the subject is recognized and a collection of suitable slides is being made. It is not considered wise to attempt to teach qualitative analysis in a one-year course and so all the time is devoted to the study of general chemistry. About one half the time is spent in the laboratory. Brief notes are made there and elaborated at home. A few quantitative experiments are performed in order that the pupils may get some conception of quantitative relations. A course in qualitative analysis is offered, but a second year is de-

voted to it. Pupils who show sufficient ability are encouraged to take up quantitative analysis or assaying, this work being done in the afternoons without credit, as these are not regular courses.

13. 'Notes on the Chlorides of Ruthenium': JAS. LEWIS HOWE.

Claus described double chlorids of trivalent ruthenium of the type $2XCl, Ru'''Cl_3$, and also those of what he considered to be the tetrachlorid of the type $2XCl, RuCl_4$. These last Joly showed to be nitroso-chlorids of the type $2XCl, RuCl_3NO$. Antony has recently succeeded in forming a true tetrachlorid, $2KCl, RuCl_4$, by the solution of potassium ruthenate, K_2RuO_4 in dilute hydrochloric acid.

When ruthenium tetroxid, RuO_4 , is treated in the cold with a strong solution of cesium (or rubidium) chlorid and a few drops of hydrochloric acid, it is gradually converted into a salt of a new series, cesium- (or rubidium) oxy-chlor-ruthenate, $2CsCl-RuO_2Cl_2$, which is instantly decomposed by water. On treatment with strong hydrochloric acid this is converted into the tetrachlorid (chlor-ruthenate), $2CsCl, Ru^{iv}Cl_4$. In most of its reactions it closely resembles the ordinary trichlorid.

This ordinary trichlorid has the formula $2CsCl, Ru'''Cl_3, H_2O$, but numerous other salts exist with varying proportions between the ruthenium trichlorid and the alkaline chlorid.

When the tetrachlorid is warmed in dilute acid solution with alcohol, rose prisms are formed of the same formula as the ordinary trichlorid, but this salt is very distinct in its properties and may be an aqua-trichlorid, $2CsCl, RuOH_2Cl_3$. This gives the tetrachlorid again with strong hydrochloric acid.

The blue solution produced by the action of H_2S on ruthenium solutions can also be obtained by electrolytic reduction, and is, when concentrated, precipitated by cesium

chlorid, but the precipitated salt has not yet been obtained in a state of purity. It seems to have the formula $3CsCl, 2Ru''Cl_2, - 2H_2O$, but is receiving further investigation.

After treatment with stannous chlorid, ruthenium trichlorid gives a yellow flocculent precipitate with caustic potash. This is soluble in hydrochloric acid, from which there crystallize brilliant yellow octahedra, containing tin, ruthenium and chlorin. These are being investigated.

This paper will be published in the *Journal of the American Chemical Society*.

14. 'On the Existence of a New Element associated with Thorium': CHAS. BASKERVILLE.

Pure thorium salts obtained from five sources were repurified and fractioned first by sulphur dioxide and second by variation in the solubility of the citrates. Three evidences of the complexity of thorium were offered.

1. Pure thorium dioxide has a specific gravity of 10.2. This was fractioned, giving oxides having specific gravities of 9.25 and 10.53. This corroborates Brauner's work on the hydrolysis of the heptahydrated thorium tetrammonium oxalate.

2. Thorium dioxide is slightly radioactive. Crookes has recently found by fractioning pure thorium nitrate that one fraction was three times as active as the other. The author has found the radioactivity to increase with the increase of specific gravity of the oxides. The oxide having the lower specific gravity is inactive. Description of methods of procedure were given.

3d. Pure thorium tetrachloride was prepared and the atomic weight of thorium determined. $223.25 \pm .05$ was the value found, which is given tentatively. The generally accepted atomic weight is 232.6.

These evidences prove the complexity of thorium and from some data already obtained the new body appears to have an

atomic weight between 260 and 280. As the original material came from the monazite sands of the Carolinas, the author desires, in case the element is ever separated in a pure form, and the indications are most favorable, to have it known as *Carolinium*.

This paper will be published in full in the *Journal* of the American Chemical Society.

15. 'Some New Laboratory Furniture': ARTHUR LACHMAN.

The author described a drawer for storing glass tubing (and showed a photograph). The drawer is open on one end and pivoted at the other. When closed it looks like an ordinary drawer, and does not extend beyond the drawer case. Upon opening, it swings out at an angle, the open end permits the inspection and withdrawal of any piece of tubing.

A special laboratory sink was described. It is 18 inches wide, 30 inches long and 4 inches deep. It is cast of iron, $\frac{3}{8}$ inch thick. The inner surface drains towards the center from all points. The straining plate consists of a perforated plate of lead which is hammered into a flange provided in the sink. The waste pipe is screwed on to a projecting pipe by means of a flange, the projecting pipe being cast into the sink. In this way no screws or other obstructions present themselves in the sink proper and the life of the sink is greatly prolonged. The sinks were cast to order, weigh about 100 pounds and cost about \$5.00.

A convenient and cheap air-bath was also described. This is merely an asbestos-covered oven, such as is used for gasoline stoves. Such ovens have been in use in the author's laboratories for over three years with excellent results. They measure about 20 by 14 inches on bottom and are about 20 inches high. A single Bunsen burner can heat them to 170° C. They will hold over sixty funnels for drying purposes. They cost only \$2.80 (in Chicago).

16. 'Recent Developments in Organic Chemistry': ARTHUR LACHMAN.

The following is a brief summary of some of the topics considered: The Richter system of registration; direct nitration of paraffins; graphitic acid; Friedel-Crafts reaction; diazo compounds; the uric-acid group; some curious nitrogen compounds and reactions; some artificial substitutes for cocaine; the odorous ingredients of the jasmine and the orange blossom (methyl anthranilate and indol); the odor of the mercaptans; the increasing importance of physical chemistry for the purposes of organic chemistry; catalysis in organic reactions; the two forms of acetylene di-iodide; the chemical nature of alcoholic fermentation; trivalent carbon; the commercial manufacture of artificial indigo. A number of details and calculations are given in this instance. Tautomerism is defined and illustrated in its various forms. The formation of acetoacetic ether. Molecular rearrangements. The stereochemistry of nitrogen, of sulphur, of tin and of iodine—the three first mentioned form optically active compounds. Some new mercury derivatives of organic compounds. Auto-oxidation. Some new organic derivatives of hydrogen peroxide. Quadrivalent oxygen in dimethylpyrone. Is oxygen really acid forming? Thiele's theory of unsaturated compounds and the benzene ring. Nef's methylene theory. Michael's theory of organic reactions. Conclusion: the unity of organic research work.

The complete paper will be printed in the *Journal of the American Chemical Society*.

17. 'The Electrolysis of Certain Proteids': MARY ENGLE PENNINGTON.

A solution of edestin, a globulin from hemp seed, dissolved in 0.6 per cent. orthophosphoric acid and subjected in a partitioned cell to the action of a current of $N.D._{100} = 0.2-0.4$ ampere and 6-18 volts, gives a heavy white precipitate in the cath-

ode chamber. This precipitate, purified as carefully as possible, contains about 2.8 per cent. of phosphorus and 16.41 per cent. of nitrogen. Its properties do not entirely coincide with any known class of proteids, but approach more nearly to those of the nucleo proteids. It is difficultly soluble in pure cold water, easily soluble in hot or boiling water and separates from the hot solution unchanged on cooling. By pepsin-hydrochloric acid digestion it yields a substance containing about 7 per cent. of phosphorus. Decomposition by boiling with sulphuric acid and subsequent treatment for nitrogen bases yields a white, crystalline substance containing nitrogen. The anode chamber, after electrolysis as above, gives a different substance, also containing phosphorus. Egg albumen behaves in an analogous manner. The cathode product showed about 2 per cent. of phosphorus.

This paper will be published in the *Journal of the American Chemical Society*.

18. 'The Reduction in an Alkaline Solution of 2,4,5 Trimethyl Benzalazine and the Preparation of some Derivatives of the Reduction Products': E. P. HARDING.

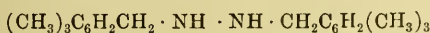
By reducing 2,4,5 Trimethyl benzalazine,



in an alkaline solution, two reduction products may be obtained depending upon the degree of reduction—one a 2,4,5 trimethyl benzal 2,4,5 trimethyl benzyl hydrazone,



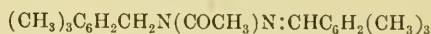
and the other a symmetrical 2,4,5 trimethyl dibenzyl hydrazine,



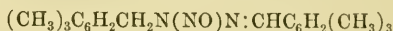
The hydrazone is a weak base. With picric acid it forms the addition product 2,4,5 trimethyl benzal 2,4,5 trimethyl benzyl hydrazone picrate,



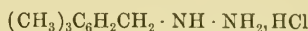
The imid hydrogen atom may be substituted by an acetyl, benzoyl or nitroso group forming the corresponding acetyl, benzoyl or nitroso derivatives, viz :



and

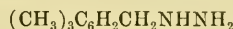


By the action of hydrochloric acid it hydrolyzes to 2,4,5 trimethyl benzaldehyde and to 2,4,5 trimethyl-benzyl hydrazine hydrochloride,

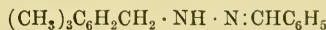


from which the free base may be obtained by the action of caustic potash.

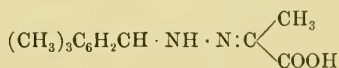
2,4,5 trimethyl benzyl hydrazine



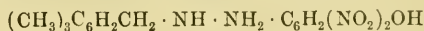
forms with benzaldehyde, benzal, 2,4,5 trimethyl benzyl hydrazone



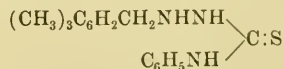
With pyrrocemic acid, it forms 2,4,5 trimethyl benzyl hydrazine pyrrocemate,



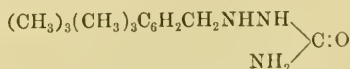
It is also capable of forming addition products. With picric acid, it produces 2,4,5 trimethyl benzyl hydrazine picrate,



with phenyl mustard oil, it forms 2,4,5 trimethyl benzyl phenyl thio semicarbazide



and with cyanic acid, 2,4,5 trimethyl benzyl semicarbazid.



This paper will be presented in the *Journal of the American Chemical Society*.

19. 'The Identification and Properties of Alpha and Beta Eucaïne': CHAS. L. PARSONS.

Alpha and beta eucaïne are new alkaloids which quite recently have been offered to the medical profession as a substitute for cocaine. There seem to be certain advantages possessed by beta eucaïne which are leading to its quite general acceptance. Chief among these are its comparatively low toxicity, its stability when boiled, which allows the solution to be easily disinfected, and its non-excitation of the heart's action. Both of these alkaloids have been synthesized in the laboratory and so far as known are not a product of life. Beta eucaïne acts as a local anæsthetic, like cocaine. Both eucaïnes resemble cocaine structurally and in general chemical properties they react much like cocaine, being easily shaken out of alkaline solution with ether, petroleum ether, benzine, chloroform, etc. Their chief distinguishing reactions are obtained with ammonia, potassium bichromate, mercurous chloride, platinic chloride, potassium permanganate and their actions under polarized light—both in the polariscope and polarizing microscope. Beta eucaïne and its hydrochloride are also characterized by a low solubility in water and alcohol.

This paper will be published in detail in the *Journal of the American Chemical Society*.

20. 'The Alkaloids of *Isopyrum* and *Isopyroïne*': G. B. FRANKFORDER.

The *isopyrum*, so far as can be learned at present, has only once been studied chemically. Hartsen in a brief paper on *Isopyrum thalictroides*, reported the isolation of two new alkaloids. The one he named *isopyrine* and the other *pseudoisopyrine*. He obtained the *isopyrine* by extracting the tubers with water and precipitating out the alkaloid by means of ammonia. The alkaloid was obtained in the pure form by extracting this ammonia precipitate with ether.

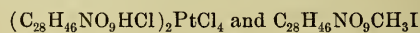
Nothing more was done with the alkaloid. No analyses were made and none of the properties given, not even the melting point.

Pseudoisopyroïne was obtained by Hartsen by extracting the root with alcohol after extracting with water. The alcoholic extract was treated with ammonia as in the case of the water extract. On evaporating off the ether the pseudo alkaloid crystallized out in star-shaped crystals. Nothing was done with this substance, not even the melting point was given.

In beginning the work on *Isopyrum biter-natum* the method given above was tried, but with unsatisfactory results. In fact, many methods were tried, a few of which gave quantities of the alkaloid. Best results were obtained, however, by first extracting with very dilute hydrochloric acid. The hydrochloride was found to be very soluble in water, and hence readily removed from the solid matter. The alkaloid was finally obtained by extracting the residue from the dilute acid with ether or by first neutralizing with ammonia. This latter step is important unless the acid solution be evaporated cautiously. Moderately strong acid decomposes the alkaloid. By extracting the acid and alkaline residues with alcohol, the hydrochloride and the free base, respectively, were obtained. Both were purified and analyzed, giving results which correspond to the formula,



In addition to the above, other salts were formed including the platinum double salt and the methyl iodide compound.



21. 'Derivatives of Camphor Oxime': G. B. FRANKFORDER and P. M. GLASOE.

The great difficulty in the study of camphor oxime is the ease with which it loses a molecule of water and forms the so-called campho nitrile. Camphor oxime acts as both acid and base. We have found that

the basic properties predominate. So marked are its basic properties that it combines with nearly all the common acids and even with the aldehydes forming peculiar para derivatives.

Monochlorcamphor oxime $C_{10}H_{15}ClNOH$.

Until recently no real halogen derivatives of camphor oxime have been made. Free chlorine acts upon it, but forms, instead of a chloride, the common hydrochloride and the nitrile. However, if the oxime is dissolved in ether and treated with sulphur dichloride, the monochloride is formed directly in almost pure state.

Monobromcamphor oxime $C_{10}H_{15}BrNOH$.

The same difficulty in introducing chlorine was experienced in making the bromine compounds. It was finally made by treating a chloroform solution of the oxime in the dark with bromine and allowing to stand until the bromine color had disappeared. The pure substance is inactive toward polarized light, has a specified gravity of 1.48 and an index of refraction of 1.557535 at $15^{\circ} C$.

Dibromcamphor oxime $C_{10}H_{14}Br_2NOH$.

By treating a boiling dilute alcoholic solution of camphor oxime with bromine in excess an oily substance settles to the bottom. The substance was removed, purified and analyzed. The results correspond to the above formula.

Numerous attempts were made to substitute the chlorine and bromine, but as yet results are unsatisfactory. No proof has likewise been obtained of the position in which the halogens enter.

22. 'A Chemical Study of the Seed of *Rhus glabra*': G. B. FRANKFORTER and A. W. MARTIN.

The seed of the *Rhus glabra* or common sumach has been examined, but almost wholly with the idea of determining the amount of tannic acid. In the present paper we have made, so far as possible, an

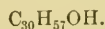
exhaustive examination with special reference to the oils and to the cholesterol present.

We began by studying the seed and husk together, but soon found it advisable to separate them, as most of the oil exists in the seed and all the tannic acid in the husk. The seed contains 9.1 per cent. of oil, while the husk contains 2.5 per cent. On the contrary, the husk contains 7.32 per cent. of tannic acid and 1.35 of malic acid, while the seed contains none.

An examination of the oils showed that the one obtained from the seed resembled that from the husk, the chief difference being in the quantity of foreign substance present. The following is a brief comparison of the properties:

	Seed Oil.	Husk Oil.
Sp. gr. at $15^{\circ}C$.	.923	.933
Index of Refraction at $15^{\circ}C$.	1.48228	1.48764
Saponification Value	194.7	190.1
Iodine Value	86.4	87.2
Drying Properties	None	None
Color	Light yellow	Dark brown

An examination of both the oils showed the presence of a substance resembling cholesterol. It was obtained by the common method for the extraction of cholesterol. It is probable that the substance obtained in each oil is the same. That obtained from the seed oil was so small that it was not studied. The husk oil contained 2.26 per cent. It was readily removed from the oil by acetone. The substance was carefully purified and analyzed. Analysis gave numbers corresponding with the formula



The molecular weight determination gave numbers agreeing with the above formula.

23. 'Phenoxozone Derivatives': H. W. HILLYER.

As indicated in the paper read at the meeting of the Association in New York, when picryl chloride acts on pyrocatechin in presence of two molecules of alkali, one

molecule of hydrochloric acid and one of nitrous acid are split off and a condensation takes place with the formation of dinitro phenoxozone.

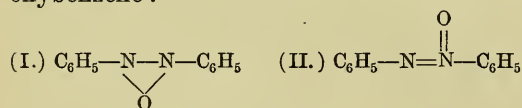
The same kind of action takes place with homopyrocatechin and qualitatively the same action results with the other ortho-dihydroxy compounds; protocatechuic ethyl ester, æsculitin, daphnetin, alizarine and nitropyrocatechin. The condensation products have been isolated but not in quantity to make satisfactory analyses. Most of them yield brilliant carmine solutions when treated with sodium ethylate. The change produced in this way is only superficial since at least in the case of the simplest one, dinitro phenoxozone, the original compound is precipitated on dilution with water.

The substance produced by action of alcoholic soda on dinitro phenoxozone has been further studied and found to be the strong acid dinitro dioxy phenoxide.

The substance formed by action of one molecule of pyrocatechin, two of picryl chloride and two of alkali is proven to be dipicryl pyrocatechin by analysis and by the fact that it splits off one molecule of picric acid and one of nitrous acid and yields dinitro phenoxozone.

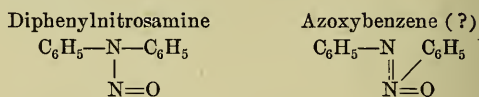
24. 'The Constitution of Azoxybenzene': ARTHUR LACHMAN.

Two formulæ have been proposed for azoxybenzene:



No positive evidence is available for either of these. The author undertakes to show, by a comparison of azoxybenzene with diphenylnitrosamine, that formula (II.) cannot represent the properties of azoxybenzene. There is considerable similarity between (II.) and the structure of diphenylnitrosamine; and since the compounds are

isomeric, similarity of reaction may also be expected:



With four different reagents (hydrochloric acid, phenyl-hydrazine, hydroxylamine, and zinc ethyl) the author obtained prompt and decisive reactions with diphenylnitrosamine under circumstances where azoxybenzene was unacted upon. From this it is concluded that only formula (I.) can be regarded as satisfactory for azoxybenzene. This conclusion is strengthened by thermochemical data; the oxidation of azobenzene to azoxybenzene gives off 257 K, whereas all other classes of nitrogen compounds have negative heats of oxidation. This shows that in azoxybenzene the nitrogen and oxygen have attained the maximum saturation of their affinities.

25. 'The Action of Zinc Ethyl on Nitro and Nitroso-Compounds, A Reply to I. Bewad': ARTHUR LACHMAN.

Bewad has recently claimed priority for the investigation of the above-named reaction. This priority is unquestioned. But Bewad is mistaken in his explanations of the various results obtained. He assumes that the nitro and nitroso groups, NO_2 and NO respectively, behave in a manner exactly analogous to the carbonyl group, CO . The author shows, on the basis of his own work, that this supposed analogy does not exist; that certain nitroso compounds show a peculiarly unique behavior with zinc ethyl; that other nitroso compounds differ from these first, as well as from carbonyl compounds; and that no reliable conclusions whatever can be drawn as yet from the behavior of nitro compounds. There is also some difference of fact to be noted in the work of Bewad and of the author, which calls for further experimentation.

26. 'Some Hydrochlorated Sulphates':

CHAS. BASKERVILLE, LIONEL WEIL and I. F. HARRIS.

The work of Ditte on $\text{HgSO}_4, \text{HCl}$ was repeated and found correct. $\text{HgSO}_4, 2\text{HCl}$ was also prepared. Hydrated cadmium sulphate ($3\text{CdSO}_4, 8\text{H}_2\text{O}$) was treated with anhydrous hydrochloric acid under different conditions of temperature, time and variation of masses and the water replaced gradually by hydrochloric acid. Eventually, under certain conditions, the sulphuric acid was entirely replaced by hydrochloric acid. E. F. Smith has made similar observations with sodium and potassium sulphates, but in no case was all the sulphuric acid replaced as observed with compounds treated of in this paper.

This paper will be published in the *Journal of the American Chemical Society*.

27. 'The Origin and Use of Natural Gas at Manitou, Colo.': WILLIAM STRIEBY.

The paper opens with a statement of the geological features of the region about Manitou in so far as they have a bearing upon the origin of the carbon dioxide, viz., the limestones at Manitou, the rock-fault following the line of the Ute Pass, the igneous rocks of the higher lands westward at Cripple Creek, etc. Analyses of waters from several springs at Manitou are given and discussed with a view of tracing the source of the mineral matters and gas contained in them. Some theories of the origin of carbon dioxide are briefly summarized and dismissed as inapplicable to this locality. A short discussion of chemical reactions occurring in rocks due to permeating solutions gives a basis for the theory adopted in this paper, and finally a few confirmatory facts are cited and a reference made to the gas springs at Saratoga, New York, and Cañon City, Colorado.

The latter part of the paper details the work done under the direction of the writer in the measurement of the gas given off at some of the springs at Manitou, the calcu-

lation of the quantity of carbonated water to be obtained, the design of suitable apparatus for catching the gas and the choice of compression and carbonating machines to produce the gassed mineral water.

The following papers were read by title. With few exceptions, they will be published in the *Journal of the American Chemical Society*.

'Analysis of a Few Southwestern Coals': HERMAN POOLE.

'Copper—Its Scientific and Commercial Value': W. S. EBERMAN.

'The Photometric Analysis of Sulphates': DANIEL D. JACKSON.

'What Constitutes Instruction in Technical Chemistry?' EDWARD HART.

'Review of Recent Work upon the Structure of Metals and Binary Alloys': J. A. MATHEWS.

'Methods of Standardizing Acid Solutions': CYRIL G. HOPKINS.

'The Determination of Sulphur in Iron and Steel': WM. A. NOYES and L. LESLIE HELMER.

'Decomposition of Sodium Nitrate by Sulphuric Acid—Part III': C. W. VOLNEY.

'Quantitative Determination of Hydrofluoric Acid': W. E. BURK.

'A Theory of the Production of Arsine and Stibine in the Marsh and Gutzzeit Tests, and Some Causes of Quantitative Variations therein': EDWIN A. HILL.

'A Study of the Chemical Composition of Meat Extracts': H. S. GRINDLEY.

'Chemical Changes produced by the Action of Bacteria': H. S. GRINDLEY.

'Derivatives of Diphenyl Ether': A. N. COOK.

'Some Experiments with the Mononitro-orthophthalic Acids': MARTSON TAYLOR BOGERT and LEOPOLD BOROSCHEK.

'On the Determination of Formaldehyde': A. G. CRAIG.

'A Modification of the Sulphuric Acid Tests for Formaldehyde in Milk': A. GUSTAV LUEBERT.

'The Synthesis of Ketodihydroquinazolins from Anthranilic Acid': AUGUST HENRY GOTTHELF.

'A Comparison of the Solubility of Acetylene and Ethylene': SAMUEL A. TUCKER and HERBERT R. MOODY.

'Cryoscopic Experiments with Sulphur': ALEXANDER SMITH.

'The Electrolytic Determination of Molybdenum': LILY GAVIT KOLLOCK and EDGAR F. SMITH.

'The Indirect Weighing of Quantitative Precipitates': R. W. THATCHER.

'Solid Hydrocarbons of the Series C_nH_{2n+2} and Liquid Hydrocarbons of the Series C_nH_{2n} , in the Less Volatile Portions of Pennsylvania Petroleum': C. F. MABERY.

'Specific Heats and Heats of Volatilization of Hydrocarbons of the Series C_nH_{2n+2} , C_nH_{2n} , and C_nH_{2n-4} , in Pennsylvania, Texas, California and Japanese Petroleum': C. F. MABERY.

'Composition of Commercial Paraffine, Vaseline, and Solid and Pasty Mixtures of Hydrocarbons Collected in Oil Wells': C. F. MABERY.

'Composition and Properties of Asphalts from Different Petroleum': C. F. MABERY.

'The Sulphohalides of Lead': VICTOR LENHER.

'The Theory of Factor Weight in Gravimetric Analysis': C. A. LITTLE.

'On Positive and Negative Halogen Ions': JULIUS STIEGLITZ.

'The Quantitative Separation and Determination of Uranium': EDWARD F. KERN.

'The Discovery of Nitro-Glycerine in an Exhumed Body': G. G. Pond.

WILLIAM MCPHERSON,
Secretary.

MEMBERSHIP OF THE AMERICAN ASSOCIATION.

THE following have completed their membership in the American Association for the Advancement of Science during the month of August:

Frank L. Abbott, Professor of Physical Sciences, State Normal School, Greeley, Colo.

Geo. E. Alexander, Chemist and Mining Engineer, 1736 Champa St., Denver, Colo.

Dr. John E. Almy, Instructor in Physics, University of Nebraska, Lincoln, Nebr.

Miss Theodosia G. Ammons, Professor of Domestic Science, State Agricultural College, Ft. Collins, Colo.

John B. Annear, Chemist, Boulder, Colo.

Geo. F. Archer, 31 Burling Slip, New York, N. Y.

Robert Armstrong, M.D., Boulder, Colo.

Barton O. Aylesworth, President State Agricultural College, Ft. Collins, Colo.

Francis N. Balch, Lawyer, 23 Court St., Boston, Mass.

George Bell, Mineralogist, 200 S. Washington Ave., Denver, Colo.

Edgar H. Berry, Draftsman, 72 E. 87th St., New York, N. Y.

Frank W. Blackmar, Professor of Sociology and Economics, University of Kansas, Lawrence, Kansas.

Fred C. Blake, Boulder, Colo.

Newton A. Bolles, Chemist, 1457 Ogden St., Denver, Colo.

Fred Bond, State Engineer, Cheyenne, Wyoming.

Joseph H. Bowman, Electrical Engineer, Apartado 21, Cordoba, Mexico.

Frank P. Brackett, Professor of Mathematics, Pomona College, Claremont, Cal.

David W. Brunton, Mining Engineer, 865 Grant Ave., Denver, Colo.

Mrs. Emma F. J. Bullene, 1431 Court Place, Denver, Colo.

Virgil M. Came, 315 Quincy Bldg., Denver, Colo.

James Carter, M.D., Carbon, Wyoming.

Rollin T. Chamberlin, Hyde Park Hotel, Chicago, Ill.

Ellery C. Chilcott, Professor Geology and Agronomy, Agricultural College, Brookings, S. D.

Arthur Cobb, Architect, 600 Equitable Bldg., Louisville, Ky.

Thomas H. Conorroe, M.D., Lecturer on Biology, Hahnemann Medical College, 833 N. 26th St., Philadelphia, Pa.

Samuel R. Cook, Professor Physics and Chemistry, Washburn College, Topeka, Kansas.

Clifford E. Corwin, Teacher of Science, High School, 508 5th St., Marietta, Ohio.

Mattoon M. Curtis, Professor of Philosophy, Western Reserve University, 43 Adelbert Ave., Cleveland, Ohio.

Alvin S. Daggette, M.D., 400 S. Craig St., Pittsburg, Pa.

A. H. Danielson, Assistant Agriculturist, Agricultural College, Ft. Collins, Colo.

Edward E. Davis, 157 N. 20th St., Philadelphia, Pa.

Manning W. Doherty, Associate Professor of Biology, Ontario Agricultural College, Guelph, Canada.

Charles R. Dryer, Professor of Geography, State Normal School, Terre Haute, Ind.

Philip K. Dumaresq, Sears Building, Boston, Mass.

George M. Duncan, Professor of Philosophy, Yale University, 299 Edwards St., New Haven, Conn.

Miss Alice Eastwood, Curator of Herbarium, Academy of Sciences, San Francisco, Cal.

David C. Eccles, Pharmacist and Chemist, 191 Dean St., Brooklyn, N. Y.

Isaac R. Edmands, Electrical Engineer, Union Carbide Co., 315 Buffalo Ave., Niagara Falls, N. Y.

E. Waite Elder, Instructor in Physics, High School No. 1, Denver, Colo.

Dr. Arthur H. Elftman, Mining Engineer, 706 Globe Building, Minneapolis, Minn.

Wilbur D. Engle, Professor of Chemistry, Univ. of Denver, University Park, Colo.

Philo J. Farnsworth, M.D., Clinton, Iowa.

Professor Wm. C. Ferril, Curator, State Historical and Natural History Soc., 2123 Downing Ave., Denver, Colo.

Dexter M. Ferry, Jr., Seedsman, 1040 Woodward Ave., Detroit, Mich.

Francis A. J. FitzGerald, P. O. Box 118, Niagara Falls, N. Y.

Robert H. Forbes, Professor of Chemistry and Dir. Agr. Exper. Sta., Territorial Univ., Tucson, Arizona.

Floyd C. Furlow, Professor Experimental Engineering, Ga. School of Technology, Atlanta, Ga.

John B. Garvin, Instructor in Chemistry, Denver High School, 2536 W. 34th Ave., Denver, Colo.

H. Allan Gleason, Asst. in Botany, Univ. of Illinois, John St., Champaign, Ill.

Gustavus E. Gordon, Scientific Director, Walker-Gordon Laboratory Co., 1120 Conn. Ave. N. W., Washington, D. C.

Professor H. A. Gossard, Professor of Entomology, Agric. Coll., Lake City, Fla.

H. P. Grabill, Student of Chemistry, Drake University, 1004 Anas Ave., Des Moines, Iowa.

U. S. Grant, Northwestern University, Evanston, Ill.

Willis H. Grant, Teacher of Chemistry and Geology, Academic High School, Pittsburg, Pa.

Clarence S. Hammatt, Electrical and Mechanical Engineer, Jacksonville, Fla.

Everhart P. Harding, Asst. in Chemistry, Univ. of Minnesota, Minneapolis, Minn.

R. H. Harper, M.D., Practicing Physician, Afton, Indian Territory.

J. Campbell Harris, 119 S. 16th St., Philadelphia, Pa.

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John W. Heston, Pres. S. D. Agri. College, Brookings, S. D.

Charles N. Hewitt, M.D., Secy. State Board of Health, Red Wing, Minn.

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Samuel J. Holsinger, Special Agt. Interior Dept., Tucson, Arizona.

Walter D. Hunter, Entomologist, Victoria, Texas.

Elsworth B. Knerr, Midland College, Atchison, Kansas.

Andrew C. Lawson, Prof. of Geology and Mineralogy, Univ. of California, Berkeley, Cal.

Henry C. Lay, Mining Engineer and Geologist, Telluride, Colo.

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Mrs. Julia A. Lender, 2201 Lincoln Ave., Denver, Colo.

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Geo. D. Louderback, Professor of Geology, Nevada State University, Reno, Nevada.

J. R. Lovejoy, Electrician, 811 Union St., Schenectady, N. Y.

Otto J. J. Luebker, Bureau of Forestry, Dept. Agriculture, Washington, D. C.

D. W. McGee, Farley, Iowa.

Howard L. McLaury, Professor of Mathematics and Physics, South Dakota School of Mines, Rapid City, S. D.

John W. Mahin, Teacher in Manual Training High School, 1411 16th Ave., Denver, Colo.

Fredrick Wm. Mally, Entomologist, Orchardist and Nurseryman, College Station, Texas.

Amos L. Mason, M.D., Physician to Boston City Hospital, York Harbor, Maine.

Dr. J. A. Mathews, Chemist and Metallurgist, 4 First Place, Brooklyn, N. Y.

Elmer D. Merrill, Assistant Agrostologist, U. S. Dept. Agriculture, Washington, D. C.

Ralph D. Mershon, Consulting Engineer, 621 Broadway, New York, N. Y.

Mrs. Cornelia Miles, Principal Broadway School, 1544 Franklin St., Denver, Colo.

Armand R. Miller, Professor of Chemistry, Manual Training High School, Kansas City, Mo.

E. J. Molera, Civil Engineer, 606 Clay St., San Francisco, California.

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William S. Yeates, State Geologist, Atlanta, Ga.

SCIENTIFIC BOOKS.

A Laboratory Course in Plant Physiology, especially as a basis for ecology. By WILLIAM F. GANONG, Ph.D., Professor of Botany in Smith College. New York, Henry Holt and Company. 1901. Octavo, cloth. Pp. vi + 147.

Practical Text-book of Plant Physiology. By DANIEL TREMBLY MACDOUGAL, Ph.D., Director of the Laboratories of the New York Botanical Garden. With one hundred and fifty illustrations. New York, Longmans, Green and Co. 1901. Octavo, cloth. Pp. xiv + 352.

Professor Ganong's little book is a product of his laboratory, and therefore has the merit of practicality. The illustrations of apparatus (about thirty) are from photographs of the appliances actually used, and the text consists of descriptions of experiments which the author has repeatedly made. The book is in two parts, in the first of which the author discusses methods of study and the necessary equipment, while in the second is given an outline of a course of experiments in the laboratory on protoplasm, nutrition, growth, reproduction and irritability. The author says (p. 23), 'It goes without saying that a greenhouse and a laboratory are indispensable for a course in physiology,' and naturally gives a good deal of attention to the plans and equipment of both. These sections of the book will prove very helpful to those who are building up their facilities for physiological work. The experiments, of which nearly one hundred are specifically indicated, are selected with reference to their availability and practicability in an elementary course. The treatment here is such as to make investigators. The author does not ask numberless leading questions of the 'kindergarten order,' nor does he leave the student without any guide, but wisely follows a middle

path suggested no doubt by his long and successful experience as a teacher.

We would call especial attention to the fact that the author has planned this course 'especially as a basis for ecology.' In some quarters there is a feeling that ecology should be one of the first things brought to the young student's attention, and so we have a swarm of elementary books for secondary school children in which 'ecology' figures prominently. We are in full sympathy with the author when he says, "More than one recent writer has described ecology as at present mostly a series of guesses; and so will much of it continue to be until given logical precision and a firm foundation in exact physiology." Evidently ecology must come *after* the student has prepared himself for it, and *not* as an introduction to botany.

Dr. MacDougal's work is the first American text-book of plant physiology of advanced grade to be published. It is intended for and adapted to the demands of such students as have already made considerable progress in the study of plant activities. In fact, we apprehend that to a large extent it will be the hand-book for the teacher, rather than for the student. However used, it must do much to stimulate physiological inquiry in colleges and universities. The aim of the work is thus defined in the preface, "The chief purpose of the author is to present practical directions for the demonstration of the principal phenomena of the physiology of the plant, and also details of experimental methods suitable for the exact analyses requisite in research work."

The sequence of topics is considerably different from that usual in works on the physiology of plants. Thus the author takes up in order, 'The Nature and Relations of an Organism,' 'Relations of Plants to Mechanical Forces,' 'Influence of Chemicals upon Plants,' 'Relations of Plants to Water,' 'Relations of Plants to Gravitation,' 'Relations of Plants to Temperature,' 'Relations of Plants to Electricity,' and other forms of energy, 'Relations of Plants to Light,' 'Composition of the Body,' 'Exchanges and Movements of Fluids,' 'Nutritive Metabolism,' 'Respiration,' 'Fermentation and Digestion,' 'Growth,' 'Reproduction.' It

is difficult to specify chapters in a work in which there is so much to commend, but to us the most interesting is that on the 'Composition of the Body' (IX.), in which the treatment, though not extended, is especially satisfactory. Here the principal topics are 'Substances found in Plants,' 'Carbohydrates,' 'Fractional Extractions,' 'Estimation of Tannins and Glucosides,' 'Determination of Sugars and Dextrins,' 'Starch,' 'Cellulose,' 'Proteids,' 'The Fats,' 'Determination of Organic and Inorganic Matter,' 'Enzymes.' We venture to say that the general introduction of the matter of this chapter into plant physiology will revolutionize much of the teaching of this subject in this country. There has been too little of the study of what plants actually are in the physiology of the past, so far as this country is concerned, and it is just here that American botanists have been weakest. This book will serve as a corrective, and it is to be hoped that it will turn the attention of students in physiological laboratories to this much-neglected aspect of their work.

CHARLES E. BESSEY.

NOTES.

THE American Institute of Mining Engineers will, as we learn from the *Railway and Engineering Review*, publish two volumes as follows:

1. 'The Genesis of Ore-Deposits,' comprising the famous treatise of the late Professor Franz Posepny, with the successive discussions thereof by Le Conte, Blake, Winchell, Church, Emmons, Becker, Cazin, Rickard and Raymond (all of which were published in Volumes XXIII. and XXIV. of the *Transactions* of the Institute, and subsequently in the special 'Posepny Volume,' issued by the Institute); also, later, papers by Van Hise, Emmons, Weed, Lindgren, Vogt, Kemp, Blake, Rickard and others, and the discussion of these papers by De Launay, Beck and many others (all of which will be published in Volumes XXX. and XXXI.); also a complete bibliography of the Institute papers and discussions on this subject from 1871 to the present time. The volume now in press will be an octavo of about 825 pages, bound in 'book-linen.' This book will be sent, postpaid,

for \$5 to members or others who subscribe for it before its issue.

2. 'The Evolution of Mine-Surveying Instruments.' This will be a volume of about 400 pages, issued in the same style as the foregoing, and containing the original paper of Mr. Dunbar D. Scott on that subject (*Transactions*, XXVIII.), first published in 1898, together with later papers continuing the same subject, and discussions thereof, by Hoskold, Lyman, Davis and many others. Subscriptions will be received for this volume in advance of its issue at \$3, under the conditions already stated above.

DISCUSSION AND CORRESPONDENCE.

WEATHER CONTROL.

A CHARACTERISTIC of storms which meteorologists do not perhaps sufficiently consider is that they are the falling down or collapsing of unstable states of the atmosphere. Such phenomena in thermodynamics are called reversible processes; let us call them *sweeping processes* or simply *sweeps*. The trend of a sweeping process may be affected to any extent, however great, by a cause, however insignificant, provided the cause acts at the critical initial stage of the sweep. For example, a mere breath may determine whether a brick chimney shall fall harmlessly into a vacant lot or with unmeasured calamity into an adjacent factory, or, to take an example from meteorology, an unstable state of the atmosphere over the United States may lead to a cyclonic movement the effects of which may differ enormously according to the time and place that the unstable state begins to break, and in the limiting case the flight of a grasshopper in Colorado or Montana may be the determining factor.

If the cyclonic movements of the atmosphere which have so much to do with the distribution of rainfall are ever to be controlled by the infinitesimal means at the disposal of man it must be by the proper application of these means during the early and exceedingly sensitive stages of these vast sweeping processes. How, when and where to apply our puny power is a matter of detail, of experiment and study.

We must study the initial phases of cyclonic

movements in their relations to subsequent trend and character, and we must devise means for inaugurating these initial phases in a way which will lead to desired results. This study has been pursued by the scientists of the Weather Bureau for many years and is the basis of the weather forecasts issued daily by this great scientific department of the government. As to the means for inaugurating at will the storm movements of the atmosphere the smoke-ring cannon of Burgomaster Stiger is the most rational that has yet been suggested, as will be explained later.

Weather control is, however, not so simple a matter as would appear from the above statement. It is a well-known fact that two cyclonic movements initially alike may have very great differences of trend and character. The explanation of this fact will be made clear by considering a simple mechanical analogy. Imagine a great number of dominoes to be stood on end not in a simple row but in a very complicated network of rows and imagine slight disturbances to be produced over the entire system; for example, a number of grasshoppers might be turned loose into the dominoe enclosure! Now there might be one particular region where the dominoes are more sensitive than elsewhere so that collapse would usually start in this region and spread over the system, but the ultimate trend and character of the collapse would depend not only upon its initial phases but quite as much upon whether a particularly vigorous grasshopper had happened to kick over a dominoe or two in regions remote from the starting point of the main collapse. The driving energy of the dominoe storm at any given place is derived from the falling of the dominoes at that place and not at all from the remote source of the storm, and if we could imagine the spreading dominoe storm to gradually make the dominoes just ahead of it taller and taller then there would be local displays of excessive violence as these tall dominoes fall. It is scarcely necessary to alter the wording of the above statement, so evident is its application to a vast stretch of atmosphere over a sun-heated continent. The dry arid regions where the sun beats down without hindrance are the regions in which the atmosphere

most quickly reaches a very sensitive state of instability and perhaps the sun-heated air on the rising slope of a mountain may determine the start of the atmospheric overturn. As the atmospheric collapse spreads over the continent its character may be greatly influenced by the degree of instability existing in the regions over which it passes and by the existence of independent storm movements. Furthermore it is known to be the case that a typical cyclone in the United States causes a great mass of warm air to be gathered near the earth's surface on its southeast front and when this mass of warm air and the overlying cold air make a summersault a tornado (cyclone, popularly called) or severe local disturbance is the result.

Our dominoe storm, to carry our analogy further, might be inaugurated with indefinitely small effort at a time when the system is ready for a more or less complete collapse, and the trend of the collapse could be controlled not only by choice of time and place of starting the collapse, but also by starting independent collapses at other times and places, and the control of weather must likewise consist of proper starting of storm movements and of their proper modification by independently inaugurated movements.

Reports are coming to us from southern Europe of the control of hail storms by means of a special form of cannon which throws a large vortex ring at high velocity into the upper atmosphere. In many details these reports are absurd, while in other details they are by no means absurd, although it must be admitted, if we credit the reports, to be a very remarkable fact that this first crude trial to control the weather—for it is the first that conforms at all to the physical requirements of the case—should be in so large a measure successful.

The problem is to upset the increasing instability of the atmosphere on a hot summer's afternoon before the beginning of that particular type of collapse, whatever it may be, that constitutes a hail storm, to set the sky off half-cocked as it were, and it is hard to think of a better means for starting a collapse of an unstable atmosphere than the smoke-ring cannon of Burgomaster Stiger. A simple concussion or

loud sound is not at all effective. The thing that is necessary is not a momentary to and fro motion of air such as accompanies a sound wave and which is very slight even in a sound wave of exceedingly great intensity, but an actual transfer of air from one place to another, such as is produced near the muzzle of a gun in what is called the blast, or such as is produced by a vortex ring.

It seems to be within the range of possibility that Stiger's cannon may be a means for controlling all kinds of storm movements.

W. S. FRANKLIN.

REVIEW OF TWO RECENT PAPERS ON BAHAMAN CORALS.

TO THE EDITOR OF SCIENCE: It was my pleasure to visit the American Museum of Natural History in New York during the first week of September, and through the courtesy of Professor Whitfield to examine the recent species of West Indian corals in that institution.

I saw two specimens that have recently been described by Professor Whitfield, and after having received copies of his papers, desire to make some remarks on them.

The first paper is entitled, 'Notice of a Remarkable Case of Combination between Two Different Genera of Living Corals,' *Bull. Amer. Mus. Nat. Hist.*, Vol. XIV., Art. XVII., pp. 221, 222, pls. XXXI., XXXII. (date, July 29, 1901). Professor Whitfield considers his specimen a combination of *Meandrina labyrinthica* and a *Ctenophyllia* which he says is perhaps nearest to *Ctenophyllia quadrata* Dana.

Are two genera represented? Most emphatically no! The *Meandrina* of Milne-Edwards and Haime (not Lamarck, 1801) is characterized by possessing distinctly toothed septa and a spongy columella, in which may be a lamellar element connecting one calicial center with the next; the series are variable in length, often very long, and usually sinuous. The wall between adjoining series is simple (not double as in *Diploria*). The septa and wall are imperforate. Pali may or may not be present; they are not of specific value in this genus. An examination of plate XXXII. will show that there are no generic differences in the specimen figured.

The genus *Ctenophyllia* Dana (= *Meandrina* Lamarck, 1801, + *Pectinia* (pars) Oken, 1815, + *Meandrina* (pars) Lamarck, 1816, + *Ctenophyllia* Milne-Edwards & Haime, 1848, + *Pectinia* Milne-Edwards & Haime, 1851 and 1857) was proposed for four species, *C. pectinata*, *C. quadrata*, *C. pachyphylla* and *C. profunda*. Dana explicitly states that the septa are 'entire or nearly so.' He also says, "This group appears to be related to the Euphyllia and has been placed in the same subfamily with them." Dana was absolutely correct in his characterization and in his understanding of the systematic relations of the genus. The *Ctenophyllia*, perhaps *quadrata*, of Whitfield differs utterly from Dana's genus *Ctenophyllia*, and according to nearly every modern student of zoophytes it would not be placed in the same family.

It can be seen, by examining the plates, that the valleys and collines of the central portion of the colony are directly continuous with those of the surrounding portion. The differences consist in the absence of pali, and in the larger collines and larger valleys in the central portion. The specimen merely shows the variation which may take place within a single colony.

The second paper is entitled, 'Some Observations on Corals from the Bahamas, with a Description of a New Species,' *Bull. Amer. Mus. Nat. Hist.*, Vol. XIV., Art. XVIII., pp. 223, 224, pls. XXXIII., XXXIV. (date, July 29, 1901).

The 'new species' described is named *Diploria geographica*. It is merely a form of the very abundant *Diploria labyrinthiformis* (Linn.) emend. Esper (= *Diploria cerebriformis* (Lamarck)). The only difference is in its possessing more angular gyrations than are common in *D. labyrinthiformis*.

These two papers are reviewed because, in my opinion, such errors should be corrected as soon as possible.

T. WAYLAND VAUGHAN.

SMITHSONIAN INSTITUTION,
WASHINGTON, D. C., Sept. 11, 1901.

TWO UNKNOWN WORKS OF RAFINESQUE.

BIBLIOGRAPHY does not indicate that Rafinesque ever published a work entitled 'Florula Lexingtoniensis,' or, in fact, it does not seem known that such a work was even contem-

plated by him. There has been discovered in the herbarium of the Academy of Natural Sciences of Philadelphia a single signature of a work with the above title, consisting of pages 73-80 inclusive, and marked K. As the number of pages would indicate, it is a quarto, though of small size.

Perhaps this intended work met the fate of the 'Western Minerva,' another of Rafinesque's Lexington attempts in literature, which, with the exception of three copies, was suppressed by the printer, because, it is said, the amount of his bill was not forthcoming. It is odd, in any event, that no mention of a 'Florula Lexingtoniensis' was made in Rafinesque's other writings.

Another of Rafinesque's works of which no record seems to have been made is the 'American Florist,' of which at least two parts appeared, as there are two copies of the second part in the library of the above-mentioned institution. This 'Second Series' is also entitled 'Eighteen Figures of Handsome American and Garden Flowers. By C. S. Rafinesque, Philadelphia, 1832.' It is a large sheet, measuring from border to border 21½ by 17½ inches, bearing illustrations of *Arctium latifolium*, *Poteria sanguisorba*, *Betonica officinalis*, *Pyrus malus*, *Bryonia alba*, *Barbarea alliaria*, *Clinopodium vulgare*, *Chrysanthemum leucanthemum*, *Fraxinus quadrangularis*, *Agrostema githago*, *Melissa officinalis*, *Saxifraga granulata*, *Spartium scoparium*, *Bupleurum rotundifolium*, *Primula farinosa*, *Alchemilla alpina*, *Hedera helix*, *Cardamine pratensis*. The illustrations are much like those in his 'Medical Botany,' but are printed in black ink. They bear numbers 19-36, the first series, no doubt, holding numbers 1-18.

WILLIAM J. FOX.

ACADEMY OF NATURAL SCIENCES,
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RECENT ZOO-PALEONTOLOGY.

THE present summer has been rich in paleontological discoveries. The most notable event is the discovery of the body of a frozen mammoth which is now being conveyed to St. Petersburg. Expeditions in this country have been sent out from many of the larger museums, and Professor Von Zittel has sent one of

his assistants, Dr. Broili, with Mr. Charles H. Sternberg, the well-known collector, into the Permian of Texas. The Natural History Museums of London have conducted explorations both in Egypt and in Greece. In the latter country Dr. A. Smith Woodward has been working in the Lower Pliocene of Pikermi, and has secured 47 boxes of valuable fossils, including horses, rhinoceroses and, of still greater rarity, another specimen of the hyracoid, *Pliohyrax*.

Mr. Charles W. Andrews, of the British Museum of Natural History, went on several expeditions into the Nile desert, accompanying the geological survey of Egypt. A year previous he had reported the existence of fossil mammals of undoubted Oligocene age; during the present expedition he made the most important discovery of early and generalized Proboscidea, especially of a small mastodon-like animal, with both premolar and molar teeth in place. Older beds were found to contain a primitive *Dinotherium*. Since the oldest *Dinotherium* and *Mastodon* of Europe are of Miocene age, this discovery not only carries the proboscidean phylum further back, but is strongly in favor of the theory of the African origin of this order. Africa has long been the dark continent of paleontology, and one of the results of English occupation will undoubtedly be a succession of paleontological discoveries of the greatest interest.

The special explorations for fossil horses by the American Museum have been completely successful. The Texas expedition in July secured eight skulls of *Protohippus* with portions of the skeletons associated. They are all in a hard matrix and somewhat crushed. The Colorado expedition has secured a complete skeleton, in a perfect state of preservation, of the large Upper Miocene or Loup Fork horse. This *Anchitherium* is the first complete skeleton of a horse of this period which has been found in this country. The explorations in the same region seem to demonstrate that there were four distinct types of horses, almost contemporaneous. It has been reported also that the Carnegie Museum secured some very complete horse skeletons, but these prove to belong to *Merycochoerus*, an oreodont.

Another discovery of importance, by the Texas party of the American Museum, is the nearly complete shell of the armored edentate *Glyptodon*, four feet in length, together with two feet of the armored tail and parts of the skeleton within the shell. Hitherto *Glyptodon* has only been known from teeth, recorded by Cope from southern Texas, in 1888, and by Leidy from Florida in 1889. The present specimen is almost identical in its elaborate shell-pattern with the Pampean glyptodons.

The explorations for Dinosaurs in the Jurassic have also been very successful. Several discoveries have been reported by the Field Columbian Museum party in western Colorado. A Carnegie Museum party has been working in the sandstone of Marsh's old quarry near Cañon City, and has secured parts of the skeleton of *Morosaurus*, and a skull of *Stegosaurus*. The American Museum has continued its exploration of the Bone Cabin Quarry, in central Wyoming, resulting in the discovery of the skull of one of the large Sauropoda, also the skull of a large carnivorous Dinosaur, and parts of the skulls of two other Dinosaurs, besides a quantity of skeletal material.

The Triassic is still the least known period. Reports from Professor Lester F. Ward of the existence of vertebrate fossils in Arizona led to a party being sent out by the National Museum under the leadership of Professor Ward, assisted by Mr. Brown, of the American Museum, resulting in the discovery of remains both of Dinosaurs and of the primitive crocodile-like Belodons. The Dinosaurs appear to be related to the Stegosaurian division, according to the preliminary examination made by Mr. F. A. Lucas, and there is also a new genus of Belodon in the collection.

H. F. O.

September 9, 1901.

REPORTS OF FOREIGN MUSEUMS.

THE report of the Australian Museum, Sydney, N. S. Wales, for 1899, shows that institution to be doing good work, although hampered by the smallness of its appropriation. Owing to what the curator terms a 'miserable appropriation' for the purchase of specimens, the growth of the collections has been principally

through donations from individuals, 317 donors having presented some 6,000 specimens. This and the attendance speak well for the popularity of the Museum. The government did, however, provide \$67,500 for an addition to the Museum building which was already a much finer structure than the National Museum of the United States. The most important accessions were an oar-fish, *Regalecus gese*, the third of the species known, and an oil-fish, or 'palu,' *Ruvettus pretiosus*; the remainder of the important additions were ethnological. In the exhibition series special attention seems to be given to groups of birds, and fifteen new 'nest groups' were added, besides an additional example of the interesting nest of the bower bird, *Chlamydodera maculata*; this was elaborately decorated at both ends with bones of mammals and birds, shells, pebbles, bits of glass and other objects. It is announced that the manuscript and illustrations for the 'Catalog of the Nests and Eggs of Birds found breeding in Australia' is well advanced. The work will comprise some three hundred pages of text, about one hundred text figures, thirty plates of eggs and forty of nests, and its publication will extend over a period of three years.

The Manchester Museum, Owens College, in its Reports for the year 1900-1901 also makes a good showing for a small expenditure. The principal increase in the collections has been in lepidoptera, plants and mollusks, among the last being an example of the very rare *Pleurotomaria adansoniana*. A specialty of this Museum appears to be the preparation of exhibits of an educational value, and among them is a series of moths selected to represent the families given in the Cambridge Natural History, dissections of Mollusca to illustrate the system of classification based on the gills, and a series of skulls to illustrate dental anatomy and arranged and labeled for the advantage of students.

A series of excellent lectures, addresses and demonstrations was, as usual, given during the year by members of the Museum staff and, as in the past, one is a little surprised at the small attendance on some of these in a city of half a million inhabitants. For example, an address by Boyd Dawkins on 'Our Neolithic Ancestors'

drew an audience of only ninety-five. The Sunday lectures, however, were better attended, the most popular being 'The Arrival of Man.' An attractive series is announced for the coming fall and winter.

F. A. L.

SCIENTIFIC NOTES AND NEWS.

THE fourth Glasgow meeting of the British Association opened its sessions on September 11. The address of the president, Professor A. W. Rücker, printed in the last issue of SCIENCE from a copy sent in advance of its delivery, was given at the inaugural meeting in the evening. Professor Rücker was introduced by the retiring president, Sir William Turner, and the usual vote of thanks was proposed by the Lord Provost of Glasgow and seconded by Lord Kelvin. The general committee held its first meeting on the 11th, when on the proposal of Sir Michael Foster, a cablegram with expressions of sympathy was sent to President McKinley. At the second meeting of the general committee Professor James Dewar was elected president for next year's meeting at Belfast, and the date of the opening of the meeting was set for Wednesday, September 10. It was decided to hold the meeting of 1903 in Southport, where the Association met twenty years previously. Sir W. Roberts-Austen and Dr. D. H. Scott were reappointed as general secretaries, Mr. G. Griffith as assistant general secretary and Professor Carey Foster as general treasurer. The following were appointed vice-presidents for the Belfast meeting: The Marquis of Dufferin, the Marquis of Londonderry, the Earl of Shaftesbury, Sir F. Macnaghten, and the Earl of Rosse, Lord Mayor of Belfast, the president of Queen's College and Professor Ray Lankester.

THE University of Adelaide, Australia, will be represented at the Yale bi-centennial by Dr. Edward C. Stirling, professor of surgery.

MR. F. J. V. SKIFF, director of the Field Columbian Museum, has been appointed director of exhibits for the St. Louis Exposition. Mr. Skiff was deputy director-general of the Columbian Exposition, and was director in chief of the United States Commission to the Paris Exposition.

THE gold medal of the Italian Science Society has been presented to Mr. Marconi for his services in the invention of wireless telegraphy.

THE Röntgen Society has awarded a gold medal to Mr. C. H. F. Müller, of Germany, for the most practical X-ray tube for general purposes. There were in all twenty-eight entries.

DR. WILLIAM PATTEN, professor of zoology at Dartmouth College, has leave of absence for the present term and is engaged in zoological work in Russia.

MR. JOHN A. FLEMING, of the U. S. Coast and Geodetic Survey, has arrived in Honolulu for the purpose of erecting and conducting a station for the study of terrestrial magnetism.

DR. CARL LUMHOLTZ, of the American Museum of Natural History, lectured on the Indians of Mexico before the Royal Geographical Society on September 14.

ON the occasion of the seventieth birthday of the great zoologist Leuckart, a portrait-bust was made by the sculptor, Seffner. He has undertaken to supply Professor Charles L. Edwards, of Trinity College, with a plaster cast. If others wish to secure copies of the bust, Professor Edwards is willing to forward the orders. The cost in Leipzig would be from 40 to 50 Marks.

THE death is announced of Dr. Philip S. Baker, who for many years held the chair of chemistry in the medical department of De Pauw University.

THE death is announced at the age of seventy-three years of Dr. Ferdinand Arnold, a German botanist, known for his researches on lichens.

DR. J. L. W. THUDICHUM died in London on September 7. He was born in Germany and graduated from the University of Giessen about fifty years ago, but soon came to London and engaged in medical practice. He conducted researches on physiological chemistry and was also the author of a volume on the 'Chemistry of Wine Production.'

THE Tufts College laboratory of biology, at South Harpswell, Maine, was closed for the

year on September 6. During the summer every table was occupied. Among those who availed themselves of its facilities for varying lengths of time were Professor Alvin Davison, of Lafayette College, Dr. Emily Ray Gregory, of Wells College, Professor Albert F. Matthews, of the University of Chicago, Professor M. A. Wilcox, of Wellesley College, Dr. C. B. Wilson, of the Westfield Normal School and Dr. F. A. Woods, of Harvard University. During the winter the laboratory will be enlarged, providing a number of private rooms for investigators.

AN International Office of Weights and Measures is to be established in Sèvres for the preservation of standards and the supplying of copies.

AN annex to the Astronomical Observatory, at Cambridge, England, is being constructed on the north side of the dome to be used as a laboratory.

THE daily papers report that Mr. S. J. Holsinger, a special agent of the Department of the Interior, has presented a report stating that pottery and other remains have been taken in an unauthorized manner from the ruins in Arizona and New Mexico, and that the government may claim the collections deposited in several museums.

THE Vallauri Prize, of the value of about \$6,000, will be awarded in 1903 for the most important scientific work accomplished whether by a foreigner or an Italian during the preceding four years.

WE learn from the London *Times* that, following their acceptance of the proposal of the British Association for an ethnographic survey of India, Lord Curzon's Government has adopted the suggestion of the Royal Society for the carrying out of a magnetic survey. Sun spots are believed to be closely connected with the perturbations of the magnetic needle, and, as Sir Norman Lockyer's inquiries are held by him to establish some association between sun spots and Indian droughts, the survey, besides subserving the cause of science, may prove to be of some practical utility from the administrative standpoint. The existing magnetic observatories at Bombay and Calcutta being

inadequate as base stations for the vast area the survey will cover, similar observatories are in course of construction at Dehra Dun, below the Himalayas, at Kodaikanal, in the Madras Presidency, and at Rangoon. The Dehra Dun observatory will be under the supervision of Colonel Gore, R.E., the Surveyor-General of the Indian Survey (whose headquarters are located there); but the other four will be in charge of Mr. John Eliot, the meteorological reporter to the Government. The Survey and Meteorological Departments will, in fact, be jointly responsible for the investigations. The field observations will be carried out by six or seven detachments of the Survey Department, and these will be controlled by Captain Fraser, R.E., who has recently been arranging in England for the purchase of the necessary instruments. Sind and the Punjab will first be taken in hand; and, as the country is now intersected with railways in all directions, enabling field detachments to quickly cover the distances from one observing station to another, it is anticipated that five years will suffice to complete the field work of the preliminary magnetic survey.

THE representatives of the newly-established Australasian confederation have appointed a commission to consider the adoption of the metric system, and it is reported that with the approval of the authorities in Great Britain, the system will be adopted in Australasia.

A NEW steamship for the U. S. Coast and Geodetic Survey, being constructed by the Townsend and Bowney Shipbuilding Company, was launched in Newark Bay on September 21. The steamship, which has been called *The Bache* in honor of the former eminent superintendent of the Coast Survey, is 136 feet in length, with a steel frame, and is to be fitted with engines developing 125 horse power.

A COMMITTEE of the Chemical Section of the British Association has been appointed to urge upon the Government the desirability of remitting the duty on alcohol used for chemical research.

It is officially estimated that the deaths from the plague in India during the past five years

exceed 600,000. Unfortunately there is no abatement. For the last week for which details are at hand there were 2,816 deaths as compared with 2,003 in the preceding week, and only 285 in the corresponding week of last year. The Bombay districts are at present suffering the most severely.

THE correspondent of the *Lancet* in India reports that bacteriological work is being started at several new places. The Port Commissioners at Rangoon propose building and equipping a laboratory chiefly at first for the examination of suspected plague. The Government of the Malay States has recently established a Research Institute open to all workers irrespective of nationality. Pathological work and chemical research, as well as bacteriological investigations, will be open to all.

THE corporation of the City of Hull has made itself responsible for the conduct of the museum of the Literary and Historical Society.

THE executive committee of the National Educational Association will meet early in October to determine the place of meeting of the next convention.

THE International Congress of Physiology opened its sessions at Turin on September 17.

An International Congress of Archeologists will be held in Greece in April, 1903. Meetings will be held at Athens, Olympia, Delphi and other points of interest.

THE International Engineering Congress, the general program of which we have already published, opened in Glasgow on September 3, with about 3,000 members in attendance.

THE eighty-first meeting of the American Institute of Mining Engineers will be held in Mexico in the first week of November. Sessions will be held in the cities of Mexico, Pachuca and Monterey, and stops will be made at various points of interest. Two special trains have been chartered, one of which will leave New York on November 1, by the Pennsylvania Railroad, and the other will be run as a second section, starting from Chicago at 10 p. m., on November 2, by the Atchison, Topeka & Santa

Fe Railway. The cost of the trip from Chicago, lasting about thirty days, including berth and meals will be \$250.

THE Dutch Society of Sciences at Harlem announces a series of subjects for the prizes to be conferred during the next three years, the details of which can be obtained from the Secretary, Professor J. Bosscha, Harlem. The prize in each case is a gold medal or 500 florins at the option of the author and the papers may be written in English.

THE *British Medical Journal* gave in a recent issue the prizes offered by the Paris Academy of Medicine, about thirty of which are open to foreigners. The François-Joseph Audiffred Prize is of the value of £1,000, and is offered to any person who is adjudged to have discovered a preventive or cure of tuberculosis. The following are also among the more important offered for the year ending with the end of February, 1902; the sum specified in each case does not necessarily go to one candidate, but may be divided. The Academy Prize, awarded annually, worth about £40, is this year for a research on the rôle of toxins in pathology; the Baillarger Prize of about £80 (biennial) is for the best work on the treatment of mental diseases and the organization of asylums; and the Charles Boullard Prize, also biennial, of £50, is for a similar subject. The Barbier Prize of £80 (biennial), is for the discovery of a cure for such 'incurable' maladies as hydrophobia, cancer, epilepsy, typhoid and cholera. The Mathieu Bourceret Prize of £50 (annual) is for work on the circulation of the blood. The Campbell Dupierris Prize (biennial), of the value of £96, is for the best work on anæsthesia or the diseases of the urinary passages. The Chevillon Prize (annual) of £65, is for the best work on the treatment of cancer. The Desportes Prize of £55 (annual), will be awarded for the best work on practical medical therapeutics. The Herpin (of Metz) Prize (quadrennial) of £50, is offered for a research on the abortive treatment of tetanus. The Theodore Herpin (of Geneva) Prize of £125 (annual), is for a research on epilepsy and nervous diseases. The Laborie Prize of £210 (annual), is given for the greatest advancement in surgical science during

the year. The Lefèvre prize (triennial) of £75, is for a research on melancholia. The Meynot Prize (annual), of £108 is for the best work on ear disease; and the Saintour Prize (biennial) of £166, for the best work on any subject in medicine.

WE learn from the *Astronomical Journal* that the council of the *Astronomische Gesellschaft* has undertaken the preparation of a new Catalogue of Variable Stars and has delegated the conduct of the work to a committee consisting of Professors Dunér, Hartwig, Müller and Oudemans. The committee request* observers of variable stars who have considerable unprinted series of observations, which would be useful in the correction of elements, either to publish them soon or to communicate them to the member of the committee in charge, Professor G. Müller, Potsdam Observatory. The Committee also announces that it will from the present time undertake the definitive notation of newly discovered variables as soon as their light-fluctuations are certainly ascertained. A list will shortly be published of the names of variables found in recent years which have heretofore remained unnamed.

THE *New York Sun*, whose astronomical news is unusually full and accurate, notes that the foreign associates of the Royal Astronomical Society are distributed as follows: Argentine Republic, 1; Austria, 1; France, 9; Germany, 8; Holland, 3; Italy, 2; Russia, 4; Sweden, 1; United States, 14. It is to be noted that the associate from the Argentine is himself an American. The American members are: Dr. E. E. Barnard, Yerkes Observatory, Chicago; Professor L. Boss, Dudley Observatory, Albany; Professor S. W. Burnham, Yerkes Observatory, Chicago; Dr. S. C. Chandler, Cambridge; Dr. W. L. Elkin, Yale University; Professor G. E. Hale, Yerkes Observatory, Chicago; Professor A. Hall, U. S. N., retired; Dr. E. S. Holden, New York; Dr. S. P. Langley, Smithsonian Institution; Professor A. A. Michelson, University of Chicago; Professor S. Newcomb, Washington; Professor E. C. Pickering, Harvard College Observatory; Professor C. A. Young, Princeton University, and Dr. J. M. Thome, National Observatory, Argentine.

UNIVERSITY AND EDUCATIONAL NOTES.

THE construction of a new science building, costing \$300,000, has been begun at Colorado College. Towards this building Dr. D. K. Pearsons gave \$50,000 and an anonymous donor has recently given \$100,000.

THE equipment of the Whitin Observatory of Wellesley College has received the addition of a sidereal clock, built by the E. Howard Clock Company of Boston.

MR. JAMES S. DICKSON, of Glasgow, has given £10,000 to the University of that city for the endowment of a lectureship of mining.

LORD KELVIN delivered the inaugural address on the occasion of the formal opening of the James Watt Laboratory of Engineering at Glasgow University on September 3. The cost of the laboratory has been about \$200,000, toward which sum about \$125,000 has been subscribed.

WE learn from the London *Times* that the new technical school with museum extension in William Brown street and Byrom street, Liverpool, the foundation-stone of which was laid on July 1, 1898, by Sir William Forwood, chairman of the Library, Museum and Arts Committee of the Liverpool Corporation, is now practically completed, and its doors will in a few days be opened to students in general. The new building, designed by Mr. E. W. Mountford, is of the modern nineteenth-century classic style, and built of Stancliffe stone, from the same quarry whence was obtained the material for St. George's Hall. It extends from the Brown Public Museum to Byrom street, where there is an imposing curved front, and the seven windows of the lower art gallery are separated by couples of Ionic columns, over thirty feet in height. The technical school occupies three lower floors of the building as well as some galleries at the very top, and is entered from Byrom street, while the two upper floors form an extension of the Brown Museum, and are entered only from that building. Notable features of the William Brown street frontage are two bold, projecting bays, with deep vaulted arches enriched with simple decoration, while emblematic statuary fills in the pediment, all the statuary being from the studio of Mr. T. W. Pomeroy. In the basement,

which is very little below the street level, are many rooms and laboratories intended for various handicrafts, with up-to-date apparatus. In a cross-gallery on the top floor of the building is a chemical laboratory where about threescore students can work, while above all is an observatory with a large equatorial telescope. Altogether the school has accommodation for 1,300 students at one time, and the electric lighting and 'Plenum' ventilation are excellent in all departments. In the chemical and nautical rooms students are already at work.

DR. E. E. SCHIEB, of the University of South Carolina, has been appointed professor of philosophy and pedagogy in Tulane University.

DR. T. H. HAINES, has been appointed assistant professor of philosophy in Ohio State University.

DR. L. W. LADD, who is a son of Dr. George T. Ladd, professor of philosophy at Yale University, has been appointed to the newly established Hanna chair in the Medical College of Western Reserve University.

DR. EMILY RAY GREGORY has been appointed professor of biology, Wells College, Aurora, N. Y.

AT Dartmouth College Mr. George H. Lyman, of Beloit College, has been called as successor to Dr. George T. Moore, professor of botany, who has accepted a government position at Washington. Charles E. Bolser, A.B. (Dartmouth), Ph.D. (Göttingen), has been appointed instructor in chemistry.

PROFESSOR JOSEPH FRENCH JOHNSON has resigned the chair of finance in the University of Pennsylvania and accepted the chair of political economy and banking in the New York University school of commerce, accounts and finance.

DR. A. STANSFIELD, instructor in assaying under Sir W. C. Roberts-Austen, at the Royal College of Science, London, has been appointed to the newly-established chair of metallurgy in McGill University.

DR. KASNER has qualified as docent in meteorology in the Polytechnic Institute at Berlin; Dr. Weinhold for mathematics at Kiel; Dr. G. Rost for mathematics at Würzburg, and Dr. E. Haunig for botany at Strasburg.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

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FRIDAY, OCTOBER 4, 1901.

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THE PROPOSED NATIONAL UNIVERSITY.*

THE paper by Hon. Chas. D. Walcott, Director of the U. S. Geological Survey, published in SCIENCE for June 28, 1901, then issued in a separate pamphlet, and now kindly brought to my notice by the author, disposes of the National University movement in the following summary manner:

But Congress has always looked on the scheme with suspicion, and not one of the various bills offered was ever acted upon by the Senate and House of Representatives. The trend of opinion has been and is that the Government should not found a National University in the sense suggested by Washington and his followers.

At first I thought to let these statements pass without notice, believing that in course of time they would correct themselves. But on reflection I conclude to make a comprehensive review of them, as also some comments on the 'Memorial' scheme so fully set forth in connection therewith, and finally to point out some of the special functions of the proposed National University which so deeply concerned Washington, but which seem never to have been duly considered by those now engaged in promoting an enterprise which its projectors intend shall defeat the establishment of such university altogether.

* A review of Hon. Chas. D. Walcott's paper on 'Relations of the General Government to Higher Education and Research.'

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.

ATTITUDE OF CONGRESS.

Of the non-passage of bills I will speak further on. Let us, first of all, see how far this declaration concerning the attitude of Congress accords with the real facts in the case.

To begin with the House, the only action ever taken by that body on the subject of a national university was affirmative and unanimous. The National Educational Association, having first by a unanimous vote, at Trenton, N. J., in 1869, declared a great American university to be 'a leading want of American education,' and appointed a 'committee consisting of one member from each of the States * * * to take the whole matter under consideration,' and to report thereon, and having twice unanimously adopted the affirmative reports of said committee (at Cleveland, in 1870, and at St. Louis, in 1871), then by unanimous vote created a permanent committee to prepare and offer to Congress a bill to establish a national university.

The committee embraced, besides the chairman, Ex-President Thomas Hill, of Harvard; Editor Godkin, of *The Nation*; State Superintendent Wickersham, of Pennsylvania; Dr. Barnas Sears, of Virginia; Col. D. F. Boyd, President of the University of Louisiana; President Daniel Read, of the University of Missouri; Dr. W. F. Phelps, President State Normal School, Winona, Minnesota; Ex-Governor A. C. Gibbs, of Oregon; Hon. Newton Bateman, Superintendent of Public Instruction of Illinois; Superintendent Emerson E. White, President-elect of the National Educational Association; General John Eaton, U. S. Commissioner of Education; Dr. Joseph Henry, Secretary of the Smithsonian Institution and President of the National Academy of Sciences; Dr. J. Lawrence Smith, of Kentucky, President of the American Association for the Advancement of Science; and Dr. Samuel Elliot, of Connecticut,

President of the American Social Science Association.

The bill prepared by these men was introduced in the House during the last session of the 42nd Congress and referred to the Committee on Education, of which Chairman Perce, of Mississippi, and Mr. Hoar, of Massachusetts, were prominent members, and near the end of the said session was unanimously returned to the House with a strong report, of which the following is the closing passage:

If, then, it be true, as the committee has briefly endeavored to show, that our country is at present wanting in the facilities essential to the highest culture in many departments of learning; and if it be true that a central university, besides meeting this demand, would quicken, strengthen and systematize the schools of the country from the lowest to the highest; that it would increase the amount and the love of pure learning, now so little appreciated by our people, and so improve the intellectual and social status of the nation; that it would tend to homogeneity of sentiment, and thus strengthen the unity and patriotism of the people; that by gathering at its seat distinguished savants, not only of our own but of other lands, it would eventually make our national capital the intellectual center of the world, and so help the United States to rank first and highest among the enlightened nations of the earth—then is it manifestly the duty of Congress to establish and amply endow such a university at the earliest possible day.

The committee, therefore, affirm their approval of the bill, and recommend its passage by the House.

It is believed that the success of the university measure in some proper form then required only that uninterrupted attention which, unhappily, a change of circumstances rendered it impossible for its friends to give. The opinion of the National Educational Association, in favor of the establishment of a national university, was reaffirmed by unanimous vote at its annual meeting, held in Detroit, on August 6, 1874, and, as seen by its recent declarations, in the same place, has endured with the years.

2. In 1890, when Senator Geo. F. Ed-

munds introduced his 'Bill to establish the University of the United States,' and moved its reference to a special committee, no opposition was made. Had he retained his physical vigor, he would doubtless have made his chairmanship of the committee effective.

3. At the Senate's session of August 3, 1892, when Senator Proctor presented the 'Memorial in regard to a National University' by John W. Hoyt, and moved that it be printed and referred, Senator Sherman moved the further printing of 5,000 extra copies, which was ordered unanimously; also, that at a subsequent session other thousands of extra copies were ordered printed without objection.

4. Although at the opening of the 52nd Congress, Senator Proctor, whose interest was very positive, assumed the chairmanship, by request, he was occupied with important measures already in hand, and submitted his sterling and unanimous report so late in the Congress that other matters prevented its consideration. The committee was a strong one and would have been potential, could they early have taken it in hand, as they would have done a question of commerce, finance or war. The Senate was ready.

5. When the Senate 'Committee to establish the University of the United States' was made a 'standing' committee, there was no opposition to the change.

6. In the 53rd Congress, when Senator Hunton was chairman of the committee, he was so circumstanced that his able report (also unanimous) could not be prepared, submitted and supported, as it was, by his own and other able speeches, until the time had come when appropriation bills had the right of way, and a single negative vote could again prevent action by the Senate.

7. It was not until during the first session of the 54th Congress, when the determination of the executive council of

the National University Committee had met with assurances of cooperation from all parts of the country, and the council, with the Chief Justice of the United States presiding and but one of its fifteen members absent, gave three protracted sessions to the framing of a new bill, that there appeared the first sign of opposition, either in or out of Congress.

The members of the executive council at that time were these:

The Honorable Melville W. Fuller, Chief Justice of the United States; Ex-U. S. Senator Geo. F. Edmunds, of Vermont; Dr. William Pepper, Ex-Provost of the University of Pennsylvania; Hon. Andrew D. White, Ex-President of Cornell University, Ambassador to Germany; Ex-Governor John Lee Carroll, of Maryland, General-President Society of Sons of the Revolution; General Horace Porter, President-General Society of Sons of the American Revolution, Ambassador to France; Ex-U. S. Senator Eppa Hunton, of Virginia; Ex-U. S. Senator A. H. Garland, late Attorney-General of U. S.; Ex-U. S. Senator J. B. Henderson; Col. Wilbur R. Smith, of Kentucky University; Gen. John Eaton, Ex-U. S. Commissioner of Education; Hon. Gardiner G. Hubbard, President National Geographic Society; Professor Simon Newcomb, Director of the Nautical Almanac, U. S. N.; Hon. John A. Kasson, Ex-U. S. Minister to Austria and Germany; Hon. Oscar S. Strauss, Ex-U. S. Minister to Turkey; G. Brown Goode, Assistant-Secretary Smithsonian Institution; Ex-Gov. John W. Hoyt, Chairman National University Committee. (In the places of Messrs. Pepper, Hubbard, Garland and Goode, since deceased, there are now: Hon. H. A. Herbert, Ex-Secretary of the Navy; Dr. S. P. Langley, Secretary of the Smithsonian Institution; Lieutenant-General Nelson A. Miles, commanding the Army.)

The bill was unanimously approved by

the other distinguished members of the National University Committee, and gave promise of early success. President David Starr Jordan, of Leland Stanford University, wrote, 'Put it through without the change of a punctuation point.' Its passage was advocated in person, before the Senate university committee, by ex-Senator Geo. F. Edmunds, ex-Provost William Pepper, of the University of Pennsylvania, Professor Simon Newcomb, General John Eaton, Hon. Gardiner G. Hubbard, Hon. John A. Kasson, ex-Gov. John Lee Carroll, Hon. Andrew D. White and John W. Hoyt; and on March 10, 1896, Senator Kyle, chairman, submitted an affirmative report, with the said supporting arguments, and with over three hundred letters from members of the National University Committee, and other papers supporting the university proposition. It was an eminently satisfactory report of 156 printed pages, and for a time was supposed to be without dissent from any member. Adverse influences from denominational and other sources had been at work, however, so that a month later a brief minority report was submitted, with opposing letters from the presidents of Harvard, Yale, Columbia, and the University of Pennsylvania, and five or six small colleges, all denominational. Even with their friends it was beyond comprehension how the minority were willing to appear with so weak a showing.

For the rest, it is sufficient to say that the rule of courtesy which allowed the minority time to get ready, the printing of affirmative reports, and other causes, resulted in a postponement of action by the chairman of the Senate committee until the following session of Congress.

8. The 'Reply to Views of the Minority,' by the chairman of the National University Committee, when submitted to the Senate by Chairman Kyle, with many additional letters of indorsement from distinguished

friends of the measure, was promptly received by the Senate and ordered printed.

9. At the opening of the second session of the 54th Congress, papers in support of the National University proposition, by Professor William H. H. Phillips, of South Dakota, and President David Starr Jordan, of Leland Stanford University, were, upon motion of Senator Kyle, ordered printed by the Senate, without dissent.

10. Before the Senate committee's report could be conveniently called up in the second session of the 54th Congress, Chairman Kyle was called to his distant home, and, although confidently expected from week to week, so that neither Senator Sherman, who was next on the committee list, nor any other member thought it fit to act in his stead, he did not actually return until within three days of the end of that Congress.

11. Upon the opening of the 55th Congress, the appointment of Senator Wellington, of Maryland, to the chairmanship was a surprise to the National University Committee, because of assurances touching the continuous and earnest work of Senator Kyle. It also proved to be without result; for, notwithstanding assurances from Chairman Wellington of his deep interest in the university cause and his purpose to do everything possible to further it, not even a meeting of his committee could be secured during the said Congress.

12. Notwithstanding these facts, coupled with the readiness of Senator Chauncey M. Depew, always a warm friend of the national university idea, to take the lead and carry the measure forward, Chairman Wellington (still in possession, under Senatorial usage), because of assurances of action, held over. And there was at last a meeting of the committee, during the first session of the 56th Congress, and an agreement, without dissent, upon the new bill offered by Senator Depew with the approval

of the National University Committee. A report was also made ready and, with one hundred additional letters (including those from Ex-President Benjamin Harrison, from ex-senators, heads of national organizations, and the presidents of sixty additional colleges and universities, beginning with the University of Virginia and embracing ten of the leading Methodist institutions), was at one time on Chairman Wellington's desk, in the Senate, for presentation. They were never submitted, however. And of course there were requests many, appeals many and promises many.

Such is a brief history of both Senatorial and committee action on the subject of a national university during the past few years. It proves unmistakably that the talk of 'suspicion' on the part of Congress is without so much as the shadow of a foundation—that there has been none but affirmative action from first to last; that Congress has in fact done everything that was ever asked of it or of either House; and that in nearly, if not in every, case such affirmative action has been prompt and unanimous. There have been trying delays, but those of the last decade are not chargeable to the Senate, but to individual members of its university committee. And it may not be improper to add that there were Senators not a few, and among the most active and influential, who were as emphatic in their expressions of disappointment at the obstructive course of a chairman chosen because of his declared friendly attitude, as were the members of the National Committee themselves.

'THE TREND OF OPINION.'

After the showing thus made of the friendly attitude of Congress, first, last and always; of the views of leading men of the nation in all the great pursuits, including the heads of all but five or six of the colleges and universities appealed to; and,

last of all, the marked demonstration again made by the National Educational Association at Detroit, it is hardly worth while to spend a moment discussing the 'trend of public opinion.' Dr. Walcott should know that it 'has been and is, that the Government' *should* 'found a national university,' and that, too, 'in the sense suggested by Washington and his followers.' I mean in the broad sense, and for the accomplishment of the great ends he had in view. There have been such advances in science and such development of educational institutions since his day as he could not foresee, and as would necessitate a different sort of university work, in some respects, from that of his day, and yet not different in that it was to be, and is to be, the highest possible—and that, too, with help rather than hindrance of all other institutions, and with a fulfilment of special offices to which it alone would be competent, as I shall show at the end of this review. The Depew bill (last before the Senate), like its forerunners, makes sure of the national university's limitation to this high field.

OPPOSITION BECAUSE OF MISCONCEPTIONS.

There were, in 1896, a few opposing senators, but, since none of them have offered valid reasons for negative action (see 'Reply'), we are not without hope that they will yet concur. If they are endowers, graduates or patrons of some half-dozen leading universities, it is difficult to believe that on this account, and right here, in the midst of unparalleled facilities for a true university—facilities provided at a cost of some \$40,000,000 to the whole people of the country, and maintained and utilized at a cost of several millions annually—they would be glad to prevent the establishment of an institution which would at once do honor to the nation and be a practical friend of their favorites. Surely any such senators will upon reflection come to agree

with the multitude of statesmen and scholars of a hundred years, the views of whom are so emphatically reaffirmed by Ambassador Andrew D. White, who just now again says, from Berlin: "It would, in many ways make itself helpful to every school, college and university in the land"; and by President Harper, of the University of Chicago, when he wrote me not very long ago: "I have always believed in such an institution and will continue to believe in it. There is everything to be gained and nothing to be lost." They will see with Dr. Cattell, the able editor of *SCIENCE*, that "all the arguments which have been urged against the establishment of a national university turn out to be in its favor." Nay, more, it is hard to believe that any right-minded, unbiased senator or representative will fail at length to see that such an institution as is planned by the National University Committee would also serve to give the United States a new dignity and importance among the nations.

Under this head should also be embraced all friends of the national university movement who, whether they have done aught to advance it or not, or have inquired into the causes of delay, are now tired of waiting for the grand result, and have been induced to lend their influence to a scheme whose origination and inauguration have been with those who intend that it shall prevent the establishment of the university. They, too, will surely right themselves, when rightly informed.

Of course the hindrances common to great movements for intellectual advancement have not been wanting in this one; such as the extent to which legislators accounted the best are often absorbed in questions that concern industrial development, commerce, finance and international differences involving war—matters all of them so related, moreover, to the ascendancy of

political parties as at times to fill the whole field of vision; causes such as the growing passion for increase of wealth and power as means of supremacy among the nations, and which leave out of consideration the no less necessary and still higher conditions of a superior civilization; such, indeed, as lie in a spirit of denominational ambition, which in some of the churches is stronger than the spirit of religious freedom or anything else. And last of all, possibly in this case more serious than all others, there is the very nobleness of the national university idea, on account of which so many eminent and influential citizens, who should make themselves felt in every practicable manner, rest in the hope that every other friend of the pending measure will do his full duty, and themselves do little or nothing—in other words shift the responsibility on Providence, forgetting that Providence helps those who first help themselves, and that no great end is realized except through sacrifice.

OTHER OPPOSING FORCES.

Lastly, there are others, the grounds of whose opposition I will not even make a subject of conjecture, confining myself to a statement of facts of interest and to the pointing out of a few faults and the total insufficiency of the 'Memorial Institution.' The author of the paper under review was himself but lately interested in the national university, as will appear from his letter of December 20, 1894, which reads as follows:

"I fully believe in establishing such a university in the interest of higher education, and I cordially indorse the statements made by the late President James C. Welling, printed on pages 95-7 of your Memorial on the subject. The statements and views expressed in the Memorial are so exhaustive and comprehensive that I do not know that I could add to them, except to record my personal approval of the movement."

The following is an extract from President Welling's letter to which Dr. Walcott here refers :

"Such a university as I here prefigure would come into no rivalry with any existing institution under the control of any denomination. It would aim to be the crown and culmination of our State institutions, borrowing graduates from them and repaying its debt by contributing in turn the inspiration of high educational standards, and helping also in its measure to train the experts, * * * who should elsewhere strive to keep alive the traditions of a progressive scholarship. * * * It is not enough that our colleges should perpetuate and transmit the existing sum of human knowledge. We must have our workers on the boundaries of a progressive knowledge if we are to establish our hold on the directive forces of modern society."

It may be added that, within a very few months, Dr. Walcott, who is still a member of the National University Committee, avowedly shared the writer's indignation on account of delays, and expressed regret that he could not contribute more to the progress of the national university movement.

FAULTS OF THE 'MEMORIAL' SCHEME.

Now, while I have neither plan nor purpose to make war upon the 'Washington Memorial Institution,' and might never have said a word concerning it but for this strange attempt upon the life of the national university movement, it seems my duty, as the matter stands, to point out some reasons why the said 'Memorial Institution,' if established exactly as its friends would have it, is not likely to meet their expectations. I do so for the benefit in particular of such of its patriotic members as, being without time for a careful study of the whole subject, may have thought of it as a possible practical begin-

ning of the national university in which they have believed.

In the first place it is to be regretted that, as devised and constituted, it is not better calculated to represent the ideas of him whom it affects to honor—that it is fragmentary and does not contemplate a final national university.

The friends and promoters of the national university movement had duly considered the question of making the best practicable beginning they could, on the scientific side, without waiting for direct Congressional authority, but soon concluded that it would be wiser to go forward and secure the desired Congressional action. The country had waited a hundred years and could wait a little longer. A proper charter then seemed within easy reach. A liberal charter is still bound to come, and at no distant day, now that the schemers have boldly thrown off the mask, on the one hand, and that the National Educational Association has again, for the fifth time, by an overwhelming vote, declared for a national university of the highest rank.

Secondly, Washington wanted a true university, for supreme work only, and for reasons first national, then universal, located at the national capital, and sustaining such relations to all other institutions and educational agencies of the country and to the government itself as would make it in a superior sense a stimulating and guiding, as well as elevating, force and influence for the universal good.

It is also such an institution as this that the truly patriotic people of the United States want to-day. Nothing less will ever satisfy, as the able advocacy of earnest men in all the past, the persistent efforts of the National University Committee, the liberal action of the U. S. Senate and the recent renewal of supporting declarations of the country's educators plainly show.

Passing these two considerations, ethical and patriotic, the scheme of the Memorial Institution is itself of a character to challenge serious criticism, as its originators will find when they come to a practical test.

According to Dr. Walcott, it is to be a private foundation, without Government support or control. But he also tells us: "The policy of the Government, as expressed, is to aid in higher education by granting [to the Washington Memorial Institution] the use of such facilities as are at its command in the District of Columbia"; and again, "The Government's part in the work of the Washington Memorial Institution, when once under successful headway, will be to enlarge the quarters of the various bureaus concerned." To be sure, he hastens to add: "This will be necessary eventually, even if no student assistants are provided for." But it is apparent that if the Memorial Institution is to utilize the Government's collections and facilities for scientific research at Washington, such collections and facilities, now inadequate to such utilization, must exceed the Government's own demands, and exceed them in proportion to the utilization by the Memorial Institution; in other words, that Congress must make constantly increasing appropriations for the benefit of the Memorial Institution. Indeed, this enlargement of Governmental collections and facilities at Washington is the very *sine qua non* of the Memorial Institution. Yet we are told the Memorial Institution is to be without Government support.

This is not all. The Memorial Institution is to be also independent of Government control, says Dr. Walcott. But he then goes on to inform us that the Cabinet and various other Government officials are largely to constitute the advisory board of the Memorial Institution, and that the character and extent of the student-assistants'

work in the various departments of the Government is to be defined by the heads thereof, so that the same may be without detriment to the public service. And so, after all, there will be considerable opportunity and indeed necessity for Government control.

It thus appears that the Memorial Institution is to avail itself of the very assistance, and is to be subject to the same influence which its promoters condemn when proposed, to a less extent, in connection with a national university.

Other difficulties will present themselves after a little careful reflection; such as these, for example:

1. The three particular functions of the Memorial Institution—to ascertain and publish the opportunities for students in the Government Departments at Washington; to receive, enroll and direct such students to the places awaiting them; and to record their work and certify it, when requested, to any institution of learning—require no such widely scattered board of trustees as is provided, but could be as well, and indeed more effectively, performed by a small local committee. Unlike a national university, with plans and policies to be developed, the Memorial Institution begins with a fixed plan, whose operation will be largely subject to the dictation of the men whom the fortuities of politics have placed in charge of the Government Departments. The number and distribution of the board in question seem but a vain pretension to the nationality to which they are confessedly opposed.

2. The number of students of the Memorial Institution being limited (very limited, in the absence of Congressional appropriations), what is to prevent the institution in whose interest the Memorial Institutions was primarily worked up from having an undue share of student-assistant places? What is to safeguard the interests

of the four hundred or more colleges and universities of the country, by insuring them equitable representation in the opportunities which the Government provides and which the Memorial Institution proposes to dispense?

3. The Departments will not readily cooperate with a non-Governmental agency calculated to interfere with its own work.

4. If the Memorial Institution claims to provide opportunities for original research and investigation, it will sadly fail, for the Government does not carry on general scientific investigations, but confines itself to certain lines of work, which are not only special, but routine. If the Government expert himself cannot be an original, independent investigator, much less can the student-assistant.

5. The Memorial Institution repudiates the idea of instruction. Yet how will the investigations by its student-assistants, in scientific work, be carried on without instruction, and pretty systematic instruction, at that, to say nothing of any work it may attempt on lines not strictly scientific?

6. Even on the very limited lines proposed by the Memorial Institution, more money will be needed than such a concern is calculated to obtain from private sources. And how is the Memorial Institution to placate its Congressional patrons, when every student-assistant, especially if he becomes a Government fixture (and the Memorial Institution anticipates that a majority of them will remain in the Government service), closes the door to just so much Congressional patronage?

7. What shall be said of the ethics of an institution which encourages scientific work by students in the Departments at Washington as a means to the attainment of degrees at certain universities whose equipments are insufficient to such degrees? It has decidedly the appearance of giving credit where credit is not due, and will

eventually discredit the Institutions it favors by such means.

8. It is said that the *esprit du corps* so desirable in every student-body could not be developed by Congressional action, in connection with scientific investigations at Washington, because it would be 'a violent departure from all precedent,' and in the next breath we are told that this happy result has been obtained by the legislation of March 3, 1901, which nominally extended the utilization of the Government's scientific equipment at Washington to all the educational institutions of the country.

9. In view of the land-grant colleges and the U. S. military and naval academies, what sense is there in the talk of 'a violent departure from all precedent' involved in a provision for a crowning university of the United States?

10. What argument that justifies a State university would not justify a national university?

11. Contrary to the views of the Memorial Institution's advocates, no university is national, whatever its 'constituency,' 'support,' 'policies' and 'sympathies,' which is not vitally and distinctively of and by the Government of the United States.

12. People are most interested in that to which they contribute, and they cannot be so easily interested in a private institution as in an institution to which they have in some form contributed, which they may justly claim to be their own, and in which alone they could have a national pride.

13. The plan of the Memorial Institution necessitates practical duplication of Government experts and scientific apparatus, a thing which the Government could properly effect only in the interest of an institution of its own creation and in due measure subject to its control.

14. If there should be a measure of competition between a national university and a few other universities, that would by no

means be a serious matter. Among existing institutions competition even proves a means of rapid growth. Neither Harvard nor Columbia collapsed when the Johns Hopkins and Chicago Universities were established. Moreover, on the national side there would be the least possible of this element, for two important reasons, namely: First, because the purpose to do a work for the most part beyond existing institutions—that is, to occupy a field especially its own—would be both controlling and constant; and, secondly, because, by reason of its origin, aims and connection with the Government, there would not only be no room for a spirit of competition with the other institutions of the country, but rather, on account of direct relations with them, a sincere and never-failing desire to promote their advancement.

15. If the existing institutions already 'far more than supply the needed opportunities for higher study and research in the United States,' why do the richest of them strive for greater facilities; why do thousands go abroad annually for facilities which cannot be obtained in this country; and what is the need of the 'Memorial Institution'?

16. If the national opportunities sought to be utilized through the Memorial Institution are of a 'genuine university character,' why not have a genuine national university to utilize them?

It thus appears that while, on the one hand, the Memorial Institution contemplates no sort of advantage which in due measure the friends of a national university have not considered and set forth, on the other it has agreed on and published certain definite and independent plans for use of the Government Departments and bureaus such as no private institution but this would be likely to venture, and which the National University Committee has not felt warranted in planning for the University of the United States.

OVER-ESTIMATES OF EXTENT OF OPPOSITION.

Citizens here and there, with a supreme interest in certain institutions, cannot immediately subordinate all personal, local, and denominational ambitions, so as to take the national and world view of this matter. Or, if seeing rightly, as it is believed some of them do, they have not yet made up their minds to suffer the temporary losses and reproaches liable to follow a patriotic declaration of independence. If, therefore, I have at any time spoken of the half-dozen institutions whose present executive heads do not concur, as opposing the national university idea, the remark was too sweeping, for I am now satisfied that many of the broadest of the men thus embraced are in heart with us, that the opponents in these institutions constitute a minority only, and that of these many will be found on the affirmative side when fully informed concerning the national university proposed.

SPECIAL OFFICES OF A NATIONAL UNIVERSITY.

Neither the above mentioned nor the unenlisted of whatever class or quarter have yet realized that the efforts made for a national university are not so much because we are still without a single exclusively post-graduate university in America, and are therefore properly regarded by the foreign world as in the second rank, with thousands of our graduates annually going abroad for the facilities we do not furnish, but rather because the national university we seek to have established at Washington would fulfill special offices of national importance which none other, whether private, denominational, or state, much less this Memorial Institution, could by any possibility fulfill—among them these:

1. It would serve to supplement, coordinate, guide, inspire and finally perfect the whole series of public educational agencies in the United States and thus entitle us to speak of 'The American System

of Education '—a system such as this great republic certainly should have without further delay.

In the words of the editor of SCIENCE, issue of February 5, 1897, "A great national university would be the head of our educational system. It would not interfere with existing universities any more than these interfere with our colleges, or our colleges with our schools. Our present universities consist chiefly of professional schools, on the one hand, and of colleges for the instruction of boys on the other. They are indeed developing toward true universities, but nothing could better hasten and direct this development than a national university."

2. A national university could more properly than other institutions, with less embarrassment to the Government, and with great common advantage, still further utilize the resources already at Washington in the form of libraries, museums, gardens, laboratories and observatories, at a cost of \$40,000,000 to the whole people, and all of which, together with the \$7,000,000 a year for maintenance and utilization, and the possible help of scientific and practical experts, are, in some part, as I have said before, an enormous capital running to waste.

3. A national university would powerfully influence ambitious students in the public schools of whatever grade, even though purposing to make their college studies, or even a measure of post-graduate study, in denominational institutions of their preference. They would keep it in view as the final goal, the place of final preparation for special spheres of activity in life.

4. Moreover, a national university would at the same time in many ways help, and in nowise hinder, all the other institutions of the country; for in the first place, being without general academic courses of study, like a college, it would receive college and

university graduates for special studies only, leaving the general work looking to purely academic degrees (certainly those below the doctorate) to existing colleges and universities; and, secondly, being free from both local and denominational ambitions, it would naturally deal with all institutions of high rank and doing any work supremely well, in a most liberal manner, and in harmony with the best system of cooperation that could be devised.

5. When in full operation the national university would be more effective than all other institutions in keeping at home the three to five thousand of our graduates who now annually go abroad for the completion of their studies. The honor of its approval would soon come to be esteemed before any that could be offered by the foreign world.

6. A national university would at length attract thousands of students of high character and attainments from other lands, whose return, after years of contact with a prosperous, cultured and happy people living under free institutions, would tend to promote the cause of liberal government everywhere.

7. A national university would be able, as would none other, to attract to its own service, as lecturers, expert workers, guides, and directors, many of the most gifted and best qualified of those in the Government service at Washington, with the triple advantage of economy to the university, of increase of revenue to those so employed, and of an improved service in the Government through the added attraction thus furnished to superior men and women who now hesitate and oftentimes refuse to enter the service because of insufficient salaries and the less than satisfying dignity of many positions on this very account. In other words, men of genius and rare acquirements would accept places in the Government, and of lower grade than otherwise,

because of promised or probable connection with the world's leading university.

8. As could none other, a national university would attract men of genius and distinction from every quarter of the world to its professorships, lectureships and fellowships, thus increasing the cultured intellectual forces of both university and country.

9. A national university, to an important extent, and as could no other institution, whatever its rank, would make itself a co-worker with the Government in the several Departments; meeting their demands with the least possible delay; making trustworthy answers (as in the military and naval Academies) to important questions; taking up, on request, the solution of difficult problems of every sort; and supplying the Government with experts of supreme ability in greater number because drawn from the field of the world.

10. A national university would create an atmosphere at the national capital that would be influential for good in all departments of the Government, and so increase the demand for public men of character and culture as to furnish a new guaranty of wise legislation, and justice of judgment, as well as of faithfulness and efficiency of administration.

11. A national university, thus honored and encouraged, would powerfully stimulate and strengthen the patriotic sentiment of the country. The people universally would come to feel a pride in it as a sign of intellectual supremacy and of exalted aims, while to students in the schools and colleges of the States it would furnish a juster conception of what is meant by the field of learning, as well as new incentives to higher, and the highest possible, attainments; thus contributing in a degree beyond calculation to make us an educated people, and filling us with the determination to become the most cultured of all peoples.

12. Having duly established a university of the United States and made it capable of fulfilling all these offices, so important, shall we not have gained for our country that rank and influence among the nations to which not all our vast and varied material resources, the genius and wonderful energy of our people, and all our conquests in war are alone equal? Heirs to the better part of this great continent, with its vast resources of every sort, we have indeed made a wonderful growth in area, population, wealth and power; and meanwhile there has been a corresponding development in the boundless realm of the sciences, so that the national university we should now establish must differ in some respects (those of extent and greatness) from that which would have been founded in the days of Washington. Nevertheless, the special reasons which he so clearly had in mind have not only remained, as they ever must, but have strengthened with the years. They inhere in the nature of the case and should be regarded as conditions of a real supremacy of the American republic and of its becoming the world's most effective promoter of human advancement.

Other offices to be fulfilled by a national university will suggest themselves; but are not these enough to satisfy and forever silence the query, "Do we really need another and national university?"

The establishment by Congress of a national university is an undertaking of so great importance, of such origin, and of such advocacy throughout the whole period of the nation's life as to have gained an abiding place in the hearts of the people. It is an undertaking, the necessity for whose success is a firm conviction among the men most worthy to be heard in the interest of American education, and one the leadership in which, from first to last, has been as purely patriotic as any that was ever known, in peace or war. Such an

undertaking will surely triumph. Schemes skilfully devised may delay, but they cannot prevent, the establishment of a University of the United States.

JOHN W. HOYT,

Chairman National University Committee.

ADDRESS OF THE PRESIDENT OF THE
PHYSIOLOGICAL SECTION OF THE BRITISH
ASSOCIATION FOR THE ADVANCE-
MENT OF SCIENCE.*

WHEN the British Association met in Glasgow twenty-five years ago I had the honor of presiding over Physiology, which was then only a subsection of Section D. The progress of the science during the quarter of a century has been such as to entitle it to the dignity of a section of its own, and I feel it to be a great honor to be again put in charge of the subject. While twenty-five years form a considerable portion of the life of a man, from some points of view they constitute only a short period in the life of a science. But just as the growth of an organism does not always proceed at the same rate, so is it with the growth of a science. There are times when the application of new methods or the promulgation of a new theory causes rapid development, and there are other times when progress seems to be slow. But even in these quiet periods there may be steady progress in the accumulation of facts, and in the critical survey of old questions from newer points of view. So far as physiology is concerned, the last quarter of a century has been singularly fruitful, not merely in the gathering in of accurate data by scientific methods of research, but in the way of getting a deeper insight into many of the problems of life. Thus our knowledge of the phenomena of muscular contraction, of the changes in the secreting cell, of the interdependence of organs illustrated by what we now speak of as internal secretion, of the events that

occur in the fecundated ovum and in the actively growing cell, of the remarkable processes connected with the activity of an electrical organ, and of the physiological anatomy of the central nervous organs, is very different from what it was twenty-five years ago. Our knowledge is now more accurate, it goes deeper into the subject and it has more of the character of scientific truth. For a long period the generalizations of physiology were so vague, and apparently so much of the nature of more or less happy guesses, that our brethren, the physicists and chemists, scarcely admitted the subject into the circle of the sciences. Even now we are sometimes reproached with our inability to give a complete solution of a physiological problem, such as, for example, what happens in a muscle when it contracts; and not long ago physiologists were taunted by the remark that the average duration of a physiological theory was about three years. But this view of the matter can only be entertained by those who know very little about the science. They do not form a just conception of the difficulties that surround all physiological investigation, difficulties far transcending those relating to research in dead matter; nor do they recollect that many of the more common phenomena of dead matter are still inadequately explained. What, for example, is the real nature of elasticity; what occurs in dissolving a little sugar or common salt in water; what is electrical conductivity? In no domain of science, except in mathematics, is our knowledge absolute; and physiology shares with the other sciences the possession of problems that, if I may use a paradox, seem to be more insoluble the nearer we approach their solution.

The body of one of the higher animals—say that of man—is a highly complex mechanism, consisting of systems of organs, of individual organs and of tissues. Physi-

* Glasgow meeting, 1901.

ologists have been able to give an explanation of the more obvious phenomena. Thus locomotion, the circulation of the blood, respiration, digestion, the mechanism of the senses and the general phenomena of the nervous system have all been investigated, and in a general way they are understood. The same statement may be made as to the majority of individual organs. It is when we come to the phenomena in the living tissues that we find ourselves in difficulties. The changes happening in any living cell, let it be a connective tissue corpuscle or a secreting cell or a nerve-cell, are still imperfectly understood; and yet it is upon these changes that the phenomena of life depend. This has led the more thoughtful physiologists in recent years back again to the study of the cell and of the simple tissues that are formed from cells. Further, it is now recognized that if we are to give an adequate explanation of the phenomena of life, we should study these, not in the body of one of the lower organisms, as was at one time the fashion, where there is little if any differentiation of function—the whole body of an amœboid organism showing capacities for locomotion, respiration, digestion, etc.—but in the specialized tissue of one of the higher animals. Thus the muscle-cell is specialized for contraction, and varieties of epithelium have highly specialized functions.

But when cells are examined with the highest microscopic powers, and with the aid of the highly elaborated methods of modern histology, we do not seem to have advanced very far towards an explanation of the ultimate phenomena. There is the same feeling in the mind of the physiologist when he attacks the cell from the chemical side. By using large numbers of cellular elements, or by the more modern and fruitful methods of micro-chemistry, he resolves the cell-substance into proteids, carbohydrates, fats, saline matter and water,

with possibly other substances derived from the chemical changes happening in the cell while it was alive; but he obtains little information as to how these proximate constituents, as they are called, are built up into the living substance of the cell. But if we consider the matter it will be evident that the phenomena of life depend on changes occurring in the interactions of particles of matter far too small even to be seen by the microscope. The physicist and the chemist have not been content with the investigation of large masses of dead matter, but to explain many phenomena they have had recourse to the conceptions of molecules and atoms and of the dynamical laws that regulate their movements. Thus the conception of a gas as consisting of molecules having a to-and-fro motion, first advanced by Krönig in 1856 and by Clausius in 1857, has enabled physicists to explain in a satisfactory manner the general phenomena of gases, such as pressure, viscosity, diffusion, etc. In physiology few attempts have been made in this direction, probably because it was felt that data had not been collected in sufficient numbers and with sufficient accuracy to warrant any hypothesis of the molecular structure of living matter, and physiologists have been content with the microscopic and chemical examination of cells, of protoplasm and of the simpler tissues formed from cells. An exception to this general remark is the well-known hypothesis of Du Bois-Reymond as to the existence in muscle of molecules having certain electrical properties, by which he endeavored to explain the more obvious electrical phenomena of muscle and nerve. The conception of gemmules by Darwin and of biophors by Weismann are examples also of a hypothetical method of discussing certain vital phenomena.

The conception, however, of the existence in living matter of molecules has not escaped some astute physicists. The sub-

ject is discussed with his usual suggestiveness by Clerk Maxwell in the article 'Atom' in the 'Encyclopædia Britannica' in the volume published in 1875, and he places before the physiologist a curious dilemma. After referring to estimates of the diameter of a molecule made by Loschmidt in 1865, by Stoney in 1868, and by Lord Kelvin (then Sir W. Thomson) in 1870, Clerk Maxwell writes:

"The diameter and the mass of a molecule, as estimated by these methods, are, of course, very small, but by no means infinitely so. About two millions of the molecules of hydrogen in a row would occupy a millimeter, and about two hundred million million million of them would weigh a milligram. These numbers must be considered as exceedingly rough guesses; they must be corrected by more extensive and accurate experiments as science advances; but the main result, which appears to be well established, is that the determination of the mass of a molecule is a legitimate object of scientific research, and that this mass is by no means immeasurably small.

"Loschmidt illustrates these molecular measurements by a comparison with the smallest magnitudes visible by means of a microscope. Nobert, he tells us, can draw 4,000 lines in the breadth of a millimeter. The intervals between these lines can be observed with a good microscope. A cube, whose side is the 4,000th of a millimeter, may be taken as the *minimum visible* for the observers of the present day. Such a cube would contain from 60 to 100 million molecules of oxygen or of nitrogen; but since the molecules of organized substances contain on an average about fifty of the more elementary atoms, we may assume that the smallest organized particle visible under the microscope contains about two million molecules of organic matter. At least half of every living organism consists of water, so that the smallest living

being visible under the microscope does not contain more than about a million organic molecules. Some exceedingly simple organism may be supposed built up of not more than a million similar molecules. It is impossible, however, to conceive so small a number sufficient to form a being furnished with a whole system of specialized organs.

"Thus molecular science sets us face to face with physiological theories. It forbids the physiologist from imagining that structural details of infinitely small dimensions can furnish an explanation of the infinite variety which exists in the properties and functions of the most minute organisms.

"A microscopic germ is, we know, capable of development into a highly organized animal. Another germ, equally microscopic, becomes when developed an animal of a totally different kind. Do all the differences, infinite in number, which distinguish the one animal from the other arise each from some difference in the structure of the respective germs? Even if we admit this as possible, we shall be called upon by the advocates of pangenesis to admit still greater marvels. For the microscopic germ, according to this theory, is no mere individual but a representative body, containing members collected from every rank of the long-drawn ramification of the ancestral tree, the number of these members being amply sufficient not only to furnish the hereditary characteristics of every organ of the body and every habit of the animal from birth to death, but also to afford a stock of latent gemmules to be passed on in an inactive state from germ to germ, till at last the ancestral peculiarity which it represents is revived in some remote descendant.

"Some of the exponents of this theory of heredity have attempted to elude the difficulty of placing a whole world of wonders within a body so small and so devoid of

visible structure as a germ by using the phrase structureless germs. Now one material system can differ from another only in the configuration and motion which it has at a given instant. To explain differences of function and development of a germ without assuming differences of structure is, therefore, to admit that the properties of a germ are not those of a purely material system."

The dilemma thus put by Clerk Maxwell is (first) that the germ cannot be structureless, otherwise it could not develop into a future being, with its thousands of characteristics; or (second) if it is structural it is too small to contain a sufficient number of molecules to account for all the characteristics that are transmitted. A third alternative might be suggested, namely, that the germ is not a purely material system, an alternative that is tantamount to abandoning all attempts to solve the problem by the methods of science.

It is interesting to inquire how far the argument of Clerk Maxwell holds good in the light of the knowledge we now possess. First, as regards the *minimum visible*. The smallest particle of matter that can now be seen with the powerful objective and compensating eyepieces of the present day is between the $\frac{1}{400000}$ and the $\frac{1}{500000}$ of an inch, or $\frac{1}{200000}$ of a millimeter in diameter, that is to say, five times smaller than the estimate of Helmholtz of $\frac{1}{40000}$ of a millimeter. The diffraction of light in the microscope forbids the possibility of seeing still smaller objects, and when we are informed by the physicists that the thickness of an atom or molecule of the substances investigated is not much less than a millionth of a millimeter, we see how far short the limits of visibility fall of the ultimate structure of matter.

Suppose, then, we can see with the highest powers of the microscope a minute particle having a diameter of $\frac{1}{200000}$ of a

millimeter, it is possible to conceive that some of the phenomena of vitality may be exhibited by a body even of such small dimensions. The spores of some of the minute objects now studied by the bacteriologist are probably of this minute size, and it is possible that some may be so minute that they can never be seen. It has been observed that certain fluids derived from the culture of microorganisms may be filtered through thick asbestos filters, so that no particles are seen with the highest powers, and yet those fluids have properties that cannot be explained by supposing that they contain toxic substances in solution, but rather by the assumption that they contain a greater or less number of organic particles so small as to be microscopically invisible. I am of opinion, therefore, that it is quite justifiable to assume that vitality may be associated with such small particles, and that we have by no means reached what may be called the vital unit when we examine either the most minute cell or even the smallest particle of protoplasm that can be seen. This supposition may ultimately be of service in the framing of a theory of vital action.

Weismann in his ingenious speculations has imagined such a vital unit to which he gives the name of a biophor, and he has even attempted numerical estimates. Before giving his figures let us look at the matter in another way. Take the average diameter of a molecule as the millionth of a millimeter, and the smallest particle visible as the $\frac{1}{200000}$ of a millimeter. Imagine this small particle to be in the form of a cube. Then there would be in the side of the cube, in a row, fifty such molecules, or in the cube $50 \times 50 \times 50 = 125,000$ molecules. But a molecule of organized matter contains about fifty elementary atoms. So that the 125,000 molecules in groups of about fifty would number $\frac{125000}{50} = 2,500$ organic particles. Suppose, as was done

by Clerk Maxwell, one-half to be water; there would remain 1,250 organic particles. The smallest particle that can be seen by the microscope may thus contain as many as 1,250 molecules of such a substance as a proteid.

Weismann's estimates as to the dimensions of the vital unit to which he gives the name of biophor may be shortly stated. He takes the diameter of a molecule at $\frac{1}{20000000}$ of a millimeter (instead of the one millionth) and he assumes that the biophor contains 1,000 molecules. Suppose the biophor to be cubical, it would contain ten in a row, or $10 \times 10 \times 10 = 1,000$. Then the diameter of the biophor would be the sum of ten molecules, or $\frac{1}{20000000} \times 10 = \frac{1}{2000000}$ or $\frac{1}{2000000}$ of a millimeter. Two hundred biophors would therefore measure $\frac{200}{2000000}$ or $\frac{1}{10000}$ mm. or 1μ (micron = $\frac{1}{10000}$ mm.). Thus a cube one side of which was 1μ would contain $200 \times 200 \times 200 = 8,000,000$ biophors. A human red blood corpuscle measures about 7.7μ ; suppose it to be cubed, it would contain as many as 3,652,264,000 biophors.

Now if the smallest particle that can be seen ($\frac{1}{2000000}$ mm.) may contain 1,250 molecules, let us consider how many exist in a biophor, which we may imagine as a little cube, each side of which is $\frac{1}{2000000}$ mm. There would then be five in a row of such molecules, or in the cube $5 \times 5 \times 5 = 125$ molecules; and if the half consisted of water about sixty molecules.

Let us apply these figures to the minute particles of matter connected with the hereditary transmission of qualities. The diameter of the germinal vesicle of the ovum is $\frac{1}{2}$ of a millimeter. Imagine this a little cube. Taking the diameter of an atom at $\frac{1}{100000000}$ of a millimeter, and assuming that about fifty exist in each organic molecule (proteid, etc.), the cube

would contain at least 25,000,000,000,000 organic molecules. Again, the head of the spermatozoid, which is all that is needed for the fecundation of an ovum, has a diameter of about $\frac{1}{2000}$ mm. Imagine it to be cubed; it would then contain 25,000,000,000,000 organic molecules. When the two are fused together, as in fecundation, the ovum starts on its life with over 25,000,000,000,000,000 organic molecules. If we assume that one-half consists of water, then we may say that the fecundated ovum may contain as many as about 12,000,000,000,000 organic molecules. Clerk Maxwell's argument that there were too few organic molecules in an ovum to account for the transmission of hereditary peculiarities does not apparently hold good. Instead of the number of organic molecules in the germinal vesicle of an ovum numbering something like a million, the fecundated ovum probably contains millions of millions. Thus the imagination can conceive of complicated arrangements of these molecules suitable for the development of all the parts of a highly complicated organism, and a sufficient number, in my opinion, to satisfy all demands of a theory of heredity. Such a thing as a structureless germ cannot exist. Each germ must contain peculiarities of structure sufficient to account for the evolution of the new being, and the germ must therefore be considered as a material system.

Further, the conception of the physicist is that molecules are more or less in a state of movement, and the most advanced thinkers are striving towards a kinetic theory of molecules and of atoms of solid matter which will be as fruitful as the kinetic theory of gases. The ultimate elements of bodies are not freely movable each by itself; the elements are bound together by mutual forces, so that atoms are combined to form molecules. Thus there may be two kinds of motion, atomic and molecular.

By molecular motion is meant, "the translatory motion of the centroid of the atoms that form the molecule, while as atomic motion we count all the motions which the atoms can individually execute without breaking up the molecule. Atomic motion includes, therefore, not only the oscillations that take place within the molecule, but also the rotation of the atoms about the centroid of the molecule." *

Thus it is conceivable that vital activities may also be determined by the *kind* of motion that takes place in the molecules of what we speak of as living matter. It may be different in kind from some of the motions known to physicists, and it is conceivable that life may be the transmission to dead matter, the molecules of which have already a special kind of motion, of a form of motion *sui generis*.

I offer these remarks with much diffidence, and I am well aware that much that I have said may be regarded as purely speculative. They may, however, stimulate thought, and if they do so they will have served a good purpose, although they may afterwards be assigned to the dust-heap of effete speculations. Meyer writes as follows in the introduction to his great work on 'The Kinetic Theory of Gases,' p. 4: "It would, however, be a considerable restriction of investigation to follow out only those laws of nature which have a general application and are free from hypothesis; for mathematical physics has won most of its successes in the opposite way, namely, by starting from an unproved and unprovable, but probable, hypothesis, analytically following out its consequences in every direction, and determining its value by comparison of these conclusions with the result of experiment."

JOHN G. MCKENDRICK.

UNIVERSITY OF GLASGOW.

* Meyer, 'Kinetic Theory of Gases.' Translated by Baynes, London, 1899, p. 6.

DATA ON SONG IN BIRDS. OBSERVATIONS
ON THE SONG OF BALTIMORE ORIOLES
IN CAPTIVITY.

MUCH has been written in regard to the songs of birds, and no small part of the literature of the subject has dealt with the problem of the way in which many kinds of birds have acquired the distinctive song that characterizes each different species.

In the eastern United States many of us recognize, without seeing, the singer, on hearing the song of one of our commoner native birds. We say, 'A robin is singing,' 'Listen to the bobolink,' 'That is a song sparrow.'

Some who pay close and particular attention realize that individuals of a given kind have sometimes slight, though marked, variations in the method of song that distinguish them from the mass of their kind and characterize them as individuals which are readily known by their *peculiar personal song*. So we say, 'This robin is a good singer,' 'The note of that thrush is particularly pleasing,' 'That oriole has some harsh notes.' Such comments are indicative of the taste or appreciation of the listener and are only introduced here to emphasize two facts. First, that the song of all the individuals of a given kind of bird, as the robins, is so characteristic that we call it the robin's song, readily recognize it, and know that, in the main, all the robins of a given region have a common song, so much alike that we do not individualize the singer. Second, that now and again individual birds of a given kind, robins again for example, are readily distinguishable as individuals by some turn or phrasing of the notes that gives to the individual singer an identity as a particular robin, with an individual song, different, to a greater or less degree, from the mass of robins in the same region.

The question at once suggests itself: How is this characteristic song acquired?

Is it a matter of inheritance? Or does each robin learn to sing? Is it inherent in the species or is this song of the robin a matter of education?

A. R. Wallace and Lloyd Morgan especially have advanced hypotheses to account for the matter of call notes and song, and Mr. Morgan's work is based on many careful experiments that are set forth in his book, 'Habit and Instinct.' But, so far, I am not aware of any prolonged or detailed account of the study of this factor, as it develops with, and extends through, the life of a given individual, nor has a second generation been carefully watched.

The following experiment, though imperfect and by no means as exhaustive as could be desired, seems, however, worthy of record, as from it certain conclusions may be drawn. The notes accumulated extend over a period of nearly five years and are briefly as follows:

On July 7, 1895, I took from a maple tree at Annisquam, Massachusetts, a nest of the Baltimore oriole. (*Icterus galbula*), which contained three very young birds. They were quite naked and showed no signs of wing or tail feathers. They appeared to be about five days old. As a record to refer to, one was killed and preserved in alcohol. The other two were carefully reared by hand and thrived well.

So far as I know, they did not hear, after coming into my possession, any birds sing, nor did any person whistle or sing to them.

At the age of between three and four weeks they were able to feed and care for themselves. They began then to fly from place to place about the room, and it became necessary to confine them in a cage. However, they were allowed the larger liberty of the sitting room for a portion of each day and were very tame and familiar, for a long period calling for food in the characteristic oriole way and begging with drooping

fluttering wings of any one who came into the room.

By August 1 they were fully fledged and the downy first plumage of the head and body began to be replaced by the compact and finished plumage of the first autumn. The wing and tail feathers were, however, not moulted at this time.

During the first week in October, the birds were taken by me to Boston. Here I lived in rooms on the upper floor of a four-story house where there were no other birds in confinement, so that no song of any kind was heard by the birds while at this place.

Now I began to appreciate that both were female birds and also noted great temperamental differences in the two. One was timid, and the other taking advantage of this characteristic, scolded and chased the timid bird both in the cage and when at large in the room. So by name I began to distinguish them as Driver and Timid, which last soon became Timmy, a name always associated in my mind with Baltimore orioles.

At this time they had a single call note very like that of wild birds, but with a slightly different quality difficult to define, more abrupt, musical and much louder. They also had the peculiar rattling chatter associated with orioles. These were all their notes and were uttered rarely, the infant appeal so prevalent during the first four weeks of their lives having disappeared with their babyhood.

During the next few months their lives had no marked events. Each day they spent much time out of the cage at large in the room. Threads interested them, and hours were spent by the two birds in sewing, for I can use no other word, threads and strings into the wire bars of the cage they lived in. Without any semblance of weaving a nest or attempting to shape one, the birds simply tied and wove the threads

into the wire until there were no loose ends. Ultimately thick bunches of thread and string on the bars characterized the cage.

I have told all this detail, really foreign to my thesis, because it seems important to record an inheritance so marked. The birds never learned to do more with threads than is here described, though they were ultimately allowed a room to live in with branches of trees to alight on, etc., and at least one of them laid eggs in an artificial nest.

On February 16, 1896, I took the birds by train from Boston to New York, where they spent the succeeding months until May 6 in a room in a large hotel. I wish to emphasize again two facts: both birds were females though I was not absolutely sure of it at this period, and, so far as I am aware, they heard no birds sing after I took them from their parents when about five days old, until after I took them to the country again on May 6, as will presently be related.

After reaching New York it was found expedient to keep them in separate cages when confined, though they were daily allowed much liberty at large in the room. During the last of February a partial moult occurred in both birds. This was chiefly the feathers of the head, throat and back. The wing and tail feathers were not shed.

Till now the two birds had looked so much alike, that in order to readily distinguish them I had early in October clipped the tips of the secondary feathers in one of Timmy's wings. This was a distinct mark even with the wings closed. But with the moult I am about to discuss, the birds ceased to be alike in appearance and were readily recognized.

Timmy in this moult acquired a distinct black throat patch, some black arrow-shaped marks in the feathers of the top of the head and decidedly dusky patches about

the region of the ears. The throat patch extended over the throat proper. The entire period taken in completing this moult was about three weeks.

The other bird, Driver, did not acquire any decided black marking about the head, throat or ears, and only showed a few scattered tiny black feathers.

Before this moult was quite completed, during the latter part of February, the birds began to sing. The interval between the singing was sometimes several days, and only a very few minutes in each day were devoted to song. This song was very low and soft, and more or less broken, reminding one of the song of the white-throated sparrow (*Z. albicollis*) as it is heard during the fall and in the early spring migrations.

Timmy was the first to sing in this way, and the period of song when noticed was brief, not lasting more than about one minute. The song was not heard again for several days. Then it became of daily occurrence, and was gradually more prolonged and better sustained. About five days after Timmy began to sing, Driver sang also. Driver soon became the chief singer, so that Timmy's weaker song was not so noticeable. But both increased in volume, and frequency all through the month of March, and during April and the first half of May while daylight lasted, the song was incessant in both birds. It was now a loud clear series of notes of great brilliancy, and poured forth in such rapid succession as to be like that of the house wren (*T. ædon*) in the intervals, and lasting about as long as the warble of that bird. Except for the 'rattle' which was now and then a part of the repertoire, this song had nothing in it that reminded one of the song of the Baltimore oriole as heard in New York, Massachusetts or at any point where the birds occur. Through the second week in May, the song of both birds gradually diminished.

I could generally, during the height of the song season, start the birds to sing by going to their cages, speaking to them and whistling a few notes. Here it seems essential to emphasize the fact that I in no way trained them to sing and made no effort to start them in song till long after their method of singing was established. In fact, the quality and phrasing of their singing was of such a character that none save an expert whistler could reproduce it.

Early in May of 1896 I took the birds to the country near New York, where we remained until July 20, 1897, a period of some fourteen months; then I moved to Princeton, New Jersey, where the remainder of their lives was passed. Both birds died during the winter of 1899-1900, apparently of old age.

To go back to the time of departure from New York in the spring of 1896. As has been stated, the birds' song became less frequent by the first week in May, and by the twentieth of that month they had ceased to sing. On June 6 I noticed the first signs of the summer moult and in a very few days it was in full progress.

It may be well to indicate some of the details of the change, though this is a divergence from the chief subject. Also, it should be borne in mind that native birds kept in confinement are generally about a month earlier in moulting and also in the song season, than are the representatives of the same species at liberty out of doors. This applies to all the species I have kept in confinement and when the birds are perfectly normal and healthy—so sound in health as to *breed in captivity*, which seems a good criterion. As examples, I may mention the bluebird (*S. sialis*), robin (*M. migratoria*), wood thrush (*H. mustelina*), catbird (*G. carolinensis*), brown thrasher (*H. rufus*), and the orchard oriole (*I. spurius*), all of which I have had live and breed and

go through the song and moult seasons year after year in captivity.

The moulting period of the two orioles occupied a month, and early in July both were in most exquisite fall plumage. The deeper orange and rusty tint that is so characteristic of the species, and the suffusion of the black areas on the throat, were as marked and fine in detail as in wild birds. At this moult for the first time the larger wing and all the tail feathers were shed and replaced. The two birds were marvels of beauty at all times, but just after the full summer moult they filled those who saw them with admiration and wonder. After the moult there was a secondary song season of short duration. The song was of the same character, but not so prolonged or elaborate.

So I have endeavored to give an idea of a year, or rather more, of these birds' lives, and the succeeding years to the end were but repetitions with but slight variation.

Each year the wearing of the tips of the feathers was apparent in January, and a partial moult such as I have described took place late in that month or in February. Then began again the peculiar low soft song at infrequent intervals, presently becoming noticeable in volume and occurrence, till the song wave reached its height and died away. Each early June found the birds putting on an entirely new garment of feathers.

I have spoken before in this paper of the observations of a second generation. I find that this perhaps conveys a wrong impression. Let me say at once that the second generation consisted of a brood of young orioles in no way related to Timmy or Driver. However, for the purpose of my subject, really these were a second generation, of birds of a given kind, subject to the influence of older birds of their own species.

On June 15, 1897, when Timmy and

Driver had passed through the song seasons and had a well-established song formula of their own, I obtained a brood of Baltimore orioles which I believed to be about six days old. The birds were secured at South Orange, N. J., a point several hundreds of miles from the birthplace of my original birds, Timmy and Driver. I shall distinguish these birds, when speaking of them, as the brood of 1897. They were reared in the same way that the other orioles had been, except that they had the *society of, and were closely associated during their early lives with,* the two older orioles.

The moults occurred at the same intervals that I have indicated, and by the winter of 1897-1898 I was able to distinguish the sexes of my four new birds by the characteristics that correlate with sex. Three were males and assumed full nuptial plumage by a partial moult in late January and part of February. The fourth bird was a female.

On my coming to live in Princeton when these 1897 orioles were about seven weeks old, they, as well as Timmy and Driver, had an especial room given over to their use, and from that time on the birds knew little or nothing of cage life.

After the spring or, rather, late winter moult of 1898, Timmy and Driver began to sing as they had done in the two previous years. At this time friends, good field ornithologists, familiar with the conventional song of the Baltimore oriole, heard them both sing, and not having up to that time seen the birds, were at a loss to identify the song as being like anything they had ever heard.

Soon after Timmy and Driver began to sing, the 1897 birds one by one joined, and in a month all were singing a song not to be distinguished from that of the two older birds. They outlived Timmy and Driver a year or more and always sang as I believe they had been taught by older birds of their

own kind. In short, only six orioles have ever sung this song, for I pursued the experiment no farther, other matters interfering.

My conclusion is that two birds, *isolated from their own kind and from all birds*, but with a strong inherited tendency to sing, originated a novel method of song, and that four birds, *isolated from wild representatives of their own kind, and associated with these two who had invented the new song*, learned it from them and never sang in any other way.

WILLIAM E. D. SCOTT,
Curator of Ornithology.

PRINCETON UNIVERSITY.

THE BOTANICAL SOCIETY OF AMERICA.

THE Botanical Society of America met in business sessions in Room 4 of the High School Building, Denver, Col., August 27 and 28, 1901, and presented its scientific program in joint session with Section G of the A. A. A. S. in the same place on August 28. The Presidential address on 'The Problems and Possibilities of Systematic Botany,' by Professor B. L. Robinson, was read by Dr. J. M. Coulter. The following program was presented:

'The Fundamental Phenomena of Vegetation': F. E. CLEMENTS.

'The Physical Basis of Ecology'; F. E. CLEMENTS.

'A System of Nomenclature for Phytogeography': F. E. CLEMENTS.

'The Plant Formations of the Rocky Mountains': F. E. CLEMENTS.

'Early Winter Color of the Plant Formations of the Great Plains': C. E. BESSEY.

'The Anatomy of the Embryo and Seedling of *Tsuga Canadensis* Carr' (by invitation): W. A. MURRILL.

'Clues to Relationships among Heterœcious Plants': J. C. ARTHUR.

'The Thermal Relations of Vegetation': D. T. MACDOUGAL.

'The Application of Ecology in Taxonomy': F. E. CLEMENTS.

'Some of the Changes now taking place in a Forest of Oak Openings': W. J. BEAL.

'The Life-History of *Vittaria Lineata*': E. G. BRITTON and A. TAYLOR.

In accordance with the adoption of an amendment to the Constitution of the A. A. S., Drs. Bessey and Halsted were chosen to represent the Society on the Council of the Association at the sessions just finished.

A committee consisting of Drs. Wm. Trelease, N. L. Britton and B. L. Robinson was appointed to report upon the condition of the National Herbarium, and to recommend changes for its improvement.

As a result of consideration of the report of the committee on the policy of the Society appointed a year ago, it was resolved "That it is the present policy of the Society to accumulate invested funds until the annual income, interest and dues, is at least \$500, and then to use such income yearly, or at greater or less intervals, as circumstance may dictate, for the best advancement of botanical knowledge."

The address of the retiring President at the next annual meeting will be delivered by Professor B. D. Halsted, who presided over the session, and whose term of office has just expired.

The officers for the ensuing year are :

President, J. C. Arthur.

Vice-President, B. T. Galloway.

Treasurer, C. A. Hollick.

Secretary, D. T. MacDougal.

Councillors, C. E. Bessey and Wm. Trelease.

D. T. MACDOUGAL,

Secretary.

NEW YORK BOTANICAL GARDEN,
BRONX PARK, N. Y. CITY.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FELLOWS ELECTED AT THE DENVER MEETING.

John Almy, Instructor in Physics, University of Nebraska, Lincoln, Nebr. (B).

J. H. Appleton, Professor of Chemistry, Brown University, Providence, R. I. (C).

Howard Ayers, President, University of Cincinnati, Cincinnati, Ohio (F).

Solon I. Bailey, Associate Professor of Astronomy, Harvard University, Cambridge, Mass. (A).

Simeon E. Baldwin, Associate Judge of Supreme Court of Errors, New Haven, Conn. (I).

W. D. Bancroft, Professor of Physical Chemistry, Cornell University, Ithaca, N. Y. (C).

C. R. Bardeen, Anatomical Laboratory, Wolfe and Monument Sts., Baltimore, Md. (F, K).

A. E. Beardsley, Professor of Biology, State Normal School, Greeley, Colo. (F).

John Andrew Bergström, Associate Professor of Psychology and Pedagogy, Indiana University, Bloomington, Ind. (K).

Ernst A. Bessey, Department of Agriculture, Washington, D. C. (G).

Frank W. Blackmar, Professor of Sociology and Economics, University of Kansas, Lawrence, Kansas, (I).

E. M. Blake, University of California, Berkeley, Cal. (A).

Thaddeus L. Bolton, Department Philosophy, University of Nebraska, Lincoln, Nebr. (K).

Louis F. G. Bouscaren, Chief Engineer, Water Works Commission, Cincinnati, Ohio (D).

Charles L. Bouton, Instructor in Mathematics, Harvard University, Cambridge, Mass. (A).

Wm. L. Bray, Professor of Botany, University of Texas, Austin, Texas (G).

Lyman J. Briggs, U. S. Dept. of Agriculture, Washington, D. C. (B).

S. J. Brown, U. S. N., U. S. Naval Academy, Annapolis, Md. (A).

Lawrence Bruner, Professor of Entomology, University of Nebraska, Lincoln, Nebr. (F).

Edward F. Buchner, New York, N. Y. (H, K).

Luther Burbank, Horticulturist, Santa Rosa, Cal. (G).

E. S. Burgess, Botanist, 11 W. 88th St., New York, N. Y. (G).

E. A. Burt, Professor of Natural History, Middlebury College, Middlebury, Vt. (G).

William Cain, Professor of Mathematics, University of North Carolina, Chapel Hill, N. C. (A, D).

Florian Cajori, Professor of Mathematics, Colorado College, Colorado Springs, Colo. (A).

C. N. Calkins, Instructor in Zoology, Columbia University, New York, N. Y. (F).

F. K. Cameron, Bureau of Soils, U. S. Department of Agriculture, Washington, D. C. (C).

W. W. Campbell, Director, Lick Observatory, Mt. Hamilton, Cal. (A).

George L. Cannon, Instructor in Geology, Denver High School (No. 1), Denver, Col. (E).

H. W. Cattell, Pathologist, 3709 Spruce St., Philadelphia, Pa. (K).

Wm. M. Chauvenet, Mining Engineer, 620 Chestnut St., St. Louis, Mo. (C).

- T. M. Cheesman, Pathologist, Garrison-on-Hudson, N. Y. (K).
- C. M. Child, Instructor in Zoology, University of Chicago, Chicago, Ill. (F).
- Frank Hurlbut Chittenden, Assistant Entomologist, U. S. Dept. Agriculture, Washington, D. C. (F).
- Russell H. Chittenden, Dean Sheffield Scientific School, Yale University, New Haven, Conn. (C, K).
- Frank H. Cilley, Mass. Inst. Technology, Boston, Mass. (A, B, D).
- Gaylord Parsons Clark, Professor of Physiology, Syracuse University, Syracuse, N. Y. (F, K).
- John S. Clark, 110 Boylston St., Boston, Mass. (I).
- S. F. Clarke, Professor of Biology, Williams College, Williamstown, Mass. (F).
- T. D. A. Cockerell, Entomologist, Las Vegas, N. M. (F).
- Chas. W. Comstock, State School of Mines, Golden, Colo. (A, D).
- Edwin Grant Conklin, Professor of Biology, University of Pennsylvania, Philadelphia, Pa. (F).
- E. B. Copeland, Plant Physiologist, Morgantown, W. Va. (G).
- L. C. Corbett, Horticulturist, U. S. Dept. of Agriculture, Washington, D. C. (G).
- F. B. Crocker, Professor of Electrical Engineering, Columbia University, New York, N. Y. (B, D).
- John Franklin Crowell, Bureau of Statistics, U. S. Treasury Dept., Washington, D. C. (I).
- Edgar R. Cumings, Indiana University, Bloomington, Ind. (E).
- Susan J. Cunningham, Professor of Mathematics and Astronomy, Swarthmore College, Swarthmore, Pa. (A).
- Allerton Cushman, Instructor in Chemistry, Bryn Mawr College, Bryn Mawr, Pa. (C).
- Arthur R. Cushny, Professor of Materia Medica and Therapeutics, University of Michigan, Ann Arbor, Mich. (K).
- C. W. Dabney, President University of Tennessee, Knoxville, Tenn. (C).
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- David Worth Dennis, Professor of Geology and Biology, Earlham College, Richmond, Ind. (F).
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- R. B. Dixon, Instructor in Anthropology, Peabody Museum, Cambridge, Mass. (H).
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- Alice Eastwood, Academy of Sciences, San Francisco, Cal. (G).
- Morton John Elrod, Professor of Biology, University of Montana, Missoula, Mont. (F).
- Edmund Arthur Engler, President Polytechnic Institute, Worcester, Mass. (A).
- Livingston Farrand, Adjunct Professor of Psychology, Columbia University, New York, N. Y. (H, K).
- Pierre A. Fish, Ithaca, N. Y. (K).
- Irving Fisher, Santa Barbara, Cal. (A, I).
- Thomas S. Fiske, Professor of Mathematics, Columbia University, New York, N. Y. (A).
- Austin Flint, Professor of Physiology, Cornell University Medical College, New York, N. Y. (F, K).
- G. B. Frankforter, Professor of Chemistry, University of Minnesota, Minneapolis, Minn. (C).
- Wm. H. Freedman, Professor Electrical Engineering, University of Vt., Burlington, Vt. (B, D).
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- Thomas W. Galloway, Professor of Biology, Missouri Valley College, Marshall, Mo. (F).
- K. W. Genthe, Instr. Zoology, University of Michigan, Ann Arbor, Mich. (F).
- George B. Germann, Registrar of Columbia University, New York, N. Y. Residence: 90 Norman Ave., Brooklyn, N. Y. (A, K).
- Wm. J. Gies, College of Physicians and Surgeons, Columbia University, New York, N. Y. (C).
- C. P. Gillette, Professor Zoology, Colo. Agri. College, Fort Collins, Colo. (F).
- H. M. Goodwin, Professor of Physical Chemistry, Mass. Inst. Technology, Boston, Mass. (B).
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- J. I. Hamaker, Professor of Geology and Biology, Trinity College, Durham, N. C. (E, F).
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Wm. E. Henderson, Associate Professor of Chemistry, Ohio State University, Columbus, Ohio (C).

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C. Judson Herrick, Dennison University, Granville, Ohio (F).

Frank H. Hitchcock, Chief of the Section of Foreign Markets, U. S. Dept. of Agriculture, Washington, D. C. (I).

N. Monroe Hopkins, Assistant Professor of Chemistry, Columbia University, Washington, D. C. (C).

S. Francis Howard, Professor of Chemistry, Mass. Agri. College, Amherst, Mass. (C).

Henry M. Howe, Professor of Metallurgy, Columbia University, New York, N. Y. (D).

Herbert A. Howe, Dir. Chamberlin Observ., Univ. of Denver, University Park, Denver, Colo. (A).

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G. H. Hudson, State Normal and Training School, Plattsburg, N. Y. (F).

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Arthur Lachman, Professor of Chemistry, University of Oregon, Eugene, Ore. (C).

Andrew C. Lawson, Professor of Geology, University of California, Berkeley, Cal. (E).

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W. B. Smith, Professor of Mathematics and Acting Professor of Philosophy, Tulane University, New Orleans, La. (A).

Clarence L. Speyers, Professor of Physical Chemistry, Rutgers College, New Brunswick, N. J. (C).

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Geo. Steiger, Chemist, Geological Survey, Washington, D. C. (C).

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Eben S. Wheeler, U. S. Assistant Engineer, Detroit, Mich. (D).

Henry Lord Wheeler, Assistant Professor of Chemistry, Sheffield Scientific School, Yale University, New Haven, Conn. (C).

William Morton Wheeler, Professor of Zoology, University of Texas, Austin, Texas (F).

Horace White, Editor of New York *Evening Post*, New York, N. Y. (I).

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Mary Alice Willcox, Professor of Zoology, Wellesley College, Wellesley, Mass. (F).

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Ind. SCIENTIFIC BOOKS.

Diplodocus Marsh. *Its Osteology, Taxonomy and Probable Habits, with a Restoration of the Skeleton. Memoirs of the Carnegie Museum*, Vol. I., pp. 1-63, pl. I.-XIII.

The *Memoirs of the Carnegie Museum* open auspiciously with this valuable contribution by Mr. J. B. Hatcher, curator of the department of vertebrate paleontology and associate editor of the publications of the Museum. The subject is the description of two remarkable skeletons of the great sauropodous dinosaur *Diplodocus* discovered by the Museum expeditions of 1899 and 1900 on Sheep Creek, Albany County, Wyoming. The first specimen consists of forty-one vertebrae, which form an unbroken series from the second or axis vertebra to the twelfth vertebra of the tail, besides extensive parts of the appendicular skeleton, all in a remarkable

state of preservation. The fourteen cervicals alone measure 21 feet and the author estimates a total length of 68 feet for the vertebral column and skull. The second skeleton belongs to a smaller animal in which one of the hind limbs is perfectly preserved, and with the aid of a fore limb and of some characters taken from the tail of a specimen in the American Museum collection, Mr. Hatcher gives (Plate XIII.) by far the most perfect restoration of a *Sauropod* which has yet been published. The neck is extraordinarily long and slender, increasing in power and in the length of the centra near the chest. The back, including only eleven vertebrae with short centra is extremely short; while the long and heavy tail evidently balances the anterior portion of the column, and the sacrum forms the center of the body. The marvelously light and yet strong structure of the vertebrae is well brought out in the pen drawings by Mr. Weber, and the author adds a number of most useful new terms for the future description of these elaborate structures. Of the animal as a whole he observes:

The restoration at once reveals the unusual proportions of *Diplodocus*. The remarkable long neck and tail contrast strikingly with the short body. The hind limbs are longer than the fore limbs, and this fact, together with the enormous elevation of the spines of the sacra and posterior dorsals, fixes the sacral region as the highest in the vertebral column, a determination first made by Osborn. The powerful ilia, firmly united to the rigidly coossified sacra with lofty coalesced spines, together with the other pelvic elements proportionately well developed, at once emphasizes the paramount importance of the pelvic region and fixes it as the center of power and motion.

Among the new important points brought out in this Memoir are the following: First, the gradual transition from the paired spines of the neck to the highest single spines of the back; the clear description and definition of the remarkable cavities surrounding the vertebrae, intramural or inside of the bones as well as around the centra and neural arches; the modification of the first two dorsals especially for the support of the scapula; the presence of four true sacra and of one dorso-sacral or pelvic vertebra, strengthening the support of

the ilium; the fact that the posterior sacral is larger than the anterior, showing the enormous power exerted by the tail; the coossification of the 17th and 18th caudal vertebræ, indicating that this was a fixed point when the animal stood upon its hind feet and partly supported itself upon the tail in the tripod condition; the excessively small neural canal throughout, the probable presence of a pair of clavicles, not hitherto observed in the Sauropoda; the hollow character of the large limb bones.

These skeletons are referred to a new species, *D. carnegiei*, in honor of the founder of the Pittsburgh Museum.

As regards the habits of these animals Mr. Hatcher speaks as follows:

From the above consideration I am inclined toward the opinion that *Diplodocus* was essentially an aquatic animal, but quite capable of locomotion on land. Though living for the most part in the more important rivers and fresh-water lakes, it may not infrequently have left the water and taken temporarily to the land, either in quest of food or in migration from one to another of adjacent bodies of water.

It is not improbable that during the period when these huge dinosaurs lived and flourished over what is now New Mexico, Colorado, Wyoming, Montana and the Dakotas, there prevailed throughout this region physical conditions somewhat similar to those which exist to-day in tropical America and more especially over the coastal plain of the lower Amazon with its numerous bayous and islands, or the more elevated valleys of the anterior in the Brazilian provinces of Amazonas and Matto Grosso with their numerous lakes and large rivers surrounded by a dense tropical vegetation with broad, level valleys subject to periodical inundations.

With the beginning of the Cretaceous there began a subsidence over this region, and a great inland sea was formed which gradually encroached upon the habitat of these animals, more and more restricting the area adapted to them, so that at about the commencement of the Upper Cretaceous the entire region formerly occupied by them had become a shallow sea save only certain islands of limited extent, and perhaps otherwise poorly adapted as the homes of such animals as were the *Sauropoda*.

A few years more of such efficient exploration as this and of such remarkably careful field and preparation work promises to give us a knowledge of the osteology of these great Sauropods almost as complete as our knowledge of the

skeleton of the recent horse, for example. The author of the present work and Dr. J. L. Wortman, who found the type skeleton, have led the way in these methods of field work.

HENRY F. OSBORN.

An Introduction to Physiology. By WILLIAM TOWNSEND PORTER, M.D., Associate Professor of Physiology in the Harvard Medical School. Cambridge, Mass., The University Press. Pp. 314.

This small volume contains in a convenient form what is apparently the course of practical physiology given for the past two or three years at the Harvard Medical School. To those who are not conversant with the difficulties that beset the practical teaching of the subject to large classes it may appear surprising that in this matter the large American medical schools should have lagged behind the smaller, in some of which courses of a considerably wider scope than that under review have not only, for the best part of a decade, been available for the advanced student of medicine, but have taken their place among the compulsory subjects of the ordinary curriculum. He, however, who knows how much wise planning and laborious organization—what material, intellectual and even moral resources—are required for the successful conduct of a practical class for a couple of hundred students will be much more ready to congratulate Dr. Porter and the Harvard Medical School on the satisfactory results of their efforts than to criticise them as belated laborers in the vineyard of practical physiology. Nor will the experienced teacher whose circumstances enable him to make free use of mammals as well as frogs seriously blame, however much he may regret, the entire omission of mammalian experiments, except those performed on the students themselves. He will nevertheless note that the lack of this element, so valuable, under proper conditions, in the training of the medical students, renders the book less suited to the requirements of schools of moderate size than would otherwise be the case. On the other hand, for those who are so situated that they can only use frogs, the work may be recommended as a sound guide to the performance of the fundamental experiments in the general physiology

of muscle and nerve. The mechanical phenomena of the circulation are also adequately treated in a series of exercises on an ingeniously constructed artificial scheme.

It would have been better, we think, to omit much of the elementary physics which bulks so largely in some of the chapters. The simple experiments on magnetic induction, lines of force and electromagnetic induction, given in Chapter II., would be in their proper place in a manual of practical physics. We doubt the wisdom of encouraging the medical student to neglect his physics, as he so often does at the period of his preliminary scientific studies, in the sure and certain hope that 'all he really requires,' the titbits of that severe and repellent science—will be served up to him later on in semi-digested form in the course of physiology.

The proofs have been read with commendable care, and few actual errors have escaped detection. On page 188, however, it is wrongly stated that 'in muscle the electrotonic currents are much stronger than in nerve.' The assertion, on page 189, that 'the electrotonic currents are absent in nerves which lack a myelin sheath' seems a little too absolute, although everybody admits that they are weaker than in medullated nerves. On page 250 one is rather staggered by the argument that 'were the slow passage of the blood in the capillaries due simply to friction, the blood would move still more slowly in the veins because the retarding influence of the friction in the veins would be added to that of the capillaries.' This would hold true if the blood possessed only kinetic energy. But since the blood in the capillaries is under a higher pressure than in the veins, there is a surplus of potential energy which is capable of being converted into kinetic.

It is a good idea to encourage the learner to discuss his results by setting him here and there a definite question for consideration. A critical comparison of the isotonic and isometric causes of contraction (pp. 221, 229) affords a valuable mental gymnastic to the student who has just been exercising his manual dexterity in obtaining them. And if Swift could extract an elegant meditation (according to the style and manner of the Hon. Robert Boyle) from so dry a piece of timber as a broomstick, the ingenuous

reader will waste no sympathy on the twentieth-century medical student, even when he is requested to tackle a somewhat unpromising theme, to write, for example (according to his own style and manner) 'a critical account of the muscle-lever in his laboratory note-book.'

G. N. I. S.

Theory of Functions of a Complex Variable. By A. R. FORSYTH, Sc.D., F.R.S., Fellow of Trinity College, Cambridge, Sadlerian Professor of Pure Mathematics. Second Edition. Cambridge, at the University Press. 1900. 8vo. Pp. xxiv + 782.

The publication of a second edition of Professor Forsyth's very valuable and comprehensive work on the theory of functions is a matter of no little interest and importance to the mathematical world. The first edition, which appeared in the spring of 1893, was the first extended systematic presentation in English of a field of modern mathematics now generally recognized as the most useful as well as the most fascinating. Furthermore it was the most comprehensive treatise on the subject in any language, treating a greater number of departments, exhibiting a greater variety of methods, and giving more references to important original contributions than any previous work. Its position in all these respects has been modified since only by a single work, the elaborate historical and bibliographical report of Professors Brill and Noether published in the third volume of the 'Jahresbericht der deutschen Mathematiker-Vereinigung.'

The new edition has been enlarged by about one hundred pages. By means of these additional pages and also by omitting about twenty pages devoted in the earlier edition to binomial differential equations, the author has been enabled to introduce an elementary discussion of the birational transformations and to give some account of Abel's theorem and its applications.

In the work of revision many improvements in the details of presentation have been introduced. The author has altered the wording of a considerable number of theorems and demonstrations which before contained slips of one sort or another. The work has thereby gained

on the side of scientific precision without becoming less agreeable to read or less easy to understand.

It would, of course, be absurd to expect a work of the magnitude and scope of the present one to be free from errors of both omission and commission.* The present writer may be permitted to point out one of the former sort which seems particularly serious, viz: the omission of the fundamental proof of Cauchy relative to the continuity of the roots of an algebraic equation. On page 181 of the new edition, as on page 162 of the old edition, the author simply takes it for granted that when the independent variable changes continuously, so will every root of the algebraic equation.

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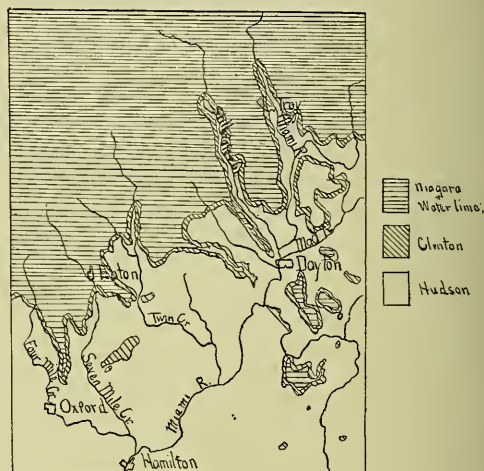
DISCUSSION AND CORRESPONDENCE.

PREGLACIAL DRAINAGE IN SOUTHWESTERN OHIO.

TO THE EDITOR OF SCIENCE: In SCIENCE for August 9, reference is made, in a review of Professor W. M. Davis, to recent papers by Tight, Bownocker, Todd and Fowke upon the subject of 'Preglacial Drainage of Ohio.' In particular Mr. Fowke is represented as advocating for the Licking and Kentucky rivers a continuance of their courses northward by way of a reversed Miami river or some of its tributaries. There seems to me to be an objection to this theory, which will become apparent to any one who will study the relation of the channels of the Miami river and its principal tributaries to the boundary outcrop of the lower and upper Silurian formations in that region. In a district where the dip of the rocks is very slight, not over four feet to the mile to the northward, all the reentrant angles, formed in a retreating Clinton limestone escarpment, look as if they had been formed by up-stream cutting action of southward-flowing streams. Note on the accompanying map not only the major northeastern reentrant

* For a careful analysis of the first edition see Professor Osgood's review published in the *Bulletin of the American Mathematical Society*, Vol. I. (1894-5), pp. 142-154. Some of the criticisms which appear there apply equally to the present edition.

of the Big and Little Miami rivers combined, but also the minor reentrants of the tributaries to the Big Miami from the northwest—those of Four Mile, Seven Mile, Twin and Stillwater Creeks, and that of the upper Miami itself. This Clinton escarpment only here and there peeps out from under its heavy mantle of glacial drift. Evidently there has been no retreat of these escarpments since the glaciers themselves retreated. The veneering of glacial drift has stereotyped this preglacial topography. It is true that geological boundary reentrants



Map
of a District in South Western Ohio
Showing sinuosity of Clinton Escarpment
in relation to southward flowing streams

Scale ——— = 2 miles

may point down stream. South of the Ohio, one is seen in the lower course of the Kentucky River—the Trenton—Hudson boundary reentrant. This is accounted for by the average dip of the rocks to the northwest on this slope of the Lexington uplift being 12 feet to the mile, while the fall of the river in the same is only 1.2 feet per mile. In order that the reentrants northwest of the Miami River should have been made by streams in that region having a reversed drainage, the average gradients of these streams could not have been greater than four feet to the mile. Four feet to the mile is about the present southwest fall of the Miami River itself, a much steeper gradient

than the preglacial Miami had, but hardly steeper than the gradients of streams occupying the channels of its present tributaries, whether they flowed north or south.

The accompanying map only shows a portion of the Silurian drainage areas to the north of the Ohio. It might have added force to the above argument, to have shown the drainage from the south as well. It would have been found to present an appearance symmetrical with that from the north. In spite of arguments derived from width-of-channel comparisons, etc., it still looks as if the Ohio River were the parent stream and that its present tributaries, the Miami, the Licking, the Kentucky have never been tributary to anything else, but represent normal lateral stream development.

ARTHUR M. MILLER.

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A POST-GRADUATE SCHOOL OF BIBLIOGRAPHY.

TO THE EDITOR OF SCIENCE: It will not be difficult for any one familiar with the development of libraries and librarianships in this country to see that we have arrived at a turning-point in their history. The large and even moderate sized libraries are developing and will continue to develop special departments in which acquisition is done by collecting rather than selecting. These departments will need for their care and utilization librarians with special knowledge. The largest libraries will specialize in several departments and consequently will need a staff of reference librarians each a specialist—a 'faculty,' as Mr. Melvil Devey calls it in a very suggestive article in the July number of *The Library*. Lastly, highly specialized libraries, each devoted to some special science or group of sciences, will grow up.

This development will necessitate some very radical changes in the class of men who will take up library work, and consequently in the provision for the education of librarians. We shall see men with university education taking responsible positions in libraries instead of seeking university professorships, and the demands of such men for opportunities to prepare themselves for their life-work without having to go back to the college or even high-school grade must be met. It cannot be met by the pres-

ent library schools as now constituted. The work these schools are doing in preparing young men and women for subordinate positions in popular libraries is an absolutely necessary one and one that must not be slighted. In addition to these we need special schools for the education of scientific librarians and bibliographers. Perhaps one or the other of the library schools can develop a school of this grade. However that may be, there should be established at the large universities special schools of bibliography of the same rank as the schools of engineering, commerce and history.

The present writer had occasion to bring this question to the attention of the librarians at the conference of the American Library Association in July of this year, as has already been noticed in SCIENCE. The question is certainly of great importance, not only to librarians, but to the scientific and educational world at large, and the purpose of these lines is to invite a discussion of the ways and means for the establishment of such schools. I hope that SCIENCE will open its columns for this discussion and that educators and scientific men and librarians, too, will take part in it.

A school such as here proposed would naturally be open to any one who would take up the study of bibliography or any of its branches, and not exclusively to prospective librarians. These studies have a fascination of their own, just as literary history, philosophy or mathematics, and are just as capable as any of these sciences of inspiring with enthusiasm the searcher after truth.

The curriculum of a school of bibliography should include the following subjects:

1. The literature of bibliography, with practical exercises in the handling of bibliographical repertories and indexes and in bibliographical compilation.

2. History and methodology of the sciences, and comparative history of literature (literature taken in its broadest sense), including the study of the systems of classification of knowledge and their relations to the schemes for classification of books.

3. History of printing and bookselling, with special emphasis on the invention of printing, and exercises in the cataloguing of incunabula.

4. History of libraries and library administration.

5. Paleography, classical and mediæval; diplomatics; administration of archives.

The studies in the schools of bibliography should lead up to the degree of Doctor of Philosophy as the studies in any other school. To create a special degree in 'library science,' as has been done in the library schools, seems unnecessary.

AKSEL G. S. JOSEPHSON.

THE JOHN CRERAR LIBRARY,
CHICAGO, Sept. 7, 1901.

NOTES ON INORGANIC CHEMISTRY.

It has been often claimed that the presence of nickel in dust is a sufficient criterion to distinguish it as being cosmic rather than terrestrial in its origin. Hartley and Ramage have, however, shown in a paper recently read before the Royal Society that nickel is found in soot, and hence that nickeliferous dust may be of terrestrial origin. They also called attention to the wide distribution of gallium in small traces, being found in all aluminous minerals, in many flue dusts, in many iron ores, and in soot and atmospheric dust. A dust is described which is probably of cosmic origin. It fell on a calm night in November, 1897, was magnetic and very uniform in composition, and unlike volcanic dust or the dust of any known terrestrial source.

A CONTINUATION of Gautier's work on the rare elements in the crystalline rocks reveals not only the presence of nitrogen and argon, but also iodine and arsenic. Helium was not found. The gases of mineral waters and the gases issuing from the earth's crust into the atmosphere seemed to be formed by the action of water at high temperature upon the nitrides, argonides, carbides, sulphides, arsenides and other accessory constituents of the igneous rocks.

THE action of manganese dioxide and other finely-divided substances in facilitating the liberation of oxygen from potassium chlorate at a low temperature, is considered by some to be merely mechanical. After a series of experiments at the Explosives Committee's laboratory at the Royal Arsenal, Woolwich, Sodeau comes to the conclusion "that the supposed ability of

chemically inert solid particles to facilitate the decomposition of potassium chlorate is unsupported by experimental evidence, and, if existing, is inadequate to explain even a small fraction of the great facilitation produced by the oxides of manganese, iron, cobalt, nickel, and copper. The action of the latter substances would therefore appear to be entirely chemical."

THE discovery, or rather the isolation, of a new element has been announced by M. Demarçay, in the *Comptes Rendus*. Some fifteen years ago Sir William Crookes called attention to an anomalous band in the spectrum of samarium, which he attributed to a hypothetical meta-element which he called S^d . A few years later De Boisbaudran described a series of lines in the spark spectrum of samarium, and called the element which he supposed their cause Z' . The element causing the band and the lines has now been isolated by Demarçay and named *Europium*. It has an atomic weight of about 151, and in its properties lies between gadolinium and samarium.

A NEW and interesting case of isomorphism is noted by Guthrie in the *Berichte*, between one of the modifications of potassium tellurate, $K_2TeO_4 \cdot 2H_2O$, and potassium osmate $K_2OsO_4 \cdot 2H_2O$. Mixed solutions of these two salts crystallize out together. This is one of the very few instances in which tellurium shows an analogy with the metals of the eighth group of the periodic system.

A PAPER has recently appeared in the *Journal de Pharmacie et de Chimie*, by E. Jungfleisch, on the 'Sulfur Industry in Sicily.' The output has increased from 150,000 tons in 1860 to 447,000 tons in 1898. The world's production at these two dates was 157,000 and 488,000 tons, Sicily thus furnishing about 90 per cent. The price during this period has not varied very largely, having been 120 francs in 1860, 142 in 1875, 100 in 1880 and 92 francs a ton in 1898. The amount of sulfur in the ore varies from the very rare richness of 75 per cent. to 20 or 25 per cent. of sulfur in the ordinary ore. A 30-per cent. ore is considered rich, while ores are worked with as little as 10 or even 8 per cent. Poorer ores than this cannot be worked profit-

ably. The older methods of obtaining sulfur from its ore by setting fire to it in covered heaps or in kilns, where the sulfur itself served as fuel, have been discarded both on account of the waste and because of the intolerable nuisance to which the fumes of the burning sulfur gave rise. Coal is in general used as fuel, although very expensive. Extraction of the sulfur with carbon bisulfid or with a concentrated solution of calcium chlorid is in many cases used, but the only method in which no noxious fumes are generated is the extraction with steam under pressure. The extent of the industry is rapidly increasing and Sicily will long continue to supply the major part of the world's production.

The use of sulfur as a fungicide is rapidly increasing in the continental vineyards, and for this purpose it is necessary that the sulfur shall be in the most finely divided condition possible. Flowers of sulfur were at first used, and then ground and sifted refined sulfur, but a large portion of even this was wasted on account of the size of the particles. 'Blown' sulfur (*zolfo ventilato*) has lately come into extensive use. The finely ground sulfur is carried by an endless chain into a strong current of air, or for the purpose of avoiding explosions, of gases as free as possible from oxygen. The sulfur dust is carried into large settling chambers where all the larger particles are separated by their more rapid deposition. The sulfur dust thus obtained is pale yellow, resembling precipitated sulfur, and is found to be very satisfactory for fungicidal purposes.

J. L. H.

CURRENT NOTES ON PHYSIOGRAPHY.

PHYSIOGRAPHIC GEOLOGY.

^{coll} THE increasing recognition of physiography as related to geology is illustrated in Brigham's excellent contribution to the Twentieth Century series ('A Text-book of Geology,' New York, Appleton, 1901, pp. 477, many illustrations). A chapter of forty pages in the middle of the book, devoted to 'Physiographic Structures,' presents a compact epitome of the subject, including a consideration of forms as the result of processes, with a brief exposition of the cycle of erosion and development of drainage. On

the other hand, physiographic discipline is not likely to be gained in forty pages, as appears from the scanty treatment of so important a matter as the adjustment of drainage (284-), the explanation of which, as here given, can hardly be appreciated by those who do not already understand it. It may be questioned whether the categorical method of separating folded structures (223-) from the origin and form of folded mountains (256-) is as effective a method of presenting the real earth to beginners as would be found in a closer connection of these naturally associated facts. The same may be said of volcanic processes (135-) and volcanic topography (262-), and of glacial processes (91-) and glacial topography (266-). There may be abundant precedent for the categorical arrangement, and some justification for it in teaching; but a more natural method would bring process and form closer together.

GLACIAL LAKES IN MINNESOTA.

WINCHELL summarizes the history of twenty-six 'Glacial Lakes in Minnesota' (*Bull. Geol. Soc. Amer.*, XII., 1901, 109-128, map), whose geographical consequences are seen in gravel and silt deposits, shore lines and especially in outlet channels. The lake waters were held up by the retreating ice lobes of the Superior and Red river troughs. The most famous of them is Lake Agassiz, so fully described by Upham (*Monogr. XXV.*, U. S. Geol. Surv.). The others were much smaller, and their outlines are at present but imperfectly traced. The outlet channels are of moderate depths, but are usually well defined by banks carved in till; the channel floors are sometimes without streams, sometimes occupied by small streams, sometimes partly covered with shallow ponds or sloughs. The fuller details of this complicated lake system will afford material for local studies for years to come.

ESKER LAKES IN INDIANA.

DRYER, who has already described the 'morainic lakes of Indiana' ('Studies in Indiana Geography,' *Terre Haute*, 1897, 53-60), now gives an account of 'certain peculiar eskers and esker lakes of northeastern Indiana,' (*Journ. Geol.*, IX., 1901, 123-129, 2 maps). The region concerned is traversed by a series of massive

moraines, the joint product of the Erie and Saginaw lobes of the Laurentide ice sheet. Unusual features abound. "Half-filled valleys and abnormal drainage lines, isolated knobs and morainic outliers, clusters and chains of lakes, kettles and kames conspire with esker-like ridges to produce a type of topography and scenery which seems artificial and almost bizarre." Two of these lakes, High and Gordy's, owe their existence and outline to the presence of eskers, whose origin is ascribed to deposition in tunnels or crevasses in the wasting ice sheet.

THE ONTARIO COAST.

THE Ontario coast between Fairhaven and Sodus bays (near Oswego, N. Y.) is described by J. O. Martin, of Cornell (*Amer. Geol.*, XXVII., 1901, 331-334), as consisting of truncated drumlins connected by stony beaches which enclose bays and marshes. Active 'long-shore movement was noted when waves came obliquely on the shore; a cobble weighing seven ounces was moved sixteen yards in ten minutes by waves whose breaking height was a foot. The recession of the shore line is rapid, in some cases several feet a year. The farmers know this, as they have to set back their shore fences from time to time. Several submerged boulder pavements, having the outline of drumlins but standing at a considerable distance off shore, seem to indicate former drumlins now swept away.

GLACIAL CORRIES IN THE CARPATHIANS.

RECALLING a recent note on corries in the Bighorn Mountains of Wyoming, reference may be made to de Martonne's studies of similar forms in the Carpathians ('*Sur la Formation des Cirques*, *Ann. de Géogr.*, X., 1901, 10-16. See also *Bull. Soc. Géol. France*, XXVIII., 1900, 275-319, and *Bull. Soc. Sci. Bucharest-Roumanie*, IX., 1900, No. 4). After a careful study of several examples, this author concludes not only that cirques or corries are certainly of glacial origin, but that they are as safe indication of glacial action as moraines, striations and rounded rocks; that they are of longer duration than the latter, and hence of greater value for the detection of somewhat remote glacial periods; and that they give definite indications of the character of the glaciation by

which they were produced, being due to glaciers of the Pyrenean type, and not to a general nor to a local ice sheet. High mountains may thus owe a significant share of their form to glaciation, although whether de Martonne would go as far in this direction as Richter has (see *SCIENCE*, April 5, 1901) does not appear.

W. M. DAVIS.

SHORTER ARTICLES.

DEFINITIONS OF PHYSICAL QUANTITIES.

THE standards of 'scholarship' must be essentially alike in all branches of knowledge, although differences in detail will show themselves according to the subject. I suppose that the attainment of these standards in the physics of to-day must include accuracy in conceiving fundamental quantities and their connection with each other. Within the past half century much careful thought has been devoted to gaining such clear conceptions and constructing a framework of relation among them. In proportion as the younger physicists inherit the results of that thought undiminished, they will themselves be trained for discriminating and exact thinking. It is therefore a matter of regret that some of our leading authorities are habitually lax in presenting certain definitions that are built into the foundations of mathematical physics. I refer particularly to deliberate statements found in text-books of great general excellence. These are fair marks for criticism, because they must aim at consistent and systematic exposition, and because they influence strongly minds that are in the formative stage. Their example should not encourage a student to confound ideas that are really distinct, nor to tolerate inaccuracy in himself. This can be said without implying a demand for pedantic nicety in writing for experts, who are able to catch the right cue, even from an elliptical expression. I shall illustrate my meaning with a few quotations from Professor Thomson's '*Elements of the Mathematical Theory of Electricity*,' and from Professor Webster's '*Theory of Electricity and Magnetism*.' These are chosen because they are books of acknowledged value; at the present time each may be taken to register high-water mark within its own range. Since they are representative, we are

all concerned that they should everywhere furnish good models.

Let us first take the general law of inverse square, on account of its widespread application. We find the definition of 'Newtonian Forces, the most familiar examples of which are the mutual attractions of the sun and the planets' (Webster, p. 113), followed by the general expression for potential energy in such cases (p. 114). The latter contains no indication of the factor which becomes gravitation constant, or dielectric constant, or permeability factor; yet it has been stated previously (p. 111) that "Potential energy is defined as work. The unit of energy is, therefore, the *erg*." The medium-factors for electric and magnetic phenomena are introduced later (p. 354), but the gravitation constant is nowhere restored in the developments, so far as I am aware.

The potential function, or potential, is very commonly defined as representing so much work. Thus, "The potential at *P* is the work done by the electric forces when the unit charge is taken from *P* to an infinite distance" (Thomson, p. 27). Or we are told that the potential function is obtained as a particular value of the potential energy, when one mass-factor is unity (Webster, p. 144). This is inconsistent with the dimensions of potential as generally accepted, and as given by the authors themselves (Thomson, p. 449; Webster, p. 559). It is consistent, however, with their definition of field as a force. The negative vector-parameter of the potential function is "The strength of the field, that is, the force experienced by a unit of mass, concentrated at the point in question" (Webster, p. 144). "The electric intensity [field] is the force acting on a small body charged with unit positive charge, when placed at this point" (Thomson, p. 13). But the dimensions of field are not those of force. Electromotive force, as difference of potential, is then of course work also; we find this explicitly stated (Thomson, p. 282; Webster, p. 333). Current, again, is work as well. " $W = 4\pi i$. Thus the work [*W*] done on unit pole, when it travels round a closed curve, * * * is equal to $4\pi i$, if *i* is the strength of the current" (Thomson, p. 325). Professor Webster gives this in the form $\Omega = I\omega$

(p. 413). Here Ω is magnetic potential, *I* current and ω solid angle.

The clue to all these confusions (except the first) is the same elementary consideration. There is a failure to distinguish, in the context and in set terms, between a numerical equality, and a 'physical equation' in which the quantities equated are of the same dimensions. But a sense of such differences must be cultivated, as a part of correct physical thought; although they may be ignored sometimes for the immediate purposes of the mathematician or of numerical determinations in the laboratory. It is probable that repeated contact with statements like those cited dulls our first impression of the contradictions in them. In order to restore its vividness, we need only to construct parallel instances, with which custom has not familiarized us. Thus, density is mass; that is, the mass of a unit volume. In a similar (numerical) sense, force, or momentum, or kinetic energy is mass in special cases. I have pointed out elsewhere ('Principles of Mechanics,' p. 242) that the true dimensional relations for the electrical quantities can be preserved very simply by defining field and potential, respectively, as force and work *per unit* (in the body affected) of the measured quality that is subject to the influences of the particular field. There is no unclearness if the (dimensional) division is indicated by this verbal device or its equivalent.

F. SLATE.

UNIVERSITY OF CALIFORNIA.

THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THERE is not much to add to the information we gave last week in regard to the Glasgow meeting of the British Association. The president of the Association was directed to write a letter to the American embassy in the name of the Association, containing expressions of regret on the death of President McKinley.

The attendance was 1,912, distributed among the different classes as follows: 310 old life members, 37 new life members, 374 old annual members, 131 new annual members, 794 associates, 246 ladies and 20 foreign members. This is a smaller attendance than at the previous

Glasgow meetings of 1855 and 1876, the Glasgow Exposition and the previous meeting of the International Engineering Congress having apparently interfered with the number of new annual members and associates.

The following grants for scientific purposes amounting to £1,000 were made :

Mathematics and Physics.—Electrical standards, £40 ; seismological observations, £35 ; investigation of the upper atmosphere by means of kites, £75 ; magnetic observations at Falmouth, £80.

Chemistry.—Relation between absorption spectra and constitution of organic substances, £20 ; wave length tables, £5 ; properties of metals and alloys affected by dissolved gases, £40.

Geology.—Photographs of geological interest, £5 ; life zones in British carboniferous rocks, £10 ; exploration of Irish caves, £45.

Zoology.—Table at the Zoological Station, Naples, £100 ; index generum et specierum animalium, £100 ; migration of birds, £15 ; structure of coral reefs of Indian region, £50 ; compound sascidians of the Clyde area, £25.

Geography.—Terrestrial surface waves, £15.

Economic Science and Statistics.—Legislation regulating women's labor, £30.

Mechanical Science.—Small screw-gauge, £20 ; resistance of road vehicles to traction, £50.

Anthropology.—Silchester excavation, £5 ; ethnological survey of Canada, £15 ; age of stone circles, £30 ; anthropological teaching, £3 ; exploration in Crete, £100 ; anthropometric investigations of native Egyptian soldiers, £15 ; excavations on the Roman site at Gelligaer, £5.

Physiology.—Changes in hæmoglobin, £15 ; work of mammalian heart under influence of drugs, £20.

Botany.—Investigations of the cyanophycene, £10 ; the respiration of plants, £15.

Educational Science.—Reciprocal influence of universities and schools, £5 ; conditions of health essential to carrying on work in schools, £2.

THE FRENCH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

INFORMATION in regard to the annual meetings of the French Association for the Advancement of Science is not easy to obtain. The secretaries do not answer letters addressed to them, and the French journals contain very inadequate reports of the proceedings. The *Revue Scientifique* does indeed publish annually the address of the president and the reports of the secretary and treasurer. None of the

French journals, however, gives the programs and officers, or similar information.

The meeting this year was held at Ajaccio, in the Island of Corsica—the date is not given in any of the French journals at hand—and the president was M. E. T. Hamy, whose address was on 'The Beginnings of Anthropology in France.' The report of the secretary contains practically nothing but a list of the more eminent members who have died during the year, and a list of those on whom prizes and honors have been conferred. The report of the treasurer is the only document that gives us information in regard to the workings of the Association. This bears witness to transactions of considerable magnitude. The permanent funds of the Association amount to about \$270,000. They were increased last year by three legacies amounting to \$6,500, and two legacies have already been received this year, one of which amounts to \$6,000. It seems strange that in France, where comparatively so little is given or bequeathed for public purposes, the French Association has been given a considerable endowment which is continually increased, whereas the American Association receives practically no part of the large sums that are annually given or bequeathed for educational and scientific purposes. It seems almost certain that if those who give money understand the needs of our Association, and the fact that the French Association from the income of its invested funds is able to support over fifty researches, the American Association will soon be placed in the same condition. As regards current income from the members and its relation to the expenses, the American Association compares favorably with that of France. Though the French Association carries on its books a very large number of members, many of them apparently do not pay the annual fees, for the total receipts are only \$9,000, whereas the expenses of administration and publication are over \$10,000, and the cost of the meeting last year was \$3,000. For this meeting the City of Paris made a special subsidy.

Among the researches for which the largest appropriations have been made are: M. Turpan, for work on Hertzian waves ; M. Cheval-

lier, for the publication of his botanical researches in Africa; M. Turquan, for the publication of his work on statistics; Abbe Breuil, for paleontological researches in l'Aisne; M. Cartailhac, for prehistoric researches in Sardinia; M. Chantre, towards the publication of his work on quaternary man in the Valley of the Upper Rhône; the Paris School of Anthropology, for researches on the antiquity of man; MM. Fournier and Repelin, towards the publication of their explorations in Provence; M. Gentil, for excavations in Algeria; and M. Rivière, for researches in the caves of Mouthe.

SCIENTIFIC NOTES AND NEWS.

PROFESSOR WOLCOTT GIBBS has been appointed one of the five official representatives of Harvard University at the bi-centennial exercises of Yale University.

DR. CARROLL D. WRIGHT, U. S. Commissioner of Labor, has been elected a member of the Paris Institute of Sociology.

WILLIAM JAMES, professor of philosophy, George Lincoln Goodale, professor of natural history and director of the Botanical Garden, and Maxime Bôcher, assistant professor of mathematics, have returned to their work at Harvard after a year's leave of absence spent abroad. We regret to learn that the health of Dr. B. O. Peirce, professor of mathematics and natural philosophy, is such that it has been necessary to extend his leave of absence.

MR. FRANK B. LITTELL, of the U. S. Naval Observatory, has been appointed a professor of mathematics in the navy.

PROFESSOR H. W. CONN, of Wesleyan University, has been appointed lecturer on agricultural bacteriology at the Connecticut Agricultural College, and has been put in charge of dairy experimentation at the Storrs Experiment Station. The experimental work is to be done partly at Storrs and partly in the biological laboratory at Wesleyan University.

DR. DAVID T. DAY, chief of the department of mines and metallurgy in the St. Louis Exposition, has added these experts to the department: Professor J. A. Holmes, state geologist of North Carolina; George F. Kunz, gem expert, with Tiffany & Co., New York City; John

Birkinbine, president of the Franklin Institute, Philadelphia; E. W. Parker, editor of the *Engineering and Mining Journal*, New York City; Jefferson Middleton, geological survey, Washington, D. C., clay expert; and Charles C. Yale, Mint Bureau, San Francisco.

WE learn from *Nature* that owing to losses in the staff by death and retirement, the following appointments have been made on the Geological Survey of the United Kingdom: Dr. J. S. Flett has been selected to assist in the petrographical work of the Survey, Mr. J. Allen Howe and Mr. H. H. Thomas have been appointed geologists on the English staff, Mr. H. B. Muff on the Scottish staff and Mr. W. B. Wright on the Irish staff.

PROFESSOR W. H. HOLMES, of the U. S. National Museum, has gone to Indian Territory to make collections of Indian remains.

MR. CLOUD RUTTER, scientific assistant of the U. S. Fish Commission, is on the Pacific Coast for the purpose of gathering salmon statistics, with headquarters on the Sacramento River near Rio Vista.

MR. S. W. LOPER, curator of the museum of Wesleyan University, spent the greater part of the summer in the study of the Cambrian formation of Cape Breton Island for the United States Geological Survey. Mr. Loper made a large collection of fossils.

It is reported that Mr. H. DeWindt and Mr. George Harding will make a third attempt to accomplish an overland journey via Bering Straits between Europe and America.

THE steamship *Windward* has arrived at Newfoundland bringing Mr. Robert Stein, of Washington, and Mr. Samuel Warmbath, of Boston. The *Windward* will return next summer for Lieutenant Peary.

A TELEGRAPH from Alice Springs on July 19 states that Professor Baldwin Spencer's expedition had finished its work at Barrow Creek, where six weeks had been spent among the Kaitish and Ummatjera tribes. The next main camp was to be formed at Tennant's Creek, about 150 miles further north.

A GRANITE monument in memory of James Bowman Lindsay, an investigator and an in-

ventor who fifty years ago made experiments in connection with wireless telegraphy, was unveiled on, September 14, at Dundee, Scotland, by Sir William Preece.

WE regret to learn that Edward W. Claypole, professor of geology at Throop Institute, Pasadena, Cal., died quite suddenly at Long Beach, Cal., on August 17, aged sixty-six years. Professor Claypole was an Englishman and had degrees of A.B. and Sc.D. from the University of London. He came to this country in 1872 and through the influence of Rev. Ed. Everett Hale, was appointed professor of natural science at Antioch College, Ohio, where he served until 1881. He was paleontologist to the second Geological Survey of Pennsylvania for two years and professor of geology at Buchtel College, Ohio, from 1883 to 1897, when he sought the milder climate of Southern California in the interest of his wife's frail health. Dr. Claypole was a geologist noted on two continents. He was a fellow of the Geological Societies of London, Edinburgh and America, and a fellow of the American Association, having served at different times as both section president and secretary of geology. He had published 'The Lake Age in Ohio' and was a frequent contributor to American and foreign scientific journals.

DR. ABRAM LITTON, who for fifty years filled the chair of chemistry both at Washington University and the St. Louis Medical College, died at his home in St. Louis on September 22 aged eighty-seven years.

THE position of assistant pomologist in the Bureau of Plant Industry of the Department of Agriculture will be filled as the result of a civil service examination on November 2. The examination is entirely on the subjects of the office, and applicants are not required to be present at any special place. On October 22, an examination will be held to fill the position of assistant in the Dairying Division of the Bureau of Animal Industry at a salary of \$1,200. The examination will be held in any city in the United States where rural free delivery has been established.

THE subject of the Fiske Fund Prize Essay (\$200) for the year 1902 is 'Serumtherapy in

the Light of the Most Recent Investigations.' Further information may be obtained from the secretary of the Board of Trustees of the Fiske Fund, Dr. Halsey DeWolf, 212 Benefit Street, Providence, R. I.

MR. W. C. MILLS, curator of the Ohio State Archeological and Historical Society, has returned to Columbus, Ohio, from a successful season of exploration in various part of Ohio. He excavated the noted Adena Mound, situated in sight of Chillicothe and perhaps the largest mound in the Scioto Valley, being 26 feet high and 445 feet in circumference. The mound contained about 6,000 cubic yards, all of which was turned over and examined. Thirty-two skeletons with many implements and ornaments were found. One specimen is a very fine carving about 8 in. long, representing the human figure. In execution it is not surpassed by any of the objects found in mounds in the Scioto Valley.

THE German Mathematical Society held its annual meeting from September 22d to 28th at Hamburg in affiliation with the Congress of German Men of Science and Physicians. Twenty-one papers are to be found on the program issued in advance of the meeting, and it is stated that the Society would consider the publication of a monthly journal in the place of the present *Jahresbericht*.

WE learn from the London *Times* that the Congress of the International Association for Testing Materials was held at Budapest, from September 9 to 14, under the presidency of Professor L. von Tetmajer, and was largely attended by engineers from all parts of the world. The delegates present included four from England, 41 from Austria, three from Belgium, nine from Denmark, two from the United States, 36 from France, 152 from Hungary, 70 from Germany, three from Norway, 12 from Italy, 26 from Russia, one from Roumania, three from Spain, one from Servia, ten from Switzerland and five from Sweden. After an inaugural presidential address and address of welcome from the Hungarian authorities, a representative of each country was elected an honorary president of the congress, Mr. Bennett H. Brough being chosen for England, and Professor H. M. Howe for the United States.

The other English and American members present were: Sir William H. Bailey (Manchester), Mr. Bertram Blount (London), Dr. C. J. Renshaw (Ashton-on-Mersey), and Dr. R. Moldenke (New York). In addition to the various reports of committees dealing with technical problems, the following papers dealing with metals were read and discussed: 'On the Measurement of Internal Tension,' by Mr. Mesnager (Paris); 'On the Forms of Carbon in Iron,' by Baron Jüptner (Leoben); 'On Brinell's Researches,' by Mr. A. Wahlberg (Stockholm); 'On the Testing of Metals by Means of Notched Bars,' by M. H. Le Chatelier (Paris), by M. G. Charpy (Paris), and by Professor Belebubsky (St. Petersburg); 'On Micrographical Researches on the Deformation of Metals,' by Mr. F. Osmond (Paris); 'On Metallography,' by Mr. E. Heyn (Charlottenberg); 'On the Testing of Railway Material,' by Mr. E. Vanderheyem (Lyons); and 'On the International Iron and Steel Laboratory,' by Professor H. Wedding (Berlin). Several papers dealing with stone and mortars were also read, and an interesting lecture on the iron industry of Hungary was delivered by Professor Edvilles (Budapest).

It is now said that the German government has authorized the purchase of the astronomical instruments originally taken from Peking by the German soldiers.

IN addition to the *Lucania*, three other steamships of the Cunard Line—the *Campania*, the *Umbria* and the *Etruria*—will be fitted with Marconi's system of wireless telegraphy.

CONSUL HAYNES, of Rouen, under date of August 26, 1901, says that the metric system is compulsory in twenty countries, representing more than 300,000,000 inhabitants—Germany, Austria-Hungary, Belgium, Spain, France, Greece, Italy, Netherlands, Portugal, Roumania, Servia, Norway, Sweden, Switzerland, Argentine Republic, Brazil, Chile, Mexico, Peru, and Venezuela—and advises American exporters in dealing with any of these countries to adopt the system.

WE learn from the *Electrical World* that the International Statistical Institute will hold this year in Budapest, from September 20 until

October 5, an international exhibit of all kinds of machines and instruments which facilitate work with figures. The aim of the exhibit is to furnish to the most competent representatives of scientific and practical statistics assembled from different parts of the world the opportunity of gathering personal information about this kind of technical construction. The exhibit will include all kinds of inventions, engines and apparatus which are intended to facilitate work with figures in general, and especially those which are devised to facilitate the compilation of statistical data and to perform the necessary proportional calculations, and to accelerate and render more economical statistical labor; especially machines for adding, multiplying, dividing, tabulators, accounting machines for the combined compilation of data, etc.

It is announced that a commission, to be presided over by Sir Colin Scott-Moncrieff, is being appointed to lay down rules for control of irrigation works in India. In connection with this announcement the London *Times* quotes figures given in the annual review of irrigation issued recently in India. From them it appears that 22 of the large productive works realized a net revenue amounting to 9.52 per cent. on the capital outlay, while 13 others yielded only 0.79 per cent., reducing the average return to 7 per cent. The total area of the crops irrigated or protected exceeded 18½ millions of acres, being an increase of over three quarters of a million during the year. The principal enhancements were in respect to the Punjab canals, the area irrigated there exceeding all previous records by over 300,000 acres, while the net return on capital in respect to that province was as high as 10.24 per cent. Still more gratifying results may be looked for in the current year, since the great Jehlum Canal, begun in the autumn of 1898, is to be formally opened in October, and will irrigate a vast tract of country lying between the Chenab and Jehlum rivers, a great portion of which has hitherto lain waste. Other large projects are being carried out in the Punjab, and will, when ready, be worked on the lines so successfully adopted in the case of the Chenab colonies. The total surplus revenue earned since irrigation works were undertaken by government has been nearly ten millions

sterling. This is the purely financial result of irrigation, regarded as an investment, and the figure quoted has no reference to its economic value in increasing food supplies, in preventing famine, and in strengthening the position of the owners and occupiers of the land. Neither does it take into account the increase of land revenue received by the State, as a result of bringing waste tracts under cultivation.

UNIVERSITY AND EDUCATIONAL NEWS.

THE Severance Chemical Laboratory of Oberlin College was dedicated on September 26, the address being made by President Ira Remsen, of the Johns Hopkins University. At the conclusion of the dedicatory exercises it was announced that Mr. Lewis Severance, of New York City, the donor of the laboratory, had given the sum of \$40,000 for an endowment for the chair of chemistry.

THE University of Southern California at Los Angeles has obtained the \$100,000, of which \$25,000 was offered by Mrs. Anna Hough on condition that the balance be given. Mrs. Hough has now offered \$40,000 towards a second \$100,000.

BY the will of the late Mrs. Martha Callahan, \$20,000 is bequeathed to Tuskegee Normal and Industrial Institute of Tuskegee, Ala.

PROFESSOR GOLDWIN SMITH has given \$10,000 to the library of the University of Toronto.

AT a recent meeting of the corporation of Yale University it was decided that the house which Professor O. C. Marsh bequeathed to the University and which is now occupied by the Forest School shall be known officially as Marsh Hall, and the grounds about it as the Yale Botanical Garden.

AT the spring meeting of the trustees of Colby College, Waterville, Me., the department of geology was abolished, and it was decided that henceforth the teaching of geology should be by the assistant in chemistry. The determination was taken suddenly, the reason assigned for the action being purely a financial one. The abolition of the department necessarily legislates Dr. W. S. Bayley from the position which he has held during the past twelve years.

DR. STURGIS, of the Connecticut Agricultural Experiment Station, Professor Brinton, the State entomologist, and Professor Hopkins, of West Virginia University, have been appointed special lecturers in the Yale Forest School.

MR. EUGENE L. LEHNERT, of Clinton, Mass., has been elected professor of veterinary medicine at the Agricultural College at Storrs.

AT the Western Reserve University, Dr. F. W. Reichmann, of the University of Chicago, has been appointed instructor in physics; Dr. O. F. Tower has been promoted to be associate professor of chemistry.

DR. CHARLES M. HAZEN has been appointed professor of biology in Richmond College, at Richmond, Va.

THE following appointments have been made at the Illinois College, Jacksonville, Ill.: J. Bishop Tingle, Ph.D. (Munich), instructor of chemistry at the Lewis Institute, Chicago, to be professor of chemistry. J. B. Overton, Ph.D. (Chicago), graduate assistant in botany in the University of Chicago, to be professor of biology. J. H. Hall, Ph.D. (Yale), assistant in the University of Chicago, to be assistant professor of physics.

MISS S. M. HALLOWELL, professor of botany at Wellesley College, has been given leave of absence for the year and the work of the department will be under Miss Clara E. Cummings, assistant professor of botany.

EDWARD C. SCHNEIDER, Ph.D. (Yale, 1901), has been appointed to take charge of the work in biology at Tabor College, Tabor, Iowa.

MR. R. M. FERRIER, B.Sc. (Glasgow), M.Sc. (Durham), has been appointed to the chair of engineering at University College, Bristol, in succession to Dr. Stanton, who has received the appointment of superintendent of the engineering department in the National Physical Laboratory.

DR. ROKURO NAKASEKO, who has been the recipient of a University Fellowship at Yale during the past two years, has returned to Kyoto, Japan, to take charge of the instruction in physiological chemistry in the Scientific School there.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

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FRIDAY, OCTOBER 11, 1901.

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THE FISH FAUNA OF JAPAN, WITH OBSERVATIONS ON THE GEOGRAPHICAL DISTRIBUTION OF FISHES.*

THE JAPANESE FISH FAUNA.

THE group of islands which constitute the empire of Japan is remarkable for the richness of its animal life. Its variety in climatic and other conditions, its nearness to the great continent of Asia and to the chief center of marine life, the East Indian Islands, its relation to the warm Black current or Kuro Shiwo from the south and to the cold currents from the north, all tend to give variety and richness to the fauna of its seas. Especially is this true in the group of fishes. In spite of the political isolation of the Japanese Empire, this fact has been long recognized and the characteristic types of Japanese fishes have been well known to naturalists.

NUMBERS OF SPECIES OF JAPANESE FISHES.

At present about 900 species of fishes are known from the four great islands which constitute Japan proper, Hondo, Hokkaido, Kiusiu and Shikoku. About 200 others are known from the volcanic islands to the north and south. Of these 1,100 species, about fifty belong to the fresh waters. These are all closely allied to forms found

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on the mainland of Asia, from which region all of them were originally derived.

FRESH-WATER FAUNAL AREAS.

Two faunal areas of fresh waters may be fairly distinguished, although broadly overlapping. The northern region includes the island of Hokkaido and the middle and northern part of the great island of Hondo. In a rough way, its southern boundary may be defined by Fuji Yama and the Bay of Matsushima. It is characterized by the presence of salmon, trout and sculpins, and northward by sturgeon and brook-lampreys. The southern area loses by degrees the trout and other northern fishes, while in its clear waters abound various minnows, gobies and the famous ayu, or Japanese dwarf salmon, one of the most delicate of food fishes. Sculpins and lampreys give place to minnows, loaches and chubs. Two genera, a sculpin* and a perch,† are confined to this region and seem to have originated in it, but like the other species, form a Chinese stock.

ORIGIN OF JAPANESE FRESH-WATER FISHES.

The question of the origin of the Japanese river fauna seems very simple. All the types are Asiatic. While most of the Japanese species are distinct, their ancestors must have been estrays from the mainland. To what extent river fishes may be carried from place to place by currents of salt water has never been ascertained. One of the most widely distributed of Japanese river fishes is the large hakone dace or chub. ‡ This has been repeatedly taken by us in the sea at a distance from any stream. It would evidently survive a long journey in salt water. An allied species § is found in the midway island of Tsushima, between Korea and Japan.

* *Trachidermis*.

† *Bryttosus*.

‡ *Leuciscus hakuensis* Günther.

§ *Leuciscus jouyi*.

FAUNAL AREAS OF MARINE FISHES.

The distribution of the marine fishes of Japan is mainly controlled by the temperature of the waters and the motion of the ocean currents. Five faunal areas may be more or less clearly recognized, and these may receive names indicating their scope, Kurile, Hokkaido, Nippon, Kiusiu, Kuro Shiwo and Riu Kiu. The first or Kurile district is frankly sub-Arctic, containing species characteristic of the Ochotsk Sea on the one hand, and of Alaska on the other. The second or Hokkaido* district includes this northern island and that part of the shore of the main island of Hondo† which lies to the north of Matsushima and Noto. Here the cold northern currents favor the development of a northern fauna. The herring and the salmon occupy here the same economic relation as in Norway, Scotland, Newfoundland and British Columbia. Sculpins, blennies, rockfish and flounders abound off the rocky shores and are seen in all the markets.

South of Matsushima Bay and through the Inland Sea as far as Kobe, the Nippon fauna is distinctly one of the temperate zone. Most of the types characteristically Japanese belong here, abounding in the sandy bays and about the rocky islands.

About the islands of Kiusiu and Shikoku, the semi-tropical elements increase in number and the Kiusiu fauna is less characteristically Japanese, having much in common with the neighboring shores of China, while some of the species range northward from India and Java. But these faunal districts have no sharp barriers. Northern fishes,‡ unquestionably of Alaskan origin, range as far south as Nagasaki, while certain semi-

* Formerly, but no longer, called Yeso in Japan.

† Called Nippon on foreign maps, but not so in Japan. where Nippon means the whole empire.

‡ *Pleuronichthys cornutus*; *Hexagrammos otakii*; *Ozorthe hexagramma*, etc.

tropical* types extend their range northward to Hakodate and Volcano Bay. The Inland Sea, which in a sense bounds the southern fauna, serves at the same time as a means of its extension. While each species has a fairly definite northern or southern limit, the boundaries of a faunal district as a whole must be stated in the most general terms.

The well-known boundary called Blackiston's Line, which passes through the Straits of Tsugaru, between the two great islands of Hondo and Hokkaido, marks the northern boundary of monkeys, pheasants and most tropical and semi-tropical birds and mammals of Japan. But as to the fishes, either marine or fresh water, this line has no significance. The northern fresh-water species probably readily cross it; the southern rarely reach it.

We may define as a fourth faunal area that of the Kuro Shiwo district itself, which is distinctly tropical and contrasts strongly with that of the inshore bays behind it. This warm 'Black Current,' analogous to our Gulf Stream, has its origin in part from a return current from the east, which passes westward through Hawaii, in part from a current which passes between Celebes and New Guinea. It moves northward by way of Luzon and Formosa, touching the east shores of the Japanese islands Kiusiu and Shikoku, to the main island of Hondo, flooding the bays of Kagoshima and Kochi, of Waka, Suruga and Sagami. The projecting headlands reach out into it and the fauna of their rock pools is distinctly tropical, as far to the northward as Tokio.

These promontories of Hondo, Waka, Ise, Izu, Misaki and Awa have essentially the same types of fishes as are found on the reefs of tropical Polynesia. The warmth of the off-shore currents gives the fauna of

Misaki its astonishing richness, and the wealth of life is by no means confined to the fishes. Corals, crustaceans, worms and molluscs show the same generous profusion of species.

A fifth faunal area, closely related to that of the Black Current, is formed by the volcanic and coral reefs of the Riu Kiu Archipelago. This fauna, so far as known, is essentially East-Indian, the genera and most of the species being entirely identical with those of the islands about Java and Celebes.

RESEMBLANCE OF THE JAPANESE AND MEDITERRANEAN FISH FAUNAS.

It has been noted by Dr. Günther that the fish fauna of Japan bears a marked resemblance to that of the Mediterranean. This likeness is shown in the actual identity of genera and species, and in their relation to each other. This resemblance he proposes to explain by the hypothesis that, at some recent period, the two regions, Japan and the Mediterranean, have been united by a continuous shore-line. The far-reaching character of this hypothesis demands a careful examination of the data on which it rests.

The resemblance of the two faunal areas, so far as fishes are concerned, may be stated as follows: There are certain genera* of shore fishes, tropical or semi-tropical, common to the Mediterranean and Japan, and wanting to California, Panama and the West Indies, and in most cases to Polynesia also. Besides these, certain others, found in deeper water (100 to 200 fathoms) are common to the two areas,† and have been rarely taken elsewhere.

* Of these, the principal ones are *Oxystomus*, *Myrus*, *Pagrus*, *Sparus*, *Macrorhamphosus*, *Cepola*, *Callionymus*, *Zeus*, *Uranoscopus*, *Lepidotrigla*, *Chelidonichthys*.

† Among these are *Beryx*, *Helicolenus*, *Lotella*, *Nettastoma*, *Centrolophus*, *Hoplostethus*, *Aulopus*, *Chlorophthalmus*, *Lophotes*.

* As *Halichoeres*, *Tetrapturus*, *Callionymus*, *Ariscopus*, etc.

SIGNIFICANCE OF RESEMBLANCE.

The significance of these facts can be shown only by a fuller analysis of the fauna in question, and those of other tropical and semi-tropical waters. If the resemblances are merely casual, or if the resemblances are shown by other regions, the hypothesis of shore continuity would be unnecessary or untenable. It is tenable if the resemblances are so great as to be accounted for in no other way.

Of the genera regarded as common, only two* or three are represented in the two regions by identical species, and these have a very wide distribution in the warm seas. Of the others, nearly all range to India, to the Cape of Good Hope, to Australia or to Brazil. They may have ranged farther in the past; they may even range farther at present. At the most, but two † are confined to the two districts in question. As equally great resemblances exist between Japan and Australia or Japan and the West Indies, the case is not self-evident, without fuller comparison. I shall, therefore, ask your attention to a somewhat fuller analysis of the evidence bearing on this and similar problems, with a view to the conclusions which may be legitimately drawn from the facts of fish distribution.

DIFFERENCES BETWEEN JAPANESE AND
MEDITERRANEAN FISH FAUNAS.

We may first, after admitting the alleged resemblances and others, note that differences are equally marked. In each region are a certain number of genera which we may consider as autochthonous. These genera are represented by many species or by many individuals in the region of their supposed origin, but are more scantily developed elsewhere. Such genera in Mediterranean waters are *Crenilabrus*, *Labrus*, *Spicara*, *Pagellus*, *Mullus*, *Boopis*, *Spondylosoma*,

* *Beryx*, *Hoplostethus* and perhaps *Macrorhamphosus*.

† *Lepadogaster*, *Myrus*.

Oblata. None of these occurs in Japan nor have they any near relatives there. Japanese autochthonous types, as *Pseudoblennius*, *Dymæria*, *Anoplus*, *Histioplerus*, *Monocentrus*, *Oplegnathus*, *Plecoglossus*, range southward to the Indies or to Australia, but all of them are totally unknown to the Mediterranean. The multifarious genera of Gobies of Japan show very little resemblance to the Mediterranean fishes of this family, while blennies, labroids, scaroids and scorpenoids are equally diverse in their forms and alliances. To the same extent that likeness in faunæ is produced by continuity of means of dispersion, is it true that unlikeness is due to breaks in continuity. Such a break in continuity of coast-line, in the present case, is the Isthmus of Suez, and the unlikeness in the faunas is about what such a barrier should produce.

SOURCES OF FAUNAL RESEMBLANCES.

There are two main sources of faunal resemblances; first, the absence of barriers permitting the actual mingling of the species; second, the likeness of temperature and shore configuration favoring the development of the same or analogous types. If the fish faunæ of different regions have mingled in recent times, the fact would be shown by the presence of the same species in each region. If the union were of a remote date, the species would be changed, but the genera might remain identical.

In case of close physical resemblances in different regions, as in the East Indies and West Indies, like conditions would favor the lodgment of like types, but the resemblance would be general, the genera and species being unlike. Without doubt, part of the resemblance between Japan and the Mediterranean is due to similarity of temperature and shores. Is that which remains sufficient to demand the hypothesis of a former shore-line connection?

EFFECTS OF DIRECTION OF SHORE-LINE.

We may first note that a continuous shore-line produces a mingling of fish-faunas only when not interrupted by barriers due to climate. A north and south coast-line, like that of the East Pacific, however unbroken, permits great faunal differences. It is crossed by the different zones of temperature. An east and west shore-line lies in the same temperature. In all cases of the kind which now exist on the earth (the Mediterranean, the Gulf of Mexico, the Caribbean Sea, the shores of India), even species will extend their range as far as the shore-line goes. The obvious reason is because such a shore-line rarely offers any important barrier to distribution, checking dispersion of species. We may, therefore, consider the age and nature of the Isthmus of Suez and the character of the faunas it separates.

NUMBERS OF GENERA IN DIFFERENT FAUNAS.

For our purposes, the genera must be rigidly defined, a separate name being used in case of each definable difference in structure. The wide-ranging genera of the earlier systematists were practically cosmopolitan, and their distribution teaches us little. Using the modern definition of genus, we find in Japan 483 genera of marine fishes; in the Red Sea, 225; in the Mediterranean, 231. In New Zealand 150 are recorded; in Hawaii, 171; 357 from the West Indies, 187 from the Pacific coast of tropical America, 300 from India, 450 from the East-Indian islands and 427 from Australia.

Of the 483 genera ascribed to Japan, 156 are common to the Mediterranean also, 188 to the West Indies and Japan, 169 to the Pacific coast of the United States and Mexico. With Hawaii Japan shares 90 genera, with New Zealand 62; 204 are common to Japan and India, 148 to Japan and the Red Sea, most of these being found

in India also. 200 genera are common to Japan and Australia.

AFFINITIES OF JAPANESE FAUNA.

From this, it is evident that Japan and the Mediterranean have much in common, but apparently not more than Japan shares with other tropical regions. Japan naturally shows most likeness to India, and next to this to the Red Sea. Proportionately less is the resemblance to Australia, and the likeness to the Mediterranean seems much the same as that to the West Indies, or to the Pacific coast of America.

But, to make these comparisons just and effective, we should consider not the fish fauna as a whole; we should limit our discussion solely to the forms of equatorial origin. From the fauna of Japan we may eliminate all the genera of Alaskan-Aleutian origin, as these could not be found in the other regions under comparison. We should eliminate all pelagic and all deep-sea forms, for the laws which govern the distribution of these are very different from those controlling the shore fishes, and most of the genera have reached a kind of equilibrium over the world.

SIGNIFICANCE OF RARE FORMS.

We may note also, as a source of confusion in our investigation, that numerous forms found in Japan and elsewhere are very rarely taken, and their real distribution is unknown. Some of these will be found to have, in some unexpected quarter, their real center of dispersion. In fact, since these pages were written, I have taken in Hawaii representatives of three* genera which I had enumerated as belonging chiefly to Japan and the West Indies. Such species may inhabit oceanic plateaus, and find many halting places in their circuit of the tropical oceans. We have already discovered that

* *Antigonia*, *Etelis*, *Emmelichthys*.

Madeira, St. Helena, Ascension and other volcanic islands constitute such halting places. We shall find many more such, when the deeper shore regions are explored, the region between market-fishing and the deep-sea dredgings of the *Challenger* and the *Albatross*. In some cases, no doubt, these forms are verging on extinction and a former wide distribution has given place to isolated colonies.

The following table shows the contents, so far as genera are concerned, of those equatorial areas in which trustworthy catalogues of species are accessible. It includes only those fishes, of stationary habit, living in less than 200 fathoms. It goes without saying that considerable latitude must be given to these figures, to allow for errors, omissions, uncertainties and differences of opinion.

DISTRIBUTION OF SHORE FISHES.

A. Japan and the Mediterranean.

Genera * chiefly confined to these regions.	2
Genera of wide distribution.....	77
Total of common genera.....	79
Total in both regions.....	399
Genera above included, found in all equatorial regions.....	55
Genera † found in most equatorial regions.....	11
Genera more or less restricted.....	13
	79

B. Japan and the Red Sea.

Genera ‡ chiefly confined to these two regions.....	2
Genera of wide distribution.....	109
Total genera common.....	111
Total in both regions.....	424

* *Lepadogaster*, *Myrus*; *Lophotes*, thus far recorded from Japan, the Mediterranean and the Cape of Good Hope is bassalian and of unknown range. *Beryx*, *Trachichthys*, *Hoplostethus*, etc., are virtually cosmopolitan as well as semi-bassalian.

† In this group we must place *Cepola*, *Callionymus*, *Pagrus*, *Sparus*, *Beryx*, *Zeus*, all of which have a very wide range in Indian waters.

‡ *Cryptocentrus*, *Asterropteryx*. The range of neither of these genera of small shore fishes is yet well known.

C. Japan and Hawaii.

Genera * chiefly confined to these regions	3
Genera of wide distribution.....	79
Total genera common.....	82
Total in both regions.....	396

D. Japan and Australia.

Genera chiefly confined to these regions..	13
Genera of wide distribution (chiefly East-Indian).....	122
Total genera common.....	135
Total in both regions.....	533

E. Japan and Panama.

Genera † chiefly confined to these regions	2
Genera of wide distribution.....	89
Total genera common.....	91
Total in both regions.....	499

F. Japan and the West Indies.

Genera ‡ chiefly confined to these regions	5
Genera of wide distribution.....	108
Total genera common.....	113
Total in both regions.....	520

G. The Mediterranean and the Red Sea.

Genera confined to the Suez region.....	0
Genera of wide distribution (chiefly Indian).....	40
Total genera common.....	40
Total in both regions.....	295

H. West Indies and the Mediterranean.

Genera chiefly confined to the equatorial Atlantic.....	11
Genera of wide distribution.....	59
Total.....	70
Total in both regions.....	373

I. West Indies and Panama.

Genera chiefly confined to equatorial America.....	68
Genera of wide distribution.....	101
Total genera common.....	169
Total in equatorial America.....	376

J. Hawaii and Panama.

Genera chiefly confined to the regions in question.....	3
Genera § of wide distribution.....	74
Total genera common.....	77
Total in both regions.....	323

* *Pikea*, *Eumycterias*, *Engyprosopron*.

† *Bairdiella*, *Aboma*. The occurrence of *Bairdiella acanthodes* in Japan needs verification.

‡ *Scombrops*, *Polymixia*, *Pseudopriacanthus*, *Antigonia*, *Chaunax*. All these genera are semi-bassalian.

§ *Sectator*, *Chænomugil*, *Garmannia*.

K. Hawaii and the East Indies.

Genera* chiefly confined to Hawaii.....	4
Genera of wide distribution in the equatorial Pacific.....	123
Genera† confined to Hawaii and the West Indies	1

Summary.

Genera (shore fishes only) in the Mediterranean Sea.....	144
Genera in the Red Sea.....	191
Genera in India.....	230
Genera in Japan (exclusive of northern forms).....	334
Genera in Australia.....	344
Genera in New Zealand.....	108
Genera in Hawaii.....	144
Genera about Panama.....	256
Genera in West Indies.....	299

EXTENSION OF INDIAN FAUNA.

From the above tables it is evident that the warm-water fauna of Japan, as well as that of Hawaii, is derived from the great body of the fauna of the East Indies and Hindostan; that the fauna of the Red Sea is derived in the same way; that the fauna of the Mediterranean bears no especial resemblance to that of Japan, rather than to other elements of the East Asiatic fauna in similar conditions of temperature, and no greater than is borne by either to the West Indies; that the faunas of the sides of the Isthmus of Suez have relatively little in common, while those of the two sides of the Isthmus of Panama show large identity of genera, although few species are common to the two sides. Of the 255 genera recorded from the Panama region, 179, or over 70 per cent., are also in the West Indies; while 68, or more than 30 per cent. of the number, are limited to the two regions in question.

THE ISTHMUS OF SUEZ AS A BARRIER TO DISTRIBUTION.

With the aid of the above table, we may examine further the relation of the fauna

* *Holotrachys, Cirrhitops, Perkinsia.*

† *Malacanthus.*

of Japan to that of the Mediterranean. If a continuity of shore-line once existed, it would involve the obliteration of the Isthmus. With free connection across this isthmus, the fauna of the Red Sea must have been once practically the same as that of the Mediterranean. The present differences must be due to later immigrations to one or the other region, or to the extinction of species in one locality or the other, through some kind of unfitness. In neither region is there evidence of extensive immigration from the outside. The present conditions of water and temperature differ a little, but not enough to explain the difference in fauna. The Red Sea is frankly tropical and its fauna is essentially Indian, much the same, so far as genera are concerned, as that of Southern Japan. The Mediterranean is at most not more than semi-tropical and its fishes are characteristically European. Its tropical forms belong rather to Guinea than to the East Indies. With the Red Sea the Mediterranean has very little in common, not so much, for example, as has Hawaii. Forty genera of shore fishes (and only fifty of all fishes) are identical in the two regions, the Mediterranean and the Red Sea. Of those, every one is a genus of wide distribution, found in nearly all warm seas. Of shore fishes, only one genus in seven is common to the two regions. Apparently, therefore, we cannot assume a passage across the Isthmus of Suez within the lifetime of the present genera. Not one of the types alleged to be peculiar to Japan and the Mediterranean is thus far known in the Red Sea. Not one of the characteristically abundant Mediterranean types* crosses the Isthmus of Suez, and the distinctive Red Sea and Indian types† are equally

* As *Crenilabrus, Labrus, Symphodus, Pagellus, Spondyliosoma, Sparisoma.*

† As *Chætodon, Lethrinus, Sphærodon, Abudedefduf,* etc.

wanting in the Mediterranean. The only genera which could have crossed the Isthmus are certain shallow-water or brackish-water forms, sting-rays, torpedoes, sardines, eels and mullets, widely diffused through the East Indies and found also in the Mediterranean. The former channel if one ever existed, had, therefore, much the same value in distribution of species, as the present Suez Canal.

GEOLOGICAL EVIDENCE OF SUBMERSION OF THE ISTHMUS OF SUEZ.

Yet, from geological data, there is strong evidence that the Isthmus of Suez was submerged in relatively recent times. The recognized geological maps of the Isthmus show that a broad area of post-Pliocene or Pliocene deposits constitutes the Isthmus and separates the nummulitic hills of Suez from their fellows about thirty miles to the eastward. The northern part of the Isthmus is alluvium from the Nile, and its western part is covered with drifting sands. The Red Sea once extended farther north than now and the Mediterranean farther to the southeast. Assuming the maps to be correct, the Isthmus must have been open water in the late Pliocene or post-Pliocene times.

Admitting this as a fact, the difference in the fish fauna shows that the waters over the submerged area must have been so shallow that rock-loving forms did not and could not cross it. Moreover, the region must have been overspread with silt-bearing fresh waters from the Nile. To such fishes as *Chatodon*, *Holocentrus*, *Thalassoma*, of the Red Sea, or to *Crenilabrus*, *Boops* and *Zeus*, of the Mediterranean, such waters would form a barrier as effective as the sand-dunes of to-day.

CONCLUSIONS AS TO THE ISTHMUS OF SUEZ.

We are led, therefore, to these conclusions:

1. There is no evidence, derivable from the fishes, of the submergence of the Isthmus of Suez.

2. If the isthmus was submerged in Pliocene or post-Pliocene times, the resultant channel was shallow and muddy, so that ordinary marine fishes or fishes of rock bottoms, or of deep waters, did not cross it.

3. It formed an open water to brackish-water fishes only.

4. The types common to Japan and the Mediterranean did not enter either region from the other, by way of the Red Sea.

5. As most of these are found also in India or Australia or both, their dispersion was probably around the south coast of Africa or by the Cape of Good Hope.

THE CAPE OF GOOD HOPE AS A BARRIER TO FISHES.

The fishes of the Cape of Good Hope are not well enough known for close comparison with those of other regions. Enough is known of the Cape fauna to show its general relation to those of India and Australia. The Cape of Good Hope lies in the South Temperate zone. It offers no absolutely impassable barrier to the tropical fishes from either side. It bears a closer relation to either the Red Sea or the Mediterranean than they bear to each other. It is, therefore, reasonable to conclude that the transfer of tropical shore fishes of the Old World between the Atlantic and Pacific, in recent times, has taken place mainly around the southern point of Africa. To pelagic and deep-sea fishes the Cape of Good Hope has offered no barrier whatever. To ordinary fishes it is an obstacle, but not an impassable one. This the fauna itself shows. It has, however, not been passed by many tropical species, and by these only as the result of thousands of years of struggle and point-to-point migration.

RELATIONS OF JAPAN TO MEDITERRANEAN
EXPLAINABLE BY PRESENT CONDITIONS.

We may conclude that the resemblance of the Mediterranean fish fauna to that of Japan or India is no more than might be expected, the present contour of the continents being permanent for the period of duration of the present genera and species. The imagined removal of barriers on any large scale would necessitate much closer resemblances than those which actually exist.

THE ISTHMUS OF PANAMA AS A BARRIER
TO DISTRIBUTION.

Conditions in some regards parallel with those of the Isthmus of Suez exist in but one other region—the Isthmus of Panama.

IDENTITY OF GENERA ON TWO SHORES OF
THE ISTHMUS OF PANAMA.

Here the first observers were very strongly impressed by the resemblance of forms. Nearly half the genera found on the two sides of this isthmus are common to both sides. Taking those of the Pacific shore for first consideration, we find that three fourths of the genera of the Panama fauna occur in the West Indies as well.

This identity is many times greater than that existing at the Isthmus of Suez. Moreover, while the Cape of Good Hope offers no impassable barrier to distribution, the same is not true of the southern part of South America. The subarctic climate of Cape Horn has doubtless formed a complete check to the movements of tropical fishes for a vast period of geologic time.

UNLIKENESS OF SPECIES ON THE SHORES OF
THE ISTHMUS OF PANAMA.

But curiously enough, this marked resemblance is confined chiefly to the genera and does not extend to the species on the two shores.

Of 1,400 species of fishes recorded from tropical America north of the Equator, only about 70 are common to the two coasts. The number of shore fishes common is still less. In this 70 are included a certain number of cosmopolitan types which might have reached either shore from the Old World.

A few others invade brackish or fresh waters and may possibly have found their way, in one way or another, across the Isthmus of Nicaragua. Of fishes strictly marine, strictly littoral, and not known from Asia or Polynesia, scarcely any species are left as common to the two sides. This seems to show that no waterway has existed across the isthmus within the lifetime, whatever that may be, of the existing species. The close resemblance of genera shows apparently with almost equal certainty that such a waterway has existed, and within the period of existence of the groups called genera. How long a species of fish may endure unchanged no one knows, but we know that in this regard great differences must exist in different groups. Assuming that different species crossed the Isthmus of Panama in Miocene times, we should not be surprised to find that a few remain to all appearances unchanged; that a much larger number have become 'representative' species, closely related forms retaining relations to the environment to those of the parent form, and, finally, that a few species have been radically altered.

This is exactly what has taken place at the Isthmus of Panama with the marine shore fishes. Curiously enough, the movement of genera seems to have been chiefly from the Atlantic to the Pacific. Certain characteristic genera* of the Panama region have not passed over to the Pacific. On the

**Hoplopagrus*, *Xenichthys*, *Xenistius*, *Xenocypris*, *Microdesmus*, *Cerdale*, *Cratinus*, *Azevia*, *Microlepidotus*, *Orthostachus*, *Isaciella*, etc.

other hand, most of the common genera* show a much larger number of species on the Atlantic side. This may be held to show their Atlantic origin.

Of the relatively small number of genera which Panama has received from Polynesia, few † have crossed the Isthmus to appear in the West Indian fauna.

GÜNTHER ON THE ISTHMUS OF PANAMA.

The elements of the problem at Panama may be better understood by a glance at the results of previous investigations.

In 1869 Dr. Günther, after enumerating the species examined by him from Panama, reaches the conclusion that nearly one third of the marine fishes on the two shores of tropical America will be found to be identical. He enumerates 193 such species as found on the two coasts; 59 of these, or 31 per cent. of the total, being actually identical. From this he infers that there must have been, at a comparatively recent date, a depression of the Isthmus and intermingling of the two faunas.‡

OBSERVATIONS IN 1885.

In an enumeration of the fishes of the Pacific coast in 1885,§ the present writer showed that Dr. Günther's conclusions were based on inadequate data.

In my list, 407 species were recorded from the Pacific coast of tropical America—twice the number enumerated by Dr. Günther. Of these, 71 species, or 17½ per cent., were found also in the Atlantic. About 800 species are known from the Caribbean and adjacent shores, so that out of the total

* *Hæmulon*, *Anisotremus*, *Gerres*, *Centropomus*, *Galeichthys*, *Hypoplectrus*, *Mycteroperca*, *Ulaema*, *Stellifer*, *Micropogon*, *Bodianus*, *Microspathodon*.

† Among these are perhaps *Teuthis* (*Acanthurus*), *Ilisha*, *Salarias*, *Myripristis*, *Thalassoma*. Some such which have not crossed the Isthmus are *Cirrhitides*, *Secutor*, *Sebastes* and *Lophiomus*.

‡ 'Fishes of Central America,' 1869, 397.

§ *Proc. U. S. Nat. Mus.*, 1885, 393.

number of 1,136 species, but 71, or 6 per cent. of the whole, are common to the two coasts. This number does not greatly exceed that of the species common to the West Indies and the Mediterranean, or even the West Indies and Japan. It is to be noted also that the number 71 is not very definitely ascertained, as there must be considerable difference of opinion as to the boundaries of species, and the actual identity in several cases is open to doubt.

This discrepancy arises from the comparatively limited representation of the two faunæ at the disposal of Dr. Günther. He enumerates 193 marine or brackish-water species as found on the two coasts, 59 of which are regarded by him as specifically identical, this being 31 per cent. of the whole. But in 30 of these 59 cases, I regard the assumption of complete identity as erroneous; so that taking the number 193, as given, I would reduce the percentage to 15. But these 193 species form but a fragment of the total fauna, and any conclusion based on such narrow data is certain to be misleading.

Of the 71 identical species admitted in our list, several (*e. g.*, *Mola*, *Thunnus*) are pelagic fishes common to most warm seas. Still others (*e. g.*, *Trachurus*, *Carangus*, *Diodon* sp.) are cosmopolitan in the tropical waters. Most of the others (*e. g.*, *Gobius*, *Gerres*, *Centropomus*, *Galeichthys* sp., etc.) often ascend the rivers of the tropics, and we may account for their diffusion, perhaps, as we account for the dispersion of fresh-water fishes on the isthmus, on the supposition that they may have crossed from marsh to marsh at some time in the rainy season.

In very few cases are representatives of any species from opposite sides of the Isthmus exactly alike in all respects. These differences in some cases seem worthy of specific value, giving us 'representative species' on the two sides. In other cases, the distinctions are very trivial, but in

most cases they are appreciable, especially in fresh specimens.

Further, I expressed the belief that "fuller investigation will not increase the proportion of common species. If it does not, the two faunas show no greater resemblance than the similarity of physical conditions on the two sides would lead us to expect."

This conclusion must hold so far as species are concerned, but the resemblance in the list of genera is too great to be accounted for in this way.

OBSERVATIONS OF DR. GÜNTHER.

In 1880 * Dr. Günther expressed his views in still stronger language, claiming a still larger proportion of the fishes of tropical America to be identical on the two sides of the continent. He concluded that "with scarcely any exceptions the genera are identical, and of the species found on the Pacific side, nearly one half have proved to be the same as those of the Atlantic. The explanation of this fact has been found in the existence of communications between the two oceans by channels and straits which must have been open till within a recent period. The isthmus of Central America was then partially submerged, and appeared as a chain of islands similar to that of the Antilles; but as the reef-building corals flourished chiefly north and east of these islands and were absent south and west of them, reef fishes were excluded from the Pacific shores when the communications were destroyed by the upheaval of land."

CONCLUSIONS OF EVERMANN AND JENKINS.

This remark led to a further discussion of the subject on the part of Dr. B. W. Evermann and Dr. O. P. Jenkins. From their paper on the fishes of Guaymas† I make the following quotations:

* 'Introduction to the Study of Fishes,' 1880, p. 280.

† *Proc. U. S. Nat. Mus.*, 1891, pp. 124-126.

"The explorations since 1885 have resulted, (1) in an addition of about one hundred species to one or other of the two faunæ; (2) in showing that at least two species that were regarded as identical on the two shores* are probably distinct; and (3) in the addition of but two species to those common to both coasts.†

"All this reduces still further the percentage of common species.

"Of the one hundred and ten species obtained by us, 24, or less than 21 per cent., appear to be common to both coasts. Of these 24 species, at least 16, from their wide distribution, would need no hypothesis of a former waterway through the isthmus to account for their presence on both sides. They are species fully able to arrive at the Pacific shores of the Americas from the warm seas west. It thus appears that not more than eight species, less than 8 per cent. of our collection, all of which are marine species, require any such hypothesis to account for their occurrence on both coasts of America. This gives us, then, 1,307 species that should properly be taken into account when considering this question, not more than 72 of which, or 5.5 per cent., seem to be identical on the two coasts. This is very different from the figures given by Dr. Günther in his 'Study of Fishes.'

"Now, if from these 72 species, admitted to be common to both coasts, we subtract the 16 species of wide distribution—so wide as to keep them from being a factor in this problem—we have left but 56 species common to the two coasts that bear very closely upon the waterway hypothesis. *This is less than 4.3 per cent. of the whole number.*"

"But the evidence obtained from a study

* *Citharichthys spilopterus* and *C. gilberti*.

† *Hæmulon steindachneri* and *Gymnothorax castaneus* of the west coast probably being identical with *H. schranki* and *Gymnothorax funebris* of the east coast.

of other marine life of that region points to the same conclusion."

"In 1881, Dr. Paul Fischer discussed the same question in his 'Manual de Conchyliologie,' pp. 168-169, in a section on the Molluscan Fauna of the Panamic Province, and reached the same general conclusions. He says: 'Les naturalistes Américiens se sont beaucoup préoccupés des espèces de Panama qui paraissent identiques avec celles des Antilles, ou qui sont représentatives. P. Carpenter estime qu'il en existe 35. Dans la plupart des cas, l'identité absolue n'a pu être constatée et on a trouvé quelques caractères distinctifs, ce qui n'a rien d'étonnant, puisque dans l'hypothèse d'une origine commune, les deux races pacifique et atlantique sont séparées depuis la période Miocène. Voici une liste de ces espèces représentatives ou identiques.' Here follows a list of 20 species. 'Mais ces formes semblables,' he says, 'constituent une infime minorité (3 per cent.)' "

"These facts have a very important bearing upon certain geological questions, particularly upon the one concerning the cold of the Glacial period.

"In Dr. G. Frederick Wright's recent book 'The Ice Age in North America,' eight different theories as to the cause of the cold are discussed. The particular theory which seems to him quite reasonable is that one which attributes the cold as due to a change of different parts of the country, and a depression of the Isthmus of Panama is one of the important changes he considers. He says: * "Should a portion of the Gulf Stream be driven through a depression across the Isthmus of Panama into the Pacific, and an equal portion be diverted from the Atlantic coast of the United States by an elevation of the sea-bottom between Florida and Cuba, the consequences would necessarily be incalculably great, so that the mere existence of such a possible cause

* P. 409.

for great changes in the distribution of moisture over the northern hemisphere is sufficient to make one hesitate before committing himself unreservedly to any other theory; at any rate, to one which has not for itself independent and adequate proof."

"In the Appendix to the same volume Mr. Warren Upham, in discussing the probable causes of glaciation, says, 'The quaternary uplifts of the Andes and Rocky Mountains and of the West Indies make it nearly certain that the Isthmus of Panama has been similarly elevated during the recent epoch. * * * It may be true, therefore, that the submergence of this isthmus was one of the causes of the Glacial period, the continuation of the equatorial oceanic currents westward into the Pacific having greatly diminished or wholly diverted the Gulf Stream, which carries warmth from the tropics to the northern Atlantic and northwestern Europe.'"

"Any *very* recent means by which the fishes could have passed readily from one side to the other would have resulted in making the fish-faunas of the two shores practically identical; but the time that has elapsed since such a waterway could have existed has been long enough to allow the fishes of the two sides to become *practically distinct*. That the molluscs of the two shores are almost wholly distinct, as shown by Dr. Fischer, is even stronger evidence of the remoteness of the time when the means of communication between the two oceans could have existed, for 'species' among the molluscs are probably more persistent than among fishes.

"Our present knowledge, therefore, of the fishes of tropical America justifies us in regarding the fish faunas of the two coasts as being essentially distinct, and believing that there has not been, at any comparatively recent time, any waterway through the Isthmus of Panama."

It is thus shown, I think, conclusively,

that the Isthmus of Panama could not have been depressed for any great length of time in a recent geological period.

CONCLUSIONS OF DR. HILL.

These writers have not, however, considered the question of generic identity. To this we may find a clue in the geological investigations of Dr. Robert T. Hill.

In a study of 'The Geological History of the Isthmus of Panama and Portions of Costa Rica,' Dr. Hill uses the following language:

"By elimination we have concluded that the only period of time since the Mesozoic within which communication between the seas could have taken place is the Tertiary period, and this must be restricted to the Eocene and Oligocene epochs of that period. The paleontologic evidence upon which such an opening can be surmised at this period is the occurrence of a few California Eocene types in the Atlantic sides of the tropical American barrier, within the ranges of latitude between Galveston (Texas) and Colon, which are similar to others found in California. There are no known structural data upon which to locate the site of this passage, but we must bear in mind, however, that this structure has not been completely explored.

"Even though it was granted that the coincidence of the occurrence of a few identical forms on both sides of the tropical American region, out of the thousands which are not common, indicates a connection between the two seas, there is still an absence of any reason for placing this connection at the Isthmus of Panama, and we could just as well maintain that the locus thereof might have been at some other point in the Central American region.

"The reported fossil and living species common to both oceans are littoral forms, which indicate that if a passage existed, it must have been of a shallow and ephemeral character.

"There is no evidence from either a geologic or a biologic standpoint for believing that the oceans have ever communicated across the Isthmian regions since Tertiary time. In other words, there is no evidence for these later passages which have been established upon hypothetical data, especially those of Pleistocene time.

"The numerous assertions, so frequently found in literature, that the two oceans have been frequently and recently connected across the Isthmus, and that the low passes indicative of this connection still exist, may be dismissed at once and forever and relegated to the domain of the apocryphal. A few species common to the waters of both oceans in a predominantly Caribbean fauna of the age of the Claiborne epoch of the Eocene Tertiary is the only paleontologic evidence in any time upon which such a connection may be hypothesized.

"There has been a tendency in literature to underestimate the true altitude of the Isthmian passes, which, while probably not intentional, has given encouragement to those who think that this Pleistocene passage may have existed. Maack has erroneously given the pass at 186 feet. Dr. J. W. Gregory states 'that the summit of the Isthmus at one locality is 154 feet, and in another 287 feet in height.' The lowest Isthmian pass, which is not a summit, but a drainage col, is 287-295 feet above the ocean.

"If we could lower the Isthmian region 300 feet at present, the waters of the two oceans would certainly commingle through the narrow Culebra Pass. But the Culebra Pass is clearly the headwater col of two streams, the Obispo flowing into the Chagres, and the Rio Grande flowing into the Pacific, and has been cut by fluvial action, and not by marine erosion, out of a land mass which has existed since Miocene time. Those who attempt to establish Pleistocene inter-oceanic channels through this pass on

account of its present low altitude, must not omit from their calculations the restoration of former rock masses, which have been removed by the general leveling of the surface by erosion."

SUMMARY OF DR. HILL.

In conclusion, Dr. Hill asserts that "there is considerable evidence that a land barrier in the tropical region separated the two oceans as far back in geologic history as Jurassic time, and that that barrier continued throughout the Cretaceous period. The geological structure of the Isthmus and Central American regions, so far as investigated, when considered aside from the paleontology, presents no evidence by which the former existence of a free communication of oceanic waters across the present tropical land barriers can be established. The paleontologic evidence indicates the ephemeral existence of a passage at the close of the Eocene period. All lines of inquiry—geologic, paleontologic and biologic—give evidence that no connection has existed between the two oceans since the close of the Oligocene. This structural geology is decidedly opposed to any hypothesis by which the waters of the two oceans could have been connected across the regions in Miocene, Pliocene, Pleistocene, or recent times."

FINAL HYPOTHESIS AS TO PANAMA.

If we assume the correctness of Dr. Hill's conclusions, they may accord in a remarkable degree with the actual facts of the distribution of the fishes about the Isthmus. To account for the remarkable identity of genera and divergence of species I may suggest the following hypothesis:

During the lifetime of most of the present species, the Isthmus has not been depressed. It was depressed in or before Miocene time, during the lifetime of most of the present genera. The channel formed was relatively shallow, excluding forms inhabiting rocky bottoms at considerable

depths. It was wide enough to permit the infiltration from the Caribbean Sea of numerous species, especially of shore fishes of sandy bays, tide pools and brackish estuaries. The currents set chiefly to the westward, favoring the transfer of Atlantic rather than Pacific types.

Since the date of the closing of this channel, the species left on the two sides have been altered in varying degrees by the processes of natural selection and isolation. The cases of actual specific identity are few, and the date of the establishment as species, of the existing forms, is subsequent to the date of the last depression of the isthmus.

While local oscillations, involving changes in coast-lines, have doubtless frequently taken place and are still going on, our knowledge of the distribution of fishes should render impossible the speculations on the dance of continents, which certain geologists and certain biologists have, at one time or another, used as a convenient means of accounting for glacial phenomena, or for anomalies in distribution. We may be also certain that none of the common genera ever found their way around Cape Horn. Most of them disappear to the southward, along the coasts of Brazil and Peru.

Further, it goes without saying, that we have no knowledge of the period of time necessary to work specific changes in a body of species isolated in an alien sea. Nor have we any data as to the effect on a given fish fauna of the infiltration of many species and genera belonging to another. All such forces and results must be matters of inference.

LAWS GOVERNING DISTRIBUTION OF ANIMALS.

I have elsewhere* had occasion to say that the laws governing the distribution of

* 'Footnotes to Evolution.'

animals are reducible to three very simple propositions.

Each species of animal is found in every part of the earth having conditions suitable for its maintenance, unless :

(a) Its individuals have been unable to reach this region through barriers of some sort; or,

(b) Having reached it, the species is unable to maintain itself, through lack of capacity for adaptation, through severity of competition with other forms, or through destructive conditions of environment; or else,

(c) Having entered and maintained itself, it has become so altered in the process of adaptation as to become a species distinct from the original type.

SPECIES ABSENT THROUGH BARRIERS.

The absence from the Japanese fauna of most European or American species comes under the first head. The pike has never reached the Japanese lakes, though the shade of the lotus leaf in the many clear ponds would suit its habits exactly. The grunt* and porgies† of our West Indian waters and the crenilabri of the Mediterranean have failed to cross the ocean and therefore have no descendants in Japan.

SPECIES ABSENT THROUGH FAILURE TO MAINTAIN FOOTHOLD.

Of species under (b), those who have crossed the seas and not found lodgment, we have, in the nature of things, no record. Of the existence of multitudes of estrays we have abundant evidence. In the Gulf Stream off Cape Cod are every year taken many young fishes belonging to species at home in the Bahamas and which find no permanent place in the New England fauna. In like fashion, young fishes from the tropics drift northward in the Kuro Shiwo to the coasts of Japan, but never finding a

permanent breeding-place and never joining the ranks of the Japanese fishes. But to this there have been, and will be, occasional exceptions. Now and then one among thousands finds permanent lodgment, and by such means a species from another region will be added to the fauna. The rest disappear and leave no trace. A knowledge of these currents and their influence is eventual to any detailed study of the dispersion of fishes.

SPECIES CHANGED THROUGH NATURAL SELECTION.

In the third class, that of species changed in the process of adaptation, most insular forms belong. As a matter of fact, at some time or another almost every species must be in this category, for isolation is a source of the most potent elements in the initiation and intensification of the minor differences which separate related species. It is not the preservation of the most useful features, but of those which actually existed in the ancestral individuals, which distinguish such species. I have elsewhere noted that natural selection must include not only the process of the survival of the fittest, but also the results of the survival of the existing. This means the preservation through heredity of the traits not of the species alone, but those of the actual individuals set apart to be the first in the line of descent in a new environment. In hosts of cases the persistence of characters rests not on any special usefulness or fitness, but on the fact that individuals possessing these characters have, at one time or another, invaded a certain area and populated it. The principle of utility explains survivals among competing structures. It rarely accounts for qualities associated with geographical distribution.

BARRIERS CHECKING MOVEMENT OF FISHES.

The limits of the distribution of individual species or genera must be found in

* *Hæmulon*.

† *Calamus*.

some sort of barrier, past or present. The chief barriers which limit marine fishes are the presence of land, the presence of great oceans, the differences of temperature arising from differences in latitude, the nature of the sea bottom and the direction of oceanic currents. That which is a barrier to one species may be an agent in distribution to another. The common shore fishes would perish in deep waters almost as surely as on land, while the open Pacific is a broad highway to the albacore or the sword-fish.

Again, that which is a barrier to rapid distribution may become an agent in the slow extension of the range of a species. The great continent of Asia is undoubtedly one of the greatest of barriers to the wide movement of species of fish, yet its long shore-line enables species to creep, as it were, from bay to bay, or from rock to rock; till, in many cases, the same species is found in the Red Sea and in the tide-pools or sand-reaches of Japan. In the North Pacific, the presence of a range of half-submerged volcanoes, known as the Aleutian and the Kurile Islands, has greatly aided the slow movement of the fishes of the tide-pools and the kelp. To a school of mackerel or of flying fishes these rough islands would form an insuperable barrier.

TEMPERATURE THE CENTRAL FACT IN DISTRIBUTION.

It has long been recognized that the matter of temperature is the central fact in all problems of geographical distribution. Few species in any group freely cross the frost-line, and except as borne by oceanic currents, few species extend their range far into waters colder than those in which the species is distinctively at home. Knowing the average temperature of the water in a given region, we know in general the types of fishes which must inhabit it. It is the similarity in temperature and physical

conditions, not the former absence of barriers, which chiefly explains the resemblance of the Japanese fauna to that of the Mediterranean or the Antilles. This fact alone must explain the resemblance of the Arctic and Antarctic faunæ.

AGENCY OF OCEAN CURRENTS.

We may consider again for a moment the movements of the great currents in the Pacific as agencies in the distribution of species.

A great current sets to the eastward, crossing the ocean just south of the Tropic of Cancer. It extends between the Gilbert and the Marshall Islands and passes on nearly to the coast of Mexico, touching the Galapagos Islands, Clipperton Island and especially the Revillagigedos. This at once accounts for the number of Polynesian species found on these Islands, about which they are freely mixed with immigrants from the mainland of Mexico.

From the Revillagigedos* the current moves northward, passing the Hawaiian Islands and thence onward to the Ladrões. The absence in Hawaii of many of the characteristic fishes of the Society Islands and the Gilbert Islands is doubtless due to the long detour made by these currents, as the conditions of life in these groups of islands are not very different. Between the Gilbert Islands and Samoa there is also a return current to the west, and northeast of Hawaii is a great spiral current, moving with the hands of the watch, forming what is called Fleurieu's Whirlpool. This does not reach the coast of California. This fact may account for the almost complete distinction in the shore fishes of Hawaii and California.†

* Clarion Island and Socorro Island.

† A few Mexican shore fishes, *Chætodon humeralis*, *Galeichthys dasycephalus*, *Hypsoblennius parvipinnis*, have been wrongly accredited to Hawaii by some misplacement of labels.

The westward current from Hawaii reaches Luzon and Formosa. It is deflected to the northward and, joining a northward current from Celebes, it forms the Kuro Shiwo or Black Stream of Japan, which strews its tropical species in the rock pools along the Japanese promontories as far as Tokio. Then, turning into the open sea, it passes northward to the Aleutian Islands, across to Sitka. Thence it moves southward as a cold current, bearing Ochotsk-Alaskan types southward as far as the Santa Barbara Islands, to which region it is followed by species of Aleutian origin. A cold return current seems to extend southward in Japan, along the East shore perhaps as far as Matsushima. A similar current in the sea to the west of Japan extends still further to the southward, to Noto, or beyond.

It is, of course, not necessary that the movements of a species in an oceanic current should coincide with the direction of the current. Young fishes, or fresh-water fishes, would be borne along with the water. Those that dwell within floating bodies of seaweed would go whither the waters carry the drifting mass. But free-swimming fishes, as the mackerel or flying-fishes, might as readily choose the reverse direction. To a free-swimming fish, the temperature of the water would be the only consideration. It is thus evident that a current which to certain forms would prove a barrier to distribution, to others would be a mere convenience in movement.

In comparing the Japanese fauna with that of Australia, we find some trace of both these conditions. Certain forms are excluded by cross-currents, while certain others seem to have been influenced only by the warmth of the water. A few Australian types on the coast of Chili seem to have been carried over by the cross currents of the South Atlantic.

CENTERS OF DISTRIBUTION.

We may assume, in regard to any species, that it has had its origin in or near that region in which it is most abundant and characteristic. Such an assumption must involve a certain percentage of error or of doubt, but in considering the mass of species, it would represent essential truth. In the same fashion, we may regard a genus as being autochthonous or first developed in the region where it shows the greatest range or variety of species. Those regions where the greatest number of genera are thus autochthonous may be regarded as centers of distribution. So far as the marine fishes are concerned, the most important of these centers are found in the Pacific Ocean. First of these in importance is the East-Indian Archipelago, with the neighboring shores of India. Next would come the Arctic Pacific and its bounding islands, from Japan to British Columbia. Third in importance in this regard is Australia. Important centers are also found in temperate Japan, in California, the Panama region, and in New Zealand, Chili and Patagonia. The fauna of Polynesia is almost entirely derived from the Indies; and the shore-fauna of the Red Sea, the Bay of Bengal and Madagascar, so far as genera are concerned, seems to be not really separable from the Indian fauna generally.

I know of but six genera which may be regarded as autochthonous in the Red Sea, and nearly of these are of doubtful value or of uncertain relation. The many peculiar genera described by Dr. Alcock, from the dredgings of the *Investigator* in the Bay of Bengal, belong to the bathybial or deep water series, and will all, doubtless, prove to be forms of wide distribution.

In the Atlantic, the chief center of distribution is the West Indies; the second is the Mediterranean. On the shores to the northward or southward of these regions occasional genera have found their origin.

This is true especially of the New England region, the North Sea, the Gulf of Guinea and the coast of Argentina. The fish fauna of the North Atlantic is derived mainly from the North Pacific, the differences lying mainly in the lower richness of the North Atlantic. But, in certain groups common to the two regions, the migration must have been in the opposite direction; exceptions that prove the rule.

REALMS OF DISTRIBUTION OF FRESH-WATER FISHES.

If we consider the fresh-water fishes alone we may divide the land areas of the earth into districts and zones, fairly agreeing with those marked out for mammals and birds. The river-basin, bounded by its shores and the sea at its mouth, shows many resemblances, from the point of view of a fish, to an island considered as the home of an animal. The nature of the various barriers limiting species in river-basins I have elsewhere* fully discussed and need not consider it further here. It is evident that, with fishes, the differences in latitude outweigh those of continental areas, and a primary division into Old World and New World would not be tenable.

The chief areas of dispersion of fresh-water fishes we may indicate as follows, following essentially the grouping proposed by Dr. Günther: †

NORTHERN ZONE (ARCTIC AND TEMPERATE).

With Dr. Günther, we may recognize, first the *Northern Zone*, characterized familiarly by the presence of sturgeon, salmon, trout, white-fish, pike, lamprey, stickleback and other species of which the genera and often the species are identical in Europe, Siberia, Canada, Alaska and most of the United States, Japan and China.

* Science Sketches: 'The Dispersion of Fresh-water Fishes.'

† 'Introduction to the Study of Fishes.'

This is subject to cross-division into two great districts, the first Europe-Asiatic, the second North American. These two agree very closely to the northward but diverge widely to the southward, developing a variety of specialized genera and species, and both of them passing finally, by degrees, into the Equatorial Zone.

Still another line of division is made by the Ural Mountains in the Old World and by the Rocky Mountains in the New. In both cases the Eastern region is vastly richer in genera and species, as well as in autochthonous forms, than the Western. The reason for this lies in the vastly greater extent of the river basins of China and the Eastern United States, as compared with those of Europe or the Californian region.

Minor divisions are those which separate the Great Lake region from the streams tributary to the Gulf of Mexico; and in Asia, those which separate China from tributaries of the Caspian, the Black and the Mediterranean.

EQUATORIAL ZONE.

The Equatorial Zone is roughly indicated by the tropics of Cancer and Capricorn. Its essential feature is that of the temperature, and the peculiarities of its divisions are caused by barriers of sea or mountains.

Dr. Günther finds the best line of separation into two divisions to lie in the presence or absence of the great group of dace or minnows,* to which nearly half of the species of fresh-water fishes the world over belong. The entire group, now spread everywhere except in the Arctic, South America, Australia and the islands of the Pacific, had its origin in India, from which its genera have radiated in every direction.

The Cyprinoid division of the Equatorial Zone forms two districts, the Indian and the African. The Ancyprinoid division includes South America, south of Mexico, and

* Cyprinidæ.

all the islands of the tropical Pacific lying to the east of Wallace's line. This line, separating Borneo from Celebes and Bali from Lompoe, marks in the Pacific the western limit of Cyprinoid fishes, as well as that of monkeys and other important groups of land animals. This line, recognized as very important in the distribution of land animals, coincides in general with the ocean current between Celebes and Papua, which is one of the sources of the Kuro Shiwo.

In Australia, Hawaii and Polynesia generally, the fresh-water fishes are derived from marine types by modification of one sort or another. In no case, so far as I know, in any island to the eastward of Borneo, is found any species derived from fresh-water families of either the Eastern or the Western Continent. Of course, minor subdivisions in these districts are formed by the contour lines of river basins. The fishes of the Nile differ from those of the Niger or the Congo, or of the streams of Madagascar or Cape Colony, but in all these regions the essential character of the fish fauna remains the same.

SOUTHERN ZONE.

The third great region, the Southern Zone, is scantily supplied with fresh-water fishes, and the few it possesses are chiefly derived from modifications of the marine fauna or from the Equatorial Zone to the north. Three districts are recognized, Tasmanian, the New Zealand and the Patagonian. The fact that certain peculiar groups are common to these three regions has attracted the notice of naturalists.

ORIGIN OF NEW ZEALAND FAUNA.

In a critical study of the fish fauna of New Zealand,* Dr. Gill discusses the origin of the four genera and seven species of fresh-water fishes found in these islands, the principal of these genera (*Galaxias*) being repre-

sented by nearly related species in South Australia and in Patagonia.*

According to Dr. Gill, we can account for this anomaly of distribution only by supposing, on the one hand, that their ancestors were carried for long distances in some unnatural manner, as (a) having been carried across entombed in ice, or (b) being swept by ocean currents, surviving their long stay in salt water, or else that they were derived (c) from some widely distributed marine type now extinct, its descendants restricted to fresh water.

On the other hand, Dr. Gill suggests that as 'community of type must be the expression of community of origin,' the presence of fishes of long-established fresh-water types must imply continuity or at least contiguity of land. The objections raised by geologists to the supposed land connection of New Zealand and Tasmania do not appear to Dr. Gill insuperable. It is well known, he says, "that the highest mountain chains are of comparatively recent geological age. It remains, then, to consider which is the more probable, (1) that the types now common in distant regions were distributed in some unnatural manner, by the means referred to; or (2) that they are descendants of forms once wide-ranging over lands now submerged." After considering questions as to change of type in other groups, Dr. Gill is inclined to postulate, from the occurrence of species of the trout-like genus *Galaxias*, in New Zealand, South Australia and South America, that "there existed some terrestrial passage-way between the several regions at a time as late as the close of the Mesozoic period. The evidence of such a connection afforded by congeneric fishes is fortified by analogous representatives among insects, mollusca and even amphibians. The separation of the several areas must have occurred little later than the late Tertiary, inasmuch as the salt-

* 'A Comparison of Antipodal Faunæ,' 1887.

* *Galaxias*, *Neochanna*, *Prototroctes* and *Retropinna*.

water fishes of corresponding isotherms found along the coast of the now widely separated lands are to such a large extent specifically different. In general, change seems to have taken place more rapidly among marine animals than fresh-water representatives of the same class."

It is not often that I have occasion to differ from Dr. Gill on a question in ichthyology; but, in this case, when one guess is set against another, it seems to me that the hypothesis first suggested, rather than the other, lies in the line of least logical resistance. I think it better to adopt provisionally some theory not involving the existence of a South Pacific Antarctic Continent, to account for the distribution of *Galaxias*. For this view I may give five reasons:

1. There are many other cases of the sort equally remarkable and equally hard to explain. Among these is the presence of species of paddle-fish and shovel-nosed sturgeon,* types characteristic of the Mississippi Valley, in Central Asia. The presence of one and only one of the five or six American species of pike † in Europe; of one of the three species of mud-minnow in Austria, ‡ the others being American. Such cases occur all over the globe and must be explained, if at all, on some hypothesis other than that of former land connection.

2. The supposed continental extension should show permanent traces in greater similarity in the present fauna, both of rivers and of sea. The other fresh-water genera of the regions in question are different, and the marine fishes are more different than they could be if we imagine an ancient shore connection. If New Zealand and Patagonia were once united other genera than *Galaxias* would be left to show it.

* *Scaphirynchus* (the shovel-nosed sturgeon) and the paddle-fish (*Polyodon* and *Psephurus*).

† *Esox lucius*.

‡ *Umbra*, the mud-minnow.

3. We know nothing of the power of *Galaxias* to survive submergence in salt water, if carried in a marine current. As already noticed, I have found young and old in abundance of the commonest of Japanese fresh-water fishes in the open sea, at a distance from any river. Thus far this species, the hakone* dace, has not been recorded outside of Japan, but it might well be swept to Korea or China. Two fresh-water fishes of Japanese origin now inhabit the island of Tsushima in the Straits of Korea.

4. The fresh-water fishes of Polynesia show a remarkably wide distribution and are doubtless carried alive in currents. One river-goby † ranges from Hawaii to the Riu Kiu Islands. Another species, ‡ originally perhaps from Brazil through Mexico, shows an equally broad distribution.

5. We know that *Galaxias* with its relatives must have been derived from a marine type. It has no affinity with any of the fresh-water families of either continent, unless it be with the Salmonidæ. The original type of this group was marine, and most of the larger species still live in the sea, ascending streams only to spawn.

When the investigations of geologists show reason for believing in radical changes in the forms of continents, we may accept their conclusions. Meanwhile, almost every case of anomalies in the distribution of fishes admits of a possible explanation through 'the slow action of existing causes.' Geologists will attach more weight to biological data, if biologists refrain from insisting on theories which at the best are mere possible explanations, in the incomplete state of our knowledge.

Finally, I may repeat that real causes are always simple when they are once known. All anomalies in distribution

* *Leuciscus hakuensis*.

† *Eleotris fusca*.

‡ *Awaous crassilabris*.

cease to be such when the facts necessary to understand them are at our hand.

DISTRIBUTING MARINE FISHES.

The distribution of marine fishes must be indicated in a different way from that of the fresh-water forms. The barriers which limit their range furnish also their means of dispersion. In some cases proximity overbalances the influence of temperature; with other forms, questions of temperature are all-important.

PELAGIC FISHES.

Before consideration of the coast lines, we may glance at the differences in vertical distribution. Many species, especially those in groups allied to the mackerel family, are pelagic—that is, inhabiting the open sea, and ranging widely within limits of temperature. In this series, some species are practically cosmopolitan. In other cases the genera are so. Each school or group of individuals has its breeding place, and from the isolation of breeding districts new species may be conceived to arise. The pelagic types have reached a species of equilibrium in distribution. Each type may be found where suitable conditions exist, and the distribution of species throws little light on questions of distribution of shore fishes. Yet, among these species are all degrees of localization. The pelagic fishes shade into the shore fishes on the one hand and into the deep-sea fishes on the other.

BASSALIAN FISHES.

The vast group of bassalian or deep-sea fishes includes those forms which live below the line of adequate light. These, too, are localized in their distribution, and to a much greater extent than was formerly supposed. Yet, as they dwell below the influence of the sun's rays, zones and surface temperatures are nearly alike to them, and the same forms may be found in the arctic or under the equator. Their differences in distribution are largely vertical, some liv-

ing at greater depths than others, and they shade off by degrees from bathybial into semi-bathybial, and finally into ordinary pelagic and ordinary shore types.

The fishes of the great depths are soft in substance, some of them blind, some of them with very large eyes, all black in color, and very many are provided with luminous spots or areas. A large body of species of fishes are semi-bathybial, inhabiting depths of 200 or 300 fathoms, showing many of the characters of shore fishes, but far more widely distributed. Many of the remarkable cases of wide distribution of type belong to this class. At such depths, red colors are almost universal, corresponding to the zone of red algæ, and the colors in both cases are perhaps determined from the fact that the red rays of light are the least refrangible.

A certain number of species are both marine and fresh water, inhabiting estuaries and brackish waters, while some more strictly marine ascend the rivers to spawn. In none of these cases can any hard and fast line be drawn, and some groups which are shore fishes of one region will be represented by semi-bathybial or fluviatile forms in another.*

LITTORAL FISHES.

The shore fishes are in general the most highly specialized in their respective groups, because exposed to the greatest variety of selecting conditions and of competition. Their distribution in space is more definite than that of the pelagic and bassalian types, and they may be more definitely assigned to geographical areas.

* The dragonets, *Callionymus*, are shore fishes of the shallowest waters in Europe and Asia, but inhabit considerable depths in tropical America. The sea-robins (*Prionotus*) are shore fishes in Massachusetts, semi-bathybial fishes at Panama. Often, arctic shore fishes become semi-bathybial in the temperate zone, living in water of a given temperature. A long period of cold weather will sometimes bring such to the surface.

DISTRIBUTION OF LITTORAL FISHES BY COAST-LINES.

Their distribution is best indicated, not by realms or areas, but as forming four parallel series, corresponding to the four great north and south continental outlines. Each of these series may be represented as beginning at the north in the Arctic fauna, practically identical in each of the four series, actually identical in the two Pacific series. Passing southward, forms are arranged according to temperature. One by one in each series, the Arctic types disappear; sub-arctic, temperate and semi-tropical types take their places, giving way in turn to south-temperate and Antarctic forms. The distribution of these is modified by barriers and by currents, yet though genera and species may be different, each isotherm is represented in each series by certain general types of fishes.

Passing southward, the two American series, the East Atlantic and the East Pacific, pass on gradually through temperate to antarctic types. These are analogous to those of the arctic, and in a few cases they are generically identical. The West Pacific* (East Asian) series is very much broken

*The minor faunal areas of shore fishes may be grouped as follows:

EAST ATLANTIC.	EAST PACIFIC.	WEST PACIFIC.
Icelandic,	Arctic,	Arctic,
British,	Aleutian,	Aleutian,
Mediterranean,	Sitkan,	Kurile,
Guinean,	Californian,	Hokkaido,
Cape.	San Diegan,	Nippon,
	Sinaloan,	Chinese,
WEST ATLANTIC.	Panaman,	East-Indian,
Greenlandic,	Peruvian,	Polynesian,
New England,	Revillagigedan,	Hawaiian,
Virginian,	Galapagan,	Indian,
Austroriparian,	Chilian,	Arabian,
Floridian,	Patagonian.	Madagascarian,
Antillean,		Cape,
Caribbean,		North Australian,
Brazilian,		Tasmanian,
Argentinian,		New Zealand,
Patagonian.		Antarctic.

by the presence of Australia, the East-Indies and Polynesia. The irregularities of these regions make a number of sub-series, which break up the simplicity expressed in the idea of four parallel series. Yet the fauna of Polynesia is strictly East-Indian, modified by the omission or alteration of species, and that of Australia is Indian at the north, and changes to the southward much as that of Africa does. In its marine fishes, it does not constitute a distinct 'realm.' The East Atlantic (Europe-African) series follows the same general lines of change as that of the West Atlantic. It extends, however, only to the South Temperate Zone, developing no Antarctic elements. The relative shortness of Africa explains in large degree, as already shown, the similarity between the tropical elements in the two Old World series, as the similarity in tropical elements in the two American series must be due to a former depression of the connecting Isthmus. The practical unity of the Arctic marine fauna needs no explanation in view of the present shore lines of the Arctic Ocean.

EQUATORIAL FISHES MOST SPECIALIZED.

In general, the different types are most highly specialized in equatorial waters. The processes of specific change, through natural selection or other causes, if other causes exist, take place most rapidly there and produce most far-reaching modification. As I have elsewhere stated, the coral reefs of the tropics are the centers of fish-life, the cities in fish-economy. The fresh waters, the arctic waters, the deep sea and the open sea, represent forms of ichthyic backwoods, regions where change goes on more slowly, and in them we find survivals of archaic or generalized types. For this reason, the study in detail of the distribution of marine fishes of equatorial regions is in the highest degree instructive.

The study of the origin of the fish groups of Japan affords a fascinating index to its multifarious problems.

DAVID STARR JORDAN.

STANFORD UNIVERSITY.

*THE LABORATORY TEACHING OF PHYSIOLOGY.**

THE student of physiology should perform the classical experiments upon which the science rests. The writer of these papers has for several years endeavored to place the laboratory teaching of physiology within the reach of every school. To accomplish this it is necessary that apparatus of precision be designed upon lines permitting its manufacture in large quantities at a small cost. The apparatus described below is believed to show progress in this direction.

the box admits the rays from a lantern or other source of light. This circular window may be closed by a clear glass plate or by any of the several diaphragms described below. Two pins, one at the side and one below the opening, are so placed that when the diaphragm rests against them its aperture will lie in the axis of the optical system. The lenses and mirrors employed with the box are mounted in square wooden blocks, to protect them from injury. When the side of the wooden block is placed against the 'rabbit strip' shown at the lower inside angle of the box the center of the lens or mirror mounted in the block will lie in the optical axis. The rays of light entering the box are made visible by the fumes of Japanese incense, a small stick of which is lighted and placed in a hole in a cork upon which fits a tin cylinder shown in Fig. 1.

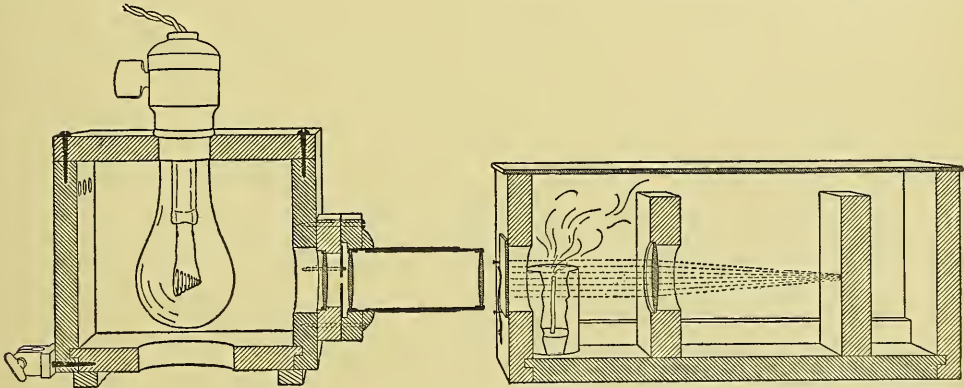


FIG. 1. The optical lantern and artificial eye.

I. THE ARTIFICIAL EYE.

The artificial eye (shown in section in Fig. 1, one fourth the actual size) consists of a wooden box the top of which is closed by laying upon it a piece of clear plate-glass. A circular opening in the front of

* Porter, W. T.: *Boston Medical and Surgical Journal*, Dec. 29, 1898. *Philadelphia Medical Journal*, Sept. 1, 1900. 'An Introduction to Physiology,' Cambridge, 1900 and 1901. 'Experiments for Students in the Harvard Medical School,' Second Series, Cambridge, Jan., 1901. Third Series, Cambridge, May 1901.

The optical lantern consists of a sixteen-candle-power electric lamp, with small spiral filament, mounted in a wooden box pierced with holes which permit thorough ventilation but do not allow the escape of light to disturb the observer. The lantern box is provided with a condensing lens and two focusing lenses mounted in draw tubes which may be easily removed. The slot for the diaphragms is furnished with a stop so placed that when the diaphragm is shoved against it the aperture of the

diaphragm will lie in the optical axis. When the focusing tubes are removed the lantern may be mounted on a stand by means of a brass ring with set screws, and then serves admirably for ophthalmoscopic or laryngological work.

The following lenses, diaphragms, etc., are provided for the experiments in physiological optics made by first-year students in the Harvard Medical School. Convex lens, four inches focus; convex lens, twenty inches focus; concave lens, twenty inches focus; astigmatic cylinder, twenty inches focus; astigmatic cylinder, five and a half inches focus; mirror, convex on one side, concave on other, one inch focus; plain mirror; diaphragm with circular aperture two millimeters in diameter; diaphragm with vertical and horizontal slits; dia-

necessary. The light rays are very distinct in any room after sunset. A hundred or more students may work in the same laboratory. If a focusing-cloth or other screen be used, the observations may be made in daylight.

II. THE CIRCULATION SCHEME.

The artificial scheme (Fig. 2) to illustrate the mechanics of the circulation in the highest vertebrates consists of a pump, a system of elastic tubes, and a peripheral resistance. The inlet and outlet tubes of the pump are furnished with valves that permit a flow in one direction only. The peripheral resistance is the friction which the liquid undergoes in flowing through the minute channels of a piece of bamboo. To this must be added the slighter resistance

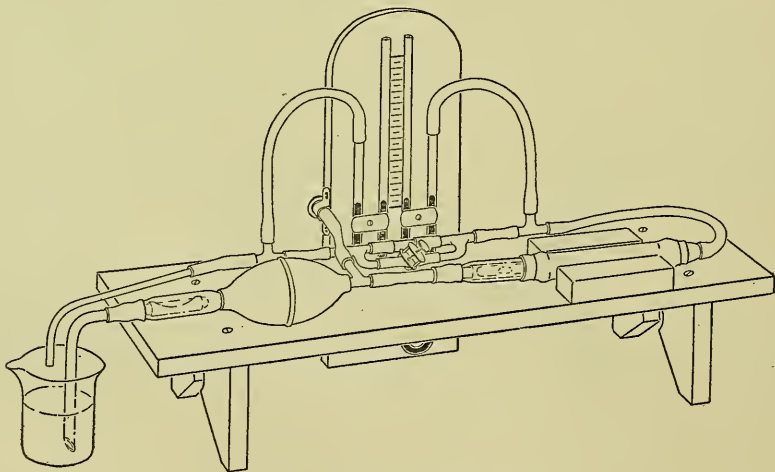


FIG. 2. The circulating scheme.

phragm with L-shaped slit; clear-glass slide; ground-glass slide; wooden screen to serve as retina; square bottle filled with eosin solution, to study refraction.

With this apparatus reflection and refraction from plain and spherical surfaces, spherical and chromatic aberration, astigmatism, myopia, and hypermetropia may be studied. A special dark room is not

due to friction in the rubber and glass tubes.

In this system the pump represents the left ventricle; the valves in the inlet and outlet tubes the mitral and aortic valves, respectively; the resistance of the channels in the bamboo the resistance of the small arteries and capillaries. The tubes between the pump and the resistance are the arte-

ries; those on the distal side of the resistance are the veins. The side branch substitutes a wide channel for the narrow ones and thus is equivalent to a dilatation of the vessels. Between the pump and the outlet valve is a side tube leading to a membrane manometer which records the changes in the pressure within the pump (the loss in conveying the pressure through the short wide connecting tubes may be neglected). A mercury manometer is placed between the pump and the capillary resistance, to measure the arterial pressure, and a second mercury manometer on the distal side of the capillary resistance to measure the venous pressure.

The device used for the aortic valve is shown in Fig. 3. A small glass tube is fastened in a larger glass tube by a collar of rubber tubing. The small glass tube is closed at one end. One side is pierced with a valve hole. The valve hole is closed by a piece of rubber tubing which is drawn over the small glass tube, and the middle portion of the rubber tubing is cut away



FIG. 3. The modified Williams' valve of the circulating scheme.

except over the hole. During the stroke of the pump the water enters the small glass tube under pressure, lifts the rubber, escapes through the valve hole, and is carried off by the large glass tube. When the pressure in the small glass tube is no longer as great as that in the surrounding large glass tube the rubber shuts the valve-hole. Backflow is thus prevented. The mitral valve is similar to the aortic, but the position of the small glass tube is reversed.

With this apparatus the physical phenomena of the circulation may be learned thoroughly. The conversion of the intermittent into a continuous flow, the relation

between rate of flow and width of bed, the relation of peripheral resistance to blood-pressure, the inhibition of the ventricle, the opening and closing of the aortic valve, the period of outflow from the ventricle, the pulse wave, the physical phenomena of the circulation in fevers and in aortic and mitral regurgitation and stenosis, may all be studied by the graphic method. Excellent pulse curves may be obtained by placing a sphygmograph upon the aortic tube.

I first described the circulation scheme in 'The Introduction to Physiology,' January, 1900. Its use during two years by large numbers of students in the Harvard Medical School has suggested certain changes which enable the apparatus to be more quickly put together. In making these changes I have been much helped by the criticism of Mr. F. H. Pratt, Dr. W. B. Cannon and others of my associates.* The accompanying figures show the most recent form of the apparatus.

III. THE MOIST CHAMBER.

The moist chamber, shown in Fig. 4, provides for the study of the electrical properties of nerve and muscle under conditions that prevent the stimulation caused by drying. It consists of a porcelain plate which bears near the margin a shallow groove. In this groove rests a glass shade which for the sake of clearness has been omitted from Fig. 4. To the porcelain plate is screwed a rod, by which the plate may be supported on a stand. Within the glass shade a right-angled rod carries a small clamp, composed of a split screw on which moves a nut, by means of which the femur of a nerve muscle preparation may be firmly grasped. The holder for the split screw is arranged to permit of motion in all directions. The right-angled rod also carries two or more unpolarizable electrodes. Each of these is

* To Mr. Pratt's skilful hand I am indebted for the drawings from which Fig. 2 and Fig. 3 were made.

borne by a spring clip. On compressing its projecting ends the clip no longer presses against the rod, but may be moved from side to side or revolved upon its axis. The electrodes are made of potter's clay, skilfully fired, and are unglazed except where they are grasped by the spring clip. They have the shape of a boot. By turning the leg of the boot in the clip the foot may be brought as near the foot of the neighboring electrode as may be desired. On placing the boot in normal saline solution the porous clay rapidly absorbs the indifferent liquid. The hollow leg of the boot is then half filled with saturated solution of zinc sulphate and

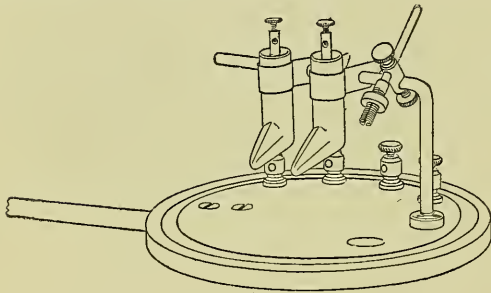


FIG. 4. The moist chamber, with spring clips and unpolarizable boot electrodes.

placed in the clip. A thick wire of amalgamated zinc, provided at one end with a hole in which a connecting wire may be fastened with a set-screw, is placed in the leg of the boot, and the other end of the connecting wire brought to one of the four binding posts shown in Fig. 4. These four posts are in electrical connection with four other posts beneath the porcelain plate. The boot electrodes are unpolarizable. They serve equally well for leading off the nerve or muscle current to the electrometer and for stimulation. They are easily cleaned and are far more convenient than the electrodes of glass and clay or plaster of Paris.

WILLIAM TOWNSEND PORTER.

HARVARD MEDICAL SCHOOL,
September 20, 1901.

ANDREW ELLICOTT DOUGLASS.

ANDREW ELLICOTT DOUGLASS died on September 30 in his eighty-second year. Anthropological science has thus lost a sincere friend. Mr. Douglass was born at West Point, New York, on November 18, 1819. He was the son of Major David Bates Douglass, and his mother was a daughter of Andrew Ellicott, professor of mathematics at West Point.

Mr. Douglass graduated from Kenyon College in 1838 and received the degree of A.M. in 1841. On completing his undergraduate course he engaged in business, being connected with the firm afterwards known as the Hazard Powder Company. In 1867 he became president of the company and retired nine years later from a successful business career.

Since 1876 Mr. Douglass devoted much of his time to the study of the Indian artifacts of the United States. He spent ten winters cruising along the Floridian coast, locating over fifty Indian mounds, many of which he excavated. For his study Mr. Douglass brought together an excellent library relating to American archeology and made a synoptical collection of over 22,000 specimens, which latter he presented to the American Museum of Natural History during the present year. This collection of implements is arranged in various special classes irrespective of geographical distribution with the purpose of solving the theory of their use. Mr. Douglass believed, however, in the geographical method of arrangement, but that both methods were necessary. A series of over a thousand hematite objects in the collection constitutes what is perhaps a unique feature. The collection is most carefully catalogued and cross-referenced as might be expected by those who knew Mr. Douglass's painstaking business method.

Mr. Douglass was a member of the Metropolitan Museum of Art and a patron of

the American Museum of Natural History. He was a fellow of the American Association for the Advancement of Science since 1885, and attended the Section of Anthropology. He was also enrolled as a member of the Linnæan Society, the Numismatic and Archeological Society, the Anthropological Society of Washington and the American Geographical Society, as well as being a life member of the Anthropological Society of Paris. At the time of his death he was the oldest living member of the American Ethnological Society.

Mr. Douglass's most recent contribution to the literature of anthropology appeared as Article X. in Vol. VIII. of the *Bulletin of the American Museum of Natural History*. This paper was entitled 'A Table of the Geographical Distribution of American Indian Relics [in a Collection exhibited in the American Museum of Natural History, New York,' with explanatory text.

Although suffering from an infirmity of old age, Mr. Douglass was enthusiastic and cheerful to the last. He was a man of great patience, charitable to those who differed from him in opinion and of a gentle and courteous nature.

HARLAN I. SMITH.

SCIENTIFIC BOOKS.

SOME RECENT WORKS ON MECHANICS.

Theoretical Mechanics. An elementary textbook. By L. M. HOSKINS, Professor of Applied Mathematics in the Leland Stanford Junior University. Published by the author, Stanford University Bookstore, agent. 1900. 8vo. Pp. ix + 436.

The Principles of Mechanics. An elementary exposition, for students of physics. By FREDERICK SLATE, Professor of Physics in the University of California. Part I. New York, The Macmillan Company; London, Macmillan and Company, Limited. 1900. 12mo. Pp. x + 299.

Theoretical Mechanics. An elementary treatise. By W. WOOLSEY JOHNSON, Professor of Mathematics, U. S. Naval Academy. New York, John Wiley and Sons; London, Chapman and Hall, Limited. 1901. 12mo. Pp. xv + 424.

Ad. Wernickes Lehrbuch der Mechanik in elementarer Darstellung mit Anwendungen und Übungen aus den Gebieten der Physik und Technik. In zwei Teilen. Erster Teil, Mechanik fester Körper, von DR. ALEX. WERNICKE. Vierte völlig umgearbeitete Auflage. Erste Abteilung, Einleitung—Phoronomie—Lehre vom materiellen Punkte. 8vo. Pp. xv + 314. Zweiter Teil, Flüssigkeiten und Gase, von RICHARD VATER. Dritte völlig umgearbeitete Auflage. 8vo. Pp. xii + 374. Braunschweig, Friedrich Vieweg und Sohn. 1900.

Of the production of books, and good books, on the science of mechanics the end is not yet in sight. The first three works on our list fall into the same class. Each of them purports to give an elementary exposition only of the science, each is a good specimen of book-making, and each is supplemented by an index. They differ from one another, however, in several important respects; and their characteristic differences reflect clearly, it would appear, the points of view of the authors. Thus, Professor Hoskins has in mind mainly the needs of the progressive and aggressive engineer, and seeks at the same time to avoid the narrower demands of specialists. Professor Slate looks at the subject as a physicist, with a keen appreciation of the broader aspects of the science and the critical examination its principles have received from recent writers like Maxwell, Mach and Love. Professor Johnson, on the other hand, with perhaps a deeper sense of the difficulties to be encountered by the student, is somewhat conservative, and follows more closely the methods which have proved so effective in the works of the great analysts.

Singularly enough, the definitions of mechanics given by these authors are very much alike, and all of them are somewhat old-fashioned. Hoskins says, "*Mechanics* is the science which treats of the motions of material bodies"; Slate says, "The science of Mechanics

is concerned with the physical phenomena involved in motion"; while Johnson says, "Mechanics is the science which treats of the motions of *material bodies*, and the causes of these motions." Definitions of the science, however, are not very important to the elementary student. He must know the subject pretty well before he can appreciate a definition of it. All such definitions as those just cited, need, as their authors doubtless anticipated, much supplementary explanation in the light of the student's enlarged experience.

Professor Hoskins follows the historical development of the subject and gives to statics first place, passing on thence to kinematics and kinetics. Professor Slate adopts the modern, more logical, order of presentation beginning with kinematics. Professor Johnson follows more closely the Newtonian method, starting with dynamics and passing on to statics and kinetics, kinematical principles being explained as needed chiefly. There is much to be said in favor of each of these methods; and for the beginner either method is effective with the aid of a good teacher; but with proper preliminary training the modern method, introduced by Kelvin and Tait, would seem to be most advantageous.

The theory of dimensions, which helps more than anything else to give clearness to ideas in mechanics, is explained and freely used in the works of Professors Hoskins and Slate, but it is unfortunately omitted from the work of Professor Johnson. The need of this theory is shown at several points in the latter work; for example, on p. 126, where the phrase 'intensity of pressure' occurs, and on p. 268, where the equally cumbersome phrase 'intensity of force' occurs. Both of these phrases, which are now happily obsolescent, are here used by the author in a very puzzling way. Commonly 'intensity of pressure' means force divided by area, or stress in the more recent use of the latter term. Commonly, also, 'intensity of force' means force divided by mass, or acceleration. But these are not the senses in which Professor Johnson has used these phrases.

Without constant appeal to the theory of dimensions it is very difficult for the most careful

authors to avoid ambiguity of language. Thus, to cite an illustration from the work of Professor Hoskins, take his equation (1), p. 194, specifying simple harmonic motion, namely,

$$\ddot{x} = -kx,$$

wherein the first member means acceleration and x is a distance. The constant k , then, must be the reciprocal of the square of a time. But Professor Hoskins says that k is 'written for the attractive force *per unit mass* at unit distance from 0' (the origin); a statement immediately contradicted and corrected by the theory of dimensions. There is a more refined obscurity in Professor Hoskins' articles 177, 178, wherein the gravitation constant is involved. It appears from these articles that the force of gravitation, like 'electric force' and 'electromotive force,' may be different from the force considered elsewhere in the book.

Nearly all the older works on mechanics are marred by such obscurities as those noted above. The gravitation constant has been erroneously defined by many eminent authors, and some of our best works, in the French and German languages especially, are disfigured by the introduction of forces of more than one species. It is high time that all such obscurities and ambiguities, so easily detected by the theory of dimensions, were banished from mechanics.

In connection with this subject of clear and definite terminology attention should be called to Professor Johnson's revival of the use of the term 'force of inertia' and to Professor Hoskins' use of the term 'effective forces.' These are properly going, if not wellnigh gone, out of fashion. They seem doomed to be replaced by the more suggestive term 'kinetic reaction,' or 'mass reaction.' The word 'inertia' is responsible for a deal of difficulty in mechanics, and it seems well to follow the example set by Maxwell in his *Matter and Motion*, and use inertia very sparingly, if at all, except in the set phrase 'moment of inertia.' It appears worth while also to note that all the works in question define the term 'stress' in its earlier sense, assigned to it by Rankine. The more recent sense of the word, especially appropriate and useful in elasticity and hydromechanics, is force per unit area; that is, force divided by

area. This rather than the original meaning of the term seems destined to persist.

The work of Wernicke is likewise intended for elementary students, and was evidently prepared for home use especially, since it is printed in German type. It is far too detailed a work, as may be inferred from the title page, not all of which is quoted above, to meet with favor, except in reference libraries on this side of the Atlantic. The authors leave little room for play of the student's imagination and less room for the development of his originality. Everything is explained in extenso, and often in a provokingly complicated or inelegant fashion. The beautifully drawn diagrams convey too much information; and the many numerical examples seem well calculated to obscure rather than to illustrate salient principles. The work is one of the happily passing texts that try to present mechanics with little or no use of the calculus, and thus waste a deal of the student's time. There is much useful information in the volumes, however, and they may prove handy for those who cannot bring an adequate preparation to the subject.

The first volume is devoted to mechanics proper and gives an elementary view of the principles applicable to rigid bodies, with many applications to machinery. The second volume treats of gases and liquids, with applications to pumps, injectors, water motors, ventilators, etc. The second volume is supplied with a good index, but the first volume has none. R. S. W.

Water Filtration Works. By JAMES H. FUERTES, M. Am. Soc. C. E. New York, John Wiley & Sons; London, Chapman & Hall, limited. Cloth, 5 × 8 in. 19 plates and 45 figures in the text. 1901. Price, \$2.50.

In this work the author has discussed in a clear and very readable form the theory and practice of water filtration as it stands to-day. As preliminary to the subject proper the author devotes a short chapter to a brief statement of the relation of typhoid fever to polluted water supplies, and discusses the various processes of natural purification and the means of protecting surface waters from pollution. The great value of filtration as a means of purification is also here set forth. Chapter II. deals with intakes and sedimentation basins. The former subject

is treated very briefly and mainly with reference to questions pertaining to quality; the latter subject is treated quite fully, as is quite proper in a work on filtration, since clarification by sedimentation is very frequently an important part of the purification process.

Following these two chapters is a full discussion of the subjects of slow sand-filtration and rapid or mechanical filtration, in each case the underlying theory being first set forth and then matters pertaining to the design, construction and operation of works. In Chapter VII. are given the author's conclusions as to the relative advantages of the two systems, together with suggestions as to possible combinations. A few pages are also devoted to a very brief consideration of minor processes of filtration. It was doubtless proper to omit any consideration of household filters, but in a special work of this kind it would seem that a fuller treatment of the use of filters in the removal of color and of iron in solution might have been desirable. A brief chapter on filtered-water reservoirs completes the volume.

A noteworthy feature of the work is the full and valuable data relating to the operation of filter plants and settling basins. The designing engineer will also find convenient the numerous conversion tables and diagrams contained therein. The book is well illustrated by half tones showing interesting phases of construction and operation, and by well-executed cuts of details, particularly of filter-regulating devices. As a whole, the work places before the engineer a good summary of the latest information on this important subject, and at the same time presents the matter in a way to be of interest to the general reader.

F. E. TURNEAURE.

DISCUSSION AND CORRESPONDENCE.

IS IT NOT TIME THAT THE TITLE 'PROFESSOR OF AGRICULTURE' SHOULD GO OUT OF USE?

In most of our State institutions, known generally as Agricultural and Mechanical Colleges or Land Grant Colleges, we have what is known as the Agricultural Department, together with other Departments of the College, as, for example, the Mechanical, Civil and Electrical Engineering Departments, the Chemical, Bio-

logical Departments, etc. In some states where these institutions have merged into or connected themselves with State Universities, many more departments are present. The institutions there have a larger significance, and instead of terming the various lines of work as departments, they are designated as Colleges. Cornell University, for example, is made up of the Colleges of Agriculture, Law, Medicine, Engineering, etc. Each college goes to make up the university and each department goes to make up a college.

There seems to have been a tendency in the evolution of the Colleges of Law, Medicine, Engineering, etc., to recognize the fact that to have just one chair, designated as that of law, medicine or engineering, was to all purposes of reasoning ambiguous. The titles of professor of law, professor of medicine or professor of engineering therefore are not commonly used. In most cases the title designates explicitly the particular department, as, in law, professor of equity jurisprudence and law of real property, professor of commercial law, etc., in medicine, professor of clinical medicine, professor of dermatology, etc., in engineering, professor of mechanical, electrical, civil, marine, mining, etc., engineering.

The School or College of Agriculture seems to be alone in not having abandoned a custom long since recognized by others as obsolete. The title of 'professor of agriculture' is not explicit enough. Where in years past one man taught everything of economic importance in regard to plants and animals, to-day there are a number of well-defined departments. Instead of the professor of agriculture, we have the professor of agronomy, soil physics, animal industry, horticulture, forestry, etc.

In the modern institution, as in the University of Illinois, we find no professor of agriculture and it is readily seen that there is little need for such. It is believed that, in the future, when the fact of its misapplication is thoroughly understood, this custom, now so common, will go out of use.

FRANK WM. RANE.

THE NEW HAMPSHIRE COLLEGE,
DEPARTMENT OF HORTICULTURE
AND FORESTRY.

THE WASHINGTON MEMORIAL INSTITUTION AND
A NATIONAL UNIVERSITY.

THE article by the Hon. John W. Hoyt, chairman of the National University Committee, published in the issue of SCIENCE for last week, may properly be the subject of a few words of comment from one who would welcome the establishment of a University of the United States and who at the same time regards the Washington Memorial Institution as the most important movement in this direction that is feasible at the present time. I am the more inclined to make these comments because Dr. Hoyt quotes from an article written by me four or five years ago without, as it seems to me, giving its full intention. I am quoted, for example, as remarking that 'all the arguments which have been urged against the establishment of a national university turn out to be in its favor.' The passage from which these words are taken reads as follows:

From a theoretical point of view it would seem that all the arguments which have been urged against the establishment of a national university turn out to be in its favor. The cost, the incompetence of government and the claim that existing universities suffice are, however, practical difficulties which we do not underestimate. Indeed, these are so evident that we should regard it as useless to advocate the immediate establishment of a great national university. We rather hope for a gradual growth from the national institutions already existing at Washington. We have there great libraries, museums and laboratories, able investigators engaged in advancing pure and applied science, and younger men learning from them the methods of research. These are the essentials of a university.

The establishment of the Washington Memorial Institution seems to be a most happy compromise between those who oppose and those who advocate the immediate establishment of a national university. Dr. Hoyt in criticising this institution probably does not represent the majority of the committee of which he is chairman. President Harper was chairman of the committee of the National Council of Education which endorsed the institution, and he doubtless regards it as the beginning of a national university. Other members of the committee may wish to confine the functions of the institution to those at present outlined, but time and the course of events will, in my opinion, prove irresistible forces. The best and

most stable results are usually secured through gradual evolution, and the Washington Memorial Institution can grow as rapidly as circumstances permit. Should there be a congressional cataclysm in favor of a national university, a foundation will be at hand which will obviate the necessity of erecting castles in the air.

The action of the National Council of Education in somewhat brusquely setting aside the report of its committee, and that of the National Educational Association in affirming its position in favor of a national university, certainly represent a strong trend of opinion. More especially are the representatives of the great State universities in favor of a national university, and these universities are the allies of the future. We are in the midst of conditions that have not existed elsewhere or heretofore. Our privately endowed colleges and universities originated largely in sectarian enthusiasm, and are still in large measure supported by adherents of special religious denominations. The unexampled gifts of rich men for public education have undoubtedly tended to maintain the stability of society and have bridged over the interval required for the people to learn the importance of higher education for the common good. But we shall not always depend on the charity of the rich, nor will our universities always be administered by business men. Pennsylvania, Johns Hopkins and Cornell are turning to the State for help; Harvard, Yale and Columbia must do the same if their prestige is to be maintained.

The obvious outcome of democratic institutions is the support of education by the people. We have district schools, city colleges and state universities. We shall have a University of the United States. It may come suddenly, but it is far more likely to result from the gradual development of the Washington Memorial Institution.

J. MCKEEN CATTELL.

SHORTER ARTICLES.

SOME OBSERVATIONS BEARING ON THE PROBABLE SUBSIDENCE DURING RECENT GEOLOGICAL TIMES OF THE ISLAND OF SANTA CATALINA OFF THE COAST OF SOUTHERN CALIFORNIA.

IN the course of the dredging operations carried on along the coast of southern California

by the Zoological Department of the University of California, during the past summer, observations were made incidentally of such obvious geological interest that I feel justified in going outside my own province to record them.

While dredging in forty-five fathoms about three-quarters of a mile off Long Point, on the north side of Santa Catalina Island, the dredge brought up large numbers of cobble stones varying in size from a sparrow's egg to a man's head. Most of them were very smooth and round, though they were covered by a thick coating of encrusting bryozoa, worm tubes, ascidians, chitens, sponges, etc., showing them to have remained undisturbed for a long period.

They were entirely similar in material and shape and size to the cobbles composing the shingle of many of the little beaches on different parts of the island, *e. g.*, that at Avalon near by.

That they came from a submerged beach was a suggestion so obvious as not to escape any of those on board the launch, in spite of the fact that there was not a geologist among us, and hence no one greatly familiar with the geological history of the region, and consequently prepared to put such an interpretation on what we saw.

When, however, we came to consider the matter in the light of facts of a wholly different character well known to geologists, and understood by them to testify that the island has been sinking beneath the waters of the Pacific in recent geological time, there would seem to be little doubt that at no very remote date in the past, geologically speaking, the *shore line of the island at the point from which these stones were taken was from three-quarters of a mile to a mile out to sea from its present position.*

The subject is so interesting as to make it worth while to present in outline the evidence from other sources tending to show that a subsidence of the island *has* taken place even if it is not still in progress.

It is now generally admitted among geologists, I believe, that San Pedro Hill on the mainland has emerged from the sea and been elevated to its present height, 1475 feet, since Post-Pliocene times. The hill, particularly on its seaward slope, is laid off into a succession

of remarkably clear-cut steps, or benches, one above another, to the number of ten in all, according to Professor Lawson. On approaching it from the sea one's imagination easily makes it the terraced grounds ages ago deserted and fallen into ruins, of one of Cronus' country seats before that crafty monarch was overthrown by all-powerful Zeus.

Professor A. C. Lawson* has brought forward arguments that are, I should think, conclusive, in support of the view that these steps are marine wave-cut terraces; that they mark the position of the ocean strand at successive periods during the elevation of the hill.

The island of San Clemente, 1,964 feet high, lying sixty miles to the southwest of San Pedro Hill, is very similar to it in topographical features, particularly as regards the terraces, the chief difference being that the terraces of the island are more sharply defined and more numerous than those of the Hill. The evidence is, then, that both the mainland of the coast, and San Clemente island emerged simultaneously from the sea.

Now the island of Santa Catalina, lying midway between the two, is wholly different from either of them topographically. It is a mountain mass as bold and jagged as one often sees, and terraces are entirely wanting. The same sally of the imagination that makes San Pedro Hill the country seat of King Cronus makes Santa Catalina Island the site of his castle; for not only have we here the rock upon which the castle stood, but in San Pedro channel, a hundred fathoms deep at not much beyond an arrow's flight from the rocky walls, we have also the moat of the castle.

The contrast between Catalina and the two land masses between which it is situated cannot be better brought out than by Professor Lawson's own words: "In all the physiographic wonderland of Southern California," he writes, "there is probably nothing more surprising than the contrast which the topography of Santa Catalina presents to that of both San Pedro Hill and San Clemente. Lying

* 'The Post-Pliocene Diastrophism of the coast of Southern California,' *Bulletin of the Department of Geology*, University of California, Vol. I., No. 4, 1893.'

midway between the two latter insular masses, in the same physiographic province, and affected by the same climatic conditions, Santa Catalina might, *à priori*, be supposed to differ from these but little in the character of its land sculpture. This supposition proves, however, to be fallacious. The difference between the aspect of the island and that of the two other neighboring insular masses is amazing, and the hypothesis which we are forced to entertain to account for it, is correspondingly startling."

The writer then proceeds to bring forward cogent arguments in support of the proposition that "*Santa Catalina was a land-mass, subject to the forces of subaerial degradation, at the time when San Pedro Hill and San Clemente began to emerge from the waters of the Pacific, in Post-Pliocene time.*"

But not only this. He finds further strong evidence, on physiographic grounds alone, that not only was the island full-born when the neighboring land masses began to emerge from the sea, but that while the latter have been undergoing elevation *Catalina itself has been subject to a process of submergence.*

In this latter view the author is defending a suggestion made by Dr. J. G. Cooper, the pioneer California naturalist who explored the island in 1863 as geologist of the California State Geological Survey.

With the addition of the evidence produced by our dredgings this summer to that brought forward by Professor Lawson, it would seem that the subsidence hypothesis reaches well nigh a demonstration.

It should be said that some of the fishermen at Avalon have known for a number of years of the existence of this particular bed of cobble stones, and it is asserted by them that the bed extends out to seventy-five fathoms.

Time would not permit us to trace out the full extent of bed. Similar cobbles were brought up at other points around the island, though not so abundantly as here; but it should be stated that most of our work here was done with the beam trawl, as this was found better adapted to our biological work. It is, however, much less likely to pick up such stones than is the dredge.

It is highly probable that careful dredging

with this as the primary object will discover similar evidence of submerged shingle beaches at many other points around the island.

WM. E. RITTER.

UNIVERSITY OF CALIFORNIA,
Sept. 7, 1901.

ZONE OF MAXIMUM RICHNESS IN ORE BODIES.

FOR a long time, and among many mining people, the theory has prevailed that ore deposits have been derived from the interior of the earth, the mineral materials being carried upward to the surface by means of heated solutions. As a result, a maxim has been established that ore bodies necessarily get richer as depth increases. The fact that many exceptions have been found to this rule is ascribed to peculiar local conditions.

Aside from the bare statement of the general rule, no limitations have been formulated by the mining men. It has remained for the geologists to reach measurable results regarding the relative richness of ore bodies at varying depths. The results are not only very satisfactory, but they are totally at variance with the commonly assumed formulæ. Late investigations demonstrate, both theoretically and practically, that the problem has been wholly misunderstood by miners; and that the so-called empirical rule has very decided limitations.

Contrary to opinions heretofore generally held, many, if not most, ore bodies are believed not to be formed by the materials coming up in a superheated condition from great depths to the surface of the earth. Revolutionary as it may seem to many who have not followed carefully the trend of recent investigation, it appears to be a fact, nevertheless, that ore bodies are to be regarded as deposits formed very near the surface of the earth's crust; or, to be more precise, formed only in that thin outer part of the zone of the lithosphere which geologists are pleased to call the zone of fracture. Unusual richness which many ore deposits show at very shallow depths has come to be looked upon as due to local enrichment long after the first concentration has taken place.

Careful study of important ore bodies indi-

cates that after a certain depth is reached, there is frequently a very marked decrease in the amount of ore material, until finally in some cases the ores become too lean to work. From the point of view of origin, diminution in richness with depth is not, then, to be regarded as an actual depreciation in grade of the ore. The real status of the case is that the original deposition of the ore has, in the upper zone undergone a greater or less augmentation in metallic content since the ore bodies first began to form.

As distinct processes, the rival theories of ascending solutions, descending solutions and laterally moving solutions no longer find countenance among those who have given the subject of ore genesis most attention, and especially among those who have approached the subject from the geological side. Ore deposition may take place through all three means, which may have equal importance. After an ore deposit has once formed under special geological conditions, the secondary enrichment which it may undergo is believed to take place largely under the influence of the descending solutions. Therefore, in the exploitation of ore bodies, everything goes to show how vitally important is a full consideration of the geological structures presented, both at the time of the first concentration and as subsequently assumed.

Under the title of 'Enrichment of Mineral Veins by Later Metallic Sulphides,' in the recently issued Volume XI. of the *Bulletin* of the Geological Society of America, Mr. W. H. Weed gives the results of his investigations concerning the zones of maximum richness in ore bodies. Briefly stated, the attempt is made to prove: (1) that the leaching of a relatively lean primary ore, commonly by surface waters, will supply the material in solution for such enrichment; (2) that the unaltered sulphides, especially pyrite, will induce precipitation, that the material precipitated is crystalline, and that a number of mineral species are commonly formed, and are now forming, in veins by such reactions; and (3) that such minerals deposited in quantity may form ore bodies of considerable size (bonanzas), or may be disseminated through the lean primary ore in strings and patches, thus enriching the ore body as a whole and

even making a former low-grade body of sufficient value to work.

It may be concluded that later enrichment of mineral veins is as important as the formation of the veins themselves, particularly from an economic standpoint. In many cases the enrichment proceeds along barren fractures and makes bonanzas. The enrichment is usually due to downward-moving surface waters, leaching the upper part of the vein and precipitating copper, silver, etc., by reaction with the unaltered ore below. As a consequence of this, veins do not increase in richness in depths below the zone of enrichment.

In the *Transactions* of the American Institute of Mining Engineers, Volume XXX., which is just being distributed, Mr. S. F. Emmons has a paper bearing upon this same subject of 'Secondary Enrichment of Ore Deposits.' The author draws upon his wide experience in calling attention to the many cases of secondary enrichment. The main theme discussed is summed up in the opening paragraphs, when he says that, 'admitting fully the general truth of the statement that the descending surface waters exert an oxidizing action, and hence that oxidation products within reach of the surface waters are the result of alteration by the latter, I have been led to believe, by observations now extending over a considerable number of years, that, under favorable conditions, the oxidation products may be changed back again into sulphides and redeposited as such, thus producing what may be called a sulphide enrichment of the original deposits. * * * Being rather a searcher after facts than a theorist, I am not deterred from accepting what may appear to me the correct reading of observed facts because it seems to contradict generally accepted theories.'

The same volume of the *Transactions* contains a practical application of Mr. Weed's theory to Montana deposits, under the title of the 'Enrichment of Gold and Silver Veins.' Attention is especially called to the dependence of such enrichments upon the presence of iron sulphide in the primary ore, and to the structural features which control the circulation of the enriching solutions below water-level. The process may be briefly described as follows. Leaching out of the metals from the portion of

the vein lying above ground-water level is to be considered as the main source of the enriching materials. The leaching is due to superficial alteration, and leaves the iron as a gossan, while the waters carrying the gold, silver, copper and other metals in solution trickle downward through the partially altered ores into cracks and water-courses which penetrate the ore body below the water-level. In weathering, the sulphides oxidize according to their relative affinity for oxygen and inversely as their affinity for sulphur. It is inferred from the evidence that ore bodies lacking in iron pyrite will not show enrichment, thus explaining the absence of any such phenomena in the pure silver-lead bodies of the Coeur d'Alene district and elsewhere.

CHARLES R. KEYES.

RECENT ZOO-PALEONTOLOGY.

VERTEBRATE PALEONTOLOGY AT THE CARNEGIE MUSEUM.

DURING the past summer three parties from the Department of Vertebrate Paleontology of the Carnegie Museum have been operating in our western fossil fields under the direction of Mr. J. B. Hatcher, the Museum's curator of vertebrate paleontology. One of these parties, in charge of Mr. O. A. Peterson, was sent to northwestern Nebraska to examine the Oligocene and Miocene deposits of that region. The work carried on by this party has been quite successful,—as might be expected from any party in charge of so experienced and skilled a collector of vertebrate fossils as is Mr. Peterson. Among other material secured may be mentioned as of especial value, skeletons of *Hoplophoneus*, *Daphænus*, *Oreodon*, *Procamelus* and *Merycochærus*, all, it is believed, sufficiently perfect to admit of mounting as complete skeletons. A second party, in charge of Mr. C. W. Gilmore, was despatched to southern Wyoming to continue the work which has been carried on by the Museum for the past two years in the Jurassic deposits at Camp Carnegie, on Sheep Creek, in Albany Co., Wyoming. This party has met with the usual success attending the two previous expeditions

to this locality, and owing to the skill and energy of Mr. Gilmore the value of the Museum's already important collections of Jurassic dinosaurs has been greatly enhanced. The third party has been in charge of Mr. W. H. Utterback, who has been engaged since November last in reopening the old quarry near Canyon City, Colorado, so long worked by the late Professor Marsh. From this quarry Professor Marsh obtained much of his best material of Jurassic dinosaurs. The bones at this quarry are imbedded in a very hard sandstone, which renders the work of securing them exceedingly difficult and tedious. Already a considerable portion of the skeletons of *Morosaurus* and *Stegosaurus* has been secured, along with other valuable material. Within the last month the work of reopening the quarries near Canyon City, which were operated for a number of years by the late Professor Cope, has been commenced by Mr. G. F. Axtell, also of the staff of this Museum.

DISCOVERIES IN NORTHERN AFRICA.

In the September number of the *Geological Magazine* Dr. Chas. W. Andrews* publishes details of his discoveries in the Western Desert of Egypt which mark the beginning of a new epoch in mammalian paleontology. The first visit to beds of upper Eocene and Oligocene age resulted in the discovery of a Sirenian (probably *Eotherium*), of *Zeuglodon*, a primitive Cetacean, and of Crocodilia, Chelonia and Amphibia. In later visits still more important fossils were secured, which Dr. Andrews has made the types of three new genera. *Palæomastodon* is a trilophodont proboscidean with five grinding teeth in the lower jaw, therefore much more primitive than the oldest Miocene mastodons of Europe. *Mærittherium*, found in older beds of supposed Upper Eocene age, is bilophodont and is probably correctly regarded by Dr. Andrews 'as a generalized forerunner of the mastodon type of proboscidean'; the upper and lower incisors are in pairs, the outer being tusk-like, as we should anticipate. A third, more aberrant type is *Braditherium* 'which in many respects resembles

Dinotherium, but in others reminds one of some of the gigantic Amblypoda of North America.' The resemblance to the Amblypoda is in our opinion unreal because all amblypods have triangular teeth, whereas this animal has quadrate bilophodont teeth and reminds us truly of *Dinotherium* as the author suggests. A strong resemblance is also seen to the great gravigrade sloths such as *Megatherium* or more correctly to their American Eocene ancestors with incisors and enameled teeth such as *Psittacotherium*; the depth of the jaw, the early wearing of the enamel, the position of the coronoid process on the outside of the lower molars, all tend to support this likeness. We shall therefore eagerly await the determination of the actual affinities of this animal. The epoch-making character of these discoveries consists in the promise they afford that Africa will prove to be the home of all those families of mammals such as the elephants, hippopotami, giraffes and antelopes, as well as of earlier types, which suddenly appeared in Europe without known ancestry. This would accord with an hypothesis independently advanced by Rüttimeyer and Osborn that Africa was an isolated center of mammalian evolution and radiation in the early tertiary, and subsequently contributed great migrations of its fauna to Europe and America.

NOTES ON PRIMITIVE AND FOSSIL BIRDS.

PYCRAFT's fourth paper in his 'Contributions to the Osteology of Birds,'* treats of the grebes and divers or Pygopodes. As regards the affinity of the Cretaceous toothed bird *Hesperornis* to this order (rather than to the separate order Odontornithes) he believes with D'Arcy Thompson that there can no longer be any doubt (p. 1041). The paper is supplemented by an excellent key to the comparative osteology of this group, a plan also followed in his extensive memoir † on the morphology and phylogeny of the *Palæognathæ* (*Ratitæ* and *Crypturi*) and *Neognathæ* (*Carinatæ*). In this memoir the pterylography, osteology and soft anatomy of the Tinamous (*Crypturi*) and of the various stru-

* 'Extinct Egyptian Vertebrates,' *Geol. Mag.*, p. 400, Sept., 1901.

* *Proc. Zool. Soc.*, London, Dec. 19, 1901.

† *Trans. Zool. Soc.*, London, Dec., 1900.

thious forms (ostrich, rhea, dinornis, aepyornis, emeu, cassowary, kiwi or apteryx) are thoroughly examined and lead the author to unite these two groups into a new division *Palæognathæ*, differing from all the remaining orders (*Neognathæ* equals *Carinatae* minus *Crypturi*) especially in skull structure.

His conclusion is that the various 'struthious' forms are widely separate in origin; the emeus and cassowaries are on the whole the most primitive, the true ostriches being a later branch from the same stem; the moas are distantly related to the aepyornithes; the kiwis (*Apteryges*) are highly aberrant. The inter-relationships of the higher birds are not discussed, but an appended phyletic tree represents *Hesperornis* as one of the *Pygopodes* and *Ichthyornis* as related to the *Steganopodes* (pelicans, tropic birds, cormorants, etc.).

H. F. O.

*THE BRITISH ASSOCIATION AND THE DEATH
OF PRESIDENT MCKINLEY.*

WE reproduce the letter addressed by the President of the British Association for the Advancement of Science to the United States Ambassador to Great Britain and the latter's reply :

BRITISH ASSOCIATION FOR THE ADVANCEMENT
OF SCIENCE.

BURLINGTON HOUSE,
LONDON, W., Sept. 19, 1901.

To his Excellency, The Hon. J. H. CHOATE, Ambassador of the United States of America.

Sir, The General Committee of the British Association for the Advancement of Science, assembled this year in Glasgow, desire me to express to you the horror with which they heard of the attack upon the late President of the United States, and their deep sorrow at his death. On the first day of the meeting in Glasgow the Association telegraphed to Mr. McKinley the assurance of their sympathy and of their earnest hopes for his recovery.

These hopes have not been fulfilled; and it is now my sad duty to inform you that the tragic fate of the President of the United States has cast a deep shadow over our meeting. Together with all our fellow-countrymen we share in the sorrow of the great sister nation which you represent; and we desire, through you, to inform the men of science of America that the members of the British Association are bound to them not only by ties of blood, not only by the links

which unite all students of nature, but by the deeper feelings which draw together those who are partners in a common sorrow, and mourn one of the leaders of our common race.

I am, sir,

Your obedient servant,

A. W. RÜCKER,

President.

AMERICAN EMBASSY,

LONDON, Sept. 23, 1901.

Sir,

I have received with heartfelt gratitude the kind expression of condolence and sympathy at the death of President McKinley which you have forwarded to me on behalf of the General Committee of the British Association for the Advancement of Science.

I shall duly advise my government of its receipt, and it will be highly appreciated by them and by Mrs. McKinley. Your kind message and hundreds of other similar communications from all parts of the British Dominions, carry an assurance of national friendship and goodwill which will be most welcome to the American people.

Yours sincerely,

JOSEPH H. CHOATE.

A. W. RÜCKER, ESQ.,

President.

SCIENTIFIC NOTES AND NEWS.

AMONG the scientific men who have expressed their intention of being present at the Yale bicentennial exercises are Professor Simon Newcomb and Professor Charles S. Minot.

PROFESSOR BASHFORD DEAN, of Columbia University, has returned from his sabbatical year, spent in studying the marine zoology of Japan, and in visiting China and the Philippines. He has sent to the American Museum of Natural History a fine collection of Ainu materials, also a series of glass sponges and of the Japanese long-tailed fowls. For the Zoological Department of Columbia he brings back extensive research and exhibition collections.

WE regret to learn that Dr. J. H. Hyslop, professor of logic and ethics in Columbia University, is ill, and has been given leave of absence for a sabbatical year which he will spend in the Adirondacks. Dr. A. L. Jones, as lecturer, will take his courses.

PROFESSORS MITSURU KUHARA and Hanichi Muraoka, occupying respectively the chairs of

chemistry and physics in the Imperial University of Kyoto, Japan, who have been spending a few weeks in this country, sailed from New York City, on October 8, for Europe, in continuation of their eastward trip around the world. They expect to reach Japan in February, in time to resume their duties at the beginning of the second half-year.

THE Hon. Andrew D. White, United States Ambassador to Germany, arrived in New York on October 5. He will return to his post in Berlin shortly.

THERE was a meeting of the students of the graduate school of Harvard University on October 3, at which Professor E. C. Pickering, director of Harvard College Observatory, made an address.

MR. S. P. JONES, of Atlanta, Ga., has been appointed assistant State Geologist of Georgia, vice Dr. Thomas L. Watson, resigned. Mr. Jones, after five years' work at the University of Georgia, practiced law a year or more, and then pursued a course of geological study with Professors Le Conte, Lawson and Merriam at the University of California. A year or two was spent in teaching, and in 1900 he refused an appointment on the Alabama Geological Survey to accept a fellowship at Vanderbilt University.

DR. ARTHUR WILLEY has resigned the post of curator to the museum at Demarara, to which he was recently appointed, and the place will be filled by Mr. R. Evans, of Oxford.

THE Swiney lectures on geology, in connection with the British Museum (Natural History), will this year be given by Mr. John S. Flett. The subject of the course of twelve lectures is 'The Geological Evidences of Former Geographical Conditions.' The first lecture will be given on October 7.

IN the death of Frederick Fraley, born on May 18, 1804, Philadelphia has lost one of its most honored citizens. Mr. Fraley was always ready to assist scientific work. He was one of the original trustees of Girard College, since 1847 trustee of the University of Pennsylvania, and since 1880 president of the American Philosophical Society.

DR. A. F. W. SCHIMPER, professor of botany at Basle, died on September 9, at the age of forty-five years.

THE London *Times* announces the death of Mr. Martin Fountain Woodward, demonstrator in biology at the Royal College of Science, South Kensington. He was the younger son of Dr. Henry Woodward, F.R.S., keeper of the department of geology in the British Museum, and was drowned on the night of September 15, by the capsizing of a boat on the Irish coast. Mr. Woodward was in temporary charge of the marine biological laboratory of the Fisheries Board for Ireland. He and his friend, Mr. W. Watson, F.R.S., assistant professor to Professor Rücker, at the Royal College of Science, were crossing from Innisbofin, when, about a mile from the shore, the boat was caught by a sudden squall and capsized. Mr. Watson and the fisherman who was with them reached the shore with the aid of an oar, but their companion was not seen again after the boat turned over. Mr. Woodward entered the Royal School of Mines and Normal College of Science in 1883, where he obtained the Murchison Prize and Medal. He was appointed demonstrator in biology in 1885 by Professor Huxley, and had since acted in that capacity to Professor Howes. He was the author of various papers on mollusca and on the dentition of mammalia. In 1898-1900 he edited an English edition of Korschelt and Heider's 'Text-book of Embryology of Invertebrates.' He was secretary of the Malacological Society of London, and was specially devoted to marine zoology, having on several occasions dredged the British and French coasts.

WE learn from *Nature* that the Reale Istituto Veneto announces nine prizes for competition in the faculties of science, letters and arts, for which essays have to be sent in at the close of the years 1901, 1902, 1903. The subjects in science include the projective properties of the two-dimensional algebraic surfaces of n -dimensional space, the geophysical and biological characters of the lakes of the Venetian district excluding the Lago di Garda, and the development of the respiratory apparatus of the pulmonate vertebrata.

THE estate of the late Jacob S. Rogers has been appraised at over \$5,600,000. It will be remembered that the greater part of the estate was bequeathed to the Metropolitan Museum of Art.

THE Paris Academy of Medicine will occupy its new building on the rue Bonaparte at the beginning of next year. It is reported that the Paris Municipal Council will secure the present building on the rue des Saints-Pères, for the Charité Hospital.

AT the recent Buffalo meeting of the American Public Health Association officers were elected as follows: President, Dr. Henry D. Holton, Brattleboro, Vt.; 1st Vice-President, Dr. Walter Reed, U. S. Army; 2d Vice-President, Dr. Jesus Chico, Guanajuato, Mexico, and Treasurer, Dr. Frank W. Wright, New Haven, Conn. The next meeting will be held in New Orleans.

The British Medical Journal states that the new Anatomical Department of the University of Glasgow was formally opened by Lord Lister on the afternoon of September 12. The department had for years been hampered by an unsuitable and insufficient accommodation, and the splendid new buildings now inaugurated have been provided through the munificence of the trustees of the late Mr. J. B. Thomson, the well-known shipbuilder. The new buildings include an excellent laboratory and museum, and for this museum Professor Cleland has presented to the university his fine collection of anatomical specimens. In his address, Lord Lister dwelt on the importance of the study of anatomy, and congratulated Professor Cleland and the university on the excellent accommodation which was now set apart for that study. Amongst the others who took part in the proceedings were Principal Story, Lord Provost Chisholm, Sir William Turner, and Professor Cleland; and after the speeches the premises were inspected by the company, and afternoon tea was served.

THE new Pathological Laboratory of the University of Oxford will be opened on October 12. Sir William Church, Bart., president of the Royal College of Physicians of London, Dr. G. Sims Woodhead, professor of

pathology in the University of Cambridge, and others will take part in the proceedings.

THE plans of Dr. Walter Wyman, surgeon-general of the U. S. marine hospital service, for the establishment of an institute for the study of yellow fever have been approved by the government.

THE Brazilian government has declared that the City of Rio de Janeiro is infected with the bubonic plague. Eleven cases of bubonic plague and four deaths are reported from Naples.

THE Fifth International Congress of Physiology was opened on September 17, in the physiological laboratory of the University of Turin, under the presidency of Professor Angelo Mosso. Sir Michael Foster was elected honorary president. Professor Fano, Professor Fredericq, Professor Grützner and Professor Sherrington were appointed general secretaries. More than 200 physiologists were present, and 186 communications were announced. A reception was given by the members of the Academy of Medicine of Turin and an exhibition of physiological apparatus was opened.

THE opening meeting of the eleventh session of the British Institution of Mining and Metallurgy will be held on October 17, in the rooms of the Geological Society, Burlington House. The meetings during the session will, to suit the convenience of the members, be held from 5 to 7 p. m., and tea will be provided at 4.30. The annual dinner will be held on the same day.

THE twenty-second annual congress of the French Geographical Society was held recently at Nancy, under the presidency of M. Fournier. There were no less than twenty-two societies represented, of which nineteen were local geographical societies. The Society made a number of recommendations, including the following: That a colonial exposition be held in Algiers; that conventional signs be universally adopted in geographical and topographical work; that the metric system be introduced in those colonies where it has not been adopted; that a decimal division of the quadrant of a circle be adopted; that additional canals be constructed in France; that certain

districts be reforested; that methods be adopted for increasing the birthrate of France, and that a postal service be organized in China under French auspices.

THE biological teachers on the transport *Thomas*, who went to the Philippine Islands in the latter part of July, organized during the voyage a biological society for the investigation of the fauna and flora of the Islands. Mr. H. H. Kenagy, formerly graduate assistant in zoology, University of Nebraska, was chosen as the first president of the organization.

THE British Antarctic exploration ship, *Discovery*, arrived at Cape Town on the 3d inst.

THE committee on the Senn Medal call attention to the following conditions governing the competition for this medal for 1902: (1) A gold medal of suitable design is to be conferred upon the member of the American Medical Association who shall present the best essay upon some surgical subject. (2) This medal will be known as the Nicholas Senn Prize Medal. (3) The award will be made under the following conditions: (a) The name of the author of each competing essay shall be enclosed in a sealed envelope bearing a suitable motto or device, the essay itself bearing the same motto or device. The title of the successful essay and the motto or device is to be read at the meeting at which the award is made, and the corresponding envelope to be then and there opened and the name of the successful author announced. (b) All successful essays become the property of the Association. (c) The medal shall be conferred and honorable mention made of the two other essays considered worthy of distinction, at a general meeting of the Association. (d) The competition is to be confined to those who at the time of entering the competition, as well as at the time of conferring the medal, shall be members of the American Medical Association. (e) The competition for the medal will be closed three months before the next annual meeting of the American Medical Association, and no essays will be received after March 1, 1902. Communications may be addressed to any member of the committee, consisting of the following: Dr. Herbert L. Burrell, 22 Newbury street, Boston, Mass.; Dr. Edward Martin, 415

South Fifteenth street, Philadelphia, Pa.; Dr. Charles H. Mayo, Rochester, Minn.

THE U. S. Geological Survey has issued a statement concerning the value of the mineral products of the United States from which we take the following:

	1880.	1890.	1900.
Metallic products.	\$190,039,865	\$305,735,670	\$552,418,627
Nonmetallic products.	173,279,135	312,776,503	516,690,262
Unspecified.	6,000,000	1,000,000	1,000,000
Total.	\$360,319,000	\$619,512,173	\$1,070,108,889

Last year the value of the mineral products for the first time exceeded a million dollars. During the past nine years the value of the silver mined has not increased, though there has been a considerable increase in the course of the last four years. During the nine years the value of the gold has increased from 33 to 39 million dollars; of pig iron from 128 million to 129 million; of copper from 38 million to 98 million, and the value of aluminum has increased thirteenfold. The value of bituminous coal has increased from 117 million to 221 million, and the value of petroleum from 30 million to 75 million. While in the case of the metals the output has increased approximately in proportion to the value, this is not the case with petroleum. In 1891 the value of crude petroleum was about 56 cents per barrel, whereas in 1890 it was \$1.20.

UNIVERSITY AND EDUCATIONAL NEWS.

By the will of the late Susan Cabot Richardson, of Milton, Mass., Radcliffe College will ultimately receive nearly \$200,000.

SYRACUSE UNIVERSITY has received an anonymous gift for the erection of a new building to be called the Hall of Natural History.

It is said that the proposed Milliken University, at Decatur, Ill., will be opened next year, with an endowment of over \$1,000,000, of which sum Mr. James Milliken has given over \$500,000. Professor S. R. Taylor, recently president of the Kansas State Normal School, will be president. The institution is under the charge of the Cumberland Presbyterian church.

MR. ANDREW CARNEGIE has given £25,000 to the Glasgow Technical College towards the £50,000 necessary to complete the required fund, £150,000, for the improvement of that institution. Mr. Carnegie has also offered £7,500 for a library at Ilkeston.

THE attendance at Cornell University, including 850 new students, is stated by President Schurman, in his annual opening address, as about 250 in excess of that of last year, and as indicating the total registration for the year, inclusive of the medical school in New York and the summer school at Ithaca, as between 3,250 and 3,500. The registration on the campus, of students in regular courses, promises to be about 2,750. Sibley College has a total attendance of new students, in all classes and courses, of above 350, almost equal to the total of upper classmen returning to the college, making the probable total registration for 1901-'02 about 750 in all grades. The College of Civil Engineering has increased fifty per cent., and the other colleges and departments report large additions. The new building for the medical department is about half completed; that for Sibley College, the great central 'dome,' about one third.

PRESIDENT SETH LOW presented his resignation to the trustees of Columbia University on October 7. It was accepted with expressions of deep regret, and Dr. Nicholas Murray Butler, professor of philosophy and education, was made acting president.

DR. GEORGE H. DENNY, professor of Latin, has been elected president of Washington and Lee University to fill the vacancy caused by the death of William L. Wilson last October. Dr. Denny is not yet thirty-one years of age.

F. H. KING, since 1888 professor of agricultural physics in the University of Wisconsin, has accepted the position of chief of a new division, created in the Bureau of Soils, and goes to the new appointment in November next. The vacancy created at the University of Wisconsin has not yet been filled.

AT Trinity College, Professor Flavel S. Luther, of the mathematical department, has returned from Europe and will take up his work after a year's absence. Rev. Herman Lilienthal has resigned as assistant in the department

of philosophy and Rev. Charles Harris Hayes, Ph.D. (Columbia, Halle and Oxford), of Portland, Me., will take his classes.

DR. EDWIN MEAD WILCOX, M.Sc. (Ohio), and Ph.D. (Harvard), formerly professor in the Agricultural and Mechanical College of Oklahoma, has been appointed professor of biology in the Alabama Polytechnic Institute, Auburn, Ala., filling the vacancy caused by the resignation of Professor F. S. Earle, who has resigned to accept a curatorship in the botanical department of Columbia University, New York.

DR. W. M. BLANCHARD, last year instructor in chemistry at the Rose Polytechnic Institute, has been appointed instructor in charge of the department of chemistry at De Pauw University, in the room of Dr. P. S. Baker, whose death we were recently compelled to announce.

THE following changes have been made in the scientific departments of the University of Maine; Gilbert A. Boggs, Ph.D. (Pennsylvania), has been appointed instructor in chemistry; John E. Burbank, A.M. (Harvard), tutor in physics; Frank H. Mitchell, B.S., tutor in chemistry; H. W. Britcher, of Syracuse and Johns Hopkins Universities, assistant in zoology; Louis R. Cary, B.S., assistant in biology, and Geo. E. Poucher, of De Pauw University, assistant in physics.

DR. ISAMBARD OWEN having definitely declined to accept the principalship of the South Wales and Monmouthshire University College, the council at a recent meeting decided to advertise for a successor to the late principal, Viriamu Jones, at a salary of £1,000 a year.

MR. W. J. POPE has been appointed professor of chemistry and head of the chemistry department at the new Municipal School of Technology at Manchester.

DR. T. E. STANTON, professor of engineering at University College, Bristol, who recently accepted the appointment of superintendent of the Engineering Department in the National Physical Laboratory, is succeeded in his chair at Bristol by Mr. R. M. Ferrier, B.Sc. (Glasgow).

PROFESSOR MAX WOLF, of Heidelberg, has received a call to the University at Göttingen as professor of astronomy and director of the observatory.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

EDITORIAL COMMITTEE: S. NEWCOMB, Mathematics; R. S. WOODWARD, Mechanics; E. C. PICKERING, Astronomy; T. C. MENDENHALL, Physics; R. H. THURSTON, Engineering; IRA REMSEN, Chemistry; CHARLES D. WALCOTT, Geology; W. M. DAVIS, Physiography; HENRY F. OSBORN, Paleontology; W. K. BROOKS, C. HART MERRIAM, Zoology; S. H. SCUDDER, Entomology; C. E. BESSEY, N. L. BRITTON, Botany; C. S. MINOT, Embryology, Histology; H. P. BOWDITCH, Physiology; J. S. BILLINGS, Hygiene; WILLIAM H. WELCH, Pathology; J. MCKEEN CATTELL, Psychology; J. W. POWELL, Anthropology.

FRIDAY, OCTOBER 18, 1901.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

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SECTION B, PHYSICS.

THE officers of this Section were: Vice-President, D. B. Brace; Secretary, John Zeleny; Member of Council, E. L. Nichols; Sectional Committee, D. B. Brace, John Zeleny, B. W. Snow, L. B. Spinney, E. L. Nichols; Member of General Committee, L. B. Spinney.

A large number of papers of unusual importance was presented before the Section, so that a keen interest was maintained in the meetings to the very end. The authors of a number of the papers were absent but had representatives who were familiar with the subjects they presented, so that beneficial discussions were possible even in these cases.

On Thursday forenoon, August 29, the Section met with the American Physical Society, and on the afternoon of the same day there was a joint meeting of Sections A and B.

The following are the abstracts of the papers that were presented:

1. 'A Spectrophotometric Comparison of the Relative Intensity of Light from Carbon at Different Temperatures': ERNEST BLAKER.

The instrument used in this work was a Lummer-Brodhun spectrophotometer, the comparison source being an acetylene flame.

The carbon studied was that of the filament of the ordinary incandescent lamp with treated surface, on the one hand, and a similar filament with smoked surface on the other. Temperatures were computed by means of the empirical relation between them and the ratio of the resistances of the hot and cold filament, established by Chatelier.*

Isochromatic curves showing the rise in intensity with the temperature were plotted for various wave lengths of the visible spectrum. These, taken separately, exhibit the form characteristic of bodies previously investigated, such as platinum and the artificially produced 'black body.'

The temperature or its reciprocal as demanded by the received equations for radiation is nearly proportional to the logarithm of the intensity.

The corresponding isothermal curves, however, show the existence of the remarkable peculiarity noted by Nichols † in a recent paper. The selective radiation in the yellow, described by that author, is even more strikingly developed at the higher temperatures covered in these experiments. It exists alike in the case of the gray-surfaced carbon and in lamp black and would lead us to classify carbon rather with the metallic oxides than with the black bodies, as regards the laws of radiation.

2. 'The Distribution of Energy in the Spectrum of the Acetylene Flame': GEORGE W. STEWART.

The great value of acetylene not only for illuminating purposes, but also in experimental research, makes the study of the distribution of energy in its spectrum of considerable importance. In the work to be described, a mirror spectrometer and fluorite prism were used to produce the spectrum, and the radiometer of Nichols to measure the radiant energy. The mirror-

prism device of Wadsworth was utilized, the main advantage gained being that the radiometer could be kept stationary. The spectrum fell upon a slit mounted directly in front of the fluorite window of the radiometer, thus avoiding the use of any lens whatever.

The source of light used in the work upon the visible portion of the spectrum was a cylindrical acetylene flame from a single-tip burner. This type was used because the intensity per unit area was greater than in the flat flame. The results, plotted in the form of a curve, afford definite data concerning the distribution of energy in the visible spectrum of this flame.

Owing to the difference in the dispersion of the prism, a slight change in the relative positions of the spectrometer and radiometer was of greater consequence in the infrared than in the visible portion of the spectrum.

The most striking characteristic of the curve of energy distribution is the set of elevations which are due to the emission bands of the gases of the flame. If the acetylene is pure, the gases to be expected are CO_2 and H_2O . According to Paschen, the maximum points of the emission bands of these gases are as follows:

H_2O Spectrum,
1.46 μ , 1.90 μ , 2.83 μ .

CO_2 Spectrum,
2.71 μ (2.68 μ when CO_2 is not dry) and 4.40 μ .

The energy curve shows elevations whose maxima agree very closely with these values. Observations of wave lengths longer than 6 μ are useless, the error due to stray radiation being so great.

Similar measurements were made upon the flame of a bunsen burner adapted for the combustion of acetylene.

In this curve all five emission bands appear and the values of the wave length at the maximum points agree with the values

* Chatelier, *Journal de Physique* (3), I., p. 203.

† Nichols, *Physical Review*, Vol. XIII., 1901.

quoted above. If we compare the bunsen and the single tip curves, we see that they do not agree in all respects. The elevations due to the emission of the H_2O gas have not the same relative values in the two cases, but this discrepancy disappears when corrections are made for slit widths. The band at 2.3μ does not appear in the bunsen flame and this fact makes its presence in the other somewhat in doubt.

The changes produced in the correction of the curves possess several points of interest. The maximum of intensity is shifted considerably toward the violet, appearing in the corrected curve at about 0.94μ .

Using Langley's method of finding the ratio of the area in the visible portion of the spectrum, to the area of the entire curve, the radiant efficiency was calculated. The value for the cylindrical flame is 0.100 and for the flat flame 0.131. The latter value is not very reliable, but there is not much doubt but that the radiant efficiency of the flat flame is the larger. Stewart and Hoxie, using a modification of the Melloni method, found the value 0.105 for the flat flame. (To be printed in the *Physical Review*.)

3. 'Experiments on a New Form of Standard High Electrical Resistance': H. C. PARKER. (By title.)

4. 'Variation of Contact Resistance with Change of E. M. F.': H. C. PARKER. (By title.)

5. 'On Flutings in a Sound Wave and the Forces due to a Flux of a Viscous Fluid around Spheres': S. R. COOK, Washburn College.

The author shows that the forces due to a perfect fluid are not sufficient to produce the laminae and flutings in a sound wave, but that there are other forces which are probably due to the viscosity of the vibrating media. That there must be other forces was first manifest by a series of experiments with air, carbon dioxide, chlorine and

hydrogen as media, using various materials to form the laminae, including filings of coin silver and platinum.

The author also shows that flutings are not confined to a stationary sound wave but are capable of being produced by direct sound waves on an open surface.

A mica disk, threaded on a fine wire in a resonance tube, was caused to vibrate in unison with the prong of a large tuning fork, whose frequency was 32 per second. Koenig's equations for the forces due to a perfect fluid when reduced to their final form are:

$$X = \frac{3/2\pi\rho R^3 R_1^3 W_0^3}{r_0^4}$$

$$Z = -\frac{3\pi\rho R^3 R_1^3 W_0^3}{r_0^4}$$

$$M = \rho R_2^3 W_0 \sin 2\theta.$$

ρ = density of medium, R , R_1 , R_2 are the radii of the sphere or disks, W_0 the velocity of the stream. This gives repulsion parallel and attraction perpendicular to the stream lines. The forces were studied by first allowing RR_1 to vary while ρ and W_0 remained constant. Then ρ was varied while all other factors were kept constant, and it was shown that

$$\frac{X_1}{X_2} = \frac{Z_1}{Z_2} = \frac{M_1}{M_2} > \frac{\rho_1}{\rho_2}$$

when ρ_1 was the density of carbon dioxide and ρ_2 that of air.

A further study of the forces was made with sealing-wax spheres and it was found that when the spheres, whose radii were less than 1 mm. were at a greater distance than one-half their diameter apart, they followed the perfect fluid forces, but when they were less than one-half their diameter they were repelled perpendicular, and attracted parallel, to the line of flow.

The author reaches the following conclusions:

1. The conditions for the formation of laminae are found whenever there is a flux of a viscous fluid around solid particles.

2. There are forces exactly opposite to those of the perfect fluid.

3. These new forces are most probably due to the viscosity of the medium.

4. The new forces in conjunction with the forces of a perfect fluid make possible a complete and clear explanation of the laminae and flutings produced in a sound wave. (To be printed in the *Phil. Mag.*)

6. 'Interferometer Curves': J. C. SHEDD, Colorado College.

The general equation of the interference curves is found to be a conic and the conditions for obtaining the various forms are determined by considering the question of eccentricity.

The various cases are taken up in detail and the experimental manipulations necessary for obtaining them are explained.

7. 'On the Absorption Spectrum of Iodine in Solution': EDWARD L. NICHOLS and WILLIAM W. COBLENTZ.

That iodine dissolved in carbon disulphide, although opaque to the visible spectrum, transmits the infra-red rays freely, has long been known, but no systematic studies of the spectrum of such solutions appear to have been made. In the study of the visible spectrum a horizontal slit spectrophotometer was used. Quantities of iodine varying from 3.3 mg. to 0.017 mg. per cubic centimeter were dissolved and their absorption spectra measured. A single broad band was found, having its maximum at $\lambda = .52\mu$, the transmission curve being steeper on the side towards the violet. For the solution containing 0.017 mg. per cc. the transmission in the center of the band was 80 per cent. With increasing concentration the band widens and becomes more dense. Solutions containing more than .25 mg. per cc. are opaque in the center of the band, and the region of opacity extends as the amount of iodine in solution is increased until the entire visible spectrum is obscured. Observations upon

iodine dissolved in alcohol showed a very different absorption spectrum. Such solutions were opaque in the violet, the transmission increasing steadily towards the red. The form of the curves was such as to indicate an absorption band of which one side only lies in the visible spectrum, the center being in the ultra-violet. To extend these measurements to the infra-red spectrum a Nichols radiometer was employed. Readings of the transmission of various solutions were made out to 2.7μ , beyond which wave-length the solvent itself rapidly becomes opaque. It was found that all solutions rose rapidly in transmitting power with increasing wave-length and became completely transparent between 1.0μ and 1.1μ , between which region and 2.7μ , iodine appears to exert no absorbing power whatever.

7a. 'A Preliminary Communication on the Pressure of Light and Heat Radiation': E. F. NICHOLS and G. F. HULL.

The experiment consisted of two parts: (1) The determination of the light pressure by observing the deflection, either static or ballistic, of a torsion balance when one vane of the balance was exposed to light, and (2) the determination, in ergs per second, of the intensity of the light falling upon the vanes. The image of an aperture, upon which the rays from an arc lamp were concentrated by two condensing lenses, was focused in the plane of the glass vanes placed symmetrically with regard to a rotation axis held by a quartz fiber of known torsion coefficient. The torsion balance was covered by a bell jar connected to pressure gauges and a mercury pump. To eliminate the disturbing action due to the residual gas in the receiver, the following devices were used: (1) The vanes were silvered and highly polished, thus making the absorption small and the reflection percentage large. (2) The silver surface of one vane was turned towards, and of the other, from,

the light, thus making the effect of the gas action and light pressure in the same direction on one vane, and in opposite directions on the other. (3) The pressure of the air in the bell jar was varied, and the pressures were chosen in the vicinity of that pressure at which the gas action was very small. (4) The length of exposure of light on the vane in most of the observations was short. The gas action, which begins at zero and increases with the length of exposure, was thus reduced in comparison with the instantaneous action of the radiation pressure. By means of an inclined glass plate placed in front of the aperture a portion of the incident light was thrown on a thermopile. The deflection of a galvanometer connected with the latter gave the relative light intensities.

Two methods of determining radiation pressure were used:

(1) The vane was exposed continuously to the light until the turning points of the vibration of the balance showed that static conditions had been reached. The other vane was then exposed. Finally the whole suspended system was turned through 180° , and the vanes were exposed in turn. The mean of the angles of deflection, multiplied by the torsion coefficient of the fiber and divided by the lever arm, gave the force in dynes acting on the vane. (2) The vanes were exposed for a quarter of the period of the suspended system. The period, damping coefficient, torsion coefficient and lever arm being known, the value of the radiation could be found. The two methods gave practically the same result except for the air pressures for which the gas action was large.

The energy falling upon the vanes was measured by means of a bolometer consisting of a thin disc of platinum, about the size of the vanes, covered with platinum black. The bolometer, occupying exactly the position which the glass vane had pre-

viously occupied, was made one of the arms of a Wheatstone bridge. The bridge was balanced, the bolometer exposed to the light, and the throw of the bridge galvanometer read. Later the disc was heated by an electric current which entered and left at two equipotential points on the bridge current and the galvanometer throw again was read. The current strength and the resistance of the disc being known, the activity of the disc is given by $i^2R \times 10^7$ ergs per second. The readings of the thermopile before mentioned made it possible to reduce all observations to a constant light intensity. If E = energy per second falling upon a surface, a = the percentage of the radiation reflected, v = the velocity of light, then, theoretically, the value of the radiation pressure is $\frac{(i + a)E}{v}$. The experimental value of the pressure as found by the authors was about 80 per cent. of the theoretical value.

8. 'The Absorption Spectrum of Ferric Hydrate': B. E. MOORE, University of Nebraska.

The author in a recent article upon 'A Spectrophotometric Study of the Hydrolysis of Ferric Chloride,' has pointed out that the final product is colloid ferric hydrate. This product can be formed by Graham's dialytic method. It would then be inferred that identical products would have identical absorption spectra.

It was found that the absorption of the two products was quite different in character. The addition of given quantities of chlorine or of hydrochloric acid, did not effect any transformation in the dialyzed colloid, *i. e.*, crystalloids, if present, were not changed by this treatment. If dialyzed ferric hydrate, or hydrolyzed ferric chloride were added to fresh dilute ferric chloride, the hydrolysis of the latter was accelerated. The greater acceleration was caused by the hydrolyzed ferric chloride. From this it is

inferred that both solutions contain identical colloids, but that the Graham's colloid contains also considerable inactive crystalloid hydrate. The absorption curve then suggests that the crystalloid has an absorption curve lying between hydrolyzed ferric chloride and non-hydrolyzed ferric chloride. (To be printed in *Physical Review*.)

9. 'Note on the Transmission of Radiation by Thin Films of Asphalt': E. L. NICHOLS.

10. 'The Faraday Effect in Solutions of Hydrolyzed Ferric Chloride': FRED. J. BATES, University of Nebraska.

The rotation of the plane of polarization in optical transparent substances, when the light is transmitted along the lines of magnetic force, has been the subject of numerous experiments since the days of Faraday, and is known as the 'Faraday Effect.' There have been many determinations of the molecular rotation of substances in solution, but little effort to determine whether the effect in solution arises from a molecule or from an ion or from both. Observations have also frequently been limited to one color (and perhaps then a mixed color), or to a few colors. It seemed desirable to extend these observations to different parts of the spectrum. This is particularly true of colored solutions, whose colors correspond hypothetically to the free periods of their vibrations, affecting the dispersion and probably the rotation of the plane of polarization.

Ferric chloride solutions afford a good means of testing this phenomenon. Observers have noted that the molecular rotation of this substance decreases upon dilution of the solution. This suggests that the rotation arises from the molecules rather than from the ions. The writer tried a solution of sufficient concentration to give him a rather large rotation. The solution was then diluted enough to leave the effect slightly but certainly noticeable.

If the rotation was proportional to the concentration, no effect was observed, which suggests that the ions are inactive or possess very small rotary power in comparison to that of the molecules. Observations by Goodwin and Moore show that dilute solutions of ferric chloride hydrolyze and finally form a new product, colloid ferric hydrate. It was thought that by restoring an iron molecule by this process there would possibly be a small rotation where previous ionization had made it unobservable. By this test it was found that the required dilution to obtain sufficient hydrolysis made the quantity of iron too small to give any further evidence by the usual method of observation. However, the use of a sunlight spectrum showed an effect as soon as one began to pass from the transparent spectral region into the absorption region. The half-shade polariscope could be read to 0.01° , and in the red the difference between a .01 normal solution (hydrolysis forced by heating the solution) and water was not more than 0.01° . The difference between an unhydrolyzed solution of this concentration and water was also unobservable. Upon examination of the hydrolyzed solution at a point in the green where the absorption is very marked, a rotation of $.79^\circ$ was observed, while at the same point the other two solutions showed no difference. That is, we have here an anomalous rotary polarization or 'Faraday Effect,' analogous to anomalous dispersion. It is clear that in this case the anomaly arises from molecules in the region of their absorption. It remains to be seen whether such an anomaly will also arise in solution where the absorption arises from ions.

11. 'Discharge of Electricity from Glowing Platinum and the Velocity of the Ions': E. RUTHERFORD.

A rectangular platinum plate 14 cm. long, 7.5 cm. wide and .002 cm. thick, was heated to incandescence by an electric

current. The platinum plate was charged to a known potential by means of a battery and the current between the platinum plate and a parallel copper plate observed by means of a sensitive galvanometer. The rate of discharge of positive and negative electrification was examined under varying conditions of temperature, distance and P. D. between the plates, and compared with the theoretical results deduced from the ionization theory of gases.

At a temperature of a dull red heat positive ions are produced at surface of the platinum plate, which travel to the opposite plate through the gas, if the platinum is positively charged. The movement of the ions disturbs potential gradient between plates and at high temperatures the slope of potential near hot plate is extremely small.

Let i = current per sq. cm. through the gas.

n = number of ions per cc. at any point distant x from platinum plate.

V = P. D. between the plates.

K = velocity of positive ion for unit potential gradient.

e = charge on ion.

d = distance between the plates.

Assuming the potential gradient zero at the platinum surface, it can readily be shown that

$$i = \frac{9V^2K}{32\pi d^3}$$

The current is thus independent of number of ions produced, *i. e.*, the temperature of the plate, providing it exceeds a certain value. Experimentally it was found :

1. For a distance of 2 cm. and under, the current at first increased rapidly with rise of temperature up to a certain point, and then more slowly. For distances of from 3 to 8 cm. the current rose to a maximum, and then steadily decreased with rise of temperature.

2. The maximum current varied approximately as square of the P. D.

3. Current diminished more rapidly than $\frac{1}{d^3}$.

The differences observed in (1) and (3) between experiment and theory are due to (a) decrease of velocity of ions with distance from heated platinum plate, (b) presence of some very slow-moving carriers produced at platinum surface at high temperatures.

The velocity of the ions was measured by a direct method depending on the use of an alternating P. D. of known frequency. The method was similar to that used previously for determination of velocity of ions produced by ultra-violet light (*Proc. Roy. Soc.*, 1898). It was found that the velocity of ions was not a constant, but varied between wide limits.

This is probably due to difference in size of ions in consequence of their varying power of forming clusters of molecules round them.

The following table gives results obtained for different distances between plates. Under heading 'calculated velocity' are given values of K calculated from equation (1) by measuring maximum current i for given distance and voltage.

Distance between plates.	Velocity in cm. per sec. for 1 volt per cm.		
	Maximum.	Average.	Calculated.
2 cms.	13	7.8	5.5
3 "	7.9	5.8	3.2
5 "	—	4.7	2.2

12. 'On Conditions controlling the Drop of Potential at the Electrodes in Vacuum-Tube Discharge': CLARENCE A. SKINNER, University of Nebraska.

With the passage of electricity through rarefied gases, it requires, relatively, a very high P. D. to force the discharge directly across the space between the electrodes when these are brought within a certain small distance apart. To locate at what part of the path the potential increases was the primary object of this investigation.

The results led to a more general investigation of the drop of potential at the electrodes.

A cylindrical vacuum-tube, with disk electrodes (perpendicular to its axis) insulated so as to force the discharge directly across the space between them, and nitrogen were used. The potential of the gas at any position was obtained by a movable wire.

As the electrodes approach each other the drop at the anode remains constant so long as there is an extended positive column. With the anode passing through the Faraday dark space its 'drop' rises to a maximum and then falls to zero in the negative glow, but rises again *rapidly* as the anode moves into and through the cathode dark space. The cathode drop remaining constant until the anode reaches the cathode dark space begins then to increase with great rapidity. During these changes the conductivity of the gas does not vary.

These results are explained on the hypothesis that the impact velocity of the discharging ion tends to prevent charge from being transmitted to the electrode; that to give up its charge the ion must first come to rest.

Other Observations.—At the cathode the drop may be expressed by the equation

$$V = C + \frac{c}{p}(a + i)$$

where i is the current density; p , the gas pressure; C , a constant approximating in value the cathode drop, as measured by Warburg; c , a constant depending on the nature of the gas, but independent of the metal used as cathode; and a , a constant. At the anode the drop appears to vary according to a similar law, where c is about one thirty-fifth its magnitude at the cathode.

The great difference in magnitude of the drops at the two electrodes may be explained on the hypothesis that the positive ion is of much greater mass than the nega-

tive and hence (for the same impact velocity), its elastic reaction being greater, the greater resistance to its discharge.

The difference in the drop occasioned by the use of different metals may be explained by their contact-potentials. Of two metals, that possessing the greater attraction for negative electricity is found to possess the lower drop as anode, apparently by its attraction for the charge on the ion aiding in overcoming the elastic reaction of the impinging ion. The same applies to the cathode. (To be printed in the *Phil. Mag.*)

13. 'The Influence of Temperature upon the Photo-electric Effect': JOHN ZELENY, University of Minnesota.

Ultra-violet light impinging upon negatively electrified bodies dissipates their charge. The electricity is supposed to be carried away by ions which are formed at the surface of the body by the rapid absorption of certain of the waves of the incident light. A study of the influence of temperature upon the effect was made to see if it would throw any light upon the question as to the relative parts played in the phenomenon by the material of the body and by the occluded gases. The charged body which was experimented upon was a platinum wire that could be heated by sending an electric current through it. The light used was obtained from an electric spark produced between two zinc rods by an induction coil. The results obtained are somewhat complicated. As the temperature was gradually increased to about 200° C., it was found that the rate at which the negative electricity was discharged diminished, but for still higher temperatures it increased again, so that at about 700° C., it was nearly three times its value at room temperature. The rate of discharge at certain temperatures depends considerably upon the immediate previous history of the wire, being much larger for a given temper-

ature, although diminishing with time, if the wire has just been hotter than if it has just been colder. The conditions at the surface of the body at these temperatures reach their steady state but slowly, while for temperatures below 100° C. this is acquired much more rapidly. Changes in the molecular arrangement of the body, as well as the amount of the occluded gas, may play a large part in the phenomenon. From an iron wire the rate of discharge while small at the lower temperatures became many times larger at the higher temperatures. It was also found that a positively charged body does not lose any charge due to the action of the light, even when its temperature is raised to that of red heat. To get an explanation for the unipolarity of the photo-electric effect, we need but consider that the intra-molecular impulses which are produced by the light, and which give rise to the discharge, are able to throw off from the body the negative ions or corpuscles, but are not able to disengage the much larger positive ions for which the forces of restitution are correspondingly greater.

14. 'The Diminution of the Potential Difference between the Electrodes of a Vacuum Tube produced by a Magnetic Field': JOHN E. ALMY.

15. 'Note on the Discharge Current from a Surface of Large Curvature': JOHN E. ALMY, University of Nebraska.

The discharge from a wire to a surrounding concentric cylinder, with reference to discharge current, especially, is studied. The law of discharge, under the conditions given below is found, $I = aV(V - b)L/R^3$, where

I = the discharge current, passing from wire to cylinder.

V = the potential difference between wire and cylinder.

L = the length of the wire.

R = the radius of the cylinder.

b = a constant, with given apparatus and gas pressure, and is very approximately the 'minimum potential' of Röntgen.

a = a constant.

The applicability to the discharge was shown with gas pressures, from 20 to 75 cm. of mercury, with cylinders, up to 10 cm. in diameter. The proportionality of current to wire length holds so long as the wire length is greater than the radius of the cylinder used. Finally, the proportionality of current to the inverse cube of the cylinder radius does not hold accurately. More strictly speaking it may be said that $I \propto \frac{1}{R^n}$ and $3.3 > n > 2.8$, in the experiments made.

16. 'The Radiant Efficiency of Vacuum Tubes': E. E. ROBERTS.

17. 'On the Spark Discharge during Rapid Oscillations': K. E. GUTHE. (By title.)

18. 'Results of Recent Magnetic Work of the U. S. Coast and Geodetic Survey': L. A. BAUER. (By title.)

19. 'The Physical Decomposition of the Earth's Permanent Magnetic Field': L. A. BAUER. (By title.)

20. 'On the Calorimetric Properties of the Ferro magnetic Substances, with special reference to Nickel-steel': B. V. HILL.

It is well known that the ferro-magnetic substances when heated through a certain range of temperature, depending on the nature of the substance, absorb latent heat and pass into an allotropic modification in which they are non-magnetic. Certain alloys (*e. g.*, nickel-steel) having been transformed into this state by heating, maintain it down to comparatively low temperatures, so that there are many so-called irreversible nickel-steel alloys to be obtained in both modifications within the same range of temperature (20° to 300° C.). This allows the properties of the alloys in the two states to be compared.

The latent heat of transformation for one sample of nickel-steel was found to be 2.783; that of another, 13.45; which, according to the theory of solutions, should have been 15.9—the application of the theory being, however, questionable. The specific heat of nickel-steel is greater in the non-magnetic state than in the magnetic (from 2 to 6 per cent., depending on the temperature interval through which it is obtained).

Six samples of iron differing in permeability showed that the greater the permeability of iron the smaller its specific heat. This supports the view that the difference in permeability is caused by a difference in composition of magnetic and non-magnetic iron.

21. 'On the Demagnetizing Effect of a Discharge in Iron when Electromagnetically Compensated': ZENO CROOK.

22. 'The Absorption Spectra of Solutions of Potassium Permanganate': B. E. MOORE, University of Nebraska.

The absorption spectra of solutions of the following concentrations, $.25n$, $.025n$, $.0025n$, $.00025n$ and $.000025n$ ($n = \text{normal}$), were studied.

The observations, though they may need later some slight correction, show that upon dilution the solutions become relatively darker in the blue, *i. e.*, there is a displacement of the absorption band toward the blue upon dilution. The phenomenon is explained upon the theory of dissociation.

23. 'The Absorption and Dispersion of Fuchsin': W. B. CARTMEL. (By title.)

24. 'On the Determination of Dispersion by Means of Channeled Spectra with the Concave Grating': P. J. ANTES.

25. 'Accidental Double Refraction in Liquids': BRUCE V. HILL, University of Nebraska.

In a former paper upon this subject (*Phil. Mag.* (5), 48, p. 485) the writer gave results of a series of experiments upon gelatinizing solutions which became double

refracting when subjected to a strain between rotating cylinders. The results indicated that we have in such solutions quasi-solids, and that there is a difference between colloid and crystalloid solutions not to be explained upon the assumption of a large molecular weight in the former.

The present experiments consist of an examination of water solutions of gelatine when subjected to a *static* strain. They vary in concentration from .1 per cent. to .5 per cent. and were too dilute to sustain their own weight. They were accordingly placed in thin-walled brass tubes 42.55 cm. in length and 2.77 cm. in diameter. Glass caps were fastened to the ends of these tubes by slipping short pieces of rubber hose over them. The tubes were strained, so that their cross-sections were elliptical, by means of clamps. The double refraction decreases so rapidly with rise in temperature that at room temperature—about 23° C.—no effect was visible in jellies of the above concentrations. The tubes were then surrounded by ice and the formation of dew upon the glass ends was obviated by slipping over the tube a second one, also having a glass cap and containing a little phosphoric anhydride. The amount of double refraction was measured as before by means of a half-shade polariscope. The seven sets of observations show that when a stress is applied, the strain increases to a certain point beyond which no further strain is produced. Further stress ruptures the solution, and the refraction diminishes or ceases. The amount a solution can be strained without rupturing depends upon the age of the solution. This point was sufficiently studied to show that the diluter jellies required much longer time to reach the point where they would sustain a maximum strain than the stronger jellies. Along with double refraction, depolarization also appears and then diminishes after standing some time.

These solutions are as fluid as water, but still behave optically as quasi-solids, capable of sustaining a static strain without a displacement of the mobile particles. This condition is reached very slowly and the depolarization early in the formation indicates that the progress of formation of the solid structure is not homogeneous, but that it later becomes so, as indicated by the disappearance of the depolarization.

26. 'Notes on Dielectric Strain': LOUIS TRENCHARD MORE, University of Cincinnati.

This paper—'Notes on Dielectric Strain'—is an answer to a paper by Dr. Paul Sacerdote (*Philosophical Magazine*, March, 1901), criticizing an article by me which appeared in the *Philosophical Magazine* for August, 1900. In attempting to extend the work of Quinke and others who found that glass, when electrified, elongated proportionally to the square of the difference of potential and inversely as the square of the thickness of the dielectric, I noticed that after errors were eliminated the effect vanished or was at least less than $\frac{\delta l}{l} = 10^{-13}$

—a result much less than that found by former investigators. My work attracted the attention of Professor Cantone and Dr. Sacerdote, the latter of whom had recently published a theoretical discussion of the subject. This theory is based on a coefficient which expresses the relation between the potential and the elongation and so fails if the elongation is eliminated. Dr. Sacerdote's criticism showed, I thought, that he had not understood my results and had underestimated the delicacy of my apparatus which seems fully capable of recording the changes of length noticed by the most accurate of former investigators—Professor Cantone.

I have in these papers shown that my apparatus was capable of measuring the effect—that it did record an effect similar to that noted by other investigators, but

that this effect was due to bending of the glass tube by electrostatic attraction—that this error being eliminated the effect vanished.

The sources of errors of former investigators are probably the following:

1. No adequate precautions were taken against lateral bending of the tube. The changes of length produced by an extremely small deflection would account for the entire amount of the effect.

2. The elongations are too close to limit of observation to establish a law when the effect itself is still questionable.

3. Changes of length on charge and discharge are not equal. This difference sometimes equals 40 per cent. of the entire change. An extraneous effect of such magnitude casts doubt on the cause of the elongation.

4. With each investigator, using improved and more delicate apparatus, the amount of the effect steadily decreases. This points either to a partial or entire influence of extraneous causes. (To be printed in the *Philosophical Magazine*.)

27. 'The Temperature Gradient of the Atmosphere, with Formula': S. R. COOK, Washburn College.

The author calls attention to the difficulty, in discussing the escape of gases from the atmosphere, of determining the temperature of the station in the upper atmosphere under consideration.

From the kite observations of the United States Weather Bureau and the recent balloon ascensions at Paris, it was shown that the rate of decrease of temperature with altitude was not constant.

From balloon ascensions made March 24, 1899, near Paris, an experimental formula $t_x = t_0 e^{-kx}$ was obtained for the temperature gradient when t_x and t_0 are the absolute temperatures at positions whose distances from the surface are x , and at the surface respectively, and when k is a constant obtained from the balloon ascensions.

The graph of the temperature gradient is given and compared with Ferrel's graph. A density graph computed from the pressure and temperature graphs is also given and compared with Cottier's density graph computed from the formula $\frac{\rho_0}{\rho_1} = \left(\frac{p_0}{p_1}\right)^v$ where v has the experimental value 1.2.

Attention is also called to the need of more accurate and systematic data for the determination of the temperature gradient at altitudes from 5,000 to 20,000 meters.

JOHN ZELENY,
Secretary.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

SECTION G, BOTANY.

THE Section met for organization on Monday, August 26, at 11.30 a. m., with the Vice-President, Mr. B. T. Galloway, in the chair. The following were the officers for the Denver meeting:

Vice-President, B. T. Galloway.

Secretary, E. A. Bessey (in absence of A. S. Hitchcock).

Sectional Committee, Wm. Trelease, Vice-President 1900; D. T. MacDougal, Secretary 1900; B. T. Galloway, Vice-President 1901; E. A. Bessey, Secretary 1901; C. E. Bessey, C. L. Shear, Miss C. E. Cummings.

Member of General Committee, W. J. Beal.

Member of Council, D. H. Campbell and L. M. Underwood.*

On Wednesday, August 28, in accordance with the custom established at the last New York meeting, Section G held a joint session with the Botanical Society of America, the officers of the latter taking charge of the meeting.

On Thursday evening the following were chosen by the General Committee as Vice-President and Secretary, respectively, for the Pittsburg meeting, June, 1902: D. H. Campbell, Leland Stanford University, and Hermann von Schrenk, Shaw School of Botany.

*Chosen to succeed D. H. Campbell after the latter's early departure.

The following is a complete list of the papers presented. Abstracts are given where furnished by the authors, except for the papers presented at the joint meeting with the Botanical Society of America, abstracts of which will be published elsewhere by the Secretary of that Society.

1. 'Thermal Relations of Plants': D. T. MACDOUGAL. (No abstract furnished.)

2. 'Experiments with Lime and Solutions of Formaldehyde in the Prevention of Onion Smut': A. D. SELBY.

Onion Smut, *Urocystis cepulae* Frost, a soil-infesting fungus, has become introduced into soils devoted to the growing of onion sets near Chillicothe, Ohio, and into those devoted to the growing of market onions about Berea, Ohio. Certain results of experiments made in 1900 at Chillicothe were published in a bulletin (No. 122) of the Ohio Experiment Station. These showed decided advantages of quicklime applied to the soil before seeding and of dilute solutions of formaldehyde in water sprinkled upon the seeds in contact with the soil, as compared with flowers of sulphur, sulphur and lime (in small quantities), and other substances heretofore proposed for the prevention of onion smut. More extended experiments along these lines were conducted both at Chillicothe and Berea during 1901. The results from Chillicothe are now at hand and show very gratifying smut prevention and corresponding increase in the yield of onion sets. All plots herein considered are 760 square feet in area; results are stated in actual and calculated yields.

Plot.	Treatment.	Actual yield lbs. per plot.	Calculated yield per acre, bushels.
I.	Lime, 34 bu. per A.	121.6	174.
II.	" 70 " " "	152.0	217.5
III.	Formalin, .375% sol.	196.0	280.8
IV.	Nothing	92. (large sets)	131.8
V.	Formalin, .75% sol.	202.	289.4
VI.	Lime, 125 bu. per A.	203.	290.8
VII.	" 70 " " "		
	and Formalin, .375% sol.	214.	306.5

Thus lime, at the rate of 70 bushels per acre, gave an increase in yield of 65 per cent. over the untreated plot. Formalin, .375 per cent. solution, an increase of 113 per cent. and double that strength an increase of 119.6 per cent. Seventy bushels of lime per acre and the weaker solution of formalin combined gave an increase of 132.5 per cent., while lime at the rate of 125 bushels per acre gave an increase of 120.5 per cent. The lime used was purchased in the ground state and was applied with a drill before the hoes, chiefly on the surface. The formaldehyde solutions were applied by trickling down with the seeds. This paper will be printed in a bulletin of the Ohio Agricultural Experiment Station.

3. 'Comparative Climate of a Meadow and Hemlock Forest': D. T. MACDOUGAL. (No abstract furnished.)

4. 'The Tylostomaceæ of North America': V. S. WHITE, presented by L. M. Underwood.

The extensive accumulation of material bearing on the stalked puffballs in the Ellis collection, supplemented by considerable material sent in from the Southwest by Professors Wooton, Cockerell and Griffiths has led to a complete revision of the species of this family, which is now appearing in the August number of the *Bulletin of the Torrey Botanical Club*. This is illustrated by ten plates (exhibited when the paper was read). A summary of the results is as follows:

The family as represented in North America consists of—

Tylostoma—Seventeen species, of which eight are new. Of these seventeen species eight are found in Colorado, which is double the number from any other State with the single exception of Kansas, which has five species. Of the eight new species four are from Colorado.

Chlamydotopus—One species recently collected in New Mexico by Professor Cocker-

ell. The genus has hitherto been known only from South America.

Battarrea—Four species of which two are new. All from the Southwest.

Queletia—One species, possibly introduced from Europe. Found once in this country.

Dictyocephalos—A new genus from Colorado, collected by Professor Bethel, of Denver; monotypic.

Much still remains to be known of the early stages of these plants; in fact very little is known of them. Much also remains to be known of their geographic and seasonal distribution. Two-thirds of the family belong to the region of the Great Plains southwestward to Texas, Sonora and southern California.

5. 'Lantern Views of the Botanical Garden of the Agricultural College of Michigan': W. J. BEAL.

The author exhibited views showing the arrangement of the garden and gave many practical hints concerning the management of botanical gardens.

6. 'Plants of the Eastern Foothills': FRANCIS RAMALEY.

The author exhibited a number of views showing some of the more characteristic plants of the eastern foothills of the Rocky Mountains in Colorado.

7. 'Some Protective Leaf Movements induced by Winter Temperature': WM. TRELEASE.

The paper records, with lantern illustrations, observations upon the drooping and inrolling of *Rhododendron* leaves and the inrolling of leaves of *Yucca flaccida*, effected when the freezing temperature is reached, by which protection is secured against undue radiation and evaporation. Reference is made to Harsberger's paper of 1889, and Darwin and Acton's and MacDougal's text-books of plant physiology which thus far appear to refer only to *Prunus laurocerasus* and the genera named.

8. 'Germination of Seeds of some Common Cultivated Plants after prolonged Immersion in Liquid Air': A. D. SELBY.

At the suggestion of Mr. J. E. Woodland, of Wooster, Ohio, who was conducting experiments with liquid air during the winter season of 1900-1901, the writer prepared and supplied him with seeds of *Ricinus*, *Lupinus luteus*, maize, flax, wheat, rye, cucumber, Russian sunflower, *Pinus sylvestris*, *Mimosa pudica*, *Onobrychis sativus*, *Chenopodium album* and *Pinus parryana*. At first the lots of seed were immersed in the liquid air directly from the room temperature and kept submerged for six and twelve hours, respectively. Later other lots were given a gradual transition from the temperature of the room to that of the liquid air and an equally gradual withdrawal, being immersed for twenty-four and forty-eight hours, respectively. The seeds were then germinated in the usual manner, together with control lots reserved when the original packages were selected. There was practically no essential effect of the treatment noticeable upon the percentages of seeds that germinated, the control, short treated, and longer treated lots giving essentially the same percentages of germination. This paper will be printed in the *Bulletin of the Torrey Botanical Club*.

On Wednesday the following program was given in joint session of Section G and the Botanical Society of America:

Address of the Retiring President—'Problems and Possibilities of Systematic Botany': B. L. ROBINSON. Read by J. M. Coulter.

'The Fundamental Phenomena of Vegetation': F. E. CLEMENTS.

'Early Winter Colors of Plant Formations upon the Great Plains': C. E. BESSEY.

'The Plant Formations of the Rocky Mountains' (lantern lecture): F. E. CLEMENTS.

'A Suggested Hybrid Origin of *Yucca gloriosa*' (lantern lecture): WM. TRELEASE.

'The Physical Basis of Ecology': F. E. CLEMENTS. (By title only.)

'The Anatomy of the Embryo and Seedling of *Tsuga canadensis* Carr' (by invitation): W. A. MURRILL. Read by J. M. Coulter.

'Clues to Relationship among Heteroecious Plant Rusts': J. C. ARTHUR. Read by L. M. Underwood.

'Some of the Changes now taking place in a Forest of Oak Openings': W. J. BEAL.

'Preliminary Notes on the Flora of Western Iowa, especially from the Physiographical-Ecological Standpoint': L. H. PAMMEL. (By title only.)

'The Life History of *Vittaria lineata*': E. G. BRITTON and A. TAYLOR. Read by L. M. Underwood.

'A System of Nomenclature for Phytogeography': F. E. CLEMENTS.

'The Application of Ecology in Taxonomy': F. E. CLEMENTS. (By title only.)

On Thursday the regular session of Section G was resumed with the following papers:

9. 'The Location of a Tropical Research Station in Porto Rico': L. M. UNDERWOOD.

The agricultural station in Porto Rico should, if possible, be located where it will also be available as a station for general botanical research. A combination of (1) the greatest amount of agricultural production, not alone in coffee, sugar and tobacco, but also in the minor products; (2) the greatest accessibility from all portions of the island, and particularly those portions where the most important agricultural products are cultivated under most favorable conditions; and (3) the most interesting botanical portion of the island, including accessibility to a large original forest, is met with in the eastern half of the island and particularly in the region between Arecibo and Utnado. With this can be com-

bined many less prominent but important accessories, particularly access to an abundant supply of potable water.

10. 'Notes on Colors of Salsify Hybrids': BYRON D. HALSTEAD.

Hybrids between *Tragopogon porrifolius* L. (garden salsify) and the wild species, *T. pratensis* L., were reported on last year. The following paper considers only the color side of the results obtained with hybrid seedlings the present year (second generation hybrids). According to the standard color chart employed (Prang's), the cultivated salsify has for the color of its corollas a mixture of violet and red, corresponding to No. 224 (VRV/L), *i. e.*, light violet red violet—a shade of purple, in ordinary language. The other parent has a plain yellow. The direct hybrid of these two is of two distinct types, the one with the color uniform throughout the head, and the other, about equally numerous, with a yellow in the center, although here the tips of all the corollas are of the same color as the ray blossoms, namely No. 241 (RRV/DD), *i. e.*, darker red red violet. It is seen by this that the *T. porrifolius* controls the color, although the violet of this parent gives place largely to red. The crossing is reciprocal and the results are the same whichever is the seed parent. Among the hundreds of seedlings grown this season no less than 36 numbers upon the color chart are represented. Out of 200 counts the following is the record for the 13 having the largest score: Yellow, 10; light yellow, 12; lighter yellow, 6; darker orange red orange, 9; darker red orange, 6; darker red, 23; dark red, 13; light red violet, 9; lighter red violet, 7; violet red violet, 23; light violet red violet, 35; lighter violet red violet, 29; dark violet gray, 6. It is seen that in the second generation the colors are many. Both parents are now represented, and many intergrades between their respective

colors. The yellows in all the tints score 28 points to 103 by the violet reds. If all the shades obtained were enumerated under their appropriate heads the violet reds would outnumber the yellows by 41. There were no pure orange blossoms, but in combination with red there were many representatives. The yellow failed to blend with any other color. In one instance there was a plant with slate-colored blossoms, thus bringing in the blue of the chromatic scale, and several specimens had a strong tendency towards chlorosis, thus completing the series in the solar spectrum. A chart of the prismatic colors, violet, blue, green, orange, yellow and red was constructed, and the parent hybrid and its seedlings located with pasters of colored paper, while the relative amount of each of the latter was shown by the size of the paper bearing the color corresponding to that of the seedling hybrid flowers thus graphically represented. It is thus evident that with the salsify hybrid, while there is uniformity the first year, it is otherwise the second season, with a tendency to revert to the parent types. The red, present in obscure form in one parent only, becomes very prominent the first year and yields many unmixed reds the second. Out of this union by selection it is probable that many strongly contrasting types might be fixed.

11. 'Observations on *Egrecia menziesii*': FRANCIS RAMALEY.

Egrecia consists, as do the other Laminariaceæ, of hold-fast, stipe and lamina; the branching of the stipe gives rise to members (branches) each having the characters of the entire frond of *Alaria*. The multiform proliferations which occur on both stipe and lamina replace functionally the large lamina in other genera. This structure is, in *Egrecia*, greatly reduced in size and importance. On account of the great elongation of the stipe a floating ap-

paratus has become necessary, and this is provided in the vesicles developed by the swelling of the stalks of certain proliferations. The presence of vesicles gives *Egregia* a superficial resemblance to *Macrocystis*, while it is probably more nearly allied to *Alaria*. A mathematical study of variation in *Egregia menziesii* leads to the conclusion that the species is in a state of equilibrium. The curves of variation are all symmetrical and remarkably similar. *Egregia* presents some interesting anatomical features which cannot be well summarized. This paper will be printed in *Minnesota Botanical Studies*.

12. 'The Morphology of the Pine Cone': C. E. BESSEY.

Although there has been much discussion of the morphology of the 'ovuliferous scale' of the pine cone, recent summaries show that it is not yet satisfactorily settled. The author suggests an explanation which he has used in his lectures to students in the University of Nebraska for several years. Comparing the cones of Cupressineæ, Taxodiæ, Araucariæ and Abietineæ, they are found to be alike, with a similar origin for their ovules, but in the Abietineæ there is in connection with each ovule a woody scale, while in Araucariæ there is a rudimentary scale. This scale is regarded as a backward development of the ovule, and the cones are therefore strictly homologous. Concisely stated, this view may be formulated as follows: The microsporangial and megasporangial cones are strictly homologous, and in the latter the sporophyll enlarges or remains small, just as a chalazal development of the megasporangium into a scale is less or more pronounced. According to this view the Abietineæ must be given place at the summit of the Conifers. This paper will be printed in SCIENCE.

13. 'General Botanical Features of the Coast Mountains of California': ALICE EASTWOOD.

The Coast Mountains of California extend from the northern to the southern part of the State, passing through about ten degrees of latitude, and rise from the sea level to an altitude of more than 9,000 feet. Consisting of many different chains and spurs, with valleys between made up of different geological formations, a great variety characterizes their flora. Many genera are in an unsettled condition and the species are uncertain. The outer ranges may be divided into four environmental zones: (1) That along the sea coast, characterized by fleshy plants or those clothed with some form of pubescence. They do not differ much from maritime plants in other regions. (2) The forest areas, along streams where the redwoods (*Sequoia sempervirens*) find a home. This keeps quite close within the area of summer fog, and the plants are dependent upon moisture and shade. (3) The grassy uplands and valleys. Here, during the rainy season, flowers (mostly annuals) grow in great profusion and form beautiful gardens. They soon disappear and the hills become yellow, except where clumps of oaks, pines, or spruces occur. (4) The brush-covered hills, where the shrubs grow so close together that it is almost impossible to travel through them except on the trails. They hold the water by their roots and prevent evaporation by their dense growth. Most of them show characteristics belonging to desert plants rendered necessary by the long drought and the intense heat to which they are subjected in the summer. The southern coast mountains become even more desert-like in the character of their flora, and here and there will be found wanderers from the desert. The northern coast mountains in general rise to a greater elevation, and in some of the chains the character of the mountains is like that of the Sierra Nevada range and the flora similar at like elevations. A great amount of work has to be

done before many of the genera are understood and a great deal of territory must be explored before the species are approximately known. Following this work, the problems of geographical distribution can be solved and life zones satisfactorily mapped out.

14. 'The Xerophytic Vegetation of the Uintah Mountains': L. H. PAMMEL.

In the Uintah range occur types of plants from the arid regions of the Southwest, boreal types in the mountains farther northward, and many forms from the main Rocky Mountain flora. The largest xerophytic areas occur in the Colorado and Green River basins. The xerophytic vegetation of the Uintah range varies with the different physiographic conditions and geologic formations. One naturally expects to find a very different flora in passing through the Green River and lower basins up to the higher peaks such as Gilbert, La Motte and Wilson; however, at an altitude of 9,200 feet the valleys and park-like openings have many xerophytic plants common to the lower basins of the streams. The succession of plant formation in this region is fairly well marked; it is not difficult, therefore, to trace a succession of plant life on the flood plains since the quaternary. The foothill and mountain floras change successively from hydrophytic to mesophytic, then to xerophytic and finally culminate in the mesophytic of the foothills with hydrophytic basins. In the Green River basin and the tributaries of the immediate vicinity of this basin the xerophytic plants are much more pronounced than in the foothills. In the broad flood plains of Green River there occur such plants as *Distichlis spicata*, the widely distributed *Hordeum jubatum*, and the western *H. cespitosum*. The habit of growth and the manner of reproduction of *Distichlis* make it well adapted to the conditions prevailing in that arid region. Two

Capparidaceous plants, *Cleome integrifolia* and *C. lutea*, are common. A somewhat similar yellow-flowered crucifer, *Stanleya pinnatifida*, is scattered through the dry lowlands. Naturally one expects to find many chenopodiaceous plants. Their succulent leaves enable them to adapt themselves to these dry regions. *Sarcobatus vermiculatus*, *Chenopodium fremontii*, *C. rubrum*, *Eurotia lanata* and *Suaeda depressa* are common plants of the dry basins. *Artemisia tridentata* with its accompanying *Eriogonum ovalifolium* and *E. umbellatum* are common at higher altitudes along Black's Fork. The terrace formation is especially well marked from the mouth of Black's Fork up to 8,500 feet. In the lower region there are small groves of *Juniperus occidentalis* var. *monosperma*, frequently accompanied by *Picea pungens*, *Juniperus communis* and *Arctostaphylos*. At an altitude of 7,500 feet three-well-defined flood plains are recognizable. The present flood plain contains mesophytic groves, the second flood plain is dotted with small patches of trees and sage brush, the third flood plain contains no trees. *Artemisia tridentata* is the most characteristic plant. *Symphoricarpos*, *Lupinus* and *Stipa* also occur. From the third flood plain there is an abrupt rise of from three to five hundred feet. The sides are lined with *Symphoricarpos*, *Prunus*, and some sage brush. The top of the benches contains almost no trees except farther up, but sage brush, *Eurotia lanata*, *Stipa*, *Castilleja*, *Orthocarpus* and *Eriogonum* are characteristic plants.

15. 'Some Aspects of the Wyoming Desert Flora': AVEN NELSON.

South central Wyoming contains an extensive area known as the Red Desert. This has a considerable flora, the most obvious members of which belong in the genera *Artemisia*, *Atriplex*, *Chrysothamnus*, *Tetradymia*, *Sarcobatus*, and *Agropyron*. Besides this there is a very considerable fugacious vegetation. This desert flora,

while a limited one, is highly organized. It is succulent and rich in water by reason of its many contrivances for husbanding all its resources. Consolidation tends to reduce expenditure. Pleiocyclic herbs successfully maintain themselves by reason of their highly developed underground organs. The prevailing color of the flowers is yellow. Some of the vegetation is exceedingly tolerant of alkali, raising the question whether this property is due to histological peculiarities or represents a physiological difference in the protoplasm.

16. 'Effects of Salt Solutions on Seeds and Plants': E. E. SLOSSON.

Experiments have been carried on for several years on the action of the salts occurring in the soil of arid regions, as alkali, on the germination of seeds and the growth of plants. Solutions of sodium chloride, sulphate and carbonate; potassium sulphate and chloride; magnesium sulphate; and sugar; in solutions ranging in strength from 0 to 100 atmospheres osmotic pressure had been tested, the following seeds being used: corn, wheat, sunflower, peas, buckwheat, rape, beans, alfalfa, rye, clover, *Scirpus paludosus* and, for comparison, wood. It has been found that the imbibition of water is less from all solutions than from pure water. Solutions of all salts and of sugar of the same osmotic pressure retard and lessen the imbibition of water by seeds to about the same extent. Isosmotic solutions produce nearly the same effect in retarding the germination of seeds. Solutions of slight osmotic pressure stimulate germination. The same results are obtained with growing plants. Plants and seeds absorb a greater amount of potassium than of sodium salts from solutions of the same osmotic pressure, and more sulphates than chlorides. Hydroxyl ions increase the absorption of salts and of water by seeds. This paper will be printed in Bulletins of the Wyoming Experiment Station.

17. 'The Position of Protococcus and Mosses on Trees': HENRY KRAEMER. (Read by title.)

18. 'Contributions to the Knowledge of the Physiology of Karyokinesis': A. C. LEWIS. (Read by title.)

This paper will be published in the *Botanical Gazette*.

19. 'Seedlings of *Arisema dracontium*': ROSINA J. RENNERT. (Read by title.)

20. 'Some Plant Adaptations on the Tucson Plains': J. W. TOUMEX. (Read by title.)

ERNST A. BESSEY,
Secretary, Section G.

MEMBERSHIP OF THE AMERICAN ASSOCIATION.

THE following have completed their membership in the American Association for the Advancement of Science during the month of September.

Edward G. Acheson, President International Acheson Graphite Co., Niagara Falls, N. Y.

Curtis Alexander, Mining Engineer and Metallurgist, Spearfish, S. D.

J. Hartley Anderson, M.D., Physician, 4630 Fifth avenue, Pittsburg, Pa.

Bion J. Arnold, 4128 Prairie avenue, Chicago, Ill.

Andrew J. Bigney, Professor of Biology and Geology, Moores Hill College, Moores Hill, Ind.

R. I. Bond, M.D., Physician, Hartshorne, Ind. Ter.

Edwin D. Carnaghan, Mechanical Engineer, Durango, Do, Mexico.

Willard Colfax Cheney, Electrical Engineer, Portland, Ore.

Francis A. Crandall, 2219 15th street, N.W., Washington, D. C.

Col. William Crozier, U. S. A. Ordnance Office, Washington, D. C.

Dr. Kary Cadmus Davis, Professor of Horticulture and Forestry, W. Virginia State University, 628 N. High street, Morgantown, W. Va.

Wm. S. Hall, Professor of Mining and Graphics, Lafayette College, Easton, Pa.

John Hays Hammond, Mining Engineer and Geologist, Denver, Colorado.

Dr. Felix B. Herzog, Electrical Engineer, 51 West 24th street, New York, N. Y.

Julius Hortvet, State Chemist, 1521 University avenue S.E., Minneapolis, Minn.

A. E. Jenks, Bureau of Ethnology, Washington, D. C.

John A. Just, Chemist, 116 West Castle street, Syracuse, N. Y.

Wm. D. Marks, The Art Club, Philadelphia, Pa.

Lucius Herbert Merrill, Professor of Biological Chemistry, University of Maine, Orono, Maine.

Benjamin L. Miller, Johns Hopkins University, Baltimore, Md.

Robert D. Murray, M.D., Marine Hospital Service, Key West, Fla.

George J. Murdock, Mechanician and Inventor, 248 Sixth avenue, Newark, N. J.

Richard A. Parker, C.E., E.M., 4 P. O. Square, Boston, Mass.

Thomas S. Perry, 312 Marlborough street, Back Bay, Boston, Mass.

Wm. L. Prather, President of University of Texas, 1914 Nueces street, Austin, Texas.

Walter Merritt Riggs, Professor of Electrical Engineering, Clemson College, Clemson College, S. C.

Fred W. Robins, Superintendent of Schools, Bethlehem, Pa.

George St. John Sheffield, Twin Elms Farm, Attleborough, Mass.

Charles H. Shinn, Inspector of Experiment Stations, University of California, Berkeley, Cal.

Harvey F. Smith, Attorney-at-law, Clarksburg, W. Va.

Norman W. Storer, Electrical Engineer, 6109 Howe Street, Pittsburg, Pa.

W. S. Sutton, Professor of Science and Art of Education, University of Texas, 1812 Congress avenue, Austin, Texas.

E. A. H. Tays, Civil and Mining Engineer, San Jose de Gracia, Sinaloa, Mexico.

Alonzo P. Troth, Supervisor of Instruction in Science, High School, Leadville, Colo.

Andrew A. Veblen, Head of Department of Physics, State University of Iowa, Iowa City, Iowa.

Wm. A. Wadsworth, Genesee, Livingston county, N. Y.

Dr. Walter F. Willcox, Professor of Economics, Cornell University, Ithaca, N. Y.

ADDRESS OF THE PRESIDENT OF THE ANTHROPOLOGICAL SECTION OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.*

I.

TWENTY-FIVE years have passed since the British Association met in Glasgow. This is a long time to look back upon, and yet

*Glasgow meeting, 1901.

the period appears short when measured by the great advance which has taken place in almost all branches of knowledge. Anthropology has shared in the general progress. The discoveries made within its confines may not have been so startling, nor yet have had such a direct influence upon the material welfare of the people, as in the case of other fields of scientific study, but its development has been steady and continuous, and it has grown much in public estimation.

At the Glasgow meeting of the Association in 1876 anthropology held a subsidiary position. It only ranked as a department, although it gained a special prominence through having Alfred Russel Wallace as its chairman. It was not until several years later that it became one of the recognized sections of the Association, and attained the high dignity of having a letter of the alphabet allotted to it. But quite independently of its official status it has always been a branch of study which has been accorded a large amount of popular favor. The anthropological meetings have, as a rule, been well attended, and the discussions, although perhaps on certain occasions somewhat discursive, have never lacked vigor or animation. Professor Huxley, who presided over the Anthropological Department at the Dublin meeting in 1878, ascribed the popularity of the subject to the many openings which it affords for wide differences of opinion between the exponents of its numerous branches, and to the innate bellicose tendency of man. As the representative of a country in which, according to the same high authority, this tendency is less strongly marked than elsewhere, and of a race which has so frequently and pointedly exhibited its abhorrence of vigorous language, I trust that my presence here as president may not react unfavorably on the interest shown in the work of the Section.

The present occasion might appear to be peculiarly appropriate for my taking stock of our anthropological possessions and summing up the numerous additions to our knowledge of 'man and his doings' which have been made during the century which has just passed. Such a task, however, is surrounded with so much difficulty that I shrink from undertaking it. The scope of the subject is enormous, and the studies involved so diverse and so varied that I feel that it is beyond my power to give any comprehensive survey of its development in all its parts. I prefer therefore to confine my remarks to that province of anthropology within which my own work has been chiefly carried on, and from this to select a subject which has for some years held a prominent place in my thoughts. I refer to the human brain and the part which it has played in the evolution of man.

One of the most striking peculiarities of man, when regarded from the structural point of view, is the relatively great size of his brain. Although with one or two exceptions the several parts of the brain are all more or less involved in this special development, it is the cerebral hemispheres which exhibit the preponderance in the highest degree. This characteristic of the human brain is rendered all the more significant when we consider that the cerebral hemispheres cannot be looked upon as being primitive parts of the brain. In its earliest condition the brain is composed of three simple primary vesicles, and the cerebral hemispheres appear in a secondary manner in the shape of a pair of lateral offshoots or buds which grow out from the foremost of these primitive brain-vesicles.

The offshoots which form the cerebral hemispheres are found in all vertebrates. Insignificant in size and insignificant in functional value in the more lowly forms, a steady increase in their proportions is manifest as we ascend the scale, until the

imposing dimensions, the complex structure, and the marvelous functional potentialities of the human cerebral hemispheres are attained. In their development the cerebral hemispheres of man rapidly outstrip all the other parts of the brain, until they ultimately usurp to themselves by far the greater part of the cranial cavity. To the predominant growth of the cerebral hemisphere is due the lofty cranial vault of the human skull; to the different degrees of development and to the different forms which they assume are largely due the variations in cranial outline in different individuals and different races—variations in the determination of which the craniologist has labored so assiduously and patiently.

I think that it must be manifest to every one that the work of the craniologist, if it is to attain its full degree of usefulness, must be founded upon a proper recognition of the relation which exists between the cranium and the brain, or, in other words, between the envelope and its contents.

The cranium expands according to the demands made upon it by the growing brain. The initiative lies with the brain, and in normal conditions it is questionable if the envelope exercises more than a very subsidiary and limited influence upon the form assumed by the contents. The directions of growth are clearly defined by the sutural lines by which the cranial bones are knit together; but these are so arranged that they admit of the expansion of the cranial box in length, in breadth and in height, and the freedom of growth in each of these different directions has in all probability been originally determined by the requirements of the several parts of the brain.

The base or floor of the cranium, supporting as it does the brain-stem or the parts which possess the greatest phylogenetic antiquity, and which have not under-

gone so large a degree of modification in human evolution, presents a greater uniformity of type and a greater constancy of form in different individuals and different races than the cranial vault, which covers the more highly specialized and more variable cerebral hemispheres.

To what extent and in what directions modifications in the form of the cranium may be the outcome of restrictions placed on the growth of the brain it is difficult to say. But, broadly speaking, I think we may conclude that the influence which the cranium, under normal circumstances, independently exerts in determining the various head-forms is trifling.

When we speak, therefore, of brachycephalic or short heads and dolichocephalic or long heads, we are merely using terms to indicate conditions which result from individual or racial peculiarities of cerebral growth.

The brachycephalic brain is not molded into form by the brachycephalic skull; the shape of both is the result of the same hereditary influence, and in their growth they exhibit the most perfect harmony with each other.

Craniology has been called the 'spoiled child of anthropology.' It is supposed that it has absorbed more attention than it deserves, and has been cultivated with more than its share of care, while other fields of anthropology capable of yielding rich harvests have been allowed to remain fallow. This criticism conveys a very partial truth. The cranium, as we have seen, is the outward expression of the contained brain, and the brain is the most characteristic organ of man; cranial peculiarities, therefore, must always and should always claim a leading place in the mind of the anthropologist; and this is all the more imperative, seeing that the brains of different races are seldom available for investigation, whilst skulls in the different museums may literally be counted by thousands.

Meantime, however, the craniologist lies buried beneath a mighty mountain of figures, many of which have little morphological value and possess no true importance in distinguishing the finer differences of racial forms. Let us take as an example the figures upon which the cephalic or length-breadth index of the skull is based. The measurement of the long diameter of the cranium does not give the true length of the cranial cavity. It includes, in addition, the diameter of an air-chamber of very variable dimensions which is placed in front. The measurement combines in itself, therefore, two factors of very different import, and the result is thereby vitiated to a greater or less extent in different skulls. A recent memoir by Schwalbe* affords instructive reading on this matter. One case in point may be given. Measured in the usual way, the Neanderthal skull is placed in the dolichocephalic class; whereas Schwalbe has shown that if the brain-case alone be considered it is found to be on the verge of brachycephaly. Huxley, many years ago, remarked that 'until it shall become an opprobrium to an ethnological collection to possess a single skull which is not bisected longitudinally,' in order that the true proportions of its different parts may be properly determined, we shall have no 'safe basis for that ethnological craniology which aspires to give the anatomical characters of the crania of the different races of mankind.' It appears to me that the truth of this observation can hardly be disputed, and yet this method of investigation has been adopted by very few craniologists.

It has become too much the habit to measure and compare crania as if they were separate and distinct entities and without a due consideration of the evolutionary

* 'Studien über *Pithecanthropus erectus*' (Dubois). *Zeitschrift f. Morph. und Anthropol.*, Band I., Heft 1, 1899.

changes through which both the brain and its bony envelope have passed. Up to the present little or no effort has been made to contrast those parts of the cranial wall or cavity which have been specially modified by the cerebral growth-changes which are peculiar to man. It may be assumed that these changes have not taken place to an equal extent, or indeed followed identically the same lines in all races.

Unfortunately our present knowledge of cerebral growth and the value to be attached to its various manifestations is not so complete as to enable us to follow out to the full extent investigations planned on these lines. But the areas of cerebral cortex to which man owes his intellectual superiority are now roughly mapped out, and the time has come when the effect produced upon the cranial form by the marked extension of these areas in the human brain should be noted and the skulls of different races contrasted from this point of view.

To some this may seem a return to the old doctrine of phrenology, and to a certain extent it is; but it would be a phrenology based upon an entirely new foundation and elaborated out of entirely new material.

It is to certain of the growth changes in the cerebrum which I believe to be specially characteristic of man, and which unquestionably have had some influence in determining head-forms, that I wish particularly to refer in this address.

The surface of the human cerebrum is thrown into a series of tortuous folds or convolutions separated by slits or fissures, and both combine to give it an appearance of great complexity. These convolutions were long considered to present no definite arrangement, but to be thrown together in the same meaningless disorder as is exhibited in a dish of macaroni. During the latter half, or rather more, of the century which has just ended it has, however, been shown by the many eminent men who have

given their attention to this subject that the pattern which is assumed by the convolutions, while showing many subsidiary differences, not only in different races and different individuals, but also in the two hemispheres of the same person, is yet arranged on a consistent and uniform plan in every human brain, and that any decided deviation from this plan results in an imperfect carrying out of the cerebral function. In unraveling the intricacies of the human convolutionary pattern it was very early found that the simple cerebral surface of the ape's brain in many cases afforded the key to the solution of the problem. More recently the close study of the manner in which the convolutions assume shape during their growth and development has yielded evidence of a still more valuable kind. We now know that the primate cerebrum is not only distinguished from that of all lower mammals by the possession of a distinct occipital lobe, but also by having imprinted on its surface a convolutionary design which in all but a few fundamental details is different from that of any other order of mammals.

There are few matters of more interest to those anthropologists who make a study of the human skull than the relationship which exists between the cranium and the brain during the period of active growth of both. Up to the time immediately prior to the pushing out of the occipital lobe, or, in other words, the period in cerebral development which is marked by the transition from the quadrupedal type to the primate type of cerebrum, the cranial wall fits like a tight glove on the surface of the enclosed cerebrum. At this stage there would appear to be a growth antagonism between the brain and the cranial envelope which surrounds it. The cranium, it would seem, refuses to expand with a speed sufficient to meet the demands made upon it for the accommodation of the growing brain. In

making this statement it is right to add that Hochstetter, in a carefully reasoned memoir, has recently cast doubt upon the reality of the appearances which have led to this conclusion, and at the recent meeting of the Anatomische Gesellschaft, in Bonn, Professor Gustaf Retzius,* one of the numerous observers responsible for the description of the early cerebrum upon which the conclusion is based, showed some inclination to waver in his allegiance to the old doctrine. This is not the time nor the place to enter upon a discussion of so technical a kind, but I may be allowed to say that whilst I fully recognize the necessity for further and more extensive investigation into this matter I do not think that Hochstetter has satisfactorily accounted for all the circumstances of the case.

When the occipital lobe assumes shape the relationship of the cranial wall to the enclosed cerebrum undergoes a complete change. The cranium expands so rapidly that very soon a wide interval is left between the surface of the cerebrum and the deep aspect of the cranial envelope within which it lies. This space is occupied by a soft, sodden, spongy meshwork, termed the subarachnoid tissue, and it is into the yielding and pliable bed thus prepared that the convolutions grow. At first the surface of the cerebral hemisphere is smooth, but soon particular areas of the cortex begin to bulge out and foreshadow the future convolutions. These suffer no growth restriction, and they assume the form of round or elongated elevations or eminences which rise above the general surface level of the cerebral hemisphere and break up its uniform contour lines in the same manner that mountain chains protrude from the surface of the globe.

As growth goes on, and as the brain

* *Anatomische Gesellschaft*, Bonn, May 28, 1901. Gustaf Retzius, 'Transitorische Furchen des Grosshirns.'

gradually assumes a bulk more nearly in accord with the cavity of the cranium, the space for surface protrusions of this kind becomes more limited. The gyral elevations are now pressed together; they become flattened along their summits, and in course of time they acquire the ordinary convolutionary shapes. While this is going on the valleys or intervals between the primitive surface elevations become narrowed, and ultimately assume the linear slit-like form characteristic of the fissures. These changes occur shortly before birth, but are not fully completed until after the first few months of infancy. The final result of this process is that the convolutions come into intimate relation with the deep aspect of the cranial wall and stamp their imprint upon it.

It is obvious that certain of the later changes which I have endeavored to portray might be ascribed to a growth antagonism between the brain and the enclosing cranium at this period. In reality, however, it is merely a process by which the one is brought into closer adaptation to the other—a using up, as it were, of superfluous space and a closer packing together of the convolutions—after the period of active cortical growth is past. Nevertheless the convolutionary pattern is profoundly affected by it, and it seems likely that in this process we find the explanation of the different directions taken by the cerebral furrows in brachycephalic and dolichocephalic heads.

The cortical elevations which rise on the surface of the early cerebrum are due to exuberant growth in localized areas. There cannot be a doubt that the process is intimately connected with the development of function in the districts concerned. We know that functions of different kinds are localized in different parts of the cortex, and when we see an area on the surface of the early cerebrum rise up in the form of

an eminence, we may reasonably conclude that the growth in the area concerned is the structural foundation of what will become later on a center of functional activity of an acute kind.

A consideration of this matter gives the clue to the simple convolutions of the ape and the complex convolutions of man, and, further, it explains how the interrupted form of fissural development is one of the essential characteristics of the human brain as compared with the simian brain. Areas which rise up in the form of one long elevation on the surface of the ape's brain appear in the form of several eminences on the surface of the human brain, and fissures which appear in the form of long continuous slits in the simian cerebrum appear in the human cerebrum in several detached bits, which may or may not in the course of time run into each other and become confluent. All this is due to the greater definition, refinement and perfection of the functions carried on in the cerebral cortex of man. It is an index of a more complete 'physiological division of labor' in the human brain.

It is not necessary, for the purpose I have in view, to enter into any detail regarding the many points of difference which become evident when the cerebral surface of the ape is compared with that of man. It is more my purpose to indicate certain of the districts of cerebral cortex which have undergone a marked increase in the human brain—an increase which may be reasonably supposed to be associated with the high mental attributes of man. To us, at the present time, it is difficult to conceive how it was ever possible to doubt that the occipital lobe is a distinctive character of the simian brain as well as of the human brain, and yet at successive meetings of this Association (1860, 1861 and 1862) a discussion, which was probably one of the most heated in the

whole course of its history, took place on this very point. One of our greatest authorities on animal structure maintained that the occipital lobe and the hippocampus minor—an elevation in its interior—were both peculiar to man and to him alone. Every one has read in the 'Water Babies' Charles Kingsley's delightful account of this discussion. Speaking of the Professor he says: "He held very strange theories about a good many things. He had even got up at the British Association and declared that apes had hippopotamus majors in their brains just as men have. What a shocking thing to say; for if it were so, what would become of the faith, hope and charity of immortal millions? You may think that there are other more important differences between you and an ape, such as being able to speak, and make machines, and know right from wrong, and say your prayers, and other little matters of that kind; but that is a child's fancy." In the light of our present knowledge we can fully understand Professor Huxley closing the discussion by stating that the question had 'become one of personal veracity.' Indeed, the occipital lobe, so far from being absent, is developed in the ape to a relatively greater extent than in man, and this constitutes one of the leading positive distinctive characters of the simian cerebrum. Measured along the mesial border, the percentage length of the occipital lobe to the total length of the cerebrum in the baboon, orang and man is as follows:

Baboon	29.7
Orang	23.2
Man	21.2

But these figures do not convey the full extent of the predominance of the occipital lobe in the ape. The anterior border of the lobe grows forwards beyond its proper limits, and pushes its way over the parietal lobe which lies in front, so as to cover over a portion of it by an overlapping lip termed

the occipital operculum. There is not a trace of such an arrangement in the human brain, and even in the anthropoid ape the operculum has become greatly reduced. Indeed, in man there is exactly the reverse condition. The great size of the parietal lobe is a leading human character, and it has partly gained its predominance by pushing backwards so as to encroach, to some extent, upon the territory which formerly belonged to the occipital lobe.* A great authority † on the cerebral surface refers to this as a struggle between the two lobes for surface extension of their respective domains. "In the lower apes," he says, "the occipital lobe proves the victor; it bulges over the parietal lobe as far as the first annectant gyrus. Already in the orang, the occipital operculum has suffered a great reduction; and in man the victory is on the side of the parietal lobe, which presses on the occipital lobe and begins, on its part, to overlap it." Now that so much information is available in regard to the localization of function in the cerebral cortex, and Flechsig has stimulated our curiosity in regard to his great 'association areas' in which the higher intellectual powers of man are believed to reside, it is interesting to speculate upon the causes which have led to the pushing back of the scientific frontier between the occipital and parietal cerebral districts.

The parietal lobe is divided into an upper and a lower part by a fissure, which takes an oblique course across it. Rudinger, ‡ who studied the position and inclination of this fissure, came to the conclusion that it

* It is necessary to emphasize this point, because in Wiedersheim's 'Structure of Man' we are told that in man there is a preponderance of the occipital lobe, and that the parietal lobe is equally developed in man and anthropoids.

† Eberstaller, *Wiener Medizinische Blätter*, 1884, No. 19, p. 581.

‡ 'Beiträge zur Anatomie und Embryologie,' als Festgabe Jacob Henle, 1882.

presents easily determined differences in accordance with sex, race and the intellectual capacity of the individual. He had the opportunity of studying the brains of quite a number of distinguished men, amongst whom were Bischoff of Bonn, Döllinger of Munich, Tiedemann of Heidelberg, and Liebig of Munich, and he asserts that the higher the mental endowment of an individual the greater is the relative extent of the upper part of the parietal lobe.

There is absolutely no foundation for this sweeping assertion. When the evolutionary development of the parietal part of the cerebral cortex is studied exactly the reverse condition becomes manifest. It is the lower part of the parietal lobe which in man, both in its early development and in its after-growth, exhibits the greatest relative increase. Additional interest is attached to this observation by the fact that recently several independent observers have fixed upon this region as one in which they believe that a marked exuberance of cortical growth may be noted in people of undoubted genius. Thus Retzius has stated that such was the case in the brains of the astronomer Hugo Gyldén,* and the mathematician Sophie Kovalevsky; † Hansemann ‡ has described a similar condition in the brain of Helmholtz; and Guszman § in the brain of Rudolph Lenz, the musician. Some force is likewise added to this view by Flechsig, who, in a recent paper, || has called atten-

* Retzius, *Biologische Untersuchungen*, neue Folge, VII., 1898, 'Das Gehirn des Astronomen Hugo Gyldéns.'

† Retzius, *Biologische Untersuchungen*, neue Folge, IX., 1900, 'Das Gehirn der Mathematikerin Sonja Kovalevsky.'

‡ Hansemann, *Zeitschrift für Psychologie und Physiologie der Sinnesorgane*, Band XX., Heft 1, 1899, 'Ueber das Gehirn von Hermann v. Helmholtz.'

§ Josef Guszman, *Anatomischer Anzeiger*, Band XIX., Nos. 9 and 10, April, 1901, 'Beiträge zur Morphologie der Gehirnoberfläche.'

|| Flechsig, 'Neue Untersuchungen über die Markbildung in den menschlichen Grosshirnklappen,' *Neurologisches Centralblatt*, No. 21, 1898.

tion to the fact that within this district there are located two of his so-called 'Terminalgebiete,' or cortical areas, which attain their functional powers at a later period than those which lie around them, and which may therefore be supposed to have specially high work to perform.

Without in any way desiring to throw doubt upon the observations of these authorities, I think that at the present moment it would be rash to accept, without further evidence, conclusions which have been drawn from the examination of the few brains of eminent men that have been described. There cannot be a doubt that the region in question is one which has extended greatly in the human brain, but the association of high intellect with a special development of the region is a matter on which I must confess I am at present somewhat sceptical.

But it is not only in a backward direction that the parietal lobe in man has extended its territory. It has likewise increased in a downward direction. There are few points more striking than this in the evolution of the cerebral cortex of man. In order that I may be able to make clear the manner in which this increase has been brought about, it will be necessary for me to enter into some detail in connection with the development of a region of cerebral surface termed the *insular district*. The back part of the frontal lobe is also involved in this downward extension of surface area, and, such being the case, it may be as well to state that the boundary which has been fixed upon as giving the line of separation between the parietal and frontal districts is purely artificial and arbitrary. It is a demarcation which has no morphological significance, whilst from a physiological point of view it is distinctly misleading.

D. J. CUNNINGHAM.

[To be concluded.]

SCIENTIFIC BOOKS.

Die Partiellen Differential-Gleichungen der Mathematischen Physik. Nach Riemann's Vorlesungen. In vierter Auflage. Neu bearbeitet von HEINRICH WEBER, Professor der Mathematik an der Universität Strassburg. Braunschweig, Druck und Verlag von Friedrich Vieweg und Sohn. 1900, 1901. Erster Band, pp. xvi + 506; Zweiter Band, pp. xi + 527.

The appearance of this new and greatly enlarged edition of the work founded on Riemann's lectures will be welcomed with delight by every student of the mathematico-physical sciences. Those acquainted with the preceding capital edition of Hattendorff do not need to be reminded of the high model of excellence in exposition he set. Professor Weber has not only amplified this model, but he has fairly canonized it, placing before the student a glorified summary of the physical concepts and the mathematical methods on which the great progress of the nineteenth century in physical science rests.

It is a good sign of the times that many eminent European mathematicians are reverting to the example set by the illustrious Gauss and followed with such signal success by Riemann, Clebsch, Kirchhoff and others. The advantages to be gained by the pure and by the applied mathematician in following such an example are mutual so far as existing science is concerned, while the better understanding of one another's work which results therefrom makes it easier to secure that sort of cooperation essential to rapid and permanent advances. The mathematical physicist is, therefore, under deep obligations to Professor Weber for the admirable presentation he has given us of the more important and more difficult branches of mathematical physics.

The reader who may be unacquainted with the earlier editions of this work should be warned against supposing it to be a treatise on any one of the subjects considered. Its great merit lies in the fact that while not a treatise, it states the salient principles and essential mathematical features of many branches of physics with a clearness and with an attractiveness rarely attained in formal treatises. No previous work, so far as we are

aware, is quite so successful in producing for the student the right combination of physical and mathematical difficulties.

The first volume is divided into three principal parts and into twenty-three sections. The first part is devoted to pure analysis, with sections in order on definite integrals, Fourier's integral, infinite series, Fourier's series, multiple integrals, functions with complex arguments, differential equations, and Bessel's functions. The second part treats of geometrical and mechanical theorems, with sections on linear infinitesimal deformation, vectors, the potential function, examples of potential function, spherical harmonics, and the fundamental principles of mechanics. The third part is devoted to applications in the fields of electricity and magnetism, with sections on electrostatics, problems in electrostatics, magnetism, electrokinetics, electrolytic conduction, steady electrical currents, flow of electricity in surfaces, flow of electricity in space and electrolytic displacements.

The second volume is divided into five parts and into twenty-three sections. The first part is concerned with the theory of linear differential equations, with sections on integration by means of hypergeometric series, integration by means of definite integrals, the P -function of Riemann, and, under the heading Oscillationstheoreme, a section treating very fully the equation $d^2y/dx^2 + \rho y = 0$, where ρ is in general a function of x . The second part is devoted to heat diffusion, with sections on the differential equation of heat diffusion, the problem when dependent on a single coordinate, and the problem of diffusion in a sphere. The third part is devoted to the theory of elasticity, with sections on the general theory of elasticity, statical problems, equilibrium and deformation of an indefinite isotropic solid, vibrations of stretched cords, Riemann's method of integration, vibration of membranes and the general theory of the differential equation of a vibrating membrane. The fourth part is occupied with electrical oscillations, with sections on electric waves, linear electric currents, and reflection of electric oscillations. The fifth part treats of hydrodynamics, with sections on general theorems, motion of rigid bodies in

fluids (two sections), discontinuous fluid motion, propagation of an impulse in a gas and aerial vibrations of finite magnitude.

When all parts of a work like this one are noteworthy for their unsurpassed excellence, it is difficult to cite parts specially commendable or to call attention to small defects. Every reader, according to his bias, will be drawn first to those sections in which he has special interest, and he must be a narrow specialist if he does not find many such sections. Generally, the work is to be praised for its admirable clearness. Some of us foreigners find the German frequently lacking in directness and perspicuity; and we are especially mystified often by the offensive use of italics so common with writers whose thoughts are unclarified. Professor Weber's style, however, is as transparent as that of the best French standards, and in this respect his work recalls the faultless exposition of such great masters as Gauss and Kirchoff.

The typography of the work is likewise unsurpassed. It, like the selection of the subject-matter and the treatment thereof, is a model for all makers of mathematical books. Book makers and publishers in America should take note of the fact that each of the volumes of this work (comprising over 500 pages per volume) 'made in Germany,' is beautifully printed, on excellent paper, and is yet less than 30 millimeters thick over all, including the rather stout half-morocco binding. To do as well in our country it will be essential to discard the miserable, thick, talc-loaded or lead-loaded paper now so commonly used here.

It would be possible to find some small faults with the presentation and treatment of the topics, here and there. 'There are spots on every sun'; but in this case, as with our orb, they do not disturb the general luminosity, and we may expect to see them disappear from future editions. In the meantime, students of mathematics and physics generally will find this work a mine of instructive and inspiring information accessible by the aid of a full table of contents and a good index. Every worker in mathematical physics should have the volumes constantly within an arm's reach.

R. S. W.

Ind.
 A *Text-book of Astronomy*. By GEORGE C. COMSTOCK, Director of the Washburn Observatory and Professor of Astronomy in the University of Wisconsin. New York, D. Appleton and Company. Cloth. Pp. 391. Price, \$1.30.

Written in simple, clear and concise language, illustrated by appropriate and well-constructed figures, made interesting by apt and homely comparisons and useful by numerous and well-chosen exercises, this book forms a welcome addition to the list of elementary text-books of astronomy. Professor Comstock has written a new book and has not merely rearranged the material of earlier ones. His purpose is clearly outlined in the first paragraph of the preface: "The present work is not a compendium of astronomy or an outline of popular reading in that science. It has been prepared as a text-book, and the author has purposely omitted from it much matter interesting as well as important to a complete view of the science, and has endeavored to concentrate attention upon those parts of the subject that possess special educational value. From this point of view, matter which permits of experimental treatment with simple apparatus is of peculiar value and is given a prominence in the text beyond its just due in a well-balanced exposition of the elements of astronomy, while topics, such as the results of spectrum analysis, which depend upon elaborate apparatus, are in the experimental part of the work accorded much less space than their intrinsic importance would justify."

Inspection of the table of contents shows that the author has departed widely from the conventional methods of treating the elements of the subject, especially in the first six and the eighth chapters. The special features of the book are numerous questions scattered throughout the text, to teach the student to think and construct as well as to read and assimilate; and many exercises, in the nature of laboratory work, all to be performed with simple apparatus, easily constructed by the students themselves. In these exercises the students obtain practice in the three fundamental processes of all practical astronomy, the measurement of time, angle and distance. Although the exer-

cises are numerous, still the author has not exhausted the list and might with profit have given more.

It would have been well, if possible, to so arrange the material that the exercises, which all fall in the first five chapters, would be more distributed. It is not necessary, of course, that the teacher present the material in just the order given, but the facts are that the large majority of teachers will present it in that way. The author has, apparently, purposely avoided all reference to the *Nautical Almanac* and *American Ephemeris*. The wisdom of this is open to question. While it is unnecessary and certainly unwise to introduce the *Ephemeris* at first and thus make the student dependent upon it, still I think it equally unwise to totally exclude it. An explanation of the *Ephemeris* and a few exercises which demand its use should, I think, be included in the most elementary course in practical astronomy. Any school in which astronomy is taught can surely afford to buy one of these books each year, and any person capable of teaching the subject should be able to use the book intelligently.

Many bits of good advice are given in connection with the exercises. On page 3, for instance, in connection with a measurement to be made, we find: "But perfection can seldom be attained, and one of the first lessons to be learned in any science which deals with measurement is that however careful we may be in our work, some minute error will cling to it and our results can be only approximately true. This, however, should not be taken as an excuse for careless work, but rather as a stimulus to extra effort in order that the unavoidable errors may be made as small as possible."

A point to be commended is the use of the metric system throughout the exercises. In the descriptive parts of the text, however, the author retains the English units. Perhaps it is best to break away gradually, but I believe no criticism would have been offered if the metric system had been used throughout.

The illustrations and figures of the book are well chosen and the student should learn something from each. Very few, if any, have been inserted for pictorial effect. Among the figures

which deserve special mention are Nos. 16 and 17, from which the position of any of the five brighter planets may be determined for a number of years; No. 23, which ingeniously illustrates the tide-raising forces; No. 54, illustrating the moon's rotation; No. 121, illustrating the determination of parallax of the fixed stars.

Of the many apt illustrations contained in the book, the following, page 121, is one of the best: "Every such timepiece, whether it be of the nutmeg variety which sells for a dollar, or whether it be the standard clock of a great national observatory, is made up of the same essential parts which fall naturally into four classes, which we may compare with the departments of a well-ordered factory: I. A time-keeping department, the pendulum or balance spring, whose oscillations must all be of equal duration. II. A power department, the weights or main spring, which, when wound, store up the power applied from outside and give it out piecemeal as required to keep the first department running. III. A publication department, the dial and hands, which give out the time furnished by department I. IV. A transportation department, the wheels, which connect the other three and serve as a means of transmitting power and time from one to the other.

"The case of either clock or watch is merely the roof which shelters it, and forms no department of its industry. Of these departments the first is by far the most important, and its good or bad performance makes or mars the credit of the clock."

The last chapter, growth and decay, deserves special mention. It is a clear, philosophic treatment of the best theories of sidereal evolution, and although not out of place in a high-school text, it might well form a part of a larger treatise.

SIDNEY D. TOWNLEY.

UNIVERSITY OF CALIFORNIA,

May 1, 1901.

SCIENTIFIC JOURNALS AND ARTICLES.

The Journal of Physical Chemistry, June, 1901.

'The Theory of Electrolytic Dissociation as viewed in the Light of Facts recently ascertained,' by Louis Kahlenberg; 'On the Gener-

alization of Clapeyron's Equation,' by Paul Sorel; 'On the Phase Rule,' by Paul Sorel. This paper by Dr. Kahlenberg demands more than passing mention. Since its enunciation by Arrhenius in 1887, the theory of electrolytic dissociation has received a recognition which has rarely been accorded a scientific theory in so short a time, and few theories have been so productive of results. Unhesitating assent has been by no means accorded it by many, especially of the older, chemists, but few attempts have been made to reveal its weaknesses experimentally. Dr. Kahlenberg, himself a pupil of Ostwald, has been one of the few who have from time to time called attention to experimental facts which were not in accord with the theory. In his present paper, the author first details a large amount of experimental work on the electrical conductivity of solutions at low and at high temperatures, and on molecular weight determinations by boiling point and cryoscopic methods, in solutions of gradually increasing strength, in which is shown often a great discrepancy between the results and those required by the dissociation theory. He then proceeds to discuss at length these and many other failures of the theory, drawing the conclusion that the theory is applicable to a decidedly limited class of solutions. The true nature of solutions must be reached by a study, not of those extremely dilute, but first of the concentrated solution, approaching the dilute solution as a limiting case. In conclusion, he says: "It must be fully and freely admitted that the dissociation theory has done much good in stimulating research in many lines. It has been fruitful in proportion to the amount of truth contained in it. Like other theories founded upon too narrow a basis of induction, it has gradually been outgrown—the facts are too much for it. It would be difficult of course to say of any theory—even of one long ago discarded—that it is entirely worthless, and so the writer has no inclination to make such a statement concerning the dissociation theory. * * * It is solely because of the rapid growth of the erroneous idea that the deductions drawn from the indiscriminate application of the simple gas equation to solutions and from the notion that all well-known facts harmonize with the theory

of electrolytic dissociation, that I have felt compelled to call attention to the real status of the experimental facts underlying these deductions."

J. L. H.

The Popular Science Monthly for October has for its opening article 'The Progress of Science,' by R. S. Woodward, being the address of the retiring president of the American Association. George Stuart Fullerton discusses 'Free-will' and the 'Credit for Good Actions' and Alexander McAdie presents some 'Fog Studies on Mount Tamalpais,' hinting at the possibility of dissipating such fogs as the one in which the steamer *Rio de Janeiro* was lost. Hugh M. Smith describes 'The French Sardine Industry' pointing out incidentally improvements that might be made in that of the United States. 'The Late Epidemic of Smallpox in the United States' is considered by James Nevins Hyde who makes a strong plea for vaccination. Edward Atkinson treats of 'Food and Land Tenure,' considering that the free land tenure of the United States is at the bottom of our great agricultural development. The final article is by W. Ramsay on 'The Inert Constituents of the Atmosphere,' describing the methods by which some of these have been discovered. The number completes Vol. LIX. and the index is appended.

The American Naturalist for September contains the third instalment of W. M. Wheeler's important and interesting description of 'The Compound and Mixed Nests of American Ants,' which includes in the present part the slave-keeping ants. The bulk of the number is taken up with the seventeenth of the 'Synopsis of North American Invertebrates,' in which H. S. Jennings treats of the Rotatoria, the paper being illustrated by nine plates comprising 171 figures.

THE Museums Journal of Great Britain for September contains a brief account of the work of 'The International Zoological Congress,' which includes some notes on the museums of Berlin and Hamburg, a paper by H. M. Platnauer, 'To Utilize Specialists,' and an account of the 'Museum of Science and Art, Edinburgh,' a very popular institution if one may

judge by the annual attendance of 350,000. A number of samples of labels used in the U. S. National Museum are given and there are notes concerning various museums and art galleries in different parts of the world.

SOCIETIES AND ACADEMIES.

NEW YORK ACADEMY OF SCIENCES, SECTION OF ASTRONOMY, PHYSICS AND CHEMISTRY.

THE section met on October 7, at the Chemist's Club. Professor Wm. Hallock reported that he had tried and failed to obtain permission of the Calumet and Hecla Company to make measurements of underground temperatures in their shaft at Keweenaw Point during the summer. He described and exhibited before the Section a new and very simple form of wind musical instrument which he found on sale at the Buffalo Exposition. The instrument was operated by blowing through the nose, the mouth cavity of the operator acting as the resonance chamber of the instrument. The tone quality was very similar to that of a flute.

Professor J. K. Rees reported that the Astronomical Department of Columbia had received from the Lick observatory a number of star photographs which were to be measured for the determination of parallax. Professor Harold Jacoby reported upon some photographs of stars near the celestial poles which had been received by the department.

Professor R. S. Woodward reported the results of an investigation he had carried on upon the effects of secular cooling and meteoric dust on the length of the terrestrial day. His investigation showed that, due to secular cooling, the length of the day will not change or has not changed, as the case may be, by so much as a half second in the first ten million years after the initial epoch, and that the total effect from secular cooling will accrue before the effect from meteoric dust will begin to be appreciable.

Professor DeRemus gave a brief account of the research laboratory in chemistry which had been lately established at Schenectady, N. Y.

F. L. TUFTS,

Secretary.

THE ELISHA MITCHELL SCIENTIFIC SOCIETY.

THE 136th meeting of the Society was held at the University of North Carolina, on Tuesday evening, October 8, when the following papers were presented :

'Interpretation of the Value $\frac{0}{0}$ ': PROFESSOR WILLIAM CAIN.

'The Work of the Beaufort Laboratory during the Season of 1901': PROFESSOR H. V. WILSON.

'Note on the Existence of a New Element associated with Thorium': PROFESSOR CHAS. BASKERVILLE.

The permanent secretary, President F. P. Venable, reported some four or five hundred exchanges as continued, and favorable progress in the cataloging and binding of the journals received in exchange.

The following officers were elected for the year: *President*, Dr. H. V. Wilson; *Vice-President*, Dr. A. S. Wheeler; *Secretary*, Dr. Chas. Baskerville.

CHARLES BASKERVILLE,
Secretary.

DISCUSSION AND CORRESPONDENCE.

AN INSTITUTE FOR BIBLIOGRAPHICAL RESEARCH.

TO THE EDITOR OF SCIENCE: In these days when large endowments are made for furthering scientific research in many directions, it is only natural that bibliographers and librarians should look forward eagerly to an endowment in the interest of that science which is the foundation of library work and, in a way, of all scientific investigation. Without bibliographies knowledge of what has been previously done in the various sciences would be wellnigh impossible; the investigator would be groping in the dark, and many a work would be written to demonstrate what had already been well demonstrated. Without bibliographies the building up of an ever so modest library would be beset with difficulties without end.

The thought that such an endowment must be made was in everybody's mind at the meeting this summer of the American Library Association. The plans for cataloging at one place books for all libraries in the country, which were discussed at the last two confer-

ences of the Association (Montreal, 1900, and Waukesha, 1901), presuppose a central bureau of some kind to organize the work and carry it out. The generous way in which the Librarian of Congress met the Publishing Board of the Association gives assurance that the cataloging of the current literature will be taken care of through the National Library. But this is only one part of the needed work. If thus the American literature of the new century will be permanently recorded (it is to be hoped that the work will be retrospective so as to cover the whole of the year 1901) we shall still lack an accurate bibliography of the American literature of past times.

There are other works of great importance that should be undertaken. Let me mention a few:

Bolton's catalogue of scientific and technical periodicals covers only one group of sciences and does not cover that one completely. A complete and accurate catalogue of serial publications of all kinds, including such as are published by societies, academies and other institutions, is a desideratum.

There is no critical and complete bibliography of bibliographies in existence. Petzholdt's monumental work does not go beyond 1866, and Henri Stein's recent volume, while bringing his predecessor's work fairly down to date, is anything but critical. It is doubtful whether a really authoritative catalogue of bibliographies can be produced without the cooperation of bibliographers and specialists in this country and Europe.

The catalogue of scientific literature undertaken under the auspices of the Royal Society of London has met with gratifying support from American libraries. But the 'Regional Bureau' for America that should do our part of the work is not yet founded. The Smithsonian Institution has provisionally undertaken to act as 'Regional Bureau,' but with all the other demands on it it is uncertain how long it can continue to cooperate in this work.

This catalogue is planned to cover only the natural and physical sciences. It is of the utmost importance that other sciences also should be covered by similar catalogues.

Furthermore, the Royal Society catalogue

covers only the current literature. The older publications should not be neglected, but should be cataloged in a series of monographs on special subjects.

The annotation of books by experts, advocated for many years with rare enthusiasm by Mr. George Iles, or at least the indexing and condensing of authoritative book reviews, is another work that would naturally come within the scope of a Central Cataloguing Bureau.

And finally, the bibliographical interests need an organ of their own where problems can be discussed and results made known.

It is clear that all these various undertakings, if carried out simultaneously, would result in a great deal of unnecessary duplication were there no central organization to guide and supervise the whole, and, if no provision were made for the utilization in many places of any title entry needed in several catalogues, without the necessity of setting up the matter anew for every time. As long ago as 1850, Professor Charles C. Jewett proposed that stereotype plates be made of the titles of all the books in American libraries, these to be kept at the Smithsonian Institution and to be utilized for the printing of catalogues of any library desiring it. The cost was too large then and the proposition too new. What was then looked upon as the visionary, though interesting, dream of an enthusiast, is now a reality, proved to be of economic value. The experience of the John Crerar Library with electrotype plates for title entries, used for printing of catalogues in book form as well as on cards, has been that the cost of making these plates and of their care and handling is less than that of printing the same matter over again from newly set type.

The purpose of these lines has been to call attention to the need of an Institute for Bibliographical Research where all the bibliographical and library interests of the country would center, and I hope that they may reach some one who might be able and willing to endow such an institute.

AKSEL G. S. JOSEPHSON.

THE JOHN CRERAR LIBRARY, CHICAGO,
Sept. 10, 1901.

DISCORD.

TO THE EDITOR OF SCIENCE: Permit me to respond briefly to Mr. W. Le Conte Stevens's remarks on 'Discord and Psychology' in the issue of SCIENCE for September 20. (1) How Mr. Stevens found out that I had not read the investigations of Professor Mayer on this subject is an enigma to me. His intimation that they were unknown to me is based solely on the fact that I do not swear by the authority of these investigations, made 25 years ago (1875). I have known them for many years. But I know also many more recent investigations which do not agree with those of Mayer. Physicists who are interested in psychological theories and discuss them in their text-books may keep up with current literature by looking once a year at the 'Psychological Index,' published annually by the *Psychological Review*, or at any other psychological bibliography. (2) With Mr. Stevens's request to criticize from the psychological standpoint the sentences quoted by him, I shall gladly comply by quoting a few sentences from a physicist who was unusually familiar with psychological literature, namely the late Professor Melde, who says (Winkelmann's 'Handbuch der Physik,' I., p. 789): 'Eine Hauptstörung eines regelmässigen Tones oder eines consonirenden Zusammenklanges bilden die Stösse oder Schwebungen. Sie können durchs Zusammenwirken der primären Töne, also durch Interferenz entstehen, oder es können auch auf rein mechanische Weise solche Stösse erzeugt werden. Ihre Wirkung muss in beiden Fällen mehr oder weniger die einer Beimischung eines Rasselgeräusches sein. Zur Erklärung des inneren Wesens einer Con- oder Dissonanz können aber nach des Verfassers Ueberzeugung auch nicht die Stösse (*viz.*, auch nicht Nebentöne) herangezogen werden, denn eine sogenannte Dissonanz besteht sicherlich auch ohne jedes Verhandensein von Stössen.'" Let me further quote from Stumpf, 'Konsonanz und Dissonanz' (1898), p. 5, where the author discusses the very investigations of Professor Mayer which I am supposed to have ignored: "Wir können Intermissionen in beliebiger Frequenz auch bei zwei konsonanten Tönen künstlich herstellen, ohne dass sie dissonant würden."

When there are beats, the psychologist speaks

of beats; when the beats are comparatively frequent, he speaks of 'roughness'; but the psychologist does not arbitrarily call roughness 'discord.' Upon the *cause* of discord the psychologists have *not* agreed; it is as yet unknown—at least to the psychologists.

MAX MEYER.

UNIVERSITY OF MISSOURI.

A CORRECTION.

IN SCIENCE for September 27, 1901, I called attention to a signature of a work entitled 'Florula Lexingtoniensis,' which I then supposed to be a work of C. S. Rafinesque. There is now no doubt that the signature in question is part of a work with the same title which appeared in the *Transylvania Journal of Medicine*, under the authorship of C. W. Short. The signature had been repaged, and does not have the appearance of a journal extract.

WILLIAM J. FOX.

ACADEMY OF NATURAL SCIENCES
OF PHILADELPHIA, PA.

CURRENT NOTES ON PHYSIOGRAPHY.

MT. KTAADN.

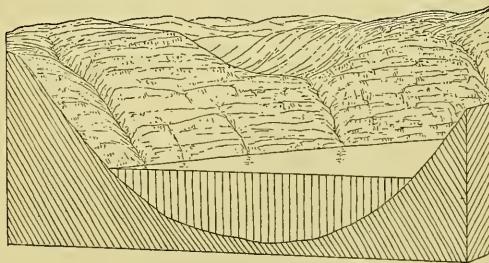
Two visits to Mt. Ktaadn (5,150') in northern Maine and four ascents have convinced Tarr that even the summit of the mountain has been glaciated, for fragments of schist, argillite and sandstone were found on its granite peaks ('Glaciation of Mt. Ktaadn, Maine,' *Bull. Geol. Soc. Amer.*, XI., 1900, pp. 433-448, 10 pl.). The greater part of the top is occupied by a 'tableland' surmounted by the several summits and gnawed into by huge basin headed valleys or corries, whose smooth and precipitous walls can hardly be scaled. Little talus lies in the basins, but a number of rock-basin lakes and terminal moraines were found on the valley floors. Where the basins come close together they are separated by sharp ridges, whose ruggedness Tarr accounts for by the moderate destructive action of the upper part of the ice sheet, as well as by postglacial weathering. He suggests that large local glaciers radiated from Ktaadn after the time of general glaciation.

Following the views of Richter, de Martonne and Matthes, recently noted in these columns, and the still earlier views of Johnson, the steep

walls and sharp dividing ridges between the Ktaadn corries would be ascribed to the retrogressive erosion of their local glaciers, aided by the excessive frost action of the Bergschrund belt; and the 'tableland' would be regarded as a residual of a larger preglacial dome.

NORWEGIAN FIORDS.

THE year-book of the Norwegian geological survey for 1900 ('Norges geologiske Undersøgelse,' No. 32, Aarbog for 1900, Kristiania, 1901, p. 263, many sketches and an English summary), contains an account of two important landslips in postglacial clays and a general discussion of the relief of certain typical areas. The highlands are regarded as presenting traces of two cycles of erosion; the older appears in the lofty snow-covered plateaus, more or less mountainous; the younger in the broad, open, high-level valleys among the high plateaus. The deeper valleys, whose deepest distal portions contain the fiords, are of later origin, after a great upheaval of the land, and are probably the work of water and ice in several interglacial and glacial epochs. Regarding the relative proportions of ice and water work, Reusch appeals to certain fiord valleys, in whose walls a number of ravines have been produced by ordinary subaerial erosion. In such cases, the valleys must have been, Reusch thinks, worn nearly to their present depth before the ravines could have been formed. Hence "the glaciers enlarged the main valley and partly destroyed the side valleys, but they cannot be said to have made the main valley." But this conclusion leaves the problem in a quandary; for if the ravines indicate the preglacial depth of the main valley, it is difficult to understand why certain



hanging lateral valleys, whose streams are much larger than those in the ravines, were not also

worn down in preglacial time to the great depth of the main valley. Moreover, as a rule, the fiord walls are not strongly ravined; they are generally rather smooth, as if they had been severely scoured. May it not therefore be supposed that the ravines are of late interglacial origin in rock structures that favor relatively rapid wearing; and that they have been eroded with respect to a valley floor which earlier glacial erosion had already deepened; while a minimum measure of the total glacial erosion is best given by the altitude of the large hanging valleys above the fiord bottoms, huge as the minimum may be?

THE ORIGIN OF MOELS.

'The Origin of Moels, and their Subsequent Dissection' (*Geogr. Journ.*, XVII., 1901, 63-69) is a discussion by Marr of the rounded mountains common in several parts of Great Britain, showing convex, dome-like tops and concave basal slopes, all covered with rock waste and vegetation, and not dissected by streams. Etymologically they are the Welsh equivalents of the 'balds' of our North Carolina mountains. Their form is ascribed to weathering under vegetation. The irregular forms into which a tableland is carved by streams would in time be subdued to moels, if weathering under a climate which favored the growth of a mantle of vegetation by which streams are excluded. In an arid or frigid climate, sharp peaks or ridges with even-sloping sides would, it is said, be developed, while running water would carve the well-known concave valley lines with steepening slope to their sources. The author goes on to show that if streams should gain a hold on a moel, either by climatic change destroying the plant mantle or by headward growth from the basal slopes, radial valleys would be carved by retrogressive erosion. Such valleys would in time reduce the intervening spurs into sharp ridges; notches would be worn in the narrowing ridges near the summit, where they are soonest consumed by the widening valley heads; and the peak of each ridge, just outside of the notch, would then be a 'tahoma,' as Russell has called such forms on Mt. Rainier (18th Ann. Rep. U. S. G. S., pt. II., 349). When one side of a mountain is exposed to rainy winds, while

the other side is relatively dry, the convex moel slope may be paired with the concave stream slope, as in certain parts of the English lake district.

Soil-creeping might have been given more explicit consideration than it here receives; for both the convex upper summit and the concave basal slopes of a valleyless moel may be largely produced by the slow creeping of the waste cover, as well as or better than 'partly by the action of the wind, and partly by inconstant runnels of water.' It seems unadvisable to treat moels as exhibiting 'the ultimate outlines of mountains which have been shaped by denudation'; for the ultimate outlines are level to the eye, and even the penultimate outlines have but a faint relief as the moels fade away. It is questionable whether the attainment of a convex summit outline is impossible in arid and frigid deserts; more probably it is merely delayed till the reduction of the mountain to a moderate relief in a late stage of the cycle weakens the forces of waste transportation to essential equality with forces of waste supply; a graded waste cover may then be formed all over the surface, whose outline will exhibit no sharp forms, but only gentle undulations. These undulations may be too gentle to be classed with the strong moels of Wales, but they deserve consideration in the general study of land forms.

W. M. DAVIS.

THE PHYLOGENY OF THE TOOTHED WHALES.

A RECENT issue of the *Memoirs of the Royal Museum of Natural History of Belgium* is devoted to a paper by Dr. O. Abel on the 'Longirostrine Dolphins of Bolderien,' in which the author describes and figures in detail the skulls of two remarkable extinct dolphins, *Cyrtodelphis sulcatus* and *Eurhinodelphis cocheteuxi*. The memoir is, however, a great deal more than the description of these crania, valuable though this be, for nearly one-half of it is devoted to observations on the phylogeny of the Odontoceti. We have a discussion of the evidence furnished by the dentition in general, and that of the pre-maxillaries in particular, the dermal armor and the general characters of

the cranium. Following this is a diagram showing *Zeuglodon* at the bottom and *Ziphius* as the most highly modified genus at the top, other genera, recent and fossil, being indicated in their proper positions at either side. This portion of the work is replete with information and abounds in references to other papers. There are, however, two points to which it may be well to call attention: The first of these is the assumption that *Zeuglodon* is the ancestor of the toothed whales, the other is the assumption that *Zeuglodon* had a highly developed dermal armor, amounting in fact to a carapace. Both of these conclusions should for the present be held in abeyance, as neither is as yet proven. This may perhaps be modified somewhat by saying that under the term *Zeuglodon* are included two perfectly distinct genera, *Basilosaurus* and *Dorudon*, and that while it seems very improbable that the former left any descendants, the structure of the latter is much nearer that of modern whales and these may be descended from that genus. There is, however, a large undescribed cetacean, indicated by vertebræ in the U. S. National Museum, found in the Eocene of Alabama and a knowledge of this form may throw some light on the problem of the origin of modern toothed whales. As to the defensive armor of *Zeuglodon* it may be well to discuss this at length later; for the present it may be said that the fine material collected by Mr. Schuchert for the U. S. National Museum shows nothing more than a few dermal ossicles, about the size of one's fist, of a rounded shape and slightly keeled on one edge. Had there been any extensive dermal armor it seems likely that it would have been collected, or at least seen, by Mr. Schuchert.

F. A. L.

ANTHROPOLOGY AT THE UNIVERSITY OF CALIFORNIA.

A DEPARTMENT of anthropology has, as we have already noted, been established by the regents of the University of California. The work of this department, for the present, will be anthropological research and the formation of a museum. Mrs. Phoebe A. Hearst has for several years been collecting a large amount of valuable material from the several expeditions

she has established, particularly in Egypt, in Peru and in California. These collections she gives to the University at Berkeley. The University has also a large collection from Alaska, presented by the Alaskan Commercial Company; and it is known that other collections are to become the property of the University when the museum is established. There are also now in the University many archeological specimens and human crania obtained from various parts of the state. For the storage and preservation of all this valuable material a temporary fire-proof building of brick and iron is to be erected at once. It is believed that this action will also be an incentive to the friends of the University to provide the funds for a museum building adequate for the proper exhibition of the collections in all departments.

As an encouragement to others and as an expression of her great interest in the new department, Mrs. Hearst, who is one of the regents and a most generous patron of the University, makes a gift of \$50,000 a year for five years for anthropological research. This amount will be devoted to continuation of the work in Egypt and in South America and to securing Greek and Roman antiquities; also to a thorough research of the archeology and ethnology of California, with particular reference to investigations of the deposits from the supposed Pliocene gravels to recent times, with the object of discovering when man first appeared on the Pacific Coast; also to a study of the many Indian tribes of California, their languages, myths and customs. For this work several parties are already in the field.

At present there will be no regular courses in the department, but university lectures on special topics in anthropology will be given from time to time. The first of these lectures was delivered on September 20 by Professor F. W. Putnam, who was invited to outline the purpose and scope of the new department and the methods of anthropological research. This was followed by a lecture on the study of the Indians by Miss Alice C. Fletcher; and the third lecture is to be by Mrs. Zelia Nuttall on the picture-writing of the ancient Mexicans.

Dr. A. L. Kroeber and Mr. P. E. Goddard have been appointed respectively instructor

and assistant in anthropology with assignment for field work among the Indians of California. Professor J. C. Merriam of the paleontological department has been given immediate charge of the research. Dr. P. M. Jones is engaged in archeological work with special reference to Santa Rosa Island. An honorary advisory committee has been appointed by the regents, as follows :

Dr. Benjamin I. Wheeler, President of the University.

Professor F. W. Putnam, Chairman of the Committee.

Mrs. Phoebe Hearst.

Miss Alice C. Fletcher.

Mrs. Zelia Nuttall.

Dr. Franz Boas.

Professor John C. Merriam.

Mr. J. G. M. E. d'Aquin has been appointed assistant secretary and executive officer of the department.

SCIENTIFIC NOTES AND NEWS.

THE eightieth birthday of Professor Rudolf Virchow has been celebrated in Berlin with elaborate ceremonies. The birthday actually occurred on Sunday, October 13, but the public exercises were on the previous day. There was a reception in the Pathological Institute in the afternoon and a banquet in the dining hall of the Prussian Diet in the evening, followed by an official reception in the parliament hall. Professor Waldeyer, secretary of the Berlin Academy of Sciences, presented 50,000 Marks, subscribed by medical men in Germany toward increasing the Virchow research fund. The Emperor has conferred an order and a medal, which have presumably been so long withheld owing to Professor Virchow's active participation on behalf of liberal institutions. The municipality of Berlin has resolved to call its new hospital, containing beds for 1,700 patients, the Virchowkrankenhaus. In New York City there was a banquet in honor of Virchow on October 12, when addresses were made by Drs. William Osler, W. H. Welch, A. Jacobi and A. H. Smith. Two days previously the *Geselligenschaftliche Verein* also celebrated the

event, on which occasion addresses were made by Drs. A. Jacobi, Franz Boas and J. N. Senner.

A STATUE of Pasteur was unveiled on September 9, at Arbois, where he spent his childhood and his holidays in later life. The monument, erected at a cost of over \$10,000, was designed by M. Daillon and represents Pasteur seated. On the pedestal are two bas-reliefs, one representing inoculation against rabies and the other agriculture profiting from Pasteur's discoveries. On the occasion of the unveiling addresses were made by M. Decrais, French minister of the colonies, and M. Liard, representing the Department of Public Instruction.

AMONG the scientific men who will be present as delegates at the bicentennial celebration of Yale University are : President H. S. Pritchett and Professors Wm. T. Sedgwick and George F. Swain from the Massachusetts Institute of Technology ; President Schurman from Cornell University ; Professors J. M. Van Vleck, W. N. Rice and W. O. Atwater from Wesleyan University, and Dr. H. C. Bumpus from the American Museum of Natural History.

DR. RUDOLF VON LEUTHOLD, has been appointed Staff-Surgeon-General of the German Army, in succession to the late Dr. von Coler.

SURGEON GENERAL GEORGE M. STERNBERG has returned to Washington after a tour of inspection in the Philippines.

PROFESSOR BASHFORD DEAN has returned to Columbia, after spending his sabbatical year in the east. He has brought back an almost complete series of developmental stages of the Port Jackson Shark, *Heterodontus japonicus*, a number of stages in the development of *Chlamydoselachus*, two new *Myxinoids*, a new *Chimæra*, together with a general zoological collection. During a visit to the Hokkaido (Yezo), he brought together several hundred specimens of Aino antiquities, which are now deposited in the American Museum of Natural History in New York. He also secured a collection of interesting glass sponges from the region of Misaki, which are also destined for the American Museum. Among other specimens are included a

number illustrating artificial selection; a series of the highly specialized varieties of Japanese gold fishes together with a number of the long-tailed fowls of Tosa, whose tail feathers sometimes reach the extraordinary length of fifteen feet. For the Columbia collection, he obtained during a visit in southern Negros, P. I., a series of dissections of *Nautilus*, prepared from fresh material. Dr. Dean, while in Japan, was the guest of the Imperial University of Tokyo, and spent most of his time at the zoological laboratory at Misaki.

PROFESSOR F. W. PUTNAM has recently returned from his trip through New Mexico and California. During part of the time he was engaged, in company with Professor J. C. Merriam, of the University of California, in a geological and archeological study of the gravels and other recent formations of California. For this purpose several caves in Calaveras and Tuolumne counties were explored, and human and other bones were found. Many old mining shafts and tunnels were also examined. On his way east Professor Putnam accepted an invitation to address the committee of the St. Louis World's Fair of 1903 in relation to the proposed ethnographical exhibit of the native peoples of the world.

MR. J. E. SPURR, who, as we have already noted, has been employed for geological surveys by the Sultan of Turkey, has begun his work in Macedonia and Albania.

DR. C. H. HERTY, of the University of Georgia, has during the summer been engaged in an investigation of the turpentine industry in southern Georgia. His results will appear in the bulletin of the Bureau of Forestry, for which he has acted as scientific assistant.

MR. WILLIAM L. CHERRY has returned to Chicago from a trip of several years' duration in Central Africa. He has brought with him to America a large ethnological collection.

DR. ROLAND B. DIXON has returned to Harvard University from an extended trip in Russia. Mr. W. C. Farabee, a graduate student at Harvard University, has been engaged during the summer in exploring a pueblo ruin in New Mexico, and A. M. Tozzer, a second-year graduate, has made a study of myths and

language of the Navajo Indians. William Jones, a student and fellow of Columbia University, has returned from Oklahoma, where he has been conducting linguistic researches conjointly for the American Museum of Natural History and the Bureau of American Ethnology. Henry Minor Huxley has returned from his anthropological expedition in Syria.

THE Philippine Forestry Bureau has made a veritable raid on the professionally educated foresters in this country. The New York State College of Forestry has lost two of its senior students, Messrs. Clark and Klemme, who were sufficiently advanced in their studies to pass the Civil Service examination, and also Mr. Hagger, its forest manager from the College Forest, and its first graduate, who leaves a position with the New York State Forest, Fish and Game Commission. Captain Geo. P. Ahern, the chief of the Forestry Bureau, also secured the services of two other foresters, Messrs. Griffith and Hareford, and of Mr. S. N. Neely, a civil engineer, formerly employed by the United States Forestry Division in timber and physics work, to conduct a wood-testing laboratory. The crop of foresters promises to grow more rapidly in the future, the New York State College of Forestry having, this year, inscribed 38 students, and the students in the Yale Forest School, showing an increase of 22.

THE sixtieth birthday of Professor Hermann Nothnagel, the eminent pathologist of the University of Vienna, has been celebrated with appropriate ceremonies by his former students.

A TESTIMONIAL banquet, in honor of Dr. N. S. Davis, was given at Chicago on October 5. There were about 350 physicians in attendance and addresses were made by a number of well-known medical men and by Dr. Davis, who was presented with a cup. Dr. Davis, who was born January 19, 1817, took an important part in the reform of medical education in the United States. The American Medical Association was established at his initiative, and he was the first editor of its journal.

DR. SAMUEL J. JONES, professor of ophthalmology and otology at the Northwestern University Medical School, died October 4, aged

65 years. He was for many years editor of the *Chicago Medical Journal and Examiner*.

WE regret to learn that Mr. Joseph S. Crosswell, a graduate of the Massachusetts Institute of Technology and instructor in shop work and drawing at the Missouri School of Mines, as a result of emotional insanity, shot and killed Miss M. Powell, after which he committed suicide.

THE death is announced of Major-General Alfred Wilkes Drayson, who was for many years professor of astronomy at Woolwich, England.

DR. MAX REESS, formerly professor of botany in the University at Erlangen, died on September 15, aged fifty-six years.

THE Board of Directors of the Rockefeller Institute for Medical Research held a meeting in New York City on October 12. It was decided to award nineteen fellowships, the holders of which will work in established laboratories.

THE Medical Society of the State of Pennsylvania met at Philadelphia on September 24, 25 and 26, under the presidency of Dr. Thomas D. Davis, of Pittsburg. Dr. F. P. Ball, of Lock Haven, was elected president for next year, and the meeting will be at Allentown.

THE New York State Medical Association will meet in New York City, beginning on October 22.

WE learn from the New York *Medical Record* that a conference of sanitary officers of the state of New York will be held at Albany on October 24 and 25. It will commence with an evening session on the twenty-fourth, which will be held in the Assembly Chamber of the capitol, and it is expected that the meeting will be addressed by Governor Odell. The next day there will be a morning and afternoon session, and the conference will close with a banquet in the evening at the hotel Ten Eyck. The object of this gathering is to afford an opportunity for meeting and making the personal acquaintance of the local and the central health authorities, and in a personal conference to present, by addresses and discussions, subjects and matters which are of practical and immediate interest to boards of health and their executive officers.

THE Christmas Island Phosphate Company has given £1,000 to the Liverpool School of Tropical Medicine for a scientific expedition to investigate beri-beri, and has also given free transportation to the members of the expedition who left Cardiff on October 4. Sir John Murray and the Colonial Office have each contributed £100 in aid of the expedition.

REUTER'S AGENCY reports that the Antarctic steamship, *Discovery*, on its way to Cape Town landed a party at South Trinidad, which remained six hours on the island. Messrs. Scott, Murray and Köttlitz ascended over 1,000 feet, obtaining some interesting natural history collections. Some new specimens of seaweed were obtained by towing a net while sailing, and were named after the *Discovery* and Mr. Scott.

WORD has been received by Professor Osborn of the discovery of the entire side of the shell of a fossil *Glyptodon* by an expedition from the American Museum of Natural History in Texas. This animal looks more like a turtle than a mammal, the body being encased in a dome-shaped shell of bone, ornamented with an elaborate mosaic pattern. It has hitherto been known in this country by only two teeth and a few pieces of the shell, recorded by Professors Cope and Leidy in Texas and Florida in 1888 and 1889. The great shell found by the American Museum is four feet long, accompanied by the heavily armored tail, all beautifully sculptured and in perfect preservation. It is not a true *Glyptodon*, but more like the species *Hoplophorus* described by Lund from the bone caverns of Brazil. This specimen has been shipped to the Museum. It was found by one of the expeditions sent out especially for fossil horses.

THE Peabody Museum of Harvard University has secured several large stone sculptures or old Mexican idols, stone faces, stone beads, etc., which were collected about forty years ago by a resident of Mexico.

THE London correspondent of the New York *Evening Post* cables that a second consignment containing the later collections made by Sir Harry Johnston in East Africa has been received at the Natural History Museum. It in-

cludes four specimens of the five-horned giraffe, two males and two females, obtained on Mount Elgon. Expert opinion, however, has not yet pronounced this giraffe to be distinct from the form already known to occur in East Central Africa. Dr. Oldfield Thomas, the mammalogist of the Museum, is preparing a critical statement for the Zoological Society. The Royal Gardens at Kew have received an important series of plants collected by Sir Harry Johnston on the Ruwenzori mountain range, several species being new to botanical science.

IN Forest Park, the site selected for the exposition to be held in St. Louis in 1903, is a group of six circular mounds. In order that they may remain during and after the fair, steps should be taken by the scientific men of St. Louis to preserve them from destruction during the erection of the buildings. They would certainly form an interesting addition to the archaeological exhibit of the exposition equal in value to the space they occupy and would afterwards remain objects of permanent interest.

THE Director-in-Chief and other members of the staff of the New York Botanical Garden have extended an invitation to members and their friends to be present in Bronx Park on Saturdays, October 12, 19, 26 and November 2, 9 and 26. A train leaves Grand Central station at 2:15 p. m. for Bronx Park, and returning leaves Bronx Park at 5:38 p. m. Opportunity will be given for inspection of the museums, laboratories, library and herbarium, the large conservatories, the herbaceous collection, the hemlock forest, the fruticetum and parts of the arboretum site. The walk planned will be a little over one mile. The following lectures will be given at 4:30 p. m. :

October 12. 'Sunlight and vegetation,' by DR. D. T. MACDOUGAL.

October 19. 'Botany of the West Indies,' by DR. N. L. BRITTON.

October 26. 'Habits and characteristics of some of the larger marine plants,' by DR. M. A. HOWE.

November 2. 'Ancestral history of some living trees,' by DR. C. A. HOLLIICK.

November 9. 'Production of cinchona bark and quinine in the East Indies,' by DR. H. H. RUSBY.

November 16. 'Botanical features of the mountains of Colorado,' by DR. L. M. UNDERWOOD.

UNIVERSITY AND EDUCATIONAL NEWS.

MRS. JAMES FINNEY HOW has given to Washington University the sum of \$100,000 as a memorial of her father, the late James B. Eads. It has not yet been decided in what way this sum shall be used.

THE University and Bellevue Hospital Medical School has received an anonymous gift of \$25,000.

COLUMBIA UNIVERSITY has received from Dean Lung a gift of \$12,000 to be added to the endowment of \$100,000 for the Chinese department given last June.

THE HON. OSCAR STRAUS has given to the University of Georgia a cabinet organ and several hundred dollars toward an equipment for work in experimental psychology.

MISS HELEN MILLER GOULD has given to Vassar College two scholarships of \$10,000 each, for the benefit of graduates of the Tarrytown High School and of the Washington Irving High School at Irvington, N. Y.

THE new building for the Tufts College Medical School was opened on October 3, when Dr. Elmer T. Capen, president of the college, made the inaugural address.

THE Missouri School of Mines is now putting in a new heating plant and has in process of erection a building to be known as 'Mechanical Hall.' It will have two stories, 150 x 60 feet, and will be used for shop work and dynamo, steam and hydraulic laboratories. A second story is being added to the chemical laboratory, and it is being enlarged by two wings 55 x 60 feet each. One of these will be devoted entirely to assaying. An extension, 42 x 80 feet, to the ore-dressing and metallurgical laboratory, which has a floor space of 60 x 75 feet, will also be added, and plans have been made for a new main building. It will be three stories, with a basement well above ground, and 140 x 85 feet. The new site for this building has been purchased, consisting of eight acres immediately adjacent to the present campus, which contains about 20 acres. The present floor space of the school, devoted to laboratories, lecture rooms, etc., is 45,085 square feet. It will be on completion of the new buildings 126,848 square feet.

THE registration at the summer quarter of

the University of Chicago in the different groups was as follows: Philosophical-sociological 1,169, language and literature 2,544, divinity 788, education 1,602, sciences 1,128. The number of courses offered in the sciences and the registration were as follows:

<i>Physical.</i>	
Mathematics.....	14 317
Astronomy.....	3 40
Physics.....	11 191
Chemistry.....	14 195
Geology.....	8 124
Totals.....	50 867
<i>Biological.</i>	
Zoology.....	9 72
Anatomy.....	9 70
Physiology.....	2 33
Neurology.....	4 28
Botany.....	11 158
Totals.....	35 361

It is reported that restrictions will be placed on foreign students attending the Technical Institute at Charlottenburg. In Berlin, in Munich, and in other technical schools, there has recently been much complaint in regard to the number of foreign students. The restrictions are aimed especially against Russians, Americans being less numerous than formerly.

It is expected that a professorship of pathology will be filled at the University of Sydney at the close of the present year.

DR. ROLAND THAXTER has been promoted to a professorship of cryptogamic botany at Harvard University.

GILBERT H. BOGGS, A.B. (Georgia), Ph.D. (Pennsylvania), has been appointed instructor in chemistry in the University of Maine. W. C. Ebaugh, A.B. (Pennsylvania), Ph.D. (Pennsylvania) has taken the professorship of chemistry and physics in Kenyon College, Gambier, Ohio. Lily G. Kollock, A.B. (Woman's College), Ph.D. (Pennsylvania), has received an appointment in the Girls' High School, Louisville, Kentucky, as professor of chemistry and physics. Thomas M. Taylor, S.B. (Oberlin), Ph.D. (Pennsylvania), becomes instructor in chemistry in Oberlin College. Leonard P. Morgan, S.B. (Pennsylvania) has accepted an instructorship in chemistry in the Mining and Agricultural College, Stillwater, Oklahoma.

In the Medical College of Western Reserve University, Dr. F. C. Waite, of the University of Chicago, has been appointed assistant professor of histology and embryology, Dr. H. B. Parker demonstrator in pathology, and Dr. R. G. Perkins lecturer on bacteriology.

At the University of Pennsylvania, Dr. M. Howard Fussell has been appointed assistant professor of medicine, Dr. Thomas R. Neilson assistant professor of genito-urinary diseases, and Dr. Elisha H. Gregory, Jr., demonstrator of anatomy. Dr. Frederick A. Packard will deliver the lectures upon applied therapeutics, and Dr. H. C. Wood, Jr., those on the physiological action of drugs, in the place of Dr. Horatio C. Wood, professor of therapeutics, who has been granted leave of absence for a year.

At Washington University, Mr. A. P. Winston has been appointed instructor in political economy and Mr. A. O. Lovejoy, lately of Leland Stanford Junior University, has been appointed professor of philosophy.

FRANCIS GANO BENEDICT, Ph.D., has been promoted to an associate professorship in chemistry, at Wesleyan University, Middletown, Conn.

DR. EARL BARNES has been appointed a special lecturer in pedagogy in the School of Pedagogy of New York University.

DR. A. A. LAWSON, of the botanical staff of the University of California, who has spent the past year at Chicago (as fellow in botany), has been appointed assistant in botany at Leland Stanford Junior University.

MR. H. T. A. HUS, M.S., a graduate student in botany at the University of California, has been appointed assistant in botany at the University of Amsterdam, Holland.

DR. HERMANN SIMON, docent in physics at Frankfort a/M., has been appointed associate professor of physics and electricity in the University at Göttingen, and Dr. Ernst Neumann, docent in applied mathematics and physics in the University of Halle, has been appointed to an associate professorship in the University at Breslau. Dr. Julius Precht, associate professor of physics at Heidelberg, has been called to the Technical Institute at Hanover.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

EDITORIAL COMMITTEE: S. NEWCOMB, Mathematics; R. S. WOODWARD, Mechanics; E. C. PICKERING, Astronomy; T. C. MENDENHALL, Physics; R. H. THURSTON, Engineering; IRA REMSEN, Chemistry; CHARLES D. WALCOTT, Geology; W. M. DAVIS, Physiography; HENRY F. OSBORN, Paleontology; W. K. BROOKS, C. HART MERRIAM, Zoology; S. H. SCUDDER, Entomology; C. E. BESSEY, N. L. BRITTON, Botany; C. S. MINOT, Embryology, Histology; H. P. BOWDITCH, Physiology; J. S. BILLINGS, Hygiene; WILLIAM H. WELCH, Pathology; J. MCKEEN CATTELL, Psychology; J. W. POWELL, Anthropology.

FRIDAY, OCTOBER 25, 1901.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

SECTION F, ZOOLOGY.

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THE first meeting of the Section was called to order by Vice-President David Starr Jordan, on Monday, August 26, at 11:30 a.m., when the Section was organized with the following officers:

Vice-President, David Starr Jordan.

Secretary, Henry B. Ward.

Member of Council, C. H. Eigenmann.

Member of General Committee, V. L. Kellogg.

Sectional Committee: C. B. Davenport, Vice-President, 1900; C. H. Eigenmann, Secretary, 1900; D. S. Jordan, Vice-President, 1901; H. B. Ward, Secretary, 1901; E. P. Felt, W. H. Ashmead, T. D. A. Cockerell.

The report from the Committee on Variation was read, and on motion the Section voted to recommend the granting of the funds requested for prosecuting the work. The report is as follows:

The grant of one hundred dollars to this committee was used to help defray the expenses of Mr. C. C. Adams incurred in collecting for study molluscs of the genus *Io*, found in the headwaters of the Tennessee River. A preliminary report has been made by Mr. Adams, and this was printed in the *Proceedings* of the Association for 1900. Mr. Adams submits at this time a second report covering the results of study on the material collected last summer, but prefers to postpone further publication until after his final expedition which he is

making this summer. The main results so far are that he has shown, by the aid of an elaborate series of measurements, that the numerous species of *To* run into each other in a very complete way, and that the differences between the shells are associated with their position up or down stream. Nevertheless, there is in most streams a more or less marked discontinuity between the smooth, globular, up-stream shells and the spiny, elongated down-stream shells. The meaning of the discontinuity (which justifies, in a way, a division of the shells into two species) is still not perfectly clear. To test certain hypotheses in respect to this discontinuity, Mr. Adams has returned to the field this summer. This piece of work is, we believe, the largest and most thoroughgoing quantitative study of the variation of a species in nature that has yet been reported upon.

The committee request the council to grant it one hundred dollars additional, to aid Mr. Adams in this his final summer's work on this topic.

The committee is glad to report an increasing interest in the quantitative study of variation, and especially the establishment by Professors Pearson and Weldon of a new journal, *Biometrika*, devoted to the results of such study.

Respectfully submitted,

F. BOAS,
CHAS. S. MINOT,
J. MCK. CATTELL,
CHAS. B. DAVENPORT,
C. H. EIGENMANN.

The following resolution was also passed requesting an appropriation for the Concilium Bibliographicum from the funds of the general society:

In view of the very limited sum at the command of the Committee on Grants, and recognizing also the fact that this money has hitherto been devoted only to the encouragement of research, this Section would

recall its request that a grant be made from these funds to the Concilium Bibliographicum.

As an important aid to research, already firmly established, of great assistance to investigators and capable of development so as to serve a wider usefulness, this Section regards the Concilium Bibliographicum as particularly deserving of support and encouragement, and to the end that such financial assistance as is necessary may be given, requests that a special appropriation of \$50 from the general funds of the Association be made for this purpose, and placed at the disposal of an advisory committee of three, consisting of President Minot, together with two other members or fellows appointed by him.

On Monday, at 3 p. m., the Section listened to the address of Vice President Davenport on 'The Zoology of the Twentieth Century,' which, in the absence of Mr. Davenport, was read by the secretary.

On Wednesday morning the Section adjourned to hear the address of Vice-President Jordan before Section G on 'Political and Social Conditions in the Hawaiian Islands.'

At a meeting of the General Committee on Thursday evening, Professor C. C. Nutting, of the University of Iowa, Iowa City, was elected vice-president and chairman of the Section for 1902, and Dr. Charles W. Stiles of the Bureau of Animal Industry, Washington, D. C., was elected secretary for 1902.

The following papers were presented before the Section and, so far as given by the authors, the abstracts for each are appended.

1. 'The Fish-Fauna of Japan, with Observations on the Distribution of Fishes': DAVID STARR JORDAN, President of Stanford University. Published in SCIENCE for October 11.

2. 'On the Morphology of the Pineal

Region based upon its Development in *Acanthias*': CHARLES SEDGWICK MINOT, LL.D.

The paper describes the development of the epiphysis, the posterior and superior commissures, the velum transversum and the paraphysis in the embryos of the dog-fish, of from 11.5 to 86.0 mm., studied chiefly by means of median sagittal sections. The velum transversum arises close to the epiphysis, and, unlike other known types, the dog-fish retains this relation permanently. The velum gives rise by its lateral expansion to the choroid plexus of the lateral ventricles. In front of the velum is the paraphysial arch, which is not identical with the paraphysis. This arch exists in all vertebrates, but has not hitherto been recognized as a constant morphological constituent of the brain. The true paraphysis arises as a small evagination from the paraphysial arch, and appears very late in development—in the oldest embryo examined it was not clearly present, so that it is uncertain whether it exists in the dog-fish at all. In amphibia and birds it is easily found, and there develops into a glandular organ, never, so far as known, into a sense-organ, as has been generally assumed hitherto. The single duct opens into the cavity of the brain. We may assume, in default of actual knowledge, that the gland supplies a secretion to the brain, being physiologically comparable to the infundibular gland of the lower vertebrates. In amphibians the velum transversum expands so much that it grows forward and across in front of the paraphysis; the enlarged velum is wholly transformed into the adult choroid plexus, as a part of which the paraphysial gland was long regarded erroneously. In birds and mammals the median portion of the velum is rudimentary or obliterated; the paraphysial arch is well developed and forms a large part of tela choroidea superior; the later portions, on

the contrary, are greatly developed to form the lateral plexus.

3. 'The Essential Mechanism of Hearing in Man': HOWARD AYRES.

4. 'On the Disappearance of the Vast Flocks of Wild Pigeons (*Ectopistes migratoria*) in Eastern North America': EDWARD T. KEIM, Denver, Colo.

In the memory of the middle-aged man many facts can be recalled relating to the annual flight of the myriads of wild pigeons through the Eastern, Middle and Central States of the United States of America. The newspapers of that period (1850 to 1870 and 1880) teemed with accounts of the vast numbers seen, and the superlative adjective was immoderately used to describe the great number and the indiscriminate slaughter. Certain wooded sections in the States of Kentucky, Tennessee, Missouri, Iowa, Illinois, Minnesota and Michigan, when the white settlers first came into these regions, were visited annually by the pigeons for nesting places, but owing to the almost ceaseless attacks by man, beast and bird, these localities were deserted for a year or more. Another fact also observed was that the abundance or scarcity of the 'mast' and the wild fruits and grains, which constituted their main food, determined the location of the annual nesting places. An account of a visit by the writer in company of a party of hunters, to the so-called pigeon roost near Maquoketa, Jackson county, Iowa, will be given, and a map of the United States showing approximate location of known breeding places will be exhibited. An effort will be made to secure mounted specimens of the male and female pigeon.

5. 'The Eleven Elements in the Superior Molar Teeth of Mammals' (illustrated by models): HENRY F. OSBORN.

6. 'The Homologies of the Mouth Parts of Insects with Complete Metamorphosis': VERNON L. KELLOGG.

Despite the continued attention of entomologists through nearly one hundred years to the problem of the homologies of the insect mouth parts, an agreement has not yet been reached as to the interpretation of these homologies in the Diptera and perhaps in other holometabolic groups. The extreme modification of certain parts and the reduction to mere unintelligible vestiges, or, indeed, to total disappearance, in the imaginal condition of the more specialized flies and the fact that even in the generalized flies the fully developed mouth-parts are so modified that a comparison with the typical biting or orthopterous mouth is difficult and hazardous, has determined this long-continued uncertainty in the determination of the mouth-part homologies. For the problem has been heretofore attacked exclusively, or nearly so, by the method of the comparative study of the fully-developed mouth structures. It is certain that no absolute determination of the homologies can be reached by this method alone. I have therefore made an attempt to trace the development of the imaginal mouth parts in the Diptera, Lepidoptera, Coleoptera and Neuroptera, while a student of mine, Mr. A. B. Spaulding, has undertaken similar work on the Hymenoptera. The special difficulty of the work lies of course in the remarkable histolytic and histogenetic conditions attending the post-embryonic development of the holometabolic insects.

It is perfectly feasible to trace continuously the development of mouth parts of the dipterous larvæ, from the first budding of the appendages on the successive head segments to fully developed larval condition. But the utter casting aside at pupation of these larval mouth structures and their supplanting by the radically different imaginal parts, which have developed from imaginal histoblasts (derived from the larval hypoderm) make it impossible to trace

a perfect continuity from embryonic anlagen to the definitive imaginal structures.

But we find in the advanced larva that the developing imaginal structures push out into and perfectly correspond with the larval parts, and that an interpretation of the homologies of the adult mouth parts in any of the holometabolic insects can be got at on the basis of this correspondence in position.

The value of this evidence from position is made apparent when the development of the imaginal mouth structures in holometabolic insects with biting mouths, as the Neuroptera and Coleoptera, are studied. There is no question in the minds of entomologists regarding the certainty of the homologies of imaginal mandibles, maxillæ and labium of these insects with the same parts of the imaginal orthopterous mouth. But a study of the development of the imaginal mouth parts in the Neuroptera and Coleoptera has revealed that perfect correspondence in position between the developing imaginal parts and the larval parts, as is apparent in the Diptera, Hymenoptera and Lepidoptera.

I have, therefore, been able to show that the interpretation of the homologies of the imaginal dipterous mouth parts formerly advanced by me (see papers on *Psyche*, 1900) on the basis of a comparative study of the fully-developed imaginal mouth structures, in all the generalized families and several of the specialized families is confirmed by the evidence derived from a study of the post-embryonic development of the imaginal parts. And further, this study shows that the ordinarily accepted interpretation of the homologies of the imaginal mouth parts of the other holometabolic orders of insects is confirmed by the study of their development.

7. 'On Taxonomic Relations between Scolytids and their Host Plants': A. D. HOPKINS, Entomologist, W. Va. Agric. Exp. Sta.

This paper embraces some of the results of the author's studies of the host plants of nearly all the described, and some 100 undescribed, North American Scolytidæ, which in addition to the literature containing references to the plants infested by these beetles in all countries, enables him to bring together for comparison a more comprehensive list of the insects and plants, than has ever before been possible. The species of insects with observed or recorded host plants represent some 500 species, 52 genera, 20 sub-groups, 7 groups, and 3 sub-families. All the host plants are found to belong to the Phanerogamæ. The Gymnospermæ are represented by 1 order, 13 genera and 30 species. The Angiospermæ by 1 order and 1 species in the Monocotyledons, and by 36 orders, 56 genera and 120 species in the Dicotyledons. The paper is illustrated by a chart, showing the relations of the primary and minor divisions in the classification of the insects with those of the plants. The genus of plants infested by the species of any genus or group of insects is shown in horizontal spaces, while the genera of insects, connected with any genera or group of plants, are shown in vertical spaces, crossing the horizontal ones. Thus the relations of genera to genera, and group to group, are presented in a most convenient manner for study and comparison. In the relations observed there seem to be some facts of considerable taxonomic importance which, if properly interpreted, and taken in connection with structural characters of the insects, will aid materially in determining natural affinities. When we came to consider these facts, and apply the evidence they furnish, towards the solving of some taxonomic problems, some rather striking results were obtained, which have guided us to the discovery of some valuable specific, generic and group characters in the insect, heretofore entirely overlooked. Closely

allied species and genera, which had been relegated to far corners in different groups, have been brought together, and order is being restored where there was much confusion. The evidence found in the fossils of Eocene rocks, and in amber, indicates that the Scolytidæ reached a high stage of development at the beginning of the Tertiary, and that it is not at all improbable that a maximum development was attained during the Jurassic or Cretaceous. We find the sequoia, and other survivors of ancient groups of conifers; the tulip, sassafras, oaks, elms, beeches, poplars and other survivors of primitive genera, and groups of other plants, supporting what are believed to be the oldest surviving types of groups and genera of Scolytidæ. This, together with the evidence furnished by the records of the host plants of existing species, furnishes guides and suggestions towards a clear conception of the probable lines of evolution of present forms from primitive generalized groups. They suggest that the progenitors of the Scolytidæ may have found their way into the soft bark and wood of conifer-like trees of the first true forest in the Devonian; or of the thick soft bark of the great tree ferns, *Sigillaria* and *Cicades*, of the Carboniferous, and that from these progenitors of the Gymnosperms, Monocotyledons and Dicotyledons the descendants of the insects have adapted themselves to the physiological changes in the evolution of their hosts, sharing with them the struggle for existence through the changes in surface and climate, from age to age, and from period to period, to the present.

8. 'Some Recent Observations on Culioidæ': L. O. HOWARD, chief entomologist, U. S. Department of Agriculture, Washington.

An account of some new work on the biology of *Aedes*, *Psorophora*, *Megarhinus* and *Stegomyia*.

9. 'The Larva of *Pyrrharcia isabella* as an Anatomical Subject': E. P. FELT, N. Y. State entomologist, Albany, N. Y.

The availability and desirability of this larva is shown and a few general statements made in regard to its internal anatomy. Attention is also called to an internal parasite and its relations to its host. Two small drawings illustrate the paper.

10. 'On the Development and Evolution of the Scolytid Gallery': A. D. HOPKINS.

This paper embraces some of the results of the author's special study of the galleries of the large number of described and many undescribed North American Scolytidæ, together with those figured from all countries, so far as available; representing in all some 400 species, 37 genera, 13 sub-groups, 7 groups and 3 subfamilies. Brief reference is made to the structural character, and characteristics of habit, which distinguish this family of beetles. In the galleries three fundamental forms, or types, are recognized: (1) The longitudinal, (2) the transverse, (3) the broad, irregular chambers which, modified or combined, form the specific types of all galleries, and these seem to fall naturally into eight primary groups and thirty-two divisions. The primary groups are designated as follows: (1) The primitive forms; (2) broad, irregular, branching forms; (3) the ambrosia galleries; (4) the intermediate or transverse branching forms; (5) the longitudinal, branching forms; (6) the double, transverse; (7) the double longitudinal; (8) the single longitudinal, or higher forms. The paper is illustrated by numerous lantern slides from photographs, and by drawings of typical forms of galleries; also by a chart which shows the relations of the various genera, sub-groups, groups and sub-families, to the groups of galleries, in horizontal and vertical spaces. The various forms of the galleries throughout the

family, so far as observed, range from the simplest longitudinal burrow (excavated in decaying bark or wood), as the primitive type, to the complex or composite form (with its many radiating branches from a central chamber), as the intermediate, and to the short, straight, longitudinal egg gallery (with its symmetrical radiating brood burrows in living bark), as representing the highest type. It is seen from a study of this diagram, that a group of allied forms of galleries does not necessarily represent any single group of species, but that the several groups of galleries represent parallel or periodic stages and relations in the evolutionary development of all the groups.

Thus if the characters, as expressed by the gallery, are properly interpreted as indicating a stage or period in the evolution, and are studied in connection with structural characters of the insects, it will indicate the natural position of a species, in its relation to other species in its group, and to similar stages and periods in other groups. The results of this line of study and thought, incompletely expressed as they are in this paper, may serve at least to suggest the course of evolution of the scolytid gallery within the maximum and minimum limit of an instinctive idea or tendency common to all individuals of the family, but expressed in varying degree as the different, low, intermediate and higher species and individuals are capable of expressing it. This suggests a parallel with the social development of the human species, in the evolution of the idea common to all, of constructing a habitation in which to rear and protect a family of offspring, as has been expressed in varying degree from the simplest to the highest perfection. It may suggest the importance of considering the law of parallel development of characters and characteristics, in species of remote, as well as near, affinity, and thus enable us to

eliminate some of the errors in our systems of classification, where a character, due to parallel development, has been mistaken for one of near affinity. And finally the results of this study of the gallery, together with the results of a study of the parallel relation of structural characters, indicate a law of parallel or periodical relation of groups of organisms somewhat similar to that of the chemical elements.

11. 'The Eye of the Blind Lizard *Rhineura floridana*': C. H. EIGENMANN, Bloomington, Ind.

The eye has been withdrawn from the surface; the tear glands are enormous as compared with the eyeball, which is very small, the optic fiber layer forming a central strand. The optic nerve does not extend to the eye. The layers of the retina have retained a high degree of specialization.

12. 'The Ontogenic Development and Degeneration of the Eye of the Blind Fish *Amblyopsis*': C. H. EIGENMANN, Bloomington, Ind.

The history of the eye of *Amblyopsis* may be divided into four periods: (1) The period of palingenic development ending when the fish is about 4.4 mm. long. (2) The period of direct development, during which the eye develops directly from a palingenic stage to the highest development the eye reaches—at the end of 10 mm. in length. (3) The period of progressive modification, during which the eye undergoes many changes without reaching a more perfect condition as an organ of vision. This ends when the fish has reached full maturity. (4) The period of degeneration ending with death; during this period the eye is gradually wiped out.

13. 'The Finding of the *Leptocephalus* of the American Eel': C. H. EIGENMANN, Bloomington, Ind.

Among many *Leptocephali* in the United States National Museum were found two which on account of their great resemblance

to the *Leptocephalus* of the European eel and on account of their differences from that of the European eel, which were just the differences between the adults, were considered the *Leptocephali* of the American eel. They were taken off New York.

14. 'A Gigantic Campanularian, with Observations concerning its Systematic Relations': C. C. NUTTING, Iowa City, Iowa.

15. 'The Harvard Embryological Collection': CHARLES S. MINOT, LL.D.

The collection was founded in connection with the Embryological Laboratory of the Harvard Medical School. It is intended to be used primarily for research work in the comparative embryology of vertebrata. It is proposed to have carefully graded stages of eighteen or more species, chosen as types of vertebrate classes, and to have of each stage three sets of serial sections in three planes—transverse, frontal and sagittal. The collection is to be thoroughly catalogued, every section being numbered. The paper describes the precise method used, the growth of the collection and other details.

16. 'On a New Type of Secretion by the Formation of Spherules': by CHARLES S. MINOT, LL.D.

The process here recorded was first observed in the glands of the cervix of the human uterus. The end of the epithelial cell, next the lumen of the gland, assumes a clearer appearance, becomes distended and then breaks off as a spherule, which lies in the gland cavity. The spherule breaks down, and its substance forms the secretion of the gland. Certain observations indicate that the same type of spherular secretion recurs in the mesonephros (Wolfian body of the pig, embryo, kidney of the frog). Mingazzini has described a somewhat similar spherule formation occurring on the basal ends of the epithelial cells of the intestine, during the resorption of food.

17. 'Laws of Adaptive Radiation': HENRY F. OSBORN.

18. 'Potential, Latent or Parallel Homology as distinguished from Phyletic or Derivative Homology (illustrated by Models)': HENRY F. OSBORN.

19. 'The Phylogenetic Relations of the Simple Vertebrates': HOWARD AYRES.

21. 'A Study of the Variations in *Sympetrum rubicundula* Say and *S. obtrusa* Hagen': MORTON J. ELROD, University of Montana.

These two species of Odonata are separated from each other on the relative sizes of the divisions of the bifid hamule, those having a little more than the apical third bifid being classed as *rubicundula*, those having the genital hamule with a fourth bifid being classed as *obtrusa*. The observations are based on the study of 394 specimens, from Maine to Montana, 223 being males. The aim of the author is to determine if the relative portions of the bifid hamule are a constant factor, and to determine if there are other factors that may be used for separation of the species.

Sixteen tables of figures are given, showing the variations observed in the fore and hind wings of both males and females, the length of males and females, the number of antecubitals, postcubitals and cross nervures of the fore and hind wings of the right and left sides of both males and females, the length of hamule of males, the relative widths of the bifid portions of the males, and the vulvar lamina of the females. The results of the measurements are as follows: The antecubitals and postcubitals are very irregular in number. There is a high percentage of both males and females of both species with five antecubitals on the hind wings. The antecubitals are much more constant than the postcubitals. The females show greater variation than the males. The left side shows greater variation than the right. The antecubitals on fore wings vary from six to nine, on hind wings from

four to seven. Postcubitals on fore wings vary from five to ten, and on hind wings from five to eleven. The males have more cross nervures than the females. Three-fourths of all the specimens have a less number of cross nervules on one wing than on the other. There is great variation in the length of the hamules. The comparison of the bifid portions of the hamules does not justify the separation into two species. There is no appreciable difference in the wings or length of body of the two species. No differences of consequence could be observed in the vulvar laminae of the females. The two species should be reduced to one, *S. rubicundula* Say, and a new description of the species written, which description is given in the paper. The variety *assimilata* is retained.

22. 'Further Studies in the Geographical Variation of *Io*': CHAS. C. ADAMS, Zoological Department University of Chicago, Chicago.

23. 'A Preliminary Statement of the Alkalinity of the Blood in Infections and the Infusion of Salts derived from Horses' Blood as a Therapeutic Measure': A. EMIL SCHMITT, New York City.

Based on the premises that the degree of alkalinity in the blood of certain species of lower animals, as horse, dog and cat, is greater than that in man, and that it is a causative factor in their immunity, and also that the alkalinity of the blood in man is reduced in the infections, and that by the infusion of alkaline solutions this can be increased and the infection thus overcome, the writer suggests the use of the salts derived from the horses' blood-ash and reports cases of puerperal septicæmia and cerebro-spinal meningitis thus treated. The views on the question of alkalinity are sustained by a number of authors, and the advantage accruing from the use of the salts derived from horses' blood-ash are set forth and compared with the prepared solutions of

salts composed according to analyses of blood-ash. The relationship of degree of alkalinity of blood and the incubation period of infections, as well as the immunity enjoyed by the black races, as also instances among the white race, and especially with lower animals compared with man, are hinted at.

No definite results as a therapeutic measure are claimed, but the author wishes to suggest a new trend of thought which will attack disease at its very foundations, altering the composition of the blood and body juices to make them uninhabitable for germ propagation. Introduction by means of infusion into the veins at the elbow instead of subcutaneously is resorted to on account of the pain and possible change of composition in the latter method. 500-1,000 cc. of the 1-per-cent. salt solution are infused at one time, controlled by the condition of arteries and heart. With this strength neither a dissolution nor a crenation of the corpuscles takes place, as demonstrated under the microscope, the isotonic coefficient of human blood compared with various strengths of this solution varying from .44-.58 per cent. No harmful effects have been noticed and venesection, to rid the body of some of its toxins in serious cases, is considered a valuable adjunct to the new form of treatment.

24. 'Cold as a Causal Factor in the Blood Changes due to High Altitude': JOHN WEINZIRL, Albuquerque, New Mexico.

Up to the present time no satisfactory explanation of the blood changes due to high altitude has been offered. The more commonly accepted hypothesis that the increased blood counts are due to diminished atmospheric pressure, or that] more red corpuscles are required to furnish sufficient oxygen to the tissues when the oxygen supply is diminished, has serious objections to it. In the first place, the oxygen absorption by the hemoglobin of the red

cells is a chemical phenomenon independent of the partial pressure of oxygen. Secondly, it is not at all plain why an increased number of red cells should be required to carry a given amount of oxygen, for, as Paul Bert has shown, the amount of oxygen actually used by an animal is constant even when the supply is diminished by one-half, or when pure oxygen is respired. Nor are the various other hypotheses that have been offered more satisfactory than the above. An experiment with common white rabbits, planned to test some of these hypotheses, accidentally revealed the fact that extreme temperature changes or a change from a warm to a cold temperature, produced all the phenomena of high altitude; and that when the animals were subsequently taken to a higher altitude the usual phenomena did not ensue.

That the blood counts made in winter are higher in red cells than those made in summer has been previously observed, and comparative tests by the writer confirm this fact. An important factor in altitude changes is a change in temperature, and since cold is capable of producing phenomena of the blood identical with those produced by high altitude, it would appear that cold is an important factor in accounting for the blood changes due to high altitude. That cold is the only factor the writer does not maintain.

HENRY B. WARD,
Secretary.

THE GLASGOW MEETING OF THE BRITISH
ASSOCIATION FOR THE ADVANCE-
MENT OF SCIENCE.

THE enterprise of the city of Glasgow in holding this year a large and successful industrial exposition attracted to that great commercial center a large number of congresses, and among others the British Association for the Advancement of Science, which held its sessions under the presi-

dency of Professor Arthur W. Rücker in the university building during the week beginning September 11. In attendance the meeting was not quite so successful as in previous years, the total number of members registered being 1,912. The following Americans had the honor of attending as guests of the Association: Chancellor MacCracken of the University of New York, Mr. Edward Atkinson of Boston, Professor Arthur Michael of Tufts College, Professor Edward W. Morley of Cleveland, Professor A. Lawrence Rotch of the Blue Hill Observatory and Professor J. Playfair McMurrich of the University of Michigan. The papers presented to the meeting reached the usual standard of excellence, and reports of the proceedings of the various sections will appear in later numbers of SCIENCE.

The usual public lectures were given by Professor W. Ramsay, on 'The Inert Constituents of the Atmosphere,' and by Mr. Francis Darwin on 'The Movements of Plants.' As is customary, numerous receptions were held in honor of the Association, and the majority of the members took advantage of the suspension of meetings of the sections, on the Saturday, to make excursions to various points of interest in the western Highlands or to visit some of the numerous great industrial enterprises which have made Glasgow famous.

THE GEOLOGICAL SECTION.

As might have been expected from the place of meeting of the Association, much of the material presented to the Geological Section dealt with the geology of Scotland. The president of the section, Mr. John Horne, acting director of the Geological Survey of Scotland, gave as his address a review of the progress in our knowledge of Scottish geology during the quarter-century which has elapsed since the last meeting of the Association in Glasgow, and furnished

such abundant evidence of the activity and skill of the Scotch geologists in recent years as to justify the hope which was expressed that their work might form a fitting sequel to the labors of such men as Hutton, Hall, Murchison, Lyell, Hugh Miller, Fleming, Nicol and Ramsay, all of whom claimed Scotland as the land of their birth. It would be difficult to satisfactorily abstract the address, since from the wealth of material with which it had to deal, it in itself was but an all too brief synopsis; but there may be mentioned, among the important additions to geology to which reference was made: the tabulation of the various divisions of the Torridonian sandstones by the Geological Survey and the determination of the pre-Cambrian age of that formation; the collection of evidence of post-Cambrian terrestrial movements in the northwest Highlands resulting in the production of reversed faults and thrusts for which a parallel can be found only in the Alps and Provence, the determination of the order of succession of the Silurian rocks of the south of Scotland by Professor Lapworth, the unraveling of the history of the secondary rocks by Professor Judd; and the study of the Tertiary volcanic rocks of the western coast.

In connection with this last-named topic attention was called to the recent discovery, in the island of Arran, of a volcanic vent covering an area of about eight square miles and now filled with volcanic agglomerate and large masses of sedimentary material which has yielded Rhætic and Lower Triassic fossils. And in a special paper Sir Archibald Geikie described an interesting circumstance which gave a basis for estimating the time intervals between successive lava flows in the inner Hebrides. This was the occurrence in the basalt of the west coast of Mull of a fossil tree whose roots were apparently imbedded in a lower sheet of lava, in which were signs of soil. The

tree, which was penetrated by calcite, extended to about five feet above this old soil, and above this was a hollow in the basalt about forty feet high, which evidently represented a cast of the tree. The conditions indicated an old lava flow which had later undergone a certain amount of disintegration and afforded a soil upon which the tree established itself; then a period succeeded during which the tree grew until it reached a diameter of eight feet and an estimated height of eighty feet; then an outflow of lava around the tree was followed by an interval during which the decay of the tree took place; and finally the outflow of the sheet of basalt, which covered and sealed up the top of the hollow left by the decay.

The geology of the nearly related north coast of Ireland also received its due share of attention, papers being presented by Messrs. McHenry and Kilroe, of the Geological Survey, on 'The Relations of the Old Red Sandstones of Northwest Ireland to the Adjacent Metamorphic Rocks and their Similarity to the Torridon Beds of Sutherland,' and on 'The Relation of the Silurian and Ordovician Rocks of Northwest Ireland to the Great Metamorphic Series.' This latter paper, which attempted to refer the metamorphic rocks of Mayo and Galway to the Lower Silurian period, awakened a considerable amount of discussion and some adverse criticism, since, if the views of the authors were correct, it became a difficult matter to explain the present difference between these rocks and the fossil-bearing Lower Silurian beds of adjoining areas. Papers were also read by Mr. G. H. Kinahan, entitled, 'Notes on the Irish Primary Rocks and their Associated Granite and Metamorphic Rocks,' and on 'Some Laccolites in the Irish Hills.'

Papers on the geology of foreign areas were comparatively few. Miss Raisin gave an account of a lithological study of volcanic

rocks collected on Perim Island and took occasion to refer to the geological history of the Red Sea area, inferring that this sea formed part of the Great Rift Valley, extending from Lake Tanganyika to the Jordan and displaying at many places volcanic outbursts on a large scale, at different periods. Dr. Logan Jack, formerly head of the Geological Survey of Queensland, gave an account of the 'Artesian Water in the State of Queensland.' The greater part of the western interior of Queensland is composed of soft beds of lower Cretaceous rocks so disposed as to crop out on the western flanks of the coast range where the elevation and rainfall are greater than in the downs of the west. Along the eastern margin of the Cretaceous outcrop is a porous sandstone whose outcrop forms a belt of from five to twenty-five miles in width, the strata dipping at a low angle beneath the clayey and calcareous beds which form the surface of the downs. The conditions accordingly seemed favorable for boring artesian wells, and a successful beginning of the development of a water supply of this nature was made under the supervision of Dr. Jack in 1885 and up to June, 1900, one hundred and eighty-five miles of boring had been made in the district, the majority of the borings being successful. Owing, however, to the fact that the artesian basins are imperfect, a considerable amount of leakage takes place from them, the water probably finding an outlet into the Great Australian Bight or the Gulf of Carpentaria.

In a paper on 'The Physical History of the Norwegian Fiords,' Professor Edward Hull described six important stages in the development of these characteristic features of the Norwegian coast. First there was the continental condition with archæan rocks; when the river erosion began, and this was succeeded by a second stage of partial submergence in early Silurian times. The third stage was the elevation of the land

during Mesozoic and Tertiary periods, accompanied by a deepening of the river channels; the fourth was the early glacial period, during which the elevation reached its greatest development. The fifth period was the post-glacial, characterized by subsidence and partial submergence of the land; and the sixth and recent stage was a stage of reëlevation to the present conditions, the process being accompanied by the formation of raised beaches.

On the mineralogical side papers were read on 'The Copper-bearing Rocks of South Australia,' by Mr. E. P. Manuell; on 'Scottish Ores of Copper in their Geological Relation,' by Mr. J. G. Goodchild; on 'The Occurrence of Barium Sulphate and Calcium Fluoride as Cementing Substances in the Elgin Trias,' by Dr. W. Mackie; and on 'The Source of the Alluvial Gold of the Kildonan Field, Sutherland,' by Mr. Malcolm Maclaren, who took occasion to advocate a return in certain cases to the old theory of the precipitation of gold from solution by carbonaceous matters, a theory which has been almost forgotten since Skey's demonstration of the power possessed by sulphides to produce complete precipitation.

Of paleontological papers there may be mentioned that by Professor Smith Woodward on 'The Bone Beds of Pikermi, Attica, and on Similar Deposits in Northern Eubœa,' giving an account of the excavations made by the trustees of the British Museum at the suggestion of Sir E. H. Egerton, British Minister at Athens. These researches have added but little to the list of forms already known to occur in the beds, though much important material was obtained, and excavations at Achmet Aga, northern Eubœa, revealed bone beds similar to those of Pikermi and containing similar fossils. The most plausible explanation of these bone deposits seems to be that the bodies of animals were carried by

torrential floods through tree-obstructed water courses to lakes in which they collected, the broken limbs and torn fragments of trunks affording evidence of the violence of the passage to the lakes. Mr. J. L. Beadnell of the Geological Survey of Egypt gave a preliminary notice of the discovery of a rich deposit of new Pliocene and post-Pliocene fossils in the Fayum depression, situated in the Libyan desert some fifty miles southwest of Cairo, and Mr. B. N. Peach presented a contribution to the Cambrian fossils of the northwest Highlands, in which he pointed out that the fossils in the Balnakiel group of the Durness dolomities present a remarkable American facies and suggested the existence in Cambrian times of a large continent extending from the north of Scotland to America, an idea which, as was pointed out by Professor Lapworth, was supported by the fact that the succession of beds in northern Scotland was paralleled only on the American continent.

Professor Sollas described a method by which serial sections, similar to those employed by zoologists, might be made of fossils, and exhibited a machine designed for the purpose by the Rev. G. Smith and also showed wax models reconstructed from serial sections of a Graptolite, of an Ophiuran and of *Palæospondylus*.

Finally reference may be made to a suggestive paper by Mr. J. R. Kilroe on 'Geology regarded in its Economic Application to Agriculture by means of Soil Maps,' in which he claimed that the geologist could furnish much information regarding the profitable localization of certain branches of agriculture, such as stock-breeding, dairying and tillage, and advocated the publication of maps which would give information as to the nature of the soil in different localities. The author believed that much of practical value could be done by the geologists even without an extensive

set of soil analyses, and described a scheme of coloration which might be employed to indicate different qualities of soil.

THE ZOOLOGICAL SECTION.

The address of the President of the zoological section, Professor J. Cossar Ewart, was entitled, 'The Experimental Study of Variation,' and was a consideration of the results of experimental breeding in their bearing on the causes of variation and on certain theories which have been more or less generally accepted. Especial interest was given to the address by the fact that the conclusions reached were based for the most part on the results of experiments conducted by the author at his Penycuik station, and the members of the association had the pleasure of studying for themselves three of the now celebrated zebra hybrids which Professor Ewart has bred.

In opening his address Professor Ewart assumed that the primary cause of variation is always the effect of external influences acting directly upon the germ-cells and proceeded to discuss certain influences which might be supposed to be active in the production of variability.

1. Age was found to have a decided effect upon the character of the offspring. A young blue-rock male pigeon was mated with a well-matured and vigorous black barb; the first pair of birds resulting from the mating were almost exactly like the female parent except that the beaks were rather longer; one of the second brood resembled the barb, while the other was of a grayish color with slightly mottled wings and a tail bar; in the third brood both birds were of a grayish color with indistinct wing bars as well as a tail bar; while in the fourth brood one bird resembled the birds of the third brood, while the other resembled closely its blue rock sire. Similar results were obtained by mating a young blue rock male with a white fantail, and

also by pairing young gray quarter-wild rabbits with an old white Angora buck, and Professor Ewart regards the gradual, 'almost mathematical' change in the coloration of the offspring as due to the gradual increase of vigor or prepotency of the young sires. The phenomena might possibly be explained by the doctrine of 'saturation' popular among breeders, but such an explanation is overthrown by the occurrence of the same results in the crossing of young females with old males.

2. Ripeness of the germ-cells. In studying the effect of this condition the Penycuik experiments confirmed the results obtained by Mr. H. M. Vernon from the hybridization of Echinoderm ova, 'the offspring resulting from the union of equally ripe germ-cells differing from the offspring developed from the conjugation of ripe and unripe germ-cells, and still more from the union of fresh and over-ripe germ-cells.'

3. The condition of the soma. Undoubtedly the germ-cells may be influenced by a diminution of the vitality of the soma, but there is no evidence to show that they are modified in such a way as to transmit definite modifications in the offspring.

4. Change of habitat. This factor acts by influencing the vigor of the soma, but 'there is no evidence whatever that definite changes of the soma, due to the direct action of the environment, can be imprinted on the germ-cells.'

5. Intercrossing and interbreeding. Intercrossing in general tends towards reversion and never results in the production of characters absolutely new to the species. It may, however, indirectly tend towards progressive variation by imparting additional vigor to the offspring, which when intercrossed frequently give rise to 'an almost infinite diversity of character.' Interbreeding, on the other hand, may be a cause of progressive variation. Vigor, however, plays a very important part in the de-

termination of the characters of the offspring and if interbreeding be performed with animals lacking in vigor or with too closely related individuals, it leads to what may be termed degeneration, the offspring being frequently delicate, of impaired fertility and, what is remarkable, frequently either entirely or nearly white.

In connection with the question of intercrossing Professor Ewart considered the swamping effect upon new varieties, pointing out how important the decision of this point is upon the validity of the doctrine of natural selection. Darwin himself nowhere suggests how new varieties escape swamping, although Wagner by his theory of isolation, and Romanes by that of physiological selection, have indicated special methods by which it may be avoided. It seems certain, however, that new varieties make their appearance even in the absence of such barriers to intercrossing, and Professor Ewart points out that it does not seem to have occurred to biologists that a new variety may be sufficiently vigorous or prepotent to swamp the old, since it is unquestionable that the vigor of the parents has much to do with the character of the offspring. Professor Ewart possesses a skewbald Iceland pony which produces richly striped hybrids to a zebra, but to whole-colored bay, Arab, or Shetland ponies invariably gives offspring colored exactly like herself. So too, black Galloway bulls frequently produce, through long-horned, brightly colored Highland heifers, offspring which would readily pass for pure Galloways, and it is known that the wolf is prepotent over the dog and the wild rabbit, rat and mouse over their tame relatives. Granting, therefore, a variety more vigorous than the ancestral form, intercrossing, instead of swamping it, would only increase the number of individuals representing it, even without any such barriers as are demanded by the theories of Wagner and Romanes.

6. Maternal impressions. There is no evidence to show that such impressions affect in any way the offspring.

7. Needs of the organism.

8. Direct action of the environment and use-inheritance. Neither of these causes is believed by Professor Ewart to have any action in the production of definite variations.

9. Telegony or infection. Referring to the celebrated case of supposed telegony described by Lord Morton, the author produced evidence showing that the observed case was more probably due to reversion than to infection, and furthermore he added to his original observations on the subject by stating that since 1895 twelve mares, after producing sixteen zebra hybrids, have given birth to twenty-two pure-bred foals, in none of which is there any indication of the action of telegony. It was also pointed out that the observations of Baron de Parana in Brazil upon the pure-bred offspring of mares previously mated with zebras, as well as his results obtained from several mule-breeding establishments which are in reality carrying on telegony experiments on a large scale, were entirely negative.

The address concluded with a brief appeal for the establishment of a well-equipped institute for biological experimentation on a large scale.

The address of the President was followed by the report of the special committees appointed at the last meeting of the Association. That on bird migration in Great Britain dealt with the migration of larks and swallows, while progress was reported by the committee on the Index Animalium, the Natural History and Ethnography of the Malay Peninsula, the coral reefs of the Indian regions and the Zoology of the Sandwich Islands.

Of the special papers presented it must suffice to mention but a few. Mr. J. Stan-

ley Gardiner gave an account, illustrated by excellent lantern slides, of his observations upon the coral islands of the Maldives, the evidence obtained seeming to indicate that they had been formed during a period of elevation. Dr. J. Y. Simpson gave the results of his observations on the occurrence of variation in binary fission. It has been generally accepted that this method of reproduction is merely a duplication and that variation does not occur in connection with it, but only as the result of a commingling of the chromatin of two individuals in conjugation. Testing this generalization by observation of successive generations of *Paramœcium* and *Stylonychia*, it was found that variation may accompany fission, modifications occurring in the general outline of the body, in its total length, in its greatest breadth, in the distance between the contractile vacuoles of *Paramœcium* and in the length of the median caudal bristle of *Stylonychia*. From the fact that such variations do occur and may be transmitted to the succeeding generation, it would seem that fission is the primary method of reproduction among the Ciliate Infusoria, and that conjugation is merely a method of compensating for the waste involved in that process.

The President of the Section gave some observations, additional to those contained in his address and illustrated by lantern slides, on zebras and zebra-hybrids. He pointed out that the stripes of the zebra were undoubtedly protective, causing the animal to become indistinguishable at a comparatively short distance, and he was able to render a dun-colored pony similarly indistinguishable by tying ribbons upon it so as to break up the uniform coloration. The lion is the most inveterate enemy of the zebra, which is protected by its coloration as well as by the rapidity of its movements, for there is no animal which the author knew which could turn about and break

into a trot so quickly as the zebra. As to the original nature of the coloration of the zebra, it was pointed out that although the forms such as the Chapman zebra, which were less striped, might be supposed to be most primitive, yet it was an interesting fact that zebra-donkey hybrids were more richly striped than pure-bred zebras.

Professor W. E. Hoyle described an interesting sub-pallial luminous organ in certain forms of Cephalopods, and Mr. J. Graham Kerr read a suggestive paper on the 'Origin of the Limbs of Vertebrates,' in which, after pointing out the unsatisfactory nature of the theories at present existent, he suggested the possibility of the limbs being derived for external branchiæ, such as are found in *Polypterus* and in certain Urodele amphibians. It may be stated, however, that from the discussion which followed, the new suggestion did not seem to be received with any great amount of favor. Major Ronald Ross gave an account of the experiments on the destruction of the mosquito now being carried on in Sierra Leone by the Liverpool School of Tropical Medicine, and stated that although the experiments had been in progress now for only two or three months, yet there was already an appreciable diminution in the numbers of the insects, and maintained that it is possible that even on the west coast of Africa, malaria may become a thing of the past.

Other papers presented to the Section were 'The Pelvic Cavity of the Porpoise as a Guide to the Determination of the Sacral Region in the Cetacea,' by Drs. Hepburn and Watson; 'The Relationship of the Premaxilla in Bears,' by Professor R. J. Anderson; 'A Method of Recording Local Faunas,' by Mr. E. J. Bles; 'The Fishes of the Coats Arctic Expedition,' and 'A Preliminary Notice of the Fauna of Franz Joseph Land,' by Mr. W. S. Bruce; 'The Behavior of Artifi-

cially Hatched Gulls,' and 'On Germinal Selection in Relation to Inheritance,' by Professor J. Arthur Thompson; 'The Tanganyika Problem,' by Mr. J. E. S. Moore; 'The Mechanism of the Frog's Tongue,' by Professor Marcus Hartog and Mr. Nevil Maskeleyne; 'Dimorphism in the Foraminifera,' by Mr. J. J. Lister; 'The Habits and Life Histories of some Sarawak Insects,' by Mr. R. Shelford; 'On a Large Nematode Parasite in the Sea-urchin,' by Dr. J. F. Gemmill; 'On the Youngest Known Larva of Polypterus,' by Mr. J. S. Budgett; on 'The Land Crabs of a Coral Island,' by Mr. L. A. Borradaile; and on 'The Fauna of an Atoll,' by Mr. C. F. Cooper.

A very pleasing incident of the meeting was the announcement of a generous gift, amounting to £3,500, from a donor who wished to remain anonymous, towards the equipment of the Scottish Marine Biological Station, now established at Millport on Cumbrae Island in the Firth of Clyde. The station, which was visited by a large number of the members of the Section, is admirably situated and is accomplishing most excellent work. The present gift will be devoted to an extension of the buildings so as to afford quarters for those who may be working at the station.

J. PLAYFAIR McMURRICH.

UNIVERSITY OF MICHIGAN.

ADDRESS OF THE PRESIDENT OF THE ANTHROPOLOGICAL SECTION OF THE BRITISH ASSOCIATION, II.

THE insular district in the fetal brain is a depressed area of an elongated triangular form. The general surface of the cerebrum occupies, all round about it, a more elevated plane, and thus the insula comes to be bounded by distinct walls, like the sides of a shallow pit dug out in the ground. The upper wall is formed by the lower margins of the frontal and parietal lobes, the lower wall by the upper margin of the

temporal lobe, and the front wall by the frontal lobe. From each of these bounding walls a separate portion of cerebral cortex grows, and these gradually creep over the surface of the insula so as to overlap it, and eventually completely cover it over and exclude it from the surface, in the same way that the lips overlap the teeth and gums. That which grows from above is called the *fronto-parietal operculum*, while that which grows from below is termed the *temporal operculum*. These appear very early, and are responsible for closing over more than the hinder three-fourths of the insula. The lower or temporal operculum is in the first instance more rapid in its growth than the upper or fronto-parietal operculum, and thus it comes about that when their margins meet more of the insula is covered by the former than by the latter. So far the development is apparently precisely similar to what occurs in the ape. The slit or fissure formed by the approximation of the margins of these two opercula is called the Sylvian fissure, and it constitutes a natural lower boundary for the parietal and frontal lobes which lie above it. At first, from the more energetic growth of the lower temporal operculum, this fissure slants very obliquely upward and backward, and is very similar in direction to the corresponding fissure in the brain of the ape. But in the human brain this condition is only temporary. Now begins that downward movement of the parietal lobe and back part of the frontal lobe to which reference has been made. The upper or fronto-parietal operculum, in the later stages of fetal life and the earlier months of infancy, enters into a growth antagonism with the lower or temporal operculum, and in this it proves the victor. The margins of the two opercula are tightly pressed together, and, slowly but surely, the fronto-parietal operculum gains ground, pressing down the temporal operculum, and thus extending

the territory of the frontal and parietal districts. This is a striking process in the brain development of man, and it results in a depression of the Sylvian fissure or the lower frontier line of the frontal and parietal lobes. Further, to judge from the oblique direction of the Sylvian fissure in the brain of the ape, the process is peculiar to man; in the simian brain there is no corresponding increase in the area of cerebral cortex under consideration.

I do not think that it is difficult to account for this important expansion of the cerebral surface. In the fore part of the region involved are placed the groups of motor centers which control the muscular movements of the more important parts of the body. These occupy a broad strip of the surface which stretches across the whole depth of the district concerned. Within this are the centers for the arm and hand, for the face, the mouth and the throat, and likewise, to some extent, the center for speech. In man certain of these have undoubtedly undergone marked expansion. The skilled movements of the hands, as shown in the use of tools, in writing, and so on, have not been acquired without an increase in the brain mechanism by which these are guided. So important, indeed, is the part played by the human hand as an agent of the mind, and so perfectly is it adjusted with reference to this office, that there are many who think that the first great start which man obtained on the path which has led to his higher development was given by the setting of the upper limb free from the duty of acting as an organ of support and locomotion. It is an old saying 'that man is the wisest of animals because of his hands.' Without endorsing to its full extent this view, I think that it cannot be a matter for surprise that the district of the cerebral cortex in man in which the arm-centers reside shows a manifest increase in its extent.

In the same region of cerebral cortex, but at a lower level, there are also situated the centers which are responsible for facial expression. In the ape there is a considerable degree of facial play; but this is chiefly confined to the region of the lips, and the muscles of the face, although present in greater mass, show comparatively little of the differentiation which is characteristic of the lighter and more feeble muscles in the face of man. And then as to the effect produced: These human muscles are capable of reflecting every fleeting emotion, every change of mind, and, by the lines and furrows their constant use indelibly fixes on the countenance, the character and disposition of an individual can to some extent be read. As the power of communication between primitive men became gradually established, facial movements were no doubt largely used, not only for the purpose of giving expression to simple emotions, such as anger or joy, but also for giving point and force to the faltering speech of our early progenitors by reflecting other conditions of mind. The acquisition of this power as well as the higher and more varied powers of vocalization must necessarily have been accompanied by an increase of cerebral cortex in the region under consideration. And in this connection it is a point well worthy of note that the area of cortex mapped out in the human brain,* as controlling the muscles of the face, mouth and throat, is as large if not larger than that allotted to the arm and hand,† and yet it is questionable if all the

* See diagram in Schäfer's article on the 'Cerebral Cortex' in his recent work on physiology.

† The comparison only refers to surface area, and this is not an absolutely true criterion of the relative amount of cortex in each region. The arm-center has a large amount of cortex stowed away within the fissure of Rolando, in the shape of interlocking gyri, which is not taken into account in a measurement confined to the superficial surface area. Still, this does not to any great degree detract from the argument which follows, seeing that the discrepancy is still sufficiently marked.

muscles under the sway of the former would weigh as much as one of the larger muscles (say the triceps) of the arm. This is sufficient to show that it is not muscle power which determines the extent of the motor areas in the cerebral cortex. It is the degree of refinement in the movements required, as well as the degree of variety in muscle combinations, which apparently determines the amount of ground covered by a motor center.

Still, the increase in the amount of cerebral cortex in man due to the greater refinement of movement acquired by different groups of muscles is relatively small in comparison with the increase which has occurred in other regions from which no motor fibers are sent out, and which therefore have no direct connection with muscles.

The remarkable conclusions arrived at by Flechsig, although not confirmed and accepted in all their details, have tended greatly to clear up much that was obscure in the relations of the different districts of cerebral cortex. More particularly has he been able to apportion out more accurately the different values to be attached to the several areas of the cerebral surface. He has shown that fully two thirds of the cortex in the human brain constitutes what he terms 'association centers.' Within these the higher intellectual manifestations of the brain have their origin, and judgment and memory have their seat. They are therefore to be regarded as the psychic centers of the cerebral cortex.

Now, it requires a very slight acquaintance with the cerebral surface to perceive that the great and leading peculiarity of the human brain is the wide extent of these higher association centers of Flechsig. Except in connection with new faculties, such as speech, there has been relatively no striking increase in the extent of the motor areas in man as compared with the cortex of the ape or the idiot, but the expansion of

the association areas is enormous, and the increase in the frontal region and the back part of the parietal region is particularly well marked. It is this parietal extension of surface which is chiefly responsible for the pushing down of the lower frontier of the parietal lobe and the consequent enlargement of its territory.

I have already referred to the views which have been recently urged by several independent observers, that in the men who have been distinguished during life by the possession of exceptional intellectual power this region has shown a very special development.

It is a curious circumstance, and one which is worthy of consideration, that in the left cerebral hemisphere the Sylvian fissure or the lower boundary of the parietal lobe is more depressed than in the right hemisphere, and, as a result of this, the surface area occupied by the parietal lobe is greater on the left side of the brain than on the right side. To the physiologist it is a matter of every-day knowledge that the left cerebral hemisphere shows in certain directions a marked functional preeminence. Through it the movements of the right arm and right side of the body are controlled and regulated. Within it is situated also the active speech center. This does not imply that there is no speech center on the right side, but simply that the left cerebral hemisphere has usurped the chief, if not the entire, control of this all-important function, and that from it are sent out the chief part, if not the whole, of the motor incitations which give rise to speech. The significance attached to the dominant power of the left hemisphere receives force from the now well-established fact that in left-handed individuals the speech function is also transferred over to the right side of the brain. To account for this functional preeminence of the left cerebral hemisphere numerous theories have been elaborated. The inter-

est attached to the subject is very considerable, but it is impossible on the present occasion to do more than indicate in the briefest manner the three views which have apparently had the widest influence in shaping opinion on this question. They are: (1) That the superiority of the left cerebral hemisphere is due to its greater weight and bulk; (2) that it may be accounted for by the greater complexity of the convolutions on the left brain and the fact that these make their appearance earlier on the left side than on the right side; (3) that the explanation lies in the fact that the left side of the brain enjoys greater advantages in regard to its blood supply than the right side.

Not one of these theories when closely looked into is found to possess the smallest degree of value. Braune* has shown in the most conclusive manner that if there is any difference in weight between the two hemispheres it is a difference in favor of the right and not of the left hemisphere; and I may add from my own observations that this is evident at all periods of growth and development. Equally untrustworthy are the views that have been put forward as to the superiority of the left hemisphere from the point of view of convoluntary development. I am aware that it is stated that in two or three cases where the brains of left-handed people have been examined this superiority was evident on the right hemisphere. This may have been so; I can only speak for the large percentage of those who are right-handed; and I have never been able to satisfy myself that either in the growing or fully developed brain is there any constant or marked superiority in this respect of the one side over the other; and I can corroborate Ecker† in his statement that there is no proof that the

convolutions appear earlier on the one side than on the other. The theory that an explanation is to be found in a more generous blood supply to the left hemisphere is more difficult to combat, because the amount of blood received by each side of the brain depends upon two factors, viz., the physical conditions under which the blood-stream is delivered to the two hemispheres and the caliber of the arteries or tubes of supply. Both of these conditions have been stated to be favorable to the left hemisphere. It is a matter of common anatomical knowledge that the supply pipes to the two sides of the brain are laid down somewhat differently, and that the angles of junction, etc., with the main pipe are not quite the same. Further, it is true that the blood-drains which lead away the blood from the brain are somewhat different on the two sides. Whether this would entail any marked difference in the blood-pressure on the two sides I am not prepared to say. This could only be proved experimentally; but, taking all the conditions into consideration, I am not inclined to attach much importance to the argument. It is easy to deal with the loose statements which have been made in regard to the size of leading supply pipe (viz., the internal carotid artery). It passes through a bony canal on the floor of the cranium on its way into the interior of the cranial box. Its size can therefore be accurately gauged by measuring the sectional area of this bony tunnel on each side. This I have done in twenty-three skulls chosen at random, and the result shows that considerable differences in this respect are to be found in different skulls. These discrepancies, however, are sometimes in favor of the one side and at other times in favor of the other side, and when the combined sectional area for all the skulls examined was calculated, it was, curiously enough, found to be $583\frac{1}{2}$ sq. mm. for the left side and 583 sq. mm. for the right side.

* 'Das Gewichtsverhältniss der rechten zur linken Hirnhälfte beim Menschen,' *Archiv für Anat.*

† *Archiv für Anthropologie*, 1868, Bd. CXI.

Leaving out of count the asymmetry in the arrangement of the convolutions in the two hemispheres, which cannot by any amount of ingenuity be twisted into such a form as to give a structural superiority to one side more than the other, the only marked difference which appears to possess any degree of constancy is the increase in the territory of the left parietal lobe produced by the more marked depression of its lower frontier line (Sylvian fissure). That this is in any way associated with right-handedness or with the localization of the active speech center in the left hemisphere I am not prepared to urge, because the same condition is present in the ape. It is true that some authorities* hold that the ape is right-handed as well as man, but in the gardens of the Royal Zoological Society of Ireland I have had a long and intimate experience of both anthropoid and lower apes, and I have never been able to satisfy myself that they show any decided preference for the use of one arm more than the other.

That differences do exist in the more intimate structural details of the two hemispheres, which give to the left its functional superiority, there cannot be a doubt; but these have still to be discovered. Bastian has stated that the gray cortex on the left side has a higher specific gravity, but this statement has not as yet received corroboration at the hands of other observers.

I have already mentioned that man's special endowment, the faculty of speech, is associated with striking changes in that part of the cerebral surface in which the motor center for articulate speech is located. It is questionable whether the acquisition of any other system of associated muscular movements has been accompanied by a more evident cortical change. The center in question is placed in the lower

and back part of the frontal lobe. We have seen that the insular district is covered over in the hinder three-fourths of its extent by the fronto-parietal and temporal opercula, and thus submerged below the surface and hidden from view. The brain of the ape and also of the microcephalic idiot with defective speech goes no further in its development. The front part of the insular district remains uncovered and exposed to view on the surface of the cerebrum. In man, however, two additional opercula grow out and ultimately cover over the fore part of the insula. These opercula belong to the lower and back part of the frontal lobe, and are to be looked upon as being more or less directly called into evidence in connection with the acquisition of articulate speech.

The active speech center is placed in the left cerebral hemisphere. We speak from the left side of the brain, and yet when the corresponding region* on the right side is examined it is found to go through the same developmental steps.

The stimulus which must have been given to general cerebral growth in the association areas by the gradual acquisition of speech can hardly be exaggerated.

During the whole course of his evolution there is no possession which man has contrived to acquire which has exercised a stronger influence on his higher development than the power of articulate speech. This priceless gift, 'the most human manifestation of humanity' (Huxley), was not obtained through the exertions of any one individual or group of individuals. It is the result of a slow process of natural growth, and there is no race, no matter how

* Rudinger and others have tried on very unsubstantial grounds to prove that there is a difference in this region on the two sides of the brain. There is, of course, as a rule, marked asymmetry; but I do not think that it can be said with truth that the cortical development of the region is greater on the left side than on the right.

* Ogle, 'On Dextral Preeminence,' *Trans. Med. Chirurg. Soc.*, 1871; Aimé Pèrè, 'Les Courbures latérales normales au rachis humain,' Toulouse, 1900.

low, savage or uncultured, which does not possess the power of communicating its ideas by means of speech. "If in the present state of the world," says Charma, "some philosopher were to wonder how man ever began to build those houses, palaces, and vessels which we see around us, we should answer that these were not the things that man began with. The savage who first tied the branches of shrubs to make himself a shelter was not an architect, and he who first floated on the trunk of a tree was not the creator of navigation." And so it is with speech. Rude and imperfect in its beginnings, it has gradually been elaborated by the successive generations that have practiced it.

The manner in which the faculty of speech originally assumed shape in the early progenitors of man has been much discussed by philologists and psychologists, and there is little agreement on the subject. It is obvious that all the more intelligent animals share with man the power of giving expression to certain of the simpler conditions of mind both by vocal sounds and by bodily gestures. These vocal sounds are of the interjectional order, and are expressive of emotions or sensations. Thus the dog is said, as a result of its domestication, to have acquired the power of emitting four or five different tones, each indicative of a special mental condition and each fully understood by its companions. The common barn-door fowl has also been credited with from nine to twelve distinct vocal sounds, each of which is capable of a special interpretation by its fellows or its chickens. The gestures employed by the lower animals may in certain cases be facial, as expressed by the grimaces of a monkey, or changes in bodily attitude, as we see continually in the dog.

I think that it may not be unreasonably inferred that in the distant past the remote progenitors of man relied upon equally

lowly means of communicating with their fellows, and that it was from such humble beginnings that speech has been slowly evolved.

There cannot be a doubt that this method of communicating by vocal sounds, facial expressions and bodily gestures is capable of much elaboration; and, further, it is possible, as some hold, that it may have attained a considerable degree of perfection before articulate speech began to take form and gradually replace it. Much of it indeed remains with us to the present day. A shrug of the shoulders may be more eloquent than the most carefully prepared phrase; an appropriate expression of face, accompanied by a suitable ejaculation, may be more withering than a flood of invective. Captain Burton tells us of a tribe of North American Indians whose vocabulary is so scanty that they can hardly carry on a conversation in the dark. This and other facts have led Mr. Tylor, to whom we owe so much in connection with the early history of man, to remark: "The array of evidence in favor of the existence of tribes whose language is incomplete without the help of gesture-signs, even for things of ordinary import, is very remarkable"; and, further, "that this constitutes a telling argument in favor of the theory that gesture-language is the original utterance of mankind out of which speech has developed itself more or less fully among different tribes." It is a significant fact also, as the same author points out, that gesture-language is, to a large extent, the same all the world over.

Many of the words employed in early speech were undoubtedly formed, in the first instance, through the tendency of man to imitate the natural sounds he heard around him. To these sounds, with various modifications, was assigned a special conventional value, and they were then added to the growing vocabulary. By this means a very decided forward step was taken, and

now primitive man became capable of giving utterance to his perceptions by imitative sounds.

Max Müller, although bitterly opposed to the line of thought adopted by the 'Imitative School' of philologists, has expressed their views so well that I am tempted to use the words he employed in explaining what he satirically branded as the 'Bow-wow Theory.' He says: "It is supposed that man, being yet mute, heard the voices of the birds, dogs and cows, the roaring of the sea, the rustling of the forest, the murmur of the brook and the whisper of the breeze. He tried to imitate these sounds, and finding his mimicking cries useful as signs of the object from which they proceeded, he followed up the idea and elaborated language."

Hood* humorously and unconsciously illustrates this doctrine by a verse descriptive of an Englishman, ignorant of French, endeavoring to obtain a meal in France:

'Moo!' I cried for milk;
If I wanted bread
My jaws I set agoing;
And asked for new-laid eggs
By clapping hands and crowing.

But, although much of early articulate speech may have arisen by the development of interjectional sounds and the reproduction, by the human vocal organs, of natural sounds, it is very unlikely that these afforded the only sources from which words were originally derived. Romanes insists upon this, and, in support of his argument, refers to cases where children invent a language in which apparently imitative sounds take no part. He likewise alludes to the well-known fact that deaf mutes occasionally devise definite sounds which stand for the names of friends. In the light of such evidence, he very properly asks, 'Why should it be held impossible for primitive man to have done the same?'

* Quoted from 'The Origin of Language,' by Hensleigh Wedgwood, 1866.

The value of spoken language as an instrument of thought is universally admitted, and it is a matter incapable of contradiction that the higher intellectual efforts of man would be absolutely impossible were it not for the support which is afforded by articulate speech. Darwin expresses this well when he says: "A complex train of thought can no more be carried on without the aid of words, whether spoken or silent, than a long calculation without the use of figures or symbols." Such being the case, I think that we may conclude that the acquisition of speech has been a dominant factor in determining the high development of the human brain. Speech and mental activity go hand in hand. The one has reacted on the other. The mental effort required for the coining of a new word has been immediately followed by an increased possibility of further intellectual achievement through the additional range given to the mental powers by the enlarged vocabulary. The two processes, mutually supporting each other and leading to progress in the two directions, have unquestionably yielded the chief stimulus to brain development.

More than one philologist has insisted that 'language begins where interjection ends.' For my part, I would say that the first word uttered expressive of an external object marked a new era in the history of our early progenitors. At this point the simian or brute-like stage in their developmental career came to an end and the human dynasty endowed with all its intellectual possibilities began. This is no new thought. Romanes clearly states that in the absence of articulation he considers it improbable that man would have made much psychological advance upon the anthropoid ape, and in another place he remarks that 'a manlike creature became human by the power of speech.'

The period in the evolution of man at which this important step was taken is a

vexed question, and one in the solution of which we have little solid ground to go upon beyond the material changes produced in the brain and the consideration of the time that these might reasonably be supposed to take in their development.

Darwin was inclined to believe that articulate speech came at an early period in the history of the stem-form of man. Romanes gives a realistic picture of an individual decidedly superior to the anthropoid ape, but distinctly below the existing savages. This hypothetical form, half simian, half human, was, according to his sponsor, probably erect; he had arrived at the power of shaping flints as tools, and was a great adept at communicating with his fellows by gesture, vocal tones and facial grimaces.

With this accomplished ancestor in his mental eye, it is not surprising that Romanes was inclined to consider that articulate speech may have come at a later period than is generally supposed.

At the time that Romanes gave expression to these views he was not acquainted with the very marked structural peculiarities which distinguish the human brain in the region of the speech center. I do not refer to the development of the brain in other districts, because possibly Romanes might have held that the numerous accomplishments of his speechless ancestor might be sufficient to account for this; I merely allude to changes which may reasonably be held to have taken place in direct connection with the gradual acquisition of speech.

These structural characters constitute one of the leading peculiarities of the human cerebral cortex, and are totally absent in the brain of the anthropoid ape and of the speechless microcephalic idiot.

Further, it is significant that in certain anthropoid brains a slight advance in the same direction may occasionally be faintly

traced, whilst in certain human brains a distinct backward step is sometimes noticeable. The path which has led to this special development is thus in some measure delineated.

It is certain that these structural additions to the human brain are no recent acquisition by the stem-form of man, but are the result of a slow evolutionary growth—a growth which has been stimulated by the laborious efforts of countless generations to arrive at the perfect coordination of all the muscular factors which are called into play in the production of articulate speech.

Assuming that the acquisition of speech has afforded the chief stimulus to the general development of the brain, and thereby giving it a rank high above any other factor which has operated in the evolution of man, it would be wrong to lose sight of the fact that the first step in this upward movement must have been taken by the brain itself. Some cerebral variation—probably trifling and insignificant at the start, and yet pregnant with the most far-reaching possibilities—has in the stem-form of man contributed that condition which has rendered speech possible. This variation, strengthened and fostered by natural selection, has in the end led to the great double result of a large brain with wide and extensive association areas and articulate speech, the two results being brought about by the mutual reaction of the one process upon the other.

D. J. CUNNINGHAM.

*PROFESSOR PAWLOW'S RESEARCHES ON
THE PHYSIOLOGY OF SECRETION.*

THE publication, last year, of the conditions which are to govern the award of the Nobel prizes was followed not long since by the announcement that Professor J. P. Pawlow of St. Petersburg had been designated, with Professor Niels R. Finsen of Copenhagen, as the first recipient of this honor, for the most important discovery in

the department of physiology or of medicine. To those readers of SCIENCE who are not familiar with the details of modern physiological investigation, a brief review of the more important work of this brilliant Russian investigator may be of interest.

Professor Pawlow's researches have, for the most part, been directed to the solution of problems connected with the physiology of secretion. His persistent efforts in this field have been crowned with success to an unusual degree; and physiology owes to him and his coworkers much of the progress which has been made in recent years towards a clearer understanding of the processes of digestion in the animal organism. New experimental methods have been devised, and older ones applied to new purposes.

With reference to the nitrogenous metabolism of the salivary glands, Pawlow showed (1888) by direct chemical analysis, that anabolic and katabolic processes are coincident in the secreting organ. This observation, usually overlooked by physiologists, was in itself an important contribution to the theory of secretion. The extensive series of experiments on the innervation of the gastric and pancreatic glands—researches which have had their origin in Pawlow's laboratory—have evoked the widest attention. In this study of gastric secretion the improvements in the general technique consisted primarily in the simultaneous introduction of an ordinary gastric fistula (in dogs) and a division of the œsophagus in the middle of the neck. The cut ends were attached to openings in the neck so that swallowed food passed out at one opening without reaching the stomach; and, through the other, food which it was desired should enter the stomach could be passed in. The more important facts ascertained by the use of this method were, that when food is eaten a flow of gastric juice is started; inasmuch

as under the experimental conditions referred to the ingested material fails to reach the stomach, the reflex character of the impulses which provoke the secretion can thus be demonstrated. The paths along which the reflex stimulation reaches the gastric glands were shown to be the vagus nerves; for while section of the splanchnics does not interfere with the reflex secretion, this reaction entirely disappears after division of the vagi. To make the proof complete, Pawlow showed that artificial stimulation of the peripheral end of a cut vagus will incite a flow of active gastric juice.

The possibility of obtaining pure gastric juice uncontaminated with the products of digestion was thus accomplished in a way never before equaled. It remained, however, to observe the production of the secretion and its properties during the course of actual digestion. Heidenhain had already developed a method of isolating one portion of the stomach from the rest, so that it was possible to keep animals in this condition under observation for a long period. In his operations, however, the nerve supply to the isolated portion was undoubtedly seriously interfered with. Pawlow improved the method, so that there remained an undisturbed nerve distribution, the functional importance of which he clearly showed. Secretion in the isolated portion could thus be followed while digestion was proceeding in the adjoining parts of the stomach.

Along similar lines our knowledge of the work of the pancreas and the production of the bile has been largely added to by Pawlow and his pupils. The introduction of a successful method for obtaining permanent fistulas has been followed by a study of the secretory activity of the pancreatic gland. The reflex character of the ordinary stimuli has been demonstrated, and the paths through which the impulses reach the gland ascertained. The existence of inhibitory

nerves for the secretory glands has been made more probable by Pawlow. The true significance of this discovery lies in the fact that it has enabled us to appreciate more clearly the mechanism by which the secretory glands, like other organs, adapt themselves so perfectly to the work which they have to accomplish at different times.

With pure digestive juices made thus readily available, it is not surprising to find interest in the study of their composition renewed. The way has been opened for more purely chemical investigations, such as the recent one of Professor v. Nencki—a colleague of Professor Pawlow—on the character of the enzymes of the gastric juice. From the general biological point of view, one of the most interesting aspects of the work of the St. Petersburg school is the demonstration of the purposeful character of secretion into the alimentary canal. Quantitatively and qualitatively the work of the glands varies with the character of the substances upon which they exert their action at different times. Changes in diet bring variations in the character of secretion. Pawlow has broadly expressed this view in summarizing his contributions to our knowledge of the specific excitability of the digestive glands. He writes: "Our results have, we trust, dispelled from our domain, once for all, the unfruitful idea that the alimentary canal is excitable by any agent whatsoever, mechanical, chemical or thermal, without regard to the peculiarity of each specific digestive task. At present, agencies such as these, vigorously applied, must be regarded merely as favoring or inhibitory influences, not as the normal and determining factors which excite secretory activity. In place of gross uncertainty (*Scheinwissen*) we now see the outlines of an artistic mechanism which, like everything that we understand in nature, exhibits an unusual degree of exactness and utility in her processes."

It remains to speak of Pawlow's work (in cooperation with v. Nencki and others) on the functions of the liver. Here again a brilliant operative technique—the Eck fistula, by which the portal blood is diverted directly into the vena cava without entering the hepatic capillaries—has inaugurated progress. The splendid researches on the seat of urea formation in mammals have modified and shaped the current teaching of this subject and other aspects of intermediary metabolism. What light they may throw upon the pathogeny of certain abnormal states, such as uræmia and diabetes, can scarcely be foretold.

Among the comparatively recent contributions to physiological literature no book has exerted a more stimulating influence than Pawlow's '*Die Arbeit der Verdauungsdrüsen*' (J. F. Bergmann, Wiesbaden, 1898). It summarizes in suggestive chapters the main achievements of the author in his chosen field of work. Its original treatment of the problems in this domain has aroused the interest of both physiologists and physicians; and the work has already served in fulfilment of the author's hope, to further physiological science by promoting a more active interchange of ideas between the practitioner and the laboratory worker. Pawlow's work has demonstrated what Sir Michael Foster has written in another connection: that "the heart of physiology is in the laboratory. It is this which sends the life-blood through its frame; and in respect to this, perhaps, more than anything else, has the progress of the past years been striking."

LAFAYETTE B. MENDEL.

SHEFFIELD SCIENTIFIC SCHOOL
OF YALE UNIVERSITY.

SCIENTIFIC BOOKS.

Report of the Sanitary Investigations of the Illinois River and its Tributaries. The Illinois State Board of Health, 1901.

The self-purification of streams has been for many years a perennial subject of discussion among sanitarians. Early faith in the power of running water to purify itself was severely shaken by the advent of the science of bacteriology, and the postulate that 'no river was long enough to purify itself' was accepted by many as representing the ultimate conclusion of science upon the subject. Recently data have been accumulating in the opposite direction and apparently indicate that under certain conditions streams do tend to become purer as they flow. A notable instance of this may be found in a report just issued by the Illinois State Board of Health on the Sanitary Investigations of the Illinois River and its Tributaries, with special reference to the effect of the sewage of Chicago on the Des Plaines and Illinois rivers prior to and after the opening of the Chicago drainage canal.

Advance notes upon the same subject, issued in 1900, gave the results of chemical and bacteriological examinations of samples of water at various points on these streams between Chicago and the Mississippi made during the summer and autumn of 1899, before the opening of the drainage canal. The present report gives, in addition to the figures then obtained, the results of further examinations made in 1900 with the drainage canal in use. The work was conducted by the State Board of Health, under the direction of Dr. John H. Long, professor of chemistry, Northwestern University Medical School, and Mr. Jacob A. Harman, civil engineer, of Peoria. Dr. Long was assisted in the qualitative bacteriological work by Professors F. Robert Zeit and Gustav Fütterer, of the Northwestern University Medical School. The reports of these gentlemen are prefaced by an introductory chapter of thirty-four pages by Dr. James A. Egan, secretary of the Illinois State Board of Health, upon the 'Pollution of the Illinois River as affected by the Drainage of Chicago and other Cities.' This contains a historical sketch of early investigations of the river, a compilation of various opinions upon the self-purification of streams and a summary of the results obtained by the recent investigations.

Dr. Long's report of the chemical and

bacteriological examinations occupies seventy-seven pages and that of Mr. Harman, entitled 'A Preliminary Sanitary Survey of the Illinois River Drainage Basin,' one hundred and five pages. They include tables showing population, rainfall, stream gaugings, water-supply and sewerage statistics, analyses, etc. The brief report by Professors Zeit and Fütterer describes the various species of bacteria found at each station, with special reference to their pathogenic qualities.

The most interesting feature of the report is naturally the comparison of the condition of the Illinois River before and after the opening of the Chicago drainage canal. In order to appreciate this a knowledge of the local conditions is necessary. For many years the bulk of the sewage of Chicago has discharged into the Chicago River, a small stream with north and south branches uniting in the heart of the city to flow into Lake Michigan. This has been a menace to the public water supply, which is taken from the lake, and in order to lessen the danger a pumping station was established at Bridgeport in 1865, by which the water from the polluted south branch was pumped into the Illinois and Michigan canal, whence it found its way westward into the Illinois and Mississippi Rivers. This not being sufficient to relieve the situation in Chicago a drainage canal was designed to connect the Chicago River with the Des Plaines River, which is one of the streams which unite to form the Illinois River. A western outlet to Lake Michigan was thus provided, which naturally changed the current in the Chicago River. After ten years of construction the canal was opened on January 17, 1900. Prior to this from 30,000 to 50,000 cubic feet per minute was pumped at Bridgeport, and it has been estimated that in 1899 this contained from 85 to 90 per cent. of the total sewage of Chicago. Since the opening of the canal the actual amount of sewage sent westward has increased, but the amount of water has increased in a far greater ratio, the law requiring a minimum flow in the canal of 300,000 cubic feet per minute. According to Dr. Long's report the increased dilution thus brought about has resulted in an improved condition of the sanitary quality of the water in the Illinois

River. The analyses upon which this opinion is based are too extensive to reproduce here, but those who dwell in the lower Illinois valley and those who have feared the possible effect of the sewage of Chicago upon the water supply of St. Louis should observe the following emphatic statement of Dr. Long: He says: "I believe that it may be safely said that if the whole of the sewage of Chicago were to be excluded from the Illinois River, the condition at Grafton (where it enters the Mississippi) would remain unchanged so far as its organic contents and bacterial organisms are concerned."

The character of the Chicago sewage, the condition of the various tributary streams, the self-purification of the Illinois River and its subsequent pollution by Peoria and other cities are all fully discussed in the report.

The analytical work appears to have been carefully done, but it is to be regretted that certain portions of what is now considered to be a complete water analysis are omitted. For example, the amount of coloring matter was not measured and consequently the determination of oxygen consumed cannot be fully interpreted. The measurement of turbidity was likewise omitted; nor is any mention made of microscopical examinations. Determinations of dissolved oxygen and free carbonic acid, taken in connection with the other observations, would have thrown much light upon the self-purification of the stream. Nevertheless, the results as they stand are of great value and reflect credit upon those who conducted the work.

It is the intention of the Illinois State Board of Health to extend observations of this character to other streams until the sanitary survey of the state shall be complete.

G. C. WHIPPLE.

Leitfaden der Wetterkunde. Gemeinverständlich bearbeitet von DR. R. BORESTEIN. Mit 52 in den Text eingedruckten Abbildungen und 17 Tafeln. Braunschweig, Friedrich Vieweg und Sohn, publishers. 1901. Price, 6 Mk.

This book is intended as a popular treatise on the weather, for the use of farmers, sailors and others whose pursuits are affected by the weather, and also for the benefit of all who

may be interested in natural phenomena. Its object is to give the elementary facts of meteorology and explain the scientific principles on which weather forecasts are made. The author hopes thus to enable his readers to better understand and apply the forecasts as made by the national bureaus and to make forecasts for themselves. The publishers explain that among other new things embodied in the book are the results of the scientific balloon ascents and an account of the various weather services of the world.

The book is interestingly written and well illustrated. The distribution of rainfall and temperature over Europe is graphically illustrated by four colored charts. Perhaps the most attractive feature in the book is the reproduction of the best of the pictures from the International Cloud Atlas, showing in approximately natural colors the different types of clouds, all of which are derived from photographs. This is a feature that other text-books would do well to copy.

The chief criticism of the book is that it is written almost entirely from a German standpoint. The quotations are chiefly from German authors and the illustrations are derived chiefly from German sources. The only map of the world contained in the book is one illustrating the distribution of pressure. Several pages are given to describing the weather service of Germany; only a paragraph is given to the weather service of the United States. The balloon ascents quoted were those made by the German Aeronautical Society, and no mention is made of modern kite work. Perhaps this was intended by the author, as he was writing chiefly for German readers, but a foreigner misses the broad cosmopolitanism such as is found, for example, in the work of Dr. Hann.

H. H. CLAYTON.

Who's Who in America. A Biographical Dictionary of Notable Living Men and Women of the United States. Edited by JOHN W. LEONARD. Chicago, A. N. Marquis and Company. 1901-1902. Pp. xvi + 1304.

The initial edition of this work, published two years ago, made a niche for itself in current literature and a place for itself on the most

convenient shelf of the student; and the second edition, now in distribution, seems still more useful. Primarily the book is a biographic dictionary of a perfection approaching the ideal, in which the lives of prominent Americans are written in sufficient fulness for practical purposes; it is also a directory to prominent Americans by full names and present addresses. Naturally the first question as to the value of such a book connects itself with the classification, *i. e.*, with the definition of prominence and with the editor's success in equitably cleaving the mass of 80,000,000 into portions of 12,000 and 79,988,000, respectively, along the precise lines of the definition. Of course the performance of this task would out-Hercules the classic hero; it can never be done with mathematical precision, and even if it were made right for one day it would be wrong for the next; yet the chief excellence of 'Who's Who in America' lies in the truly remarkable measure of success with which the editor has established and maintained his primary definition. It is this measure of success in classifying prominence which gives the work its greatest utility; for the user may be reasonably certain of finding within it desired facts relating to any celebrity, and this without undue labor of search through irrelevant biographic material.

The 1899 edition contained 8,602 names, of which 752 are omitted in the 1901 edition, 498 by reason of known death, and the remaining 254 for various reasons; the later edition includes 11,551 names. Classified by residence (as they are in the introductory pages), these celebrities are distributed throughout the 45 States, 6 Territories and 1 District of the United States, and 47 foreign countries; 11,137 reside in the United States, 370 live permanently abroad, and 44 do not report. Of those resident in the United States 2,849 are credited to New York, 1,010 to Massachusetts, 889 to District of Columbia, 880 to Pennsylvania and 704 to Illinois; then follow Ohio, 422; New Jersey, 314; California, 291; Connecticut, 266; Missouri, 222; Maryland, 205; and the remaining States and Territories yielding less than 200 each of the aggregate. It would not be easy to class the celebrities by vocation, and the editor has not attempted to do so; but scientists may

feel gratification in the fact that their important class has received especial care and effort, and that scientific eminence seems to have adequate recognition—indeed, scarcely a page is without one or more names distinguished in some line of scientific activity. Withal the book is a model of condensation and—considering the extreme difficulty of attaining accuracy in details of biography, bibliography, nomenclature, residence, etc.—a marvel of accuracy.

The new edition, like the old, is enriched by a readable prefatory narration of editorial experience, and still more by suggestive statistical tables, of which that entitled 'Educational Statistics' is a real contribution to knowledge. Of the 11,551 persons biographed, 9,760 furnished educational data, and in 8,141 cases the data permit useful classification. Of these 8,141 persons, 5,775 are collegians and 4,810 out of these graduates; 808 were educated only in common schools, 282 were privately educated, while 31 were self-taught. These figures, with the carefully selected data on which they rest, afford America's strongest argument in favor of higher education; at the same time they reveal the country's unparalleled element of strength in the possibility of eminence to those helped only by the public schools, and even to those not helped at all, along educational ways.

The book is notably fit in size, weight, quality of paper, typography, abbreviations, binding, and other matters which go to make up satisfactory book-making.

W J M.

SCIENTIFIC JOURNALS AND ARTICLES.

THE *Botanical Gazette* for July contains the following papers: Charles E. Allen writes 'On the Origin and Nature of the Middle Lamella.' The general conclusion is reached that this structure is not merely the partition wall as laid down, either as a single or a double layer; nor is it merely an intercellular substance or cement, a means for binding the cells together. It is a wall layer with a complicated history, undergoing after its appearance changes in form, in mass, and in chemical composition. Carleton E. Preston has written upon 'Structural Studies of Southwestern Cactaceæ.' From a study of eight representative forms various

conclusions are reached, among which are the following: There is a slight variation in the roots as regards branching and vascular limits; in the stem there is a great range of structural deviations, which take place along definite lines and by definite steps, the variation extending to bundle branching and reticulation, extent of succulence, character of parenchyma, of pith and cortex, development of mucilage, and even to the kinds of elements entering into the xylem. Suggestive results from the systematic point of view were also obtained. Alfred Rehder has written upon *Vasilima* and *Schizonotus* of Rafinesque, both of which he regards as properly synonyms of *Sorbaria*. Arthur Bennett makes the first record of the appearance of *Potamogeton polygonifolius* in Newfoundland, the only other known North American situation being on the island of Nova Scotia.

In the numbers for August and September three continued papers appear. Dr. F. L. Stevens has written upon 'Gametogenesis and Fertilization in *Albugo*'; and Dr. W. L. Bray upon 'The Ecological Relations of the Vegetation of Western Texas.' Both of these papers will be noticed upon their conclusion in the October number. The third paper is by Dr. Florence May Lyon, entitled 'A Study of the Sporangia and Gametophytes of *Selaginella apus* and *S. rupestris*.' The description of *S. apus* is the first account yet published of the details of development of both gametophytes of any species of *Selaginella*. A preliminary study of the megaspore and female gametophyte of *S. rupestris* is added. The most striking fact observed is the persistent retention of the megaspores within the unshed sporangia throughout the formation of the prothallium and of the embryo. In the case of *S. rupestris*, at the time the strobilus is separated from the plant by the decay of the vegetative part beneath, it appears covered with sprouting plantlets. The megaspores of *S. apus* are shed before the embryo has emerged. The significance of this sequence of events lies in the resemblance to the formation of seeds in the higher plants. But one or two megaspores of *S. rupestris* form, whereas the normal number four appears in *S. apus*. The description of the male gametophyte

differs from that given by Belajeff. It consists of a single cell, presumably the vestige of the prothallium, and the two masses of spermatozoid-producing cells. Fertilization is accomplished in a manner suggestive at least of the seed plants. The microsporangia open with force when the male gametophytes are mature, and the latter are shed like pollen grains. The outer wall of the microspore has cracked open at this stage and the endospore protrudes in a papilla-like protuberance like a very short pollen tube. This ruptures and the spermatozoids are freed in a mass of slime that is attracted toward the archegonia. Microspores were found within the megasporangia, having been hurled in when the latter were gaping open. The bryophyte-like character of the spermatozoids claimed for the Lycopodiaceæ was not demonstrated in these two species. As regards their form they were typically fern-like, spirally coiled, and the presence of cilia not determined. The methods by which the strobili were sectioned with their nut-like spores *in situ* is given in detail.

In all the numbers there are the usual 'Briefer Articles,' 'Reviews of Current Literature' and 'News Items.'

THE August number of the *American Geologist* contains a history and biographical sketch of the late George M. Dawson, of Canada. The paper is accompanied by a portrait of Mr. Dawson and a bibliography of his writings. 'The Pleistocene Problem of the North Atlantic Plain,' by Geo. Shattuck, contains a discussion of the views of W J McGee and N. H. Darton followed by those of Professor R. D. Salisbury. The writer concludes by stating his own views based on considerable field work in the area. He claims that five terraces have formed in this period and he approaches their study through a study of the present work of the Chesapeake and the Atlantic Ocean. For these four formations below the present terrace he proposes the following names: (1) Talbot, (2) Wicomico, (3) Sunderland, (4) Lafayette. In the editorial comment is an extended description of 'The Department of Geology in the National Museum.' This discussion is accompanied with five plates illustrating types of the various

collections. Following this is the 'Review of Recent Geological Literature' and the 'Author's Catalogue of Recent Geological Literature.' The September number contains a valuable discussion of 'The Basic Rocks of Northeastern Maryland and their Relation to the Granite,' by Alfred Gray Leonard. The author describes several rocks, all from a limited area, ranging from acid to ultra-basic. He attempts 'to show that these types are intimately associated in their geological occurrence and closely related in composition; that many of the types graduate into others by intermediate varieties, and that they probably represent facies of one original magma.' The article is accompanied by four plates of microphotographs illustrating rock structures, and a map showing the distribution of the varieties in the area studied. 'A Preliminary Geologic Section in Alpena and Presque Isle Counties, Michigan,' by Amadeus W. Grabau, has a plate showing a geological section at Thunder Bay accompanied by a description of the various outcrops. This is followed by 'Editorial Comment on the Archæan of the Alps.'

THE October number of the *American Journal of Mathematics* (Vol. XXIII., No. 4) has the following articles:

Memoir on the Algebra of Symbolic Logic, by A. N. Whitehead; Secular Perturbations of the Planets, by G. W. Hill; Representation of Linear Groups as Transitive Substitution Groups, by L. E. Dickson; A Class of Number Systems in Five Units, by G. P. Starkweather.

The Osprey for August contains articles on 'Birds about Lake Tahoe,' by Milton S. Ray; 'Life History of the Prairie Warbler,' by Jno. W. Daniels, Jr.; 'Camping on the Old Camp Grounds,' II., by Paul Bartsch; 'Cage Birds of Calcutta,' by Frank Finn, and the seventh instalment of 'The Osprey or Fishhawk: Its Characteristics and Habits,' by Theodore Jill.

DISCUSSION AND CORRESPONDENCE.

DIFFERENTIATION OF SUBJECTS AND TITLES IN COLLEGES.

In your last issue Professor F. W. Rane makes objection to the all-comprising title of professor of agriculture, and very properly

points out that the subject is now so differentiated that the nomenclature in professorship should follow suit. While the claim is perfectly proper, I cannot suppress a smile in reading the signature of the 'Professor of Horticulture and Forestry.' Why should not Mr. Rane begin differentiation at home? Horticulture and forestry are two so widely different subjects that the man who proposes to teach them both must, indeed, be able to turn his coat most readily. Both, to be sure, have to deal with trees, being both branches of the wider field of arboriculture; but each deals with entirely different classes of trees, for entirely different purposes by, entirely different—I might almost say opposite—methods. The forester is after the substance of the tree; the final object of his efforts is attained by the cutting, the removal of the tree. The horticulturist's object is not the substance but the fruit, or, if he be a landscape gardener, the form and beauty of the tree, both aims being only fulfilled by the presence of the tree. These different objects are attained by entirely different methods, as could be readily pointed out, did space permit.

I would not wish to discourage any laudable attempt to make students of horticulture and of other agricultural branches know something of forestry, but it is a question whether they can get much professional knowledge of either the one or the other subject from an undifferentiated professor of horticulture and forestry. As we have now two fully organized colleges of forestry, the one at Yale with two, the other at Cornell with three, professors of forestry, without any other branches to teach, it would appear quite time for other colleges, who find it necessary or desirable to educate foresters, to realize the wide difference between the various branches of arboriculture, and not mix up botany, horticulture, landscape gardening and forestry in their courses and professors' titles.

B. E. FERNOW.

NEW YORK STATE COLLEGE OF FORESTRY.

A FINAL WORD ON DISCORD.

TO THE EDITOR OF SCIENCE: Mr. Max Meyer, in his criticism a few weeks ago, implied that I had made a mistake in a book review. This,

it appears, was not because I had objected to a certain numerical statement about discord, but because I had referred to a curve by the late Professor Mayer which Mr. Meyer considers worthless. The work of Helmholtz in the same domain he also considers worthless. He quotes Melde and Stumpf, who differ with Mayer and Helmholtz. He concludes by saying "Upon the *cause* of discord the psychologists have *not* agreed; it is yet unknown—at least to the psychologists."

For many years I have been convinced that beats do not constitute the sole cause of discord, but that probably they constitute one efficient and important element. So far as this may be admitted, Mayer's curve is the nearest approach to an expression of facts within the range he selected. The present controversy seems to be chiefly regarding authorities. Criticism intended to be destructive is not a substitute for constructive evidence. The opinions of Melde and Stumpf are of course worthy of respect, but they do not prove Helmholtz and Mayer to be wholly wrong. It does not seem to me that the subject is of sufficient importance to call for further discussion.

W. LE CONTE STEVENS.

WASHINGTON AND LEE UNIVERSITY,
October 12, 1901.

THE BICENTENNIAL OF YALE UNIVERSITY.

THE program of the bicentennial exercises of Yale University being celebrated this week is as follows:

MONDAY, OCTOBER 20.

- 10:30 A. M.—Divine service in the Battell Chapel. Sermon by the Rev. Joseph Hopkins Twichell, A. M.
- Special divine services in Center Church, sermon by the Rev. Newman Smyth, D. D.; in the United Church sermon by the Rev. Joseph Anderson, D. D.; in Trinity Church, sermon by the Rev. Walton Wesley Battershall, D. D.; and in the First Methodist Church.
- 3:00 P. M.—Address by the Rev. Professor George Park Fisher, D. D., LL. D., on 'Yale in its Relation to Christian Theology and Missions'; Battell Chapel.
- 8:00 P. M.—Organ recital by Professors Samuel Simons Sanford, A. M., and Harry Benjamin Jepson.

SUNDAY, OCTOBER 21.

- 9:30 A. M.—Dedication of the Ives-Cheney Memorial Gateway.
- 10:30 A. M.—Address by Thomas Thacher on 'Yale in its Relation to Law'; Battell Chapel.
- Address by Professor William Henry Welch, LL. D., on 'Yale in its Relation to Medicine'; Battell Chapel.
- 3:00 P. M.—Address of welcome to guests by President Arthur Twining Hadley, LL. D., with spouses; Battell Chapel.
- 5:00 P. M.—Reception of the guests of the university and representatives of the alumni by President Hadley, in the Yale Art School.
- 8:00 P. M.—Assembly of students and graduates on the campus.
- 9:00 P. M.—Torchlight procession of students and graduates.

TUESDAY, OCTOBER 22.

- 10:30 A. M.—Address by President Cyrus Northrop, LL. D., on 'Yale in its Relation to the Development of the Country'; Battell Chapel.
- Address by President Daniel Coit Gilman, LL. D., on 'Yale in its Relation to Science and Letters'; Battell Chapel.
- 2 P. M.—Football games at Yale Field; Yale University vs. Bates College; Yale University vs. team of graduates.
- 4:30 P. M.—Choral performance of Professor Horatio Parker's 'Hora Novissima,' by the Gounod Society and the New Haven Symphony Orchestra; Hyperion Theater.
- 8 P. M.—Illumination of the campus; student dramatic performance and singing in the campus amphitheater.

WEDNESDAY, OCTOBER 23.

(Commemoration Day.)

- 10 A. M.—Assembly of guests and graduates on the campus.
- 10:30 A. M.—Procession of guests and graduates to the Hyperion, as escort to President Roosevelt. Commemorative poem by Edmund Clarence Stedman, L. H. D., LL. D.
- Commemorative address by David Josiah Brewer, LL. D.
- Orchestral and choral music.
- Greek festival hymn by Professor Thomas Dwight Goodell, Ph. D., the music by Professor Horatio Parker, A. M.
- Conferring of honorary degrees on President Roosevelt and others.
- 2:30 P. M.—Concert by the Boston Symphony Orchestra, Mr. Wilhelm Gericke, conductor; Hyperion Theater.

4 P. M.—Dedication of Woodbridge Hall.

Address by Donald Grant Mitchell, LL.D.

5 P. M.—Farewell reception of the guests and graduates of the University by President Hadley and Mrs. Hadley, in the University Hall.

RESOLUTIONS ON THE RESIGNATION OF THE PRESIDENT OF COLUMBIA UNIVERSITY.

THE Council of Columbia University, representing the faculties, has adopted the following minute, on the occasion of the resignation of President Low :

When Mr. Low became the President of Columbia College, in the academic year 1889 90, the institution consisted of four faculties, in charge respectively of the schools of arts, mines, law and political science. These faculties numbered 122 officers of instruction ; and these schools were attended by 1,134 students. The faculties were connected with each other only through the president and trustees of the college ; and the schools existed alongside of each other without any principle or custom of reciprocity. The library of the college contained 91,000 volumes, and the wealth of the corporation was estimated at \$10,-500,000. The faculties, schools, library and entire equipment were crowded into the narrow and noisy quarters bordering upon the tracks of the New York Central railway.

To-day Columbia University consists of nine faculties, in charge respectively of Columbia College, Barnard College, Teachers College and the university schools of law, medicine, applied science, pure science, philosophy and political science. These faculties now number 385 officers of instruction ; and these colleges and schools are now attended by 4,500 students. The faculties are now coordinated with each other in the University Council in which all of the educational activities and interests of the university are officially represented ; and a complete system of reciprocity between all parts of the institution and also with the Union Theological Seminary now prevails. The library of the university now contains 311,000 volumes ; and the wealth of the corporation is now estimated at eighteen millions of dollars, of which one and one half millions of dollars, in round numbers, represent the splendid generosity and munificence of Mr. Low himself. And, finally, the university is now located upon a site and possesses a physical equipment unsurpassed in beauty, comfort and completeness by those of any institution of learning in the world.

This magnificent achievement, wrought within the short period of twelve years, has no parallel in the educational history of any country or of any age ; and

no further or higher proofs of Mr. Low's abilities as an educator and an administrator than the mere recital of these facts are necessary.

But Mr. Low brought to the solution of the problems of the university qualities even more important and needful than these intellectual powers. First and highest among these qualities, and most indispensable, was the power to win and to hold the full and unwavering confidence and the cordial and zealous cooperation of all his colleagues, a power which can come only from an innate love of truth, joined with an open mind, a high sense of justice, unbending integrity, kindness of heart and genuine deference in manner. Every officer of the university felt that his interests and the interests of his department were safe in the hands of Mr. Low, and that no occult influences would ever be allowed to prevail in the administration of the affairs of the institution.

"It is the recollection of these rare and invaluable traits even more than of his administrative abilities which makes the parting with him so hard and regretful and which moves this Council to express the hope and wish for itself and for the bodies represented in it that from his seat in the Board of Trustees of the University Mr. Low may still continue to manifest his old interest in the development of the university and may still exert his great powers in the promotion of its welfare.

"Though conscious that these words do not express with any adequacy the feelings of the members of this body concerning the obligations of the university and all of its officers to Mr. Low and their deep regret at his retirement from the Presidency yet your committee would beg to recommend that the minute be spread in full upon the records of the University Council and that the Secretary be directed to transmit a copy of it with a suitable letter to Mr. Low."

THE CARNEGIE TECHNICAL SCHOOLS.

THE report of the committee of the Board of Trustees of the Carnegie institutions at Pittsburgh has been made public. It formally approves the scheme of the sub-committee and of the advisory committee of experts on the 'Plan and Scope' of the proposed Carnegie technical system of industrial education, as outlined by the latter in the report published in *SCIENCE* in July last and commented upon in the address of Mr. Brashear before his section of the American Association for the Advancement of Science, which appeared in our issue of September 13.

The committee recommends the organization

of the central feature of a scheme to comprehend, ultimately, if properly sustained, a series of schools of graded character from the evening classes and the trade schools for artisans and youth, of both sexes, to the technical high school, the schools of engineering and architecture aggregated in a technical college, and to the aggregations of these schools and colleges in a technical university which shall include a department of research. It is proposed to employ the gift of Mr. Carnegie, presented at the time of his announcement of his ambition in this direction, in the establishment of a technical institution to occupy substantially the same position and to do practically the same kind of work as the Pratt Institute in Brooklyn, the Drexel in Philadelphia and similar schools in other large cities. It is recommended that a plot of land of about 60 acres area be at once secured and this institution immediately organized.

"The plan and scope as laid down by the committee and the experts invited to give counsel will make the school of national importance and place it in the front rank of similar schools in the world."

The endowment at present advised is said to be \$5,000,000, and the final and completed form of the 'university' will presumably require about double that sum.

When studying a plan and determining the scope of the institution, the expert advisers were called upon, each for a statement, and were later called together as a committee, and the present report states that 'appreciating the dignity and the magnitude of the subject, we were agreeably surprised to find that all reports agreed in their essential features.'

"Accordingly when the members of the Advisory Committee held their final meeting in June they had no difficulty in uniting in a general scheme for technical education."

The scheme was in outline the largest possible; the idea being to provide a model, so far as it might be carried, and to hold up an ideal toward which to approximate as time and means should permit. The introduction of manual training, in cooperation with the public schools, and a general system and policy of constant cooperation in all practicable ways,

the provision of day and evening classes for artisans, the organization of a scientific and technical high school for youth of both sexes unable to find means and time for a liberal education and yet requiring instruction in the fundamental principles of the industries into which they are to be inducted, together with provision for general education, in conjunction with the public schools, the neighboring university, the great libraries of Pittsburgh and vicinity and with the operations of the existing Carnegie Institute, art school and museum, constitute the first and a great task. Later, if practicable, the educational structure will be built up and down and broadened into a great system offering the industrial classes Huxley's ladder 'from the gutter to the university.'

"The Carnegie Technical College with its crowning features of scientific research and publication, must be left for future endowment. Its realization would complete a technical university unequalled in its scope and influence, an institution worthy to foster the highest aspirations of Pittsburgh—or of any metropolis, the committee might have added."

Finally, the committee remarks: "We would respectfully suggest to Mr. Carnegie the many advantages to be derived from handling as a whole, rather than in parts, whatever scheme of technical education he may contemplate."

"The Advisory Committee wisely recommends that an endowment should be provided of such magnitude and character as will safely maintain the required income on the face of falling rates of interest and the demands of a steady growth."

THE NEW YORK PATHOLOGICAL INSTITUTE.

ANNOUNCEMENT is made that the plan of reorganization of the Pathological Institute of the New York State Hospitals for the Insane undertaken by the State Commission in Lunacy is gradually taking shape. An advisory board has been appointed, whose duty it is to aid in the development of the Institute and the carrying on of its work on broad lines and to assist the new Director soon to be appointed. It is the aim of the reorganized Institute to carry on work in the sciences correlated with psychiatry

according to the original plan, but with some modifications intended to meet more immediately the needs of the hospitals. Original research in the various sciences having a bearing upon the subject of insanity will go on as before, but in addition the Institute will be utilized to give special instruction in clinical psychiatry, as well as methods of scientific research to the physicians on the staffs of the hospitals for the insane and to young men about to take up an asylum career. In order to obtain this clinical experience the Institution needs to be combined with a hospital for the insane, and to bring this about it is for the present to be connected with one of the asylums on Ward's Island, and until such time as a reception hospital for the insane can be established in Manhattan. In selecting the members of the Advisory Board, the Lunacy Commission deemed it expedient to have the three University Medical Schools of New York City represented, *viz.*: Columbia, Cornell and Bellevue-University. Furthermore it was decided to accord to the chief sciences correlated with psychiatry representations upon the Advisory Board. These sciences are pathology, chemistry, psychology and general biology. Inasmuch as the Pathological Institute was created for the utilization of the material of all the State hospitals, and for the purpose of raising the standard of scientific study, treatment and care of the insane under State care, it was thought best that these institutions should also have a voice upon the Advisory Board. A member to represent general clinical medicine and neurology was likewise selected. Accordingly the Commission in Lunacy has established an advisory board consisting of the following men: James Ewing, Professor of Pathology, Medical Department of Cornell University; Dr. Christian A. Herter, Professor of Pathological Chemistry, Bellevue and University Medical College; Dr. J. McKeen Cattell, Professor of Psychology, Columbia University; Dr. Hermon C. Bumpus, Assistant to the President of the American Museum of Natural History, to represent the department of General Biology; Dr. Henry Hun, Professor of the Diseases of the Nervous System, Albany Medical College, to represent Neurology and General Clinical Medicine; Dr. Charles W. Pilgrim, superin-

tendent of the Hudson River State Hospital, at Poughkeepsie, and Dr. A. E. Macdonald, superintendent of the Manhattan State Hospital, East, to represent the State Hospitals; Dr. Frederick Peterson, President of the Lunacy Commission, a member *ex officio*. All appointments to the advisory board are permanent except two. The two superintendents of asylums on the board were elected by the fourteen asylum superintendents of the State at a meeting held in Buffalo, September 28, for a term of two years only, thus permitting all the asylums to be represented in rotation on the board.

THE AMERICAN PHILOSOPHICAL SOCIETY.

A COMMITTEE of the American Philosophical Society has sent to members the following letter in regard to an annual general meeting of the Society in Easter week:

The American Philosophical Society, animated by the desire which led its founder, the illustrious Franklin, to issue his 'Proposals for promoting Useful Knowledge among the British Plantations in North America,' and which in 1743 resulted in the formation of this Society on a national basis, and in the selection of Philadelphia as its seat, because of its 'being the city nearest the centre of the continent colonies,' has for some time recognized the fact that the changes which the lapse of 158 years have wrought, demand modified conditions to meet existing requirements.

Ever since its foundation the national character of the Society has been maintained. In consequence there has latterly arisen among its members a conviction that the time has come when the interests of useful knowledge in the United States can be greatly promoted by the holding, in addition to its usual semi-monthly meetings, of at least one general meeting in each year, which from the information to be derived from the papers presented and their discussion by those most competent to add to our knowledge, shall attract the members of the Society from all parts of the country to their mutual advantage as well as to that of this, the first and oldest scientific society in America, and one of the oldest in the world.

With this view the Society has authorized the holding of a general meeting which for the ensuing year, has been fixed in Easter week and the undersigned have been appointed a committee to make the necessary arrangements.

Members desiring to present papers, either for themselves or others, are requested to send to the secre-

aries at as early a date as practicable and not later than February 15, 1902, the titles of the papers, accompanied by a brief abstract, so that they may be duly announced on the programme which will be issued immediately thereafter and which will give in detail the arrangements for the meeting.

The Publication Committee, under the rules of the Society, will arrange for the immediate publication of the papers presented.

It should be borne in mind that the Society, by means of its publications, which present a series covering 140 years and include *Transactions* in quarto and *Proceedings* in octavo, with its large exchange list embracing, practically, the scientific societies of the world, and with its exceptional facilities for immediate issue, offers unrivalled avenues for prompt publication and wide circulation of the papers read before it.

Mindful of the brilliant history of the Society, extending back into the first half of the eighteenth century, its members should obviously be solicitous that its career at the outset of the twentieth century shall fully maintain the high prestige which the preceding centuries have given to it both at home and abroad. Hence it is felt that with their cordial and active cooperation secured the proposed general meetings may be made a powerful factor in advancing the interests for the promotion of which the Society was founded.

SCIENTIFIC NOTES AND NEWS.

A MEETING of the executive committee of the American Society of Naturalists was held at Boston on October 19, to complete the arrangements for the Chicago meeting of the Naturalists and affiliated societies. The meeting of the Naturalists will be on Tuesday and Wednesday of Convocation week, that is December 31 and January 1. The discussion before the Naturalists will be on Wednesday afternoon, and the annual dinner, at which the president, Professor Wm. T. Sedgwick, will give the address, will take place in the evening. The subject selected for the discussion is 'The Relations of the American Society of Naturalists to other Scientific Societies.'

DR. WILHELM WALDEYER, professor of anatomy in the University of Berlin, has been sent by the University of Berlin and the Berlin Academy of Sciences as their representative at the bicentennial exercises of Yale University.

A GOLD plaque will be presented to M. Bertelot next month to celebrate the fiftieth anni-

versary of his entering as an assistant the chemical laboratory of the Collège de France.

MR. BARBOUR LATHROP, of Chicago, and Mr. D. G. Fairchild, of the U. S. Department of Agriculture, will leave San Francisco next month on another expedition, with a view to investigating exotic plants that might be introduced into the United States. They go first to the South Sea Islands and Australia and later to India.

PROFESSOR W. B. SCOTT, of Princeton University, is still in South America, working on the Patagonian Expedition Reports. When last heard from he was at Buenos Ayres, examining specimens in the museums of that place.

THE Hanbury gold medal for 1901 was presented on October 1 to Dr. George Watt by the president of the Pharmaceutical Society. This medal, which was established as a memorial to Daniel Hanbury, is awarded biennially for original research in the chemistry and natural history of drugs.

THE council of the Institution of Civil Engineers has, in addition to the medal and prizes given for communications discussed at the meetings of the institution in the last session, made the following awards in respect of other papers dealt with in 1900-1901: A Telford medal and a Telford premium to Reginald Pelham Bolton (New York); a Watt medal and a Telford premium to J. Emerson Dowson (London); a George Stephenson medal and a Telford premium to W. T. C. Beckett (Calcutta); a Manby premium to E. K. Scott (London); a Trevithick premium to T. A. Hearson, R.N. (London); a Telford premium to J. A. W. Peacock (Tantah, Lower Egypt).

DR. NORMAN MOORE gave the Harveian Oration before the Royal College of Physicians, London, on October 18.

PROFESSOR ROBERT KOCH has been sent by the German Government to Gelsenkirchen, where there is a serious outbreak of typhus, as many as fifty cases being reported in a single day.

DR. CHARLES HENRY BROWN, a New York physician, who has given special attention to nervous diseases and had for many years been

editor of the *Journal of Nervous and Mental Diseases*, died on October 15, at the age of fifty-four years.

GEORGE B. SIMPSON, for thirty-five years the accomplished delineator of fossils for the paleontological department at Albany and a well-known student of the fossil Bryozoa, died on October 15.

M. R. KÖNIG, of Paris, well known for his scientific instruments and his investigations on acoustics, has died at the age of sixty-nine years.

MR. WILLIAM WEST, known for his study of fresh-water algæ, has died in India from cholera, at the age of twenty-six years.

THE deaths are also announced of Dr. Peter M. Pokrowskij, professor of mathematics at the University of Kiew, and of Dr. Alex. F. Berger, docent in mathematics in the University of Upsala.

THE next International Congress of Physiologists will be held at Brussels in 1904, under the presidency of Professor Heger.

THE Nineteenth Congress of the American Ornithologists' Union will convene at the American Museum of Natural History, New York City, on Monday, November 11, at 8 o'clock p. m. The evening session will be devoted to the election of officers and members and the transaction of other routine business. The meetings, open to the public and devoted to the reading and discussion of scientific papers, begin on Tuesday morning and continue for three days. In connection with the Congress there will be a conference of representatives of the Audubon Societies, for the purpose of forming plans for more effective cooperation.

THE Coast and Geodetic Survey steamers *Pathfinder* and *MacArthur* have nearly completed the survey of the Fox Island channels which form the entrance or exit for all Bering Sea commerce. The steamers *Patterson* and *Gedney* are now charting Cross Island and Icy Straits, of the Southeast archipelago. The *Pathfinder* will proceed to the Philippines before long via Nagasaki to take up the work of surveying called for by the Philippine Commission.

THE Antarctic expedition from Sweden, under the direction of Professor Otto Norden skjöld, left Göteborg on the steamship *Antarctic* on October 16. Professor Nordenskjöld is accompanied by Professor Ohlin, the well-known explorer, and M. K. A. Anderson, as zoologists; Dr. Bodman, hydrographer and magnetician; M. Skottoberg, botanist, and Dr. E. Ekolof, medical officer. Captain Larsin, a Norwegian, who has already made several voyages to the South Polar regions, is in charge of the *Antarctic*. The vessel will proceed to Terra del Fuego and thence to the South Polar regions, where the field of exploration will not conflict with those chosen by Great Britain and Germany. Professor Nordenskjöld expects to land with a party while the vessel makes explorations about Terra del Fuego.

As we have already announced the coast and Geodetic Survey has established a magnetic observatory at Sitka, Alaska, and is constructing another at Honolulu. These observatories will cooperate with the German and British Antarctic expeditions in making simultaneous observations.

As the daily papers have very fully reported M. Santos-Dumont in his air ship on October 19, succeeded in circumnavigating the Eifel Tower and returning to Saint Cloud. The trip was made within the half hour allowed by M. Deutsch for the award of his prize, but owing to a delay in landing the prize was not awarded.

REUTER'S AGENCY gives the following information concerning Dr. Sven Hedin, the Swedish traveler, based upon a letter from him, dated July 10. It appears that Dr. Sven Hedin, at the time of the dispatch of the letter, was at the foot of the Akka Tagh, in Northern Thibet, and intended to proceed in the direction of Ladak in order to survey accurately the region about the source of the Indus. Next spring he proposed to return to Osh via Kashgar. Meanwhile, a caravan of 15 horses has arrived at Kashgar bringing the results of two years of the traveler's work in the shape of scientific collections, maps, photographs and diaries.

R. W. AMIDON, M.D., of New York City, is spending October and November near Chau-

mont, Jefferson County, N. Y., investigating ancient village sites. In this region there are mounds of various sizes, in the top of each of which is a saucer-shaped depression that is in every case about eight feet in diameter. It seems possible that these mounds may be the remains of earth-covered houses of various sizes, which had smoke holes approximately of the same diameter.

DR. MARCUS S. FARR, assistant in geology at Princeton, and Mr. Earl Douglass, fellow in biology, with a party of students spent the summer in geological explorations in the southern part of Montana. Valuable fossils were collected and are now being mounted at Princeton.

It appears that there will be no further contest in regard to the will of the late Jacob S. Rogers and that the Metropolitan Museum of Art will receive over \$5,000,000 for its endowment. It is perhaps scarcely necessary to state that the Museum includes archeology, as well as the fine arts, in its scope, and this large bequest will thus directly contribute to scientific work.

THE principal buildings for the St. Louis Exposition, as officially decided upon, will in many cases be larger than buildings constructed for similar purposes at previous expositions. There is to be an agricultural building, 700 by 2,000 feet; a manufacturers' building, 600 by 600 feet; a liberal arts building, 600 by 1,200 feet; a social economy building, 550 by 700 feet; a transportation building, 600 by 1,200 feet; an education building, 550 by 700 feet; an art building, 300 by 600 feet, with two wings, each 200 by 300 feet; a mines and metallurgy building, 600 by 1,200 feet; an electricity building, 600 by 550 feet, and a Government building, to cover 100,000 square feet. The estimated cost of these buildings is \$7,000,000. To these will probably be added buildings for fish and fisheries, for machinery, for forestry and for horticulture.

WE learn from *Nature* that a small residential laboratory has been opened at the Hakgala Botanic Gardens, near Nuwara Eliya, at an elevation of 5,600 feet above sea-level. The

laboratory is a branch of the Peradeniya Institution, and consists of a small building containing a working room 21 feet x 12½ feet, a living room, two bedrooms, kitchen, etc. The climate is temperate, fires being required in the evenings at least. The botanic garden itself is said to be very beautiful, and occupies an unrivaled position for the study of equatorial hill vegetation, for on one side there are jungles stretching for 25 miles or more into the wet region of the hills, on the other grassy plateau reaching for an equal distance into the dry region, and extending from 3,000 to 7,000 feet above sea-level. The garden itself contains both jungle and patana reserves of several hundred acres.

A COMMITTEE appointed by the recent German Geographical Congress has offered a prize of at least \$150 for a paper on 'The changes in the course of the Rhine between Bonn and Cleves in historic times, and how have they affected the settlements on its banks?'

THE foreign journals report that the Berlin Academy of Sciences and the Danish Academy at Copenhagen have decided to prepare a collection of all the medical works of antiquity under the title of 'Corpus Veterum Medicorum,' and will cause a thorough examination to be made of all libraries, Oriental and European, which are likely to contain MSS. dealing with medical subjects.

THE letter press of Britton and Brown's 'Illustrated Flora,' with some abridgment and numerous emendations, but without the illustrations, has been compressed into a single portable volume, which is to be published at once by Henry Holt & Co., under the title, Britton's 'Manual of the Flora of the Northern States and Canada.'

A REPRESENTATIVE of Reuter's Agency reports an interview with Herr Oscar Neumann, the eminent German explorer, who has recently completed an eighteen months' journey in Central Africa from Zeila to Khartum. Traveling for the most part through absolutely unknown country, he made some valuable discoveries, and has brought home the largest zoological collection ever made in Central Africa. He was also enabled to make a complete geological

survey. He met with no hostility on the part of the natives and had no fighting during the whole journey. The physical difficulties were, however, often very great. Describing his journey, Herr Neumann said: "Baron Erlanger and myself, accompanied by three Europeans—Dr. Ellenbech and Messrs. Heutemuller and Hillgart—left Zeila in January of last year, and journeyed into Somaliland, where we had considerable difficulty, and were unable to proceed east owing to the movements of the Mad Mullah. After crossing the Shibel River we traversed with difficulty a district full of caves and came to the land of the Arosi Galle. We visited the holy towns of Sheikh Hussein and the holy mountains of Abulnass and Abulcassim, which have never previously been explored. Subsequently we traveled northwest by a new route to Adis Abeba, crossing a plateau 9,000 feet high. We left the capital in November last, and proceeded southwest along the lakes to Lakes Stephanie and Rudolf. We adopted the new eastern route of the Great Rift Valley instead of following the tracks of Captain Wellby or Mr. Harrison. Between the Hawash River and Lake Stephanie we discovered that, instead of five lakes, there are no less than seven lakes, probably all relics of the great diluvial lake basin. After a slow and tedious journey we crossed the Omo River and traveled through the quite unknown Abyssinian provinces of Ksha and Konta, which have only been occupied since the Italian war. Subsequently I came to Kaffa, one of the richest provinces of Abyssinia, covered with dense forest, in which there is much coffee cultivation. My object now was to explore the sources of the Gelo River, an important affluent of the Sobat. I first passed through the land of Gimirra and the independent countries of Binescho and Scheko. Shortly afterwards I found the Gelo River and followed its course, but the further I proceeded the more difficult became the traveling. My caravan was now in a terrible plight. Glanders had again broken out, and out of 65 animals I had only 13 mules, two horses, and two donkeys left. I was therefore compelled to throw away tents, clothes, stores, etc., in fact everything but my books and collections. Our condition was made harder by

reason of the fact that we were going through a country which had almost been depopulated owing to Abyssinian raids. Suddenly a steamer appeared, having on board Slatin Pasha and Bluett Bey, Mudir of Fashoda, who took us in safety to Khartum." During the whole of this long and arduous journey Herr Neumann never had any trouble with the natives.

BEFORE the Section of Mathematics and Physical Science of the British Association, Dr. R. T. Glazebrook, the superintendent of the National Physical Laboratory, exhibited plans of the new institution now being erected at Bushey, gave a short history of the building, and described the objects with which it has been founded. According to the account in the *London Times* he said that the main building consisted of a substantial central block about 70 feet square standing on a vaulted basement. At each corner there was a large wing practically single-storied; the rooms in these were being fitted up for various special purposes. In the central building itself would be two general laboratories. There would be a large entrance-hall, arranged as an apparatus room, and a library. The basement contained six rooms of fair size; the floor had been covered with a thick layer of concrete. The walls were very thick, so that they were extremely steady, and the temperature and conditions all favorable for steady work. In addition there were other smaller rooms in the basement; two of these were entirely surrounded by thick interior walls and arrangements would be fitted to maintain a steady temperature throughout the year. At the back was another wing containing a number of rooms suited for special researches, and there a lift had been fitted and also a mercury column having a height of about 50 feet. For the more delicate physical work the ground-floor and basement of the old house afforded ample accommodation. For the engineering work a room 80 feet by 50 feet had been built, lighted from the north by a weaving shed roof. It was divided longitudinally into two bays by a series of rolled steel pillars. The one bay would contain a light traveling crane; along the other ran a line of shafting for driving the machinery and for experimental purposes. Adjoining this

laboratory was a drawing office, while the engine-house and boiler rooms were close at hand. Power, obtained from a 60-kilowatt Parsons turbine, would be distributed electrically to various parts of the laboratories; this form of engine was chosen for the express purpose of avoiding vibration as far as possible. The necessary tools were in order and in course of installation. The work which the committee hoped to attack in the first instance was that which had already been under the consideration of the Alloys Research Committee of the Mechanical Engineers. Apparatus for the photomicrographic examination of steel rails was being set up, and machines for testing the elastic properties of alloys were in course of construction. Pressure gauges and steam indicators would also be tested. The height of the building would not allow the mercury column, now being erected, to measure more than 200 pounds to the square inch, but apparatus was being constructed for pressures in excess of that amount. Considerable attention was to be given to high temperature thermometry, the testing of platinum thermometers, and the measurement of electrical quantities. Before the end of the year the committee hoped the laboratory would be fully and usefully occupied. Acknowledgment was made of the generosity of Sir Andrew Noble, who had given an excellent comparator, a dividing engine, and some measuring apparatus of the highest class to the laboratory.

At the recent Glasgow meeting of the British Association, Dr. A. G. Green read before the chemical section a paper on the coal-tar industry. According to the report in the *London Times*, he remarked that, owing to the numerous ramifications of the coal-tar industry and the manifold applications to which its products were applied, it might be regarded as the pulse of chemical industry as a whole. He had, therefore, traced the relative progress in the industry in England and Germany during the last fifteen years. At the commencement of that period England, although the originator of the manufacture of aniline dyes, was not holding its own against Germany, but was, at any rate, supplying Germany with the raw material. Now, even that was not the case,

for owing to the ample introduction of coke ovens, in which the by-products were recovered, Germany was producing coal-tar in plenty for its own use, and in the other departments of the industry the relative positions of the two countries was still worse for us. The export of coal-tar colors from Germany, exclusive of alizarines, was 4,646 tons in 1885 and 17,639 tons in 1899. In 1894 the value of the total exports of these colors amounted to £2,600,000, and in 1898 to £3,500,000. The value of the total chemical industry of Germany in 1897 was 46½ millions of pounds; at least a tenth of this might be put down to coloring matters and another tenth to other coal-tar products, making the coal-tar industry in Germany of an annual value of nine to ten million pounds. This remarkable activity has caused vast sums of money to be usefully invested and was giving employment to increasing numbers of work-people. The Badische-Anilin Fabrik in 1889 had a capital of £900,000, which had now been increased by £750,000, while the number of work-people employed, 4,800 in 1896, had risen to 6,485 in 1900. The total capital of the six largest coal-tar color firms in Germany amounted to at least 2½ millions; they employed about 500 chemists, 350 engineers and technical men, 1,360 business managers, clerks, and travelers, and over 1,800 work people. The total capital invested in the coal-tar color trade in England did not exceed £500,000, the total number of chemists employed could not be more than 30 or 40, and the number of workmen engaged in this manufacture probably did not amount to over 1,000. The exports of coal-tar colors from England had fallen from £530,000 in 1890 to £366,000 in 1900. The imports, on the other hand, had steadily increased from \$509,000 in 1886 to £720,000 in 1900. The colors used by the Bradford Dyers' Association were 10 per cent. of English make, 80 per cent. German, 6 per cent. Swiss, and 4 per cent. French. It was an apathy toward higher education and research that was the cause of this decadence. Moreover, the encouragement given to chemical research work by these great industries was enormous. Other industries of Great Britain were also threatened. The Germans were busy producing artificially

natural dye-stuffs, largely consumed in England and extensively grown in British possessions; indigo was the latest object of this particular kind of enterprise, and a sum of 1 $\frac{3}{4}$ millions sterling was being devoted to the achievement of the extermination of this natural dye-stuff.

UNIVERSITY AND EDUCATIONAL NEWS.

MR. JOHN D. ROCKEFELLER has promised to contribute \$200,000 toward the endowment fund for Barnard College, Columbia University, provided that an equal sum is given by others before January 1, 1902.

THE corner stone of the new Medical Building of the University of Michigan was laid on the 15th inst., under the auspices of the State Medical Society, by Dr. Leartus Connor, the president of that body. Addresses were delivered in connection with the ceremonies by the Hon. Regent Kiefer, President Angell, Dr. J. A. McCorkle, professor of medicine in the Long Island College Hospital and a member of the class of '73 of the University of Michigan, and by Professor J. G. Adami of McGill University. The building, which has been made necessary by the rapid growth in recent years of the Medical Department, will contain the laboratories and class-rooms of the departments of hygiene, bacteriology, anatomy, histology and pathology, and the contracts for its erection call for an expenditure of \$88,000, exclusive of what may be required for the heating, plumbing and general equipment. The old Medical Building, which has been the home of the Medical School for fifty years, will be remodeled throughout and adapted for the use of the departments of pharmacology, physiology and chemistry.

AT the Massachusetts Institute of Technology Capt. William Hovgaard, of the Danish Navy, has been appointed professor of naval design in the department of naval architecture. Dr. H. P. Talbot has been made head of the department of chemistry. Dr. Talbot has for some years past been professor of analytical chemistry, and, since the departure of Dr. Drown, has in a measure acted as head of the department.

MR. HENRY M. HUXLEY has been made Hemenway fellow and assistant in anthropology at Harvard University.

THE New York *Evening Post* states that D. K. Zangogiannis, who was appointed professor of pedagogy at the University of Athens two years ago, and who had made a special study of German educational systems, has been deposed by the Government because of an article he wrote for a German periodical in which he criticised the Greek high schools.

DR. JOHN YOUNG, professor of natural history at Glasgow, has been obliged by the condition of his health to resign his chair after thirty-five years' service in the University. He will continue to act as curator of the Hunterian Museum.

DR. PURSER, professor of the institutes of medicine in the School of Physic, Trinity College, Dublin, has resigned the chair he has held for twenty-seven years.

AT Trinity College, Cambridge, the annual election to fellowships has been held, when four vacancies were filled. The new fellows in the sciences are Harold Albert Wilson, B.A., advanced student; certificate of research 1899 for papers on 'The electrical conductivity of flames containing salt vapors,' 'Velocity of solidification,' 'The influence of dissolved substances and of electrification on the re-formation of clouds,' and 'On the variation of the electric intensity along the electric discharge in rarefied gases'; Allen scholar, 1900; Clerk Maxwell scholar, 1901; and James Hopwood Jeans, B.A., bracketed second Wrangler, Mathematical Tripos, Part I, 1898; First Class, Division 1, Mathematical Tripos, Part II., 1900; Isaac Newton student, 1900; Smith's Prize, 1901.

DR. H. ERDMANN, of the University of Halle, has been appointed to a full professorship of inorganic chemistry, in the Technical Institute at Berlin. Dr. G. A. Gmeiner has been appointed professor of mathematics in the German university at Prague.

ON page 620 of the last issue of SCIENCE the word 'geological' was omitted before the word research in the sixth line.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

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FRIDAY, NOVEMBER 1, 1901.

THE RELATIONS OF YALE UNIVERSITY TO LETTERS AND SCIENCE.*

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In the mediæval convents, from which our academic usages are derived, there were annalists who noted the passing events. Dry and meager are such records—dry and meager will our annals seem unless we see in them the working of principles and methods during a period of two centuries. It will be my endeavor to set forth the relations of Yale to science and letters in such a way that with historic insight you may discover the tendency and the influence of the school in which we have been trained, and may thus appreciate its benefits more fully than ever before. I shall not follow closely the order of chronology, and under the circumstances of this address, I must omit the praise of living men, however richly deserved, nor can I mention many of the departed, however honored and beloved. Law, medicine and theology must be avoided; 'it is so nominated in the bond.' It will be good for each one of us to bear in mind the seven searching questions of an ancient critic—

Quis, Quid, Ubi, Quibus auxiliis, Cur, Quomodo, Quando,

and to remember also that there is no process by which we can draw forth in forty

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minutes the rich vintages stored up in a period of forty lustrums.

The Collegiate School of Connecticut began well; Yale College improved upon the Collegiate School; Yale University is better than Yale College. The process has been that of evolution, not of revolution; unfolding, not cataclysmic; growth, and not manufacture; heredity and environment, the controlling factors. What we are, we owe to our ancestry and our opportunities. Hence the 'Relation of Yale to Letters and Science' cannot be adequately treated without looking outside the walls, as well as inside—by considering the wilderness of Quinnipiac; the dependence of the colony upon the mother country; the bicephalous State of Connecticut; the prosperous city of New Haven and its proximity to the great metropolis; and especially by considering what has been going on in the macrocosm of literature and knowledge where we represent a microcosm. Such a survey I shall not attempt, for I must keep close bounds. Yet even brevity must not suppress the fact that among the original colonists of New Haven, the real progenitors of Yale College, were three broad-minded men of education—John Davenport, a student of Oxford and a minister in London; Theophilus Eaton, the King's ambassador at the Court of Denmark; and Edward Hopkins, a merchant of enterprise and fortune, and earliest benefactor of American learning. Their successors also, the men of 1701, James Pierpont at the front, were worthy exponents of the ideas they had inherited; they were the wisest, broadest and most learned men of this region in that day. Liberal ideas were then in the advance and, thank God, are not yet in the background.

New England brought from Old England the customs, the studies, the graduates of Oxford and Cambridge, not those of Scotland or France or Germany. The exotic

germs were nurtured by Harvard for more than sixty years before the times were ripe for a second college in this region. Harvard instructors, laws, courses, phrases, were then adopted by the Collegiate School of Connecticut, and our alma mater began her life as a child of the new Cambridge and a grandchild of the old. 'Harvard has nourished Yale eighty years kindly ordered in Providence,' are the words of President Stiles. Yale has never ceased to be grateful for this noble ancestry, nor broken the chain of historic continuity. Yale does not forget that an honorable pedigree is its priceless possession, and delights to-day to honor its ancestry.

The seventeenth century was not the most brilliant period of university education in the mother country. The functions of universities had been usurped by colleges. Their scope was restricted; their regulations rigid and petty. Science and letters were subordinate to logic and grammar, and the maintenance of orthodoxy. Nevertheless, the new school made the best of it—and while still without a fixed habitation or a name, acquired both influence and reputation. It began with books, not bricks; with teachers, the best that could be had; and with ideas in respect to intellectual discipline which soon bore fruit in the service of Church and State.

The division between our first and second centuries, corresponding with the eighteenth and nineteenth centuries of our era, is not simply determined by the calendar. There are two periods to be considered as well as two centuries, each deriving its characteristics from the spirit of the age. The first of these, our forefathers went through the good old colony times of dependence upon England; the Revolution; the establishment of constitutional government; and the enlargement of national life and hope. It was the period too when a free church was to be established in a free state, when Chris-

tianity was to be promoted without the rule of hierarchy. The business of a college was to train two sets of leaders, those who would develop and administer republican government under new conditions, and those who would be ministers of the word of God among a Christian people separated from the Establishment. For scholastic discipline the books and methods approved in the mother country and adopted in Harvard were the only instruments. Such words as letters and science were not in their vocabulary. Religion and law, or as they said, the church and state, were the dominant concerns of patriot and sage.

Days of privation, anxiety, dispute, apprehension and experiment, introduced a time of stability, prosperity and union—years of plenty after years of want—and the second century opened with courage equal to opportunities. It is true that the ideas of original research, of experiment and observation, now so familiar, were hardly perceptible, but science had begun its triumphal march, and the humanities, in a broad sense, were destined to engage more and more the attention of educated men.

In the first decade, our record of 'the noble living and the noble dead' includes the name of one who was trained by alma mater for more than provincial usefulness and fame, Dr. Jared Eliot, who like the sages of antiquity, had the cure of souls and the care of bodies. A physician as well as a presbyter, living in a country town, preaching constantly, traversing a wide district on errands of mercy, he showed the qualities of an original investigator. He could ask hard questions and proceed to search for their answers; he would make no assertions that were not based upon observation or experiment, and he submitted his conclusions, by the printing press, to the scrutiny of the world. These are his sayings: "Entering on the borders of terra

incognita I can advance not one step forward, but as experience, my only pole-star, shall direct. I am obliged to work as poor men live, from hand to mouth, and as light springs up before me, as I advance." Again: "As all theory not founded upon matter of fact and that is not the result of experience, is vague or uncertain, therefore it is with great diffidence that I have offered anything in way of theory which is only conjectural and shall always take it as a favor to be corrected and set right."

It is not too much to claim that he made the first contribution from this land of iron and gold to the science of metallurgy in a memoir entitled, 'The art of making very good if not the best iron from black sea sand'; and he was a century or more in advance of his times in the promotion of scientific agriculture, as any one may see by looking up the six tracts, which he published in quick succession, and afterwards collected in a volume, on 'Field Husbandry in New England.' His science did not drown his humor, and he has left this short biography of his laboratory assistant, who was skeptical about results and needed stimulus: "He being a sober man (says Eliot) who could use strong drink with moderation and temperance, I promised him if he could produce a bar of iron from the sand, I would send him a bottle of rum." Such in colonial days was the spirit that promoted research.

No wonder that Benjamin Franklin found Eliot out and wrote him affectionately, "I remember with pleasure the cheerful hours I enjoyed last winter in your company, and I would with all my heart give any ten of the thick old folios that stand on the shelves before me, for a little book of the stories you then told with so much propriety and humor." Poor Richard, when he ranked ten folios below the wit and wisdom of his friend in Guilford, paid a compliment to the collegiate school of Connec-

ticut, but he had not in mind the folios with which the college was founded.

If it be true that Eliot was chosen a member of the Royal Society of London, the distinction is very great, for only David Humphreys, among Yalensians, had the like honor before the recent triumvirate, Dana, Newton and Gibbs.

Of Jonathan Edwards, the philosopher and theologian, I have no right to speak, but he must not be exiled from men of letters, especially since it is customary in recent years to call him by the name of one of the most illustrious of epic poets. His contemporaries placed no limits on their praise, and even wrote on his tombstone *Secundus nemini mortalium*, thus transcending the well-known Florentian epitaph, *nulli aetatis suae comparandus*.

His grandson, with pardonable atavism, declares that he

in one little life the Gospel more
Disclosed, than all earth's myriads kened before,
and then, alarmed by his own eulogy, he
adds, "The reader will consider this propo-
sition as poetically strong, but not as
literally accurate."

Edwards may be called a poet suppressed. His writings are often noteworthy for the graceful language in which refined thoughts have expression, and although no rhymes or verses of his are extant, some passages have a Miltonic ring. The most orthodox among us may hazard the opinion that his visions of the future state are fitly classified as works of the imagination.

Many years ago this extraordinary man was likened by Dr. Samuel Osgood, of New York, to Dante, and this comparison has been recently amplified in two brilliant addresses by Dr. Allen and Dr. Gordon in the commemoration of Edwards at Northampton, a century and a half after his banishment. A cooler critic has called him a great glacial boulder, one of the two huge literary boulders deposited in New England

thought by the receding ice of the eighteenth century. These striking terms may excite a smile, but they are not uttered carelessly, nor are they misfit. The logic of Edwards is like a rock, fixed as those masses of stone upon yonder hill where the regicides took refuge, hard to move and not easily broken up. Cotton Mather was his fellow traveler upon the ice fields which once covered New England, leaving scratches and furrows on many an eminence.

It is pleasanter to think of the flaming preacher as the Dante of New England. His language often glows with fire; his words burn; his fancy carries him to the borders of the Inferno and to the gates of Paradise. Nor is this all we can say. Our Dante had his Beatrice, and the words in which he speaks of her may well be placed in a parallel with that which narrates the love of the Italian for the daughter of Folco. Hear the earliest record that has come down to us of Dante's precocious and enduring love. "She was perhaps eight years old, very comely for her age and very gentle and pleasing in her actions, with ways and words more serious and modest than her youth required; and besides this, with features very delicate and well formed, and further so full of beauty and of sweet winsomeness that she was declared by many to be like an angel." "Although a mere boy, Dante received her sweet image in his heart with such appreciation that from that day forward it never departed thence while he lived."

Four centuries after Dante, Jonathan Edwards made this note in respect to the New England maiden of fourteen years, who became his wife. "They say there is a young lady in New Haven who is beloved by that Great Being who made and rules the world, and that there are certain seasons in which the Great Being comes to her and fills her mind with exceeding great delight. * * * She is of a wonderful sweetness,

calmness and universal benevolence, especially after this Great God has manifested Himself to her mind. She will sometimes go about from place to place, singing sweetly, and seems to be always full of joy and pleasure, and no one knows for what. She loves to be alone, walking in the fields and groves, and seems to have some One invisible always conversing with her."

Dante and Edwards alike in love, alike in their spiritual fervor, and in their impressive imagery, were alike in exile—both were driven from their homes, both died among strangers, both have been honored with increasing reverence by the descendants of those who rejected them.

In his youth Edwards showed a noteworthy proclivity toward the study of nature. An article is extant which he wrote at the age of twelve, recording his observations upon spiders and displaying the same qualities as those of Lubbock and Maeterlinck. Moreover, his undergraduate notebook gives evidence that his mind was alert for knowledge in other fields, and that he could ask searching questions in physics, including electricity, meteorology, physical geography and vegetation. One who was familiar with these precocious memoranda remarks that if they were written, as supposed, between the ages of fourteen and sixteen, 'they indicate an intellectual prodigy which has no parallel.' If he had been taught to use the lens and the meter as he used the lamp, he might have stood among the great interpreters of nature—the precursor of Franklin, Rumford and Rowland.

He was nurtured by theological dialectics, and he excelled not in physics, but in metaphysics, so to-day instead of honoring him as a leader in literature or science, we can only acknowledge with filial reverence, his wonderful influence upon the opinions and characters of six generations. The laws of intellectual inheritance are obscure, and the

influences he has handed down cannot be measured. It is, however, noteworthy that three of his descendants occupied the presidential chair of Yale for nearly sixty years, many others have been among our teachers; indeed there are few years in our second century in which the faculty has not included one or more of his posterity. I have read the printed verses of seven of his descendants—no small part colored (may I be pardoned for saying so) with the cerulean hue of religious fervor.

It is interesting to dwell upon the names of Edwards and Eliot as men of more than provincial fame, because the number of Yalensians who can be regarded as contributors to literature and science prior to the Revolution is small. The historian, Tyler, has taken the year 1765 as the close of the sterile period, when colonial isolation was ended and American literature began to be worthy of the name. Before that time neither Harvard nor any of the other colleges has much to speak of; yet afterwards, until the close of the eighteenth century, the product is almost as scanty. A recent paper enumerates the texts by which the youthful minds were disciplined.* Although the manuals and the methods were not inspiring, they encouraged discrimination and that power which used to be called ratiocination, 'generation of judgments from others actually in our understanding.' You may say that this is not 'experimental science nor literary culture,' and you say well. The ore, indeed, may have been extracted by the Eliot process, from black sand, but the Bessemer process had not been invented for turning iron into steel; nevertheless, we have the assurance of a recent Massachusetts critic,† that the highest literary activity of the later eighteenth century had its origin at Yale College.

* By Professor Schwab.

† Barrett Wendell.

Our elder brethren of the eighteenth century, with whom most of us have no more acquaintance that we get from the hortus siccus of a biographical dictionary, were men quite as intellectual as men of our day. When their acquaintance is cultivated and when the minute incidents of their lives and their quaint characteristics are sought out, they are as interesting as our contemporaries. Let us cease to regard them as mummies. The story of Manasseh Cutler is a succession of romantic incidents. Bishop Berkeley's transitory interest in the college and his permanent influence upon it is a captivating record. Jeremiah Dummer, little more than a name to most of us, was called by Charles Chauncey one of the three greatest New Englanders. The story of Liberty Hall, where William Livingston lived with his charming family of daughters, might be commended as the basis of a novel to the author of Hugh Wynne. Rector Clap, the fighting rector, led a life full of racy incidents, and certainly we have no more picturesque character on the roll than Dr. Stiles, now reintroduced by Professor Dexter to the society of which he was once a distinguished ornament—that extraordinary polyhistor to whom all knowledge was attractive, all tongues appetizing and all events pregnant.

As we recall the writers of influence and distinction among our brethren, we cannot fail to observe the dominant religious spirit which most of them show, and it may be well at the outset to remind you that the identity of theology and poetry is not peculiar to New England. The earliest biographer of Dante declared that 'theology was nothing else than the poetry of God.' 'Not only is poetry theology, but theology is poetry,' says Boccaccio, and then he adds that if these words of his merit but little faith, 'the reader may rely on Aristotle, who affirms that he had found that poets were the first theologians.' Judged by this

standard, we might find a good deal of poetry in our Yalensian products, during the eighteenth century, but by the criteria of modern scholarship, not much that would be commended by Matthew Arnold, not much that our own anthologist would cull for preservation.

Before the middle of our first century there appeared in New York a volume containing seven hundred lines of verse, entitled 'Philosophical Solitude; or the choice of a rural life: by a gentleman educated at Yale College.' This anonymity did not long conceal the authorship of William Livingston, one of the brightest students of his time, distinguished in many ways—once as 'the Presbyterian lawyer,' and later as Governor of New Jersey and member of the Constitutional Convention. His brother, also a Yalensian, was a signer of the Declaration. The verses show the influence of Pope, and among other points of interest in them, are allusions to the writers whom this young graduate desired for his intimate friends in the rural life he intended to lead.

In the Revolutionary War, two of our brethren, while acting as chaplains, were composers of patriotic songs. Many years later, the inspiration of the muses descended upon a number of recent graduates, who became known as 'the Hartford wits,'—'four bards with Scripture names,' John, Joel, David and Lemuel, any one of whom could produce an epic as surely, if not as quickly, as the writer of to-day would compose an article for the *Yale Review*. The group included John Trumbull, a precocious youth fitted for college at the age of seven, whose burlesque treatment of the Revolutionary war called 'McFingal,' ran through thirty unauthorized editions; the versatile Joel Barlow, author of 'Hasty Pudding,' who worked for half his life, we are told, upon the 'Columbiad,' having in the interval of his engagements adapted Watts's Psalms to the use of Connecticut churches

and added several original hymns; David Humphreys, who translated a French tragedy, entitled the 'Widow of Malabar,' and composed several ambitious poems; and finally, Lemuel Hopkins, an honorary graduate. The Harvard historian whom I have already quoted has said that at the time the Hartford wit wrote, no Harvard man had produced literature half as good as theirs.

Perhaps one may, without offence, at this late day, refer to the ponderosity of this early poetry. 'McFingal' and 'Hasty Pudding' and the 'Progress of Dulness' would hardly be found amusing in these days, although they were mirthful. 'Greenfield Hill' is hard reading. The seriousness of such subjects as the 'Conquest of Canaan,' the 'Vision of Columbus,' the 'Anarchiad,' and 'The Last Judgment, a Vision,' was characteristic of the times and was adequately sustained by the serious treatment to which these themes were subjected. Indeed, in this period, lofty ideals were entertained, and long and elaborate poems were so naturally attempted that a commencement orator (as late as 1826) delivered a discourse on 'some of the considerations which should influence an epic or a tragic writer in the choice of an era.' The spirit of Hebrew poetry hovered over our elms, more constant than Calliope or Euterpe. It suggested dramas, which have died, it found expression in hymns, which have lived. I could name five of these. Brethren, answer the question of Emerson—

Have you eyes to find the five
Which five hundred did survive?

At the beginning of our second century we come upon the name of John Pierpont, preacher, patriot, advocate of every cause which would improve his fellow men, whose verses are at the front of two recent anthologies. Bryant just missed enrolment among us. He took a dismissal from Williams in

order to enter Yale, but he did not fulfil his purpose. Fitzgreen Halleck, a native of this county, did not go to any college. Not long after Pierpont, the two Hillhouses were graduated. The elder, James, was author of 'Percy's Masque' and three other dramas, the last of which, entitled 'The Judgment, a Vision,' was intended (says the author) to present 'such a view of the last grand spectacle as seemed most susceptible of poetical embellishment.' He was a gifted writer of fine taste and lofty ideals; and his writings were most highly esteemed by the generation to which he belonged. His name is dear to us as the poet of Sachem's wood, the beautiful park at the head of Hillhouse Avenue—the park and the avenue alike commemorating his distinguished father, to whom the city of Elms is beyond estimate indebted. For East Rock and West Rock he suggested the names of 'Sassacus' and 'Regicide.'

Later came Brainard, cut down in his youth, and brought to life at the call of Whittier; and William Crosswell, son of the rector of Trinity Church, one of the most cultivated of churchmen, whose poems, ten years after he died, were edited by Bishop Coxe. In the class of 1820 were two men whom we honor for so many other reasons that we forget their poetry—Woolsey and Bacon. As the first quarter of the century closed, the college diploma was given to James G. Percival, that unique, eccentric, impracticable combination of science and literature, learned to superfluity, versatile to inconstancy, loving nature, books, words, yet disliking men as he met them; geographer, geologist, linguist, lexicographer, poet, with much of the distinction and a fair amount of the infelicity which characterizes genius. His metrical studies are remarkable illustrations of the Laws of Verse. Next came N. P. Willis, graceful in prose and verse, remembered by some for his Biblical lyrics, and by others

for lines in praise of New Haven elms; and soon, Ray Palmer, whose sacred song has been translated into twenty languages, and sung in Arabic, Tamil, Tahitian, Mabratta and Chinese, as well as in the tongues of Christendom. George H. Colton, one of a family that has cultivated the muses, published a poem on Tecumseh soon after he graduated in 1840. Twenty years later came Weeks and Sill—Weeks who died before he had stretched his wings for the flights of which he was capable; and Sill, bright and beloved Sill, whose verses, collected since his death, exhibit as do his essays and letters, an intellect strong, unconventional and suggestive. These are not all the departed whom we may hold in honorable remembrance.

It is no part of my plan to say much about the living, but there are two writers entitled to special mention—Finch, the author of stanzas which have brightened the fame of Nathan Hale; and Stedman, anthologist and historian of Victorian poetry, the poet of yesterday and to-morrow, the youth who won his laurels as an undergraduate writer in the *Yale Literary Magazine*; the singer who wears them still upon his frosty brow.

The comparison has been made between the graduates of Harvard and of Yale, and the long and brilliant list of historians and poets of Cambridge has been contrasted with the shorter and less famous list of New Haven. Our friends at heart will doubtless attribute something, as is their wont, to the proximity of Boston, a beacon set upon the hill, a port of entry for the culture of other lands, where the Athenæum, still foremost among the society libraries of the United States, was an inspiring resort, close akin to the London Library, giving to men of letters both sustenance and stimulant. It is however, probable that the difference between the two colleges is due to the fact that in Eastern Massachusetts during the last century

dogmatic theology has been neglected and the ablest intellects have been free to engage in literary production. Perhaps this is true. I do not know. We may claim this, however, without making any comparison, that Yalensians from the beginning were brought up in obedience to 'Duty, stern daughter of the voice of God'; that the College was founded for the fitting of men to serve the church and state, and that the graduates of Yale, whether famous or unknown, are devoted to the service of their country and show that they have been trained to think, to reason, to write and to speak with freedom and with force. We can every one of us recall classmates and friends, men we have heard and men we have heard of, who have been like village Hampdens, or mute inglorious Miltons; and we can also recall those who have shown, at the bar and on the bench, in the cabinet and in diplomacy those qualities which under other conditions would have made them orators and authors. The point I make is this, that the Yale training has tended to the development of strength rather than of grace. "I thank God" said a famous preacher who studied in both places, "that I struck no literary roots at Yale and no theological roots at Harvard." "I thank God too," said one of his teachers at New Haven.

It is certainly true that hundreds of the graduates of Yale have been accurate and forcible writers, who have known what to say and how to say it; and that they have in this way rendered an incalculable service to the country, far and wide, even though we admit that, under the pressure of strenuous life, but few of them have shown those literary qualities which are usually evoked where writers and critics come in close relation to one another, as they do in cities and in large universities. Long ago, Bishop Fraser said of the United States, that the people were the most generally edu-

cated, if not the most highly educated, people in the world. Something like this we may say of the Yale alumni—if they number few men of genius, they number many men of talents, usefulness and power; if there are none who are equal to Tennyson and Schiller and Victor Hugo, there are many who have been the advocates of truth and the promoters of social reform, in terse and vigorous English. They have excelled in the pulpit and at the bar, and in the halls of legislation, so that without mentioning the names of men whom we have personally known, I will remind you of that long line of jurists and statesmen who were living near the beginning of our second century, William Samuel Johnson, Pelatiah Webster, John C. Calhoun, James Kent, Jeremiah Mason, and that constellation of New England theologians, an innumerable host, from Edwards to Taylor.

Professor Kingsley was called the Addison of America, and he had such wit, knowledge and grace as might have given him distinction in literary composition if he had so directed his energy; but he was one of those 'generally useful men' that this college produces, who held at one time what we should call four chairs. We should all be proud to claim as the product of our alma mater James Fenimore Cooper, but we cannot, for like Shelley from Oxford, he was driven out because of a boyish misdemeanor. Professor Kingsley once told me this story: The novelist Cooper, Judge Kane, of Philadelphia, and Hon. John C. Spencer, of New York met at a dinner. 'Where were you educated?' said one. 'I had the honor of being turned out of Yale College,' was the reply. 'And so did I,' said the second; and 'I had the same honor,' said the third. *Hæc fabula docet* that boyish liveliness is not always fatal to mature success. If we cannot claim Cooper, Theodore Winthrop is ours—the essayist and novelist, whose posthumous

fame shows what was lost to letters when he died a patriot's death upon the field of battle.

Lounsbury says that Cooper left Yale with little learning in his head and then he wittily adds, "No one will doubt this who has learned to view with profoundest respect the infinite capability of the human mind to resist the introduction of knowledge."

In the second quarter of the nineteenth century the influence of Coleridge is apparent. William Adams, Horace Bushnell, Lyman Atwater, William Watson Andrews and Noah Porter are conspicuous examples of this infusion of idealism. Their writings are in evidence. The powerful imagination which produced 'The Ancient Mariner' and 'Christabel' had been directed to the transcendent study of the Infinite, and many who turned away from the most rigid tenets of Calvin, and from the literal interpretation of the Old Testament, were strengthened and guided by the philosopher of Highgate. Bushnell confessed greater indebtedness to the 'Aids to Reflection' than to any other book—save the Bible. Of the theological emancipator, I am not called upon to speak—of the gifted writer more than passing mention must be made. His sermons, addresses and essays always arrested the attention and excited the imagination of those who heard and those who read them. For example, his estimate of Connecticut, his 'Age of Homespun,' indeed all the contents of his 'Work and Play,' and many parts of 'Nature and the Supernatural,' glow with life and fancy, and will be as good reading for our grandchildren as they were for our fathers. The incisive notes of his voice as I first heard it when an undergraduate, still ring in my ears—and his racy sentences, his inspiring and suggestive phrases, and the eloquence of his thoughts were even more impressive than his voice. The name of Horace Bushnell

is a precious heirloom handed down from the Yale of the last century to the Yale of the present. He was an orator, a poet, a lover of nature, and of man—fearless, original, persuasive, too liberal for the conservatives, too conservative for the liberals of that day, now honored in both their schools. Horace Bushnell is the greatest of this group. Indeed I should place him, in genius, next to Jonathan Edwards.

Not a few of our brethren have excelled in historical writing. Stiles wrote a history of the exiled Judges, and Benjamin Trumbull the history of Connecticut; Samuel Farmer Jarvis was designated historiographer of the Episcopal Church; Moses Coit Tyler is the historian of American literature; Andrew D. White is the defender of science versus bigotry, whose history should make us grateful that Yale has been one of the most important American agencies for the emancipation of the human intellect from ignorance and dogmatism; Charles L. Brice is the exponent of Gesta Christi; George P. Fisher, an honored member of the faculty for almost fifty years, stands in the foremost rank among the ecclesiastical historians of this country, and Leonard Bacon, the Puritan, always remarkable for clearness and vigor, whether religion or politics was his theme, is the author of discourses on the early days of New Haven, which remain unsurpassed in the field of local history. He was like a modern Isaiah, the trenchant defender of political righteousness. Stillé's pamphlet, 'How a Free People conduct a Long War,' was one of the most inspiring products of the uprising for the Union; and Schuyler's studies in Turkistan and his essays in diplomacy are enduring memorials of another 'all round man,' observer, critic, traveler, essayist, historian, diplomatist—good in whatever he undertook.

Comparative philology was introduced among us by Josiah W. Gibbs, but the

chief impulse in this direction came from Salisbury, the first to teach Sanskrit in America. He recognized the ability and secured the services of one who was not a graduate, it is true, but an adopted son, whose honors are our honors, whose fame carries the name of Yale to every university of the Indo-European world, that illustrious scholar, William D. Whitney. We must remember that James Murdock in 1851 published a translation of the Peshito Syriac version of the New Testament; that Moses Stuart at an earlier day carried from New Haven to Andover, an enthusiastic, if not always accurate, devotion to Biblical literature; and that a learned and devoted scholar, Eli Smith, within sight of Mt. Lebanon, translated nearly all the Bible into Arabic, as in later days Hiram Bingham translated it into one of the languages of the Pacific Ocean.

Another interesting phase of philological study is shown in the attention given to the study of the languages of the North American Indians. This began very early, when Sargent, Brainard, Spencer and Edwards were engaged as missionaries to the aborigines in Western Massachusetts and in Central New York. The philological importance of the American speech was recognized in recent days by James Hammond Trumbull, who with rare aptitudes for the elucidation of knotty problems, directed his attention to the Indian languages of the Eastern States, and was soon acknowledged as foremost in that uninviting and perplexing field of inquiry. Before long we shall have his lexicon of the Natick Speech, so that he who will may cultivate the love of comparative literature by reading Eliot's Indian Bible. Daniel G. Brinton in other branches of aboriginal research has also won renown.

An unusual manifestation of the love of letters is shown by the attention given during the last century to lexicography. For

a time Yale was a veritable storm-center. Webster versus Worcester, and Worcester versus Webster were chieftains in this 'Battle of the Books,' and both authorities were graduates of Yale. Lately, Whitney, W. the Third, has taken rank with the best antecedents, and a score of cooperative Yalensians, many of them specialists, have been engaged in the improvement of the three great dictionaries. It is customary to laugh at the changes in spelling proposed by Noah Webster, and certainly some of the Johnsonese definitions which he propounded were mirth-provoking—('sauce,' for example)—but revised and improved by Goodrich, Porter, Kingsley and others, his dictionary holds its own. Its popularity was due in part, no doubt, to Webster's spelling book, of which the annual sale at one time was twelve hundred thousand copies. By this primer a very great service was rendered to letters—for it helped to counteract any tendency toward provincial or dialectic peculiarities among the heterogeneous people of the United States.

Apart from theology, philosophy has engaged the attention of many of our ablest brethren. This is especially true of the time since Porter was called to the professorship which he held with conspicuous distinction for almost half a century, including the years of his presidency. A recent investigator has traced the influence of this able teacher, well versed in the modern writers of Germany, who made metaphysics interesting to those who were indifferent, and at his best in the analysis of conflicting theories and in the detection of subtle errors. As a lawyer for the defense, he would have been the peer of Rufus Choate. Not a few of his pupils have been led through philosophy to pedagogics and are winning distinction in this field.

This review would be incomplete if I did not mention the *Yale Literary Magazine*,

which for more than three score years has kept up the love of literature among the undergraduates, and has furnished them with appreciative readers, critical enough and friendly enough for discipline. Many editorial writers have been trained by their service on this magazine, since Evarts set the press in motion. Older Yalensians have had their opportunities in magazines of wider circulation, the *Christian Spectator*, the *New Englander* and the *Yale Review*, not officially connected with the college, but supported by the faculty.

The literary societies also, which for more than a century were maintained with vigor, seem to me to have been one of the very best agencies for youthful discipline. The spontaneous efforts of young men, excited by the emulation of their comrades, and controlled by the friendly criticism of their peers, were admirable exercises for the development of the love of poetry, oratory, essay writing and debate.

One of the greatest services which this college has rendered to literature and science has been the preparation of an innumerable host of teachers and professors. The list is too long for recapitulation here—but a few names must be recalled. The earliest was Jonathan Dickinson, first president of Princeton, deemed in his time the peer of Edwards, whose immediate successors were likewise Yalensians. Next came Samuel Johnson, the friend of Berkeley, first president of Columbia University, elected president of the University of Pennsylvania, and his more famous son, William Samuel Johnson, who succeeded to the presidency of Columbia, and stood in the first rank among the statesmen of the period just subsequent to the Revolution. From the Wheelocks, of Dartmouth to Sturtevant, of Illinois, Chauvenet, of St. Louis, and Chapin, of Beloit, the file leaders in our colleges have constantly been elected from Yale. At a recent date lived Thomas H. Gallaudet,

pioneer in the instruction of deaf mutes, and Henry Barnard, ever to be associated with Horace Mann, as advocate, expounder and promoter of the American system of common schools. Nor can I forget Henry Durant, and the other graduates of this college, who went to the Pacific coast, 'with college on the brain,' and planted in California the seeds of learning which now bear harvests of golden grain. A happy thought gave the name of Berkeley to the site near the Golden Gate, where an institution begun by our brothers fulfils the remarkable prophecies of Timothy Dwight, written in 1794 :

All hail ! Thou Western World ! by heaven designed

The example bright to renovate mankind !
Soon shall thy sons across the mainland roam
And claim on fair Pacific's shore a home.

Where marshes teemed with death, shall meads unfold,

Untrodden cliffs resign their stores of gold.

Where slept perennial night, shall science rise,
And new-born Oxfords cheer the evening skies !

Let us turn from letters to science. As I scan the administrative records, from the beginning onward, with the aid of our right well beloved and trustworthy archivists, the two Kingsleys and Dexter, when the scepter passes from one president to another, the balance is kept true. Pierson was an exponent of geometry and a defender of the faith, who wrote out lectures upon physics, and dictated them to successive classes ; Cutler's short service gives little indication of his attitude ; Williams loved public life more than academic perplexities ; Clap was a writer on ethical and astronomical subjects, a student of the Bible, scarcely equalled, says his successor, in mathematics and physics by any man in America ; Daggett, extremely orthodox, was scientific enough to warn his townsmen, scared by 'the Dark Day,' not to be alarmed nor 'inspired to prophesy any future events—till they should come to pass' ; Stiles was familiar with

every department of learning, 'theology, literature, science, whatever could interest an inquisitive mind * * * he included among the subjects of his investigations' ; * the elder Dwight is well known for the impulse that he gave to the expansion of the college in all directions ; the judicious Day was the author of a metaphysical study and of mathematical text-books ; Woolsey is distinguished as the promoter of classical literature, and at the same time as the president under whom the School of Science was developed ; Porter and the younger Dwight brought the University forward to its present comprehensiveness and influence in all branches of knowledge. Indeed, science and letters have always been the care of the corporation, and such will be the care while the helm is held by the discerning and vigorous pilot under whom the bark begins another voyage and so long as the alumni crew support the master and the mates.

Considering the hesitation with which the English universities recognized the study of nature as their concern, and how easy it is to awaken hostilities between the students of science and letters, or between ecclesiastics and naturalists, it is well to remember how early science came into the Yale curriculum, and how steadily it has held its place. A chair of mathematics, physics and astronomy was instituted thirty years before the professorship of ancient languages. As it is pleasant to associate the name of Sir Isaac Newton with the beginning of our library, it is likewise pleasant to remember Benjamin Franklin as a donor of scientific apparatus. 'Immortalis Franklinus' he was called by Stiles.

Before the college was fifty years old he became its valued friend, and was enrolled among the laureati in 1753. Four years previous, he had sent here an electrical

* J. L. Kingsley.

machine which enabled the young tutor, Ezra Stiles, to perform the first electrical experiments tried in New England. A Fahrenheit thermometer was a subsequent gift, and his influence led the University of Edinburgh to confer upon Stiles a Doctor's degree.

At the dawn of scientific activity in New England we see the commanding and attractive figure of our elder brother, Manasseh Cutler, storekeeper, lawyer, soldier, statesman, pastor, preacher, physician and naturalist, member of the Legislature and of Congress, appointed to the federal bench, advocate of the 'homestead' policy, and a pioneer among the settlers of the wilderness of Ohio. His greatest distinction is the part that he took in drafting and passing the ordinance of 1787, by which slavery was excluded from the Northwest Territory and a grant of the public domain was secured for the promotion of education. That is a record to be proud of, brethren of the Alumni, but it does not include the whole story. Cutler, a man of the true scientific spirit, an observer of the heavens above and of the earth beneath, is the father of New England botany. He made a noteworthy contribution to the memoirs of the American Academy, collected and described between three and four hundred plants of New England, and left seven volumes of manuscript notes, which are now in the Harvard herbarium, awaiting the editorial care of a botanical antiquary. Franklin and Jefferson valued him as a friend, and his correspondents in Europe were among the chief naturalists of the day.

About the beginning of the nineteenth century, Dwight and his three professors, who only uttered *sotto voce* the word university (though Stiles had written it in 1784), lest they should be regarded as pretenders, introduced a new era in which the progress has been constant and of increasing rapidity. In this new era, classical studies have been

promoted by Kingsley, the lover of antiquity, whose keen sword defended the study of classics; Woolsey, the lover of letters, who introduced to us Plato and the dramatists of Greece; Thacher, the lover of students; Hadley, the lover of lore; Packard, the lover of learning—and by the accomplished standard bearers still living; and science likewise had its skilled promoters: Silliman, leader in chemistry, mineralogy and geology, the alluring teacher, the captivating lecturer, unsurpassed by any, equalled only by Agassiz; Olmsted, the patient, inventive instructor, whose impulses toward original investigation were not supported by his opportunities; Loomis, interpreter of the law of storms and master of the whirlwind; Dana, the oceanographer, [who wore the tiara of three sciences; Newton, devoted to abstract thought, who revealed the mysteries of meteoric showers and their relation to comets, not before suggested; and Marsh, the inland explorer, whose discoveries had an important bearing on the doctrine of evolution—these all with the brilliant corps of the Sheffield Scientific School were men of rare ability who expounded and illustrated the laws of nature with such clearness and force that the graduates of Yale are everywhere to be counted as for certain the promoters of science.

Two agencies are conspicuous in the retrospective of this second era, the *American Journal of Science*, and the Sheffield Scientific School. Benjamin Silliman showed great sagacity when he perceived, in 1818, the importance of publication, and established of his own motion, on a plan that is still maintained, a repository of scientific papers, which through its long history has been recognized both in Europe and in the United States, as comprehensive and accurate; a just and sympathetic recorder of original work; a fair critic of domestic and foreign researches; and a constant promo-

ter of experiment and observation. It is a unique history. For more than eighty years this journal has been edited and published by members of a single family—three generations of them—with unrequited sacrifices, unquestioned authority, unparalleled success. In the profit and loss account, it appears that the college has never contributed to the financial support, but it has itself gained reputation from the fact that throughout the world of science Silliman and Dana, successive editors from the first volume have been known as members of the faculty of Yale. I am sure that no periodical, I am not sure that any academy or university in the land has had as strong an influence upon science as the *American Journal*.

A century has nearly passed since Benjamin Silliman was chosen a professor and went to Scotland, there to fit himself for the duties of the chair. What a century it has been! The widespread interest among our countrymen, in geology, mineralogy and chemistry is due in no small degree to his instructions here, and to the lectures that he delivered in every city between Boston and New Orleans.

The Sheffield school celebrated three years ago its semicentennial, and its useful services were rehearsed by one who will not venture to offer you a twice told tale. You must, however, permit him to remind you that fifty years ago the choice of studies was but timidly permitted in the traditional college, and that there was a strong demand for courses less classical, more scientific than were then offered. These wants the school supplied without antagonism or rivalry, though not without the awakening of alarm. It proved to be a rich addition to the resources and the renown of Yale, as every one admits. Its faculty was made up chiefly of men whose ideas were broad, whose distinction was acknowledged, whose methods were approved, and this, with the

munificent support of the benefactor whose name the school has been proud to bear, enabled Yale to stand forth as the ready, wise and resolute promoter of education in science. The alumni of the school are the proofs of its success.

Agricultural science in the United States owes much to the influences which have gone out from the Sheffield School. John P. Norton, John A. Porter, Samuel W. Johnson, William H. Brewer, each in his own peculiar way, has rendered much service. Johnson is preëminent, and in addition to his standing as a chemist, is honored as one of the first and most persuasive advocates of the experimental stations now maintained, with the aid of the Government, in every part of the country. We cannot forget the value of 'the crops'—we may forget how much their value has been enhanced by the quiet, inconspicuous, patient and acute observations of such men as those whom I have named, the men behind the men who stand behind the plow. They are the followers in our generation of Jared Eliot, the colonial advocate of agricultural science.

In the thirties there was an informal association which may be called a voluntary syndicate for the study of astronomy. Its members were young men of talents, enthusiasm and genuine desire to advance the bounds of human knowledge, but their time was absorbed by various vocations, and their apparatus seems lamentably inadequate in these days of Lick and Yerkes, of spectroscopes, heliometers and photography. Yet we may truly claim that the example and success of these Yale brethren initiated that zeal for astronomical research which distinguishes our countrymen.

The Clark telescope, acquired in 1830, was an excellent glass, though badly mounted, and was then unsurpassed in the United States. One of its earliest and noteworthy

revelations was the appearance of Halley's comet, which was observed, from the tower in the Athenæum, weeks before the news arrived of its having been seen in Europe. This gave an impulse to observatory projects in Cambridge and Philadelphia, and college after college soon emulated the example of Yale by establishing observatories in embryo, for the study of the heavens. The most brilliant luminary in the constellation was Ebenezer Porter Mason, a genius, who died at twenty-two, having made a profound impression on his contemporaries by discoveries, observations, computations and delineations. After his death, which was lamented like that of Horrox, it was not thought an exaggeration to compare his powers with those of Sir William Herschel—or even of Galileo. Under the leadership of Olmsted, Herrick, Bradley, Loomis and Hamilton L. Smith were associate observers, and they were afterwards reinforced by Twining, Lyman and Newton. Chauvenet became a writer and teacher of renown, and Stoddard carried to the Nestorians the telescope that he had made at Yale under the syndicate's influence.

The investigations of these astronomers were directed to the aurora borealis, the zodiacal light, the recurrence of comets, the meteoric showers, and the possible existence of an intra-mercurial planet. Newton became the most distinguished of the group. Partly by antiquarian researches in the records of the past, continuing the notes of Herrick, partly by mathematical analysis and a careful comparison of the paths of meteors he determined the periodicity of these mysterious and fascinating phenomena, and their relation to comets.

The astronomical syndicate of Olmsted and his pupils was long ago dissolved, but its spirit hovers near us, and beyond Sachem's wood, in the Winchester Observatory, skilled astronomers with their great heliometer are engaged upon problems

which were not even thought of by the discerning intellect of Mason and his brilliant confreres.

In the science of mineralogy Yale has long maintained the American leadership. Every one of us has heard the story of the candle-box of specimens, which Silliman carried to Philadelphia to be named, and every one of us has seen the subsequent accretions to the nucleus, beginning with the Gibbs cabinet, now shown in the Peabody Museum. No one is likely to overestimate the influence of this collection upon the mind of James D. Dana, nor to overestimate the value of his treatise on mineralogy which, revised and enlarged by able cooperators, continues to be a standard text-book in every country where mineralogy is studied.

In view of its recent acquisition, I am tempted to speak of the Museum as the 'House of the Dinosaur.' Its choice collections give an epitome of the sciences of mineralogy, crystallography, meteoroids, geology, paleontology and natural history, from the days of Silliman to those of the Danas, Brush, Marsh and Verrill.

The heart of a university is its library. If that is vigorous, every part of the body is benefited. Our college began with books; the incunabula were given by the founders, good books no doubt, if not a single volume relating to classical literature or the sciences was among them. Noteworthy accessions came at an early day, some of them from Elihu Yale. Think of eight hundred volumes sent from England, including the gifts of many famous writers. Remember such donors as Sir Richard Steele, of the *Spectator*, and the great Sir Isaac Newton, and then be grateful to forgotten Jeremiah Dummer, who collected and forwarded this precious invoice. Fifteen years later than Dummer's donation came nine hundred volumes from Bishop Berkeley, which with his bequest for scholarships and prizes, entitle him to receive the highest praise as

an early and liberal promoter of the humanities. Renewed homage should now be given to the benefactor whose timely and catholic bounty enriched this adolescent college. Therefore, let us repeat once more the verse of Alexander Pope and ascribe 'to Berkeley, every virtue under heaven.' Gratitude to this great philosopher shall not diminish our acknowledgments to that long line of donors who have made the library worthy of the university which has grown up around it.

Bibliographers and librarians are the servants of the temple—*servi servorum academicæ*—and such as Edward C. Herrick, Henry Stevens, William F. Poole, and James Hammond Trumbull, are rare men, conspicuous among the promoters of historical research.

In controversial periods the attitude of Yale has been very serviceable to the advancement of truth. The Copernican cosmography was probably accepted from the beginning, although elsewhere the Ptolemaic conceptions of the universe maintained their supremacy, and the notes which Rector Pierson made on physics when he was a student in Harvard come 'between the Ptolemaic theory and the Newtonian' (Dexter). When geology became a science, its discoveries were thought to be in conflict with the teachings of the scripture. Ridicule answered the arguments of science, and opprobrium was thrown upon the students of nature. Brave Silliman stood firm in the defense of geology, and although some of the bastions on which he relied became untenable, the keep never surrendered, the flag was never lowered. When the modern conceptions of evolution were brought forward by Darwin, Wallace and their allies, when conservatists dreaded and denounced the new interpretation of the natural world, the wise and cautious utterances of Dana at first dissipated all apprehensions of danger, and then accepted

in the main the conclusions of the new biological school. The graduates who came under his influence were never frightened by chimæras. Marsh's expeditions to the Rocky Mountains, and his marvelous discoveries of ancient life, made the Peabody Museum an important repository of geological testimony to the truth of evolution.

I remember the surprise of Huxley in 1875 when, at a dinner of the X Club in London, I told him of Marsh's discovery of the fossil horse. In the following year, the great English naturalist came to New Haven to see in the Peabody Museum that of which he had heard and read. In his lectures at New York he soon described the work of Marsh, and subsequently referred to its important bearings.

Scant justice has been done in this discourse to the sciences promoted at Yale—and the deficiency is the more apparent when I think of the men now living whose work has been precluded from our scope. The next centennial discourse will do justice to them. Among the departed whose careers were made outside the walls of Yale, Percival, the geologist of Connecticut and Wisconsin; J. D. Whitney, the geologist of California; Chauvenet, the mathematician; Hubbard, the astronomer; Sullivant, the chief authority in mosses as Eaton is in ferns; F. A. P. Barnard, the accomplished president of Columbia; Eli Whitney, the inventor of the cotton-gin, and S. F. B. Morse, whose name is familiar from its relation to the electric telegraph—are especially entitled to honorable mention in this jubilee. So is a much older graduate, David Bushnell, the inventor of submarine explosives—the precursor of the modern torpedists.

There is a good deal to think about in the annals of Yale. It is not a perfect record. Deficiencies, errors, failures are met with from time to time—such as are

found in every human institution, even in those most sacred. It is not my business to seek them or point them out. It is rather my privilege to honor the good men that have built up for us and for our successors this great edifice, upon the firm foundations of devotion and faith; to admire the skill, the prudence and the honesty with which inadequate resources have been husbanded; and especially to appreciate that admirable union of conservative and progressive forces which keeps hold of that which is good until the better is reached, that believes in the study of nature and all its manifestations, and of man and all that he has achieved in language, philosophy, government, religion and the liberal arts.

This honored and reverend seminary has taught thousands of men of talent to be wise and good citizens, avoiding avarice and pretense, ready for service wherever Providence might call them, in education, philanthropy, diplomacy, statesmanship, church-work, literature and science; not a few men of genius have submitted themselves to her discipline and acknowledged the inspiration derived from her counsels; some of her sons have laid down their lives for God and their country; many have carried to the ends of the earth her precepts and principles; all, or nearly all, have been the friends and supporters of republican institutions, the lovers of sound learning and good books, the promoters of science whenever their aid was wanted, its alert defenders against bigotry and alarm, confessors of the christian doctrine.

The new order which gives to adolescence an extreme freedom in the choice of studies may be more favorable than the old to the production of men of letters, poets, orators, historians, essayists—and of investigators who will extend the bounds of mathematical, physical and natural science. Nobody can tell. Every one is hopeful. But with

all their gettings, may the new generation emulate their forebears in wisdom, self-control, sound judgment, and in hearty appreciation of all that books have recorded and all that nature has revealed.

Much reproach has been thrown upon the studies of colonial days because they were mainly directed toward theology and philosophy, and because there was so little study of the natural world. It is well to reply that nature studies are the growth of the last century, since Berzelius, Cuvier and Liebig initiated the modern methods of inquiry, carried on by Faraday, Darwin and Dana. Remember also that rigid discipline in logic and dialectics makes clear and accurate thinkers, fitted to treat the current questions of society with discrimination, perspicuity and persuasion. If our grandfathers did not excel in what we are pleased to call literature, they were taught to follow the rule of an illustrious writer, 'to use words coinciding as closely as possible with what we feel, see, think, experience, imagine and reason.' Such men were fitted to take part in the great Revolution of 1776, and in the war of 1861; to be influential in the formation of the Constitution of the United States, and in the administration of justice and order in every State of the Union, qualified likewise to lead in the organization and development of academies of science and schools of learning, defenders of the faith, upholders of right conduct, advocates of civil service reform, promoters of literature and science, and in general, trained by such discipline as they here received in mathematics, logic, history, language, philosophy and science, to be the leading men in every community where their homes were placed.

On fame's eternal camping ground
 Their silent tents are spread,
 And glory guards, with solemn round,
 The bivouac of the dead.

DANIEL C. GILMAN.

THE GLASGOW MEETING OF THE BRITISH
ASSOCIATION FOR THE ADVANCE-
MENT OF SCIENCE.

THE GEOGRAPHICAL SECTION.

THE president of the Geographical Section, Dr. H. R. Mill, took as the subject of his address the definition of the task of scientific geography and the subdivisions of the subject. In giving a brief review of the ideas of the older geographers, attention was called to an important, but well-nigh forgotten, work by Nathaniel Carpenter, fellow of Exeter College, Oxford, published 1625, under the title 'Geographie Delineated forth in two Books, containing the Spherick and Topickall parts thereof,' a work characterized by a clear appreciation of the relations of the various subdivisions of the subject and by a clear perception of the good and the bad in the work of his predecessors and contemporaries.

Dr. Mill defined geography as 'the science which deals with the forms of relief of the earth's crust, and with the influence which these forms exercise on the distribution of all other phenomena,' and he divides the subject into: (1) Mathematical geography, which regards the earth as a spinning ball lighted and warmed according to a rigid succession of diurnal changes. (2) This merges into physical geography which is concerned with the contemporary changes in the crust and in the surrounding fluid envelopes. (3) Biogeography or the geographical distribution of life, and finally (4) Anthro-geography or the relation of man to the earth's crust, a subject which must be separated for the more general third division on account of the number of exceptions it presents to the laws governing the distribution of the lower forms of animal life and on account of the exceptional powers possessed by man for modifying the conditions of the earth's surface. Viewed from this broad standpoint it is evident that enough attention has not

been paid to geography by the universities. It is true that Oxford possesses a school of geography and Cambridge has a reader in that subject, while in this country physical geography receives most able attention in a few of our great universities; but more should be done towards coordinating the various subdivisions of the subject. Nowhere can this be better done than in the universities. Viewed in the broad sense, as outlined by Dr. Mill, geography would form a discipline worthy of a place upon our college curriculums; the practical advantages to be derived from a comprehension of the materials already in hand would be great both in direct results and in suggestions for future work.

Of this last Dr. Mill's address is a proof in itself and while many of his suggestions are more especially applicable to the needs of the British Isles, still some might be profitably carried out in connection with the surveys of this country. Thus maps showing the character of the superficial soil, such as the *cartes agronomiques* of France, would be a most valuable asset in the hands of any government and the same is true of carefully collated material with reference to the rainfall and configuration of stream-beds in different sections of the country, the horse-power of the rivers and streams being eventually determined from such data as has already been done in Finland. Mention may also be made of the population maps constructed by Mr. Bosse on the plan of indicating by dots the exact distribution of the population, the usual method of estimating population by counties or states giving but imperfect ideas of the true distribution. The population map of England shows in a most remarkable manner the relation of population to the geological character and configuration of the country and a knowledge of the conditions governing distribution in any country cannot fail to be of the

greatest importance from both political and sociological standpoints.

A number of papers describing itineraries in various portions of the world were presented to the section, but reference need be made to but few of these and of the more general topics discussed a few may be briefly mentioned. Professor Ireland, in a paper on 'The Geographical Limits of Popular Government,' maintained that climatic conditions unfitted the inhabitants of tropical regions for representative government, and in these regions the administration must be placed in the hands of trained Europeans. Dr. W. G. Smith presented an account of the botanical survey of Scotland, which is at present being carried out on the basis of a modification of the plan adopted by Professor Flahault of Montpellier. The entire flora is regarded as being composed of a number of 'plant associations,' in each of which there is one or more dominant species, and the object of the survey is to map out these associations. Maps of the associations of Northern Perthshire and of an area in the vicinity of Edinburgh have already been published and the work on Fife and Forfar is ready for publication. Professor Moreno, of the Museum of La Plata, gave an interesting account of the anthropogeography of the Argentine Republic, in the course of which he took the position that the races of South America were of great antiquity and that instead of the civilizations of Peru and Bolivia coming from the north, they were in reality much older than such civilizations as that of the Pueblos.

An account of the National Antarctic Expedition organized by the Royal and the Royal Geographical Societies was given by Dr. Scott Keltie, and Mr. W. S. Bruce described the plans of an expedition which he hoped to lead next year to the Weddell Sea and which he spoke of as the Scottish National Antarctic Expedition, since the

expenses have been entirely defrayed by Scotsmen. Captain Lemaire gave an interesting account of the Belgian Scientific Expedition to Ka-Tanga, Central Africa, in 1897, and spoke in hopeful terms of the possibilities of the high plateaus of that region for European colonization, stating that all the usual European vegetables and many fruits had already been cultivated with great success. Finally, a paper by Dr. A. Lawrence Rotch, director of the Blue Hill Observatory near Boston, was presented under the title 'Exploration of the Atmosphere at Sea by Kites.' It was pointed out that on land the use of kites was possible only when the wind blew at a velocity of over twelve miles an hour, but on ships this difficulty was done away with, the motion of the vessel giving the desired velocity. The importance of some knowledge as to the height to which the trade winds extended and also as to the direction and strength of the higher currents was pointed out and the possibility of acquiring such knowledge by the use of kites was suggested.

A conference was held with the Geological and Zoological Sections for the purpose of discussing the scheme of a survey of the lakes of the British Isles which is to be carried out by Sir John Murray and Mr. Lawrence Pullar. It is intended to make a complete survey of each lake from all standpoints, bathymetrical, thermometrical, geological, botanical and zoological. Many interesting suggestions were made in the discussion which followed the reading of a letter by Sir John Murray stating the plans that he had formed for the work and a resolution was passed expressing the gratification of the Sections that such a survey was to be carried out.

THE ANTHROPOLOGICAL SECTION.

The address of the president of the Anthropological Section, Professor D. J. Cun-

ningham, of Dublin, was devoted to a consideration of the characteristics of the human brain and their significance. After pointing out the necessity for greater attention on the part of craniologists to the relations which exist between the brain and the cranium, reference was made to the discussions as to the relative development of the occipital lobe in man and apes, which enlivened the meetings of the Association forty years ago. With the knowledge we now possess it seems strange that such a discussion was ever precipitated, for not only is the occipital lobe largely developed in the ape, but it possesses even a greater development than in man. Measured along its medial border the percentage length of the lobe to the entire length of the cerebrum in the baboon, orang and man is, respectively, 29.7, 23.2 and 21.2, and even these figures do not show the full preponderance of the occipital lobe in the ape, for its anterior border extends so far forward as to overlap a portion of the parietal lobe and form an occipital operculum, a condition entirely lacking in man. Instead, then, of the preponderance of the occipital lobe being the distinguishing feature of the human brain, it is the greater relative development of the parietal, which encroaches to a certain extent upon the territory occupied in the lower forms by the occipital.

The conclusions of Rüdinger, derived from a study of the brains of a number of distinguished men, that the intellectual endowment of an individual stands in relation to the development of the upper part of the parietal lobe, Professor Cunningham believes to be entirely without foundation. Indeed, in the evolutionary development of the cerebral cortex it is the lower part of the lobe which shows the greater relative increase and has extended itself both backwards and downwards, the latter process leading to a marked depression of the Syl-

vian fissure to an extent quite foreign to the brain of any ape. And in this connection it is interesting to note that the recent studies of the brains of the astronomer Hugo Gylden and of the mathematician Sophie Kowalewsky by Retzius, of Helmholtz, by Hansemann and of the musician Rudolph Lenz by Guszman, have all revealed an apparently marked development of the cortex of the lower parietal region. Furthermore, it is an interesting fact that in the left cerebral hemisphere the Sylvian fissure is more depressed than in the right. It is well known that physiologically the left hemisphere shows a decided preeminence, to account for which various theories have been suggested. That it is due to the greater bulk or weight of the hemisphere seems to have been disproved, nor can it be held to be due to the greater complexity of the convolutions, nor to a better blood supply.

What, then, may have been the cause both of this asymmetry and of the general development of the parietal lobe. Professor Cunningham points out that in the parietal region are the centers for the arm, hand, face, throat and mouth and, to a certain extent, the motor center for speech, and the center for the facial muscles. These latter, it is true, present a greater bulk in the ape than in man, but both they and the muscles governed by the other centers named are certainly more highly differentiated and capable of performing movements of greater refinement than in the ape, and it is this very degree of refinement which determines the amount of the area covered by a cortical center, rather than the mass of the organ supplied. On this basis, then, the greater development of the parietal lobe in man is readily explained, and since it is well known that the motor center for speech is asymmetrical and on the left side, an explanation is afforded of the asymmetrical development of the lower parietal region in

the human brain. Indeed Professor Cunningham holds that the "stimulus which must have been given to general cerebral growth in the association areas by the gradual acquisition of speech can hardly be exaggerated." "Some cerebral variation—probably trifling and insignificant at the start, and yet pregnant with the most far-reaching possibilities—has in the stem-form of man contributed that condition which has rendered speech possible. This variation, strengthened and fostered by natural selection, has in the end led to the great double result of a large brain with wide and extensive association areas and articulate speech, the two results being brought about by the mutual reaction of the one process upon the other."

Of the papers presented to the Section several were on matters of local archeology, Dr. R. Munro giving an account of a 'Kitchen-midden at Elie'; Messrs. J. G. Cunningham and Thomas Ross describing respectively Roman camps at Ardoch and Delvine and Dr. Duncan and T. H. Bryce reporting on 'The Results of their Excavations in the Island of Arran' where they found a number of skulls and implements evidently belonging to a prehistoric dolichocephalic race. Of somewhat more general interest were papers by Dr. J. F. Gemmill, who described the development of the human stapes, coming to the conclusion that it arose quite independently of the periotic bone and was developed from the hyoid, though not from its most proximal portion, this giving rise to the incus; by Mr. R. A. S. Macallister, on 'The Age of the Ogham writing in Ireland,' the conclusion reached being that for the most part the inscriptions were certainly christian in origin; and by Dr. Rivers, 'On the Functions of the Maternal Uncle in Torres Straits,' showing that the wife's brother was really the head of the house, even in tribes where the descent was now paternal.

Especial interest attached to a paper by Mr. Brant Sero, a Canadian Mohawk, on 'Dekanawideh, the law-giver of the Canienghakas,' in which was given an account of the law still in use, with some modifications, among the Canienghakas or Mohawks of Canada and of which the salient principle was the establishment of a totemic council of women, who in turn elected an hereditary council composed of seven lords or masters, who made the laws and whose titles descended through the maternal line.

A report was presented by Mr. R. A. S. Macallister on the recent excavations made under the Palestine Exploration Fund, the main purpose of which had been the recovery of the city of Gath. Though the work in this direction had proved unsuccessful much material had been collected which throws light on the culture of the inhabitants of Palestine at different periods. At Tel-es-Safi, a height overlooking the valley of Elab, a building was found at the depth of 14 to 18 feet which there are reasons for regarding as one of the 'high places' mentioned in the Book of Kings.

A report was also submitted upon the results of the Cretan explorations. Excavations which were begun in 1900 have been continued at Knossus and have revealed an ancient palace which there are reasons for identifying with the traditional House of Minos. Upon the walls and floors of this were remains of a large series of frescoes among which are full-length figures of the cup-bearer, interesting as being the first known portrayal of a man of the Mycenæan age. The art remains evidence a high degree of skill and artistic perception, and several finds illustrate a close connection with ancient Egypt and Babylonia. The most striking discovery, however, is that of a series of clay tablets engraved with a linear script and demonstrating the existence in prehistoric Hellas of a system of writing antedating by about eight centuries the

earliest known Greek inscriptions, and by six or seven the first dated record of Phœnician script. In addition to the linear tablets others of a contemporary age were discovered inscribed with characters of a hieroglyphic nature, probably of an entirely different language. Excavations have also been carried on at Praseos, the capital of the ancient Eteocretans, and have yielded an inscription in Greek characters of the fifth century B. C., but composed in the Eteocretan language, and excavations at Zakro, in the extreme east of the island, revealed about 150 clay impressions of Mycænæan gems and signets, some of which throw new light on the early religion of Crete.

In connection with the meeting of the Section a pleasing incident was the formal opening of the new Anatomical Laboratory of the University of Glasgow, erected with the aid of a bequest from the trustees of the late Mr. J. B. Thompson. The chair was occupied by Lord Lister, and speeches were made by Mr. Barr in behalf of the Thompson trustees, Principal Story on behalf of the University, Sir William Turner and Professor Cleland, who has presented to the University his large collection of anatomical preparations. At the close of the speech-making the guests were entertained in the new laboratories by Professor and Mrs. Cleland and were given an opportunity of examining the arrangement of the rooms and the collections.

THE PHYSIOLOGICAL SECTION.

The opening address of the Physiological Section, delivered by the President, Professor J. G. McKendrick, was a consideration of the dilemma suggested by Clerk Maxwell in his article on the Atom in the *Encyclopædia Britannica*. The dilemma was to the effect that a germ cell cannot be structureless, yet it is too small to contain a sufficient number of molecules to account

for all the characteristics which are transmitted by it. Professor McKendrick, on making calculations based on more modern data concludes that Maxwell's estimate of the possible number of molecules in an ovum is too small and instead of containing only something like a million the fecundated ovum may start with as many as twelve million million organic molecules, a number probably sufficiently great to account for the transmission of all hereditary characters. He also suggested that since the physicists conceive of molecules as being more or less in motion, it is possible that the activities of living matter may be due to a certain *kind* of motion as yet unknown to physicists.

Sir John Burdon Sanderson described the application of the telephone to the investigation of the rhythmic phenomena of muscles and detailed the results obtained by this method by Miss Buchanan, working in the physiological laboratory at Oxford, and which have already appeared in the *Journal of Physiology*. Professor Sherrington gave an account of experiments upon the cerebral cortical centers in two chimpanzees, the first experiments of the kind which had been performed on animals higher in the scale of life than monkeys. In one of the animals the cortical center for the hand was delimited and excised, the result being an immediate paralysis of the hand, which, however, in a few weeks completely passed away. In the second animal the center for the foot was similarly treated, with similar results. A study of the degenerated tracts in the first animal revealed the existence of a direct pyramidal tract in the spinal cord, a group of fibers which has hitherto been supposed to occur only in man. The degeneration resulting from the extirpation of the foot center did not affect this tract.

Dr. Kennedy, of Glasgow, described, with lantern views, a case in which a long-standing spasm of the facial muscles had been

greatly relieved by dividing the facial nerve and grafting its distal end upon the spinal accessory, the operation being an application of results obtained by experiments in nerve grafting performed on lower animals.

Professor Reed, of Dundee, pointed out that the assertion that proteids in solution exerted osmotic pressure was in all probability due to the use of impure preparations, since by using carefully washed recrystallized proteid no trace of such pressure could be obtained on a membrane formed of formalized gelatine. It would appear from this result that the so-called solutions of proteids were not true solutions but merely suspensions. Professor Reed also called attention to an observation he had made that the absorption of glucose by the intestine was favored by the presence of potassium salts as compared with those of sodium, and attributed the result to an ionic effect.

Dr. W. Brodie Brodie, of Glasgow, gave the results of experiments he had made on the action of oxalates on muscle tissue. He pointed out that it had been shown that the presence of calcium salts was necessary for the rhythmic contraction of the heart, and from his experiments it seemed probable that at the moment of muscular contraction there was a liberation of calcium from a salt of that metal present in the muscle substance. Oxalates did not destroy the irritability of resting muscles, although they did have that effect on muscles in a state of activity, and the results of previous observers require to be modified to this extent. It was probable that the action of the oxalate was due to the precipitation by them of the calcium liberated during contraction.

Professor Noel Paton reported on the results of observations made in conjunction with Drs. Gulland and J. S. Fowler on the hæmopoietic function of the spleen, and stated that they had not been able to obtain any evidence that the organ took part in the production of blood corpuscles.

Dr. W. H. R. Rivers gave an account of the measurement of a visual illusion in the cases of thirty-eight natives of Murray Island, Torres straits, compared with forty-two Englishmen. The apparatus used was the Müller-Lyer line with reversed arrowheads, the standard line having a length of 75 mm. The illusion proved to be much less, on the average, among the islanders, to whom the two lines appeared equal when the movable line measured 60 mm. while the same appearance occurred to the Englishmen at 55 mm. Dr. C. S. Myers reported some observations which he had made with Galton's whistle on the same islanders, which showed that at all ages they were unable to hear as high a note as inhabitants of Buchan, Aberdeenshire.

THE BOTANICAL SECTION.

The presidential chair of the Botanical Section was occupied by Professor I. Bayley Balfour, who selected for his address a discussion of the causes which have led the Angiosperms to become the dominant type of the existing flora. Before the appearance of the Angiosperms upon the earth's surface there was a dense vegetation, composed of Pteridophytes and Gymnosperms, but this is now represented by a relatively small number of forms, having been replaced by Angiosperms. What, then, were the causes which have led to the dominance of this latter type, what are the structural peculiarities which have given it the advantage over its predecessors? The climatic differences of our epoch, contrasted with earlier periods, naturally suggest themselves as factors in the change, and of these differences perhaps the most important is the great difference in the relative proportions of the land and water areas upon the globe. "The statement is warranted that the Angiosperms have become dominant in great measure because in their construction the problem of the plant's relationship to

water on a land area has been solved more satisfactorily than in the case of the groups that preceded them."

By the formation of the flower and seed the Angiosperms freed themselves from the risks which attend sexual reproduction in heterosporous Pteridophytes by providing a special nidus for the development of the germ and thereby rendering it directly independent of the presence of water. The tegumentary system of the Angiosperm ovule has for its primary function the conveyance and storage of water for the embryo and in addition serves as a food reservoir. The function of the ovular tegmina cannot now be regarded as of so much importance in the reproductive act as was formerly the case, and the existence of haustoria which penetrate them, either from the embryo itself or the embryo-sac, point clearly to their function as reservoirs of food and water. In passing it was pointed out that the classification of the Dicotyledons into Unitegmineæ and Bitegmineæ proposed recently by van Tieghem seems to rest upon an insecure foundation, since all the genera in certain families, such as the Rosaceæ and Ranunculaceæ are not alike in respect to the number of teguments.

And it is not only to this development of special water reservoirs for the ovule that the Angiosperms owe their advantage as a land-type, but in two features of their water-carrying system they are greatly superior to the older types. No one will deny that their general monostely is a more perfect arrangement for water carriage in a massive plant than is polystely, nor is there doubt that the vasa which are conspicuous characteristics of the Angiosperms are more favorable for a rapid transport of water than are tracheids.

Passing on to a consideration of the differentiation of the Angiosperms into classes, Professor Balfour discussed the new class proposed by van Tieghem, that of the

Liorhizal dicotyledons, and came to the conclusion that the two recognized families included in the class, the Nymphaeaceæ and Gramineæ, do not present sufficiently distinctive characters to warrant their separation from the already established classes. The most recent observations on the embryogeny of the Nymphaeaceæ seem to indicate that the apparent dicotyledonous nature of the embryo is due to the splitting of a simple cotyledon, and if this be correct the order is most properly assignable to the monocotyledons and the structure of the root-tip upon which von Tieghem lays so much stress is what might be expected. The idea that the epiblast of the embryos of the Gramineæ represents a second cotyledon, Professor Balfour is inclined to dispute, and points out that in any event its occurrence is not universal in the order, since it is present in *Triticum* and absent in *Secale*, present in *Elymus* and absent in *Hordeum*. The evidence as to the morphological significance of the structure is at present too obscure to warrant its being taken as a basis for the separation of the Gramineæ from monocotyledons.

Recognizing then but the two classes, Monocotyledons and Dicotyledons, the lecturer stated that if he were to express an opinion as to their phyletic relationship it would be that they had arisen on separate lines of descent. The Dicotyledons are by far the more adaptive and progressive, though this does not necessarily imply their more recent origin, and the advantages which they present over the Monocotyledons in their free internodal growth and copious root system as compared with the contracted stem growth and arrested root system of the latter, are but a carrying out of the structure of the embryo with its terminal plumular and root buds and its lateral cotyledons, so markedly different from what obtains in the Monocotyledons, in which the cotyledon is terminal, the plumu-

lar bud lateral and the primary root bud often internal.

As regards the genetic relations of the various groups into which the two classes are divided, Professor Balfour believes that there is "no evidence to sanction the belief, or even the expectation, that there is extant any family of Dicotyledons or Monocotyledons which represents, even approximately, a primitive type in either class. The stem in each has gone. We have the twigs upon a few broken branches."

The list of papers presented to the Section was somewhat extensive and mention can be made of only a few. Professor Letts and Mr. John Hawthorne submitted a report on some observations they had made upon the absorption of ammonia by *Ulva latissima*. They found that this sea-weed could absorb within twenty-four hours all the ammonia from a sample of rather highly polluted sea-water (containing 0.046 parts of ammonia per 100,000) and suggested the possibility of this characteristic of the *Ulva* being turned to practical account. Professor Marshall Ward presented the results of his observations on the brown rust of the brome grasses. The seeds of the grasses could be treated antiseptically and sown in nutritive solutions and when inoculated with uredospores would give rise to pure cultures of the rust. The results gave no support to the idea that there might be an internal or seminal infection and it was found that although the uredo was in all morphological respects the same in all species on which they were grown, the spores grown on *B. sterilis* would never infect a plant of *B. mollis*, although they could be readily transferred to other plants of *B. sterilis*. Spores from *B. mollis* would infect its allies such as *B. secalinus* and other species of the *Serrafalcus* group, but failed on members of the *Stenobromus* group and so with other cases.

Mr. A. C. Seward described some sections

of jet from Yorkshire which he had studied in the British Museum. Sections cut from specimens which consisted partly of petrified wood and partly of jet showed a gradual transition from Araucarian wood to pure jet lacking all indications of ligneous origin. It would seem from these sections that the Whitby jet was formed by an alteration of coniferous wood.

Other papers presented were on 'The Structure and Morphology of the Flowers of *Cephalotaxus*,' by Mr. W. C. Woodsell; 'The Histology of the Sieve-tubes of *Pinus*,' by Mr. A. W. Hill; 'A Contribution to our Knowledge of the Gametophyte in the Ophioglossales and Lycopodiales,' by Dr. W. H. Lang; 'The Vascular Anatomy of the Cyatheaceæ,' by Mr. D. T. Gwynne-Vaughan; 'The Anatomy of *Danaea* and other Marattiaceæ,' by Professor Brebner; 'Spore Formation in Yeast' by Mr. T. Barker; and on 'A Diplodia Parasitic on Cacao and on the Sugar Cane,' by Mr. A. Howard.

J. PLAYFAIR McMURRICH.

UNIVERSITY OF MICHIGAN.

SCIENTIFIC BOOKS.

Monographien aus der Geschichte der Chemie herausgegeben von George W. A. Kahlbaum, IV. and VI. Hefte. CHRISTIAN FRIEDRICH SCHÖNBEIN, 1799-1868. Ein Blatt zur Geschichte des 19. Jahrhunderts von Georg W. A. Kahlbaum, Ed. Schaer und Ed. Thon. Leipzig. 1899 and 1901. 2 vols. 8vo. Portraits.

The previous volumes of this series of 'Monographs' have dealt with 'Lavoisier's Theory and its Acceptance in Germany,' 'Dalton's Theory of Atoms in Modern Light,' 'Berzelius' Growth,' and the 'Correspondence of Liebig and Schönbein,' by divers writers; the volumes before us deal with the scientific labors and personal character of the eminent chemist and physicist Schönbein by one who enjoyed superior opportunities for his undertaking, occupying a chair in the University of Basel analogous to that held by the famous man, and favored with the friendship of his living heirs.

Through the liberality of the daughters and numerous correspondents of Schönbein, Dr. Kahlbaum had the privilege of handling and studying between 1,500 and 1,600 letters, as well as 350 printed papers from the brain and hand of the man he sought to portray. These letters were carefully catalogued and partially indexed to make them readily available. While occupied with his manuscript, he learned that Professor Ed. Schaer, a pupil of Schönbein was also at work on a biography of him, and correspondence led them to produce a joint work.

Such is the origin of these volumes, which contain more than 550 pages.

The scientific labors of Schönbein comprise his discovery of the passivity of iron, that of ozone, of guncotton and of collodion, besides the many lesser points which in his indefatigable studies of these bodies he encountered. He discovered the remarkable behavior of iron with nitric acid shortly after he had begun his duties as professor of chemistry and physics at the University of Basle, in 1835. Dr. Kahlbaum notes that Schönbein's discovery had been anticipated by James Keir in 1790, but entirely forgotten and neglected. Schönbein's researches on electrical topics were continued many years until 1849, but meanwhile the study of that illusive substance, ozone, discovered in embryo in 1839, absorbed much of his energy. The early history of the enormously difficult problems connected with ozone and the fallacy of 'antozone' are detailed in a satisfactory manner.

No one of the discoveries made by Schönbein made him more popularly known than that of guncotton, destined to play so important a rôle in international, as well as industrial, enterprises; this dates from 1846. Its value as a substitute for gunpowder was at once perceived, and experiments with firearms were instituted as early as May of the same year. It is a sad commentary on the unprofitableness of pure science from the money point of view that this prime discovery brought to Schönbein only eighteen to twenty thousand dollars, while Alfred Nobel gained through it more than ten million dollars!

The discovery of collodion has been claimed for several Americans and Dr. Kahlbaum has

made a careful study of these claims; it appears that Dr. Charles T. Jackson discovered the solubility of gun-cotton in January, 1847, and two of his students (Bigelow and Maynard) in February of the same year found the solution useful in surgical cases. The name collodion was given to it by Dr. A. A. Gould in 1848, by which time it was well known to American practitioners. The exact date of Schönbein's discovery is uncertain, but in February, 1847, De la Rive wrote from Geneva inquiring as to the nature of Schönbein's discovery 'here much discussed.' So it is clear that the invention was made on both sides of the Atlantic almost simultaneously and quite independently.

After pursuing studies at the Universities of Erlangen and Tübingen, Schönbein secured in 1825 the position of teacher in an institute at Epsom, England, and the two years he spent there had a marked influence on him through life. He attended at that time a lecture by Faraday, but did not seek his acquaintance; ten years later, having discovered the passive nature of iron in nitric acid, he addressed a letter describing this to Faraday, and this was the beginning of a correspondence and friendship lasting twenty-six years and only broken by the death of the Englishman. The 'Letters of Faraday and Schönbein' have been edited by Drs. Kahlbaum and Darbishire, and published in a handsome volume (London and Basle, 1899). Schönbein's correspondence with Liebig forms Heft V. of these *Monographien*.

Notwithstanding the arduous labors of Schönbein in his university duties and in the chemical laboratory, he found time for conducting a large correspondence with his brother scientists, and also for writing to the secular daily press; from 1831 to 1832 he was associate editor of the *Basler Zeitung* on a salary of sixty dollars per annum; he was a frequent contributor to the columns of Stuttgart newspapers, and to the *Schwäbische Mercur* from 1833 to 1848.

The portrait in the first volume shows a heavily built, thick set man, smooth shaven and with full head of hair; his physiognomy is singularly earnest, without being so charming as that of Bunsen. The volumes contain indexes of names of persons and brief tables of contents. HENRY CARRINGTON BOLTON.

Die Krystallisation von Eiweissstoffen und ihre Bedeutung für die Eiweisschemie. Von DR. FR. N. SCHULZ. Jena, Gustav Fischer. Pp. 43. 1901.

Not many years have passed since it was customary for physiological chemists, following the suggestion of Thomas Graham, to class proteid substances as *colloids*, in distinction from the *crystalloids* which readily pass through diffusion membranes. The fact that native proteids are indiffusible no longer necessarily implies that they are not capable of crystallization. The achievements of recent years in the preparation of various proteids, both animal and vegetable, in crystalline form have marked a great advance in the study of this important group of organic compounds. The prominent rôle which the proteids assume in the life-processes of all organisms has long made them conspicuous objects of investigation; and now that the possibility of separating them in crystalline form has given promise of improvements in the methods of purification and identification, a new impetus has been given to the investigation of the chemistry of the proteids.

Professor Schulz's monograph is a comprehensive compilation of the literature on the crystallization of the proteids. It includes a review of the occurrence of proteid crystals ready-formed in animal and plant tissues, and a more extensive description of the separation and properties of crystalline preparations from non-crystalline native proteid mixtures. This includes in particular the crystallization of egg- and serum-albumin and the readily obtained vegetable proteids. Other less certain instances (fibrin, casein, heteroalbumose, etc.) are considered in the light of the evidence at present available. Hæmoglobin and related compounds are treated in somewhat greater detail, which their earlier discovery justifies. It is a matter of historical interest to note that Schulz names B. Reichert as the discoverer of the blood crystals (1847), whereas this honor is usually assigned to Otto Funke (1851).

In the concluding pages of Schulz's monograph brief reference is made to the crystallography of the proteid crystals and the significance of crystallization for the chemistry of

the proteids. It is a satisfaction to American readers to find the American contributions to the literature of the subject adequately reported by a German writer. Dr. Schulz is a professor at Jena.

LAFAYETTE B. MENDEL.

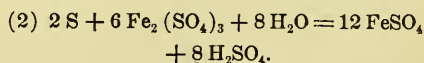
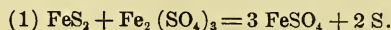
SHEFFIELD SCIENTIFIC SCHOOL OF
YALE UNIVERSITY.

SOCIETIES AND ACADEMIES.

CHEMICAL SOCIETY OF WASHINGTON.

THE 128th regular meeting of the Washington Section of the American Chemical Society was held at Cosmos Club Hall, Thursday evening, October 10. The following program, was presented:

Dr. H. N. Stokes, 'Pyrite and Marcasite.' Dr. Stokes stated that the physical characteristics by which these geologically important dimorphous forms of iron disulphide are distinguished are not always applicable, especially when they occur in the form of concretions. The paper describes a method by which they can always be determined, which consists in boiling an excess of the carefully prepared mineral with a standard solution of ferric ammonium alum, under absolute exclusion of air, until the alum is completely reduced. The reaction takes place in two stages:



The second reaction is always incomplete, only a portion of the sulphur being oxidized to sulphuric acid. Under the standard conditions the percentage of sulphur oxidized is 60.4 in the case of pyrite and 18 in that of marcasite. The percentage of sulphur oxidized, or the *oxidation coefficient* (p), is obtained from the equation

$$p = \frac{8.333 b}{c - a} - 25,$$

which is deduced from the above equations, and in which a , b and c represent the permanganate equivalents of the standard solution and of the ferrous iron and total iron of the resulting solution, respectively. The proportion of the minerals in a mixture of both can be

determined to within 1 to 3 per cent. by finding its oxidation coefficients and referring to an empirical curve of oxidation coefficients obtained by experiments with artificial mixtures. It was shown that the concretions described by geologists and mineralogists as marcasite are frequently pyrite, that the density affords no criterion of the composition, and that the hypothesis that most specimens of pyrite and marcasite, even when well crystallized, are mixtures of the two, or paramorphs, is without foundation. It was also shown that their behavior towards cupric sulphate solutions is essentially similar and affords no evidence in support of the hypothesis of Brown that the chemical constitution of the two minerals, or the state of valency of the iron is different. The full details are to be found in the recently published Bulletin No. 186 of the United States Geological Survey.

W. H. Seaman, 'Insolubility of Inorganic Salts in Hydrocarbons'; contribution from the laboratory of Howard University Medical College. The author stated that several years ago he had the pleasure of announcing to the society a generalization on the insolubility of glycerol ethers in glycerol. Now he is able to make a still more important generalization, that all inorganic salts are insoluble in hydrocarbons of the paraffin series. Fifty-three different salts have been kept in contact with benzine, kerosene and soft paraffin for periods varying from two to six months, without taking up a sufficient quantity of any salt to produce any residue on evaporation in a watch glass that is visible by a pocket microscope.

The writer does not know of a single analysis of petroleum in which the presence of inorganic salts has been reported, and in view of the fact that the petroleum has been in contact with some kinds of salts since it was formed, the natural conditions go far to support the generalization stated. Only in the case of $(\text{NH}_4)_2\text{CO}_3$ was there any marked change; a brownish color was generally developed when in contact with this salt, the cause of which is not ascertained. At the suggestion of Professor F. W. Clarke, anhydrous Fe_2Cl_6 was prepared and tested, but the result was the same. The following is a list of the salts used:

Ammonium sulfocyanid, bromid, phosphate, oxalate, carbonate, chlorid, nitrate; antimony sulfid; barium chlorid, nitrate, carbonate, di-oxid; bismuth nitrate; arsenious acid; calcium chlorid and nitrate; ferric chlorid and ferrous sulfate; ferric ferrocyanid; magnesium carbonate; potassium bromid, cyanid, carbonate, iodid, bichromate, sulfate, chlorate; magnesium dioxid; potassium acetate; sodium bicarbonate, acetate, nitrate and sulfate; tartar emetic; zinc oxid; potassium ferrocyanid, chromate, hydrate, picrate, chlorid, nitrate; sodium borate, carbonate, chlorid, hydrate, nitrite, thiosulfate; ammonium molybdate, bichromate, sulfate; ammonia alum; magnesium sulfate and lithium carbonate.

L. S. MUNSON,
Secretary.

NEW YORK SECTION OF THE AMERICAN CHEMICAL SOCIETY.

THE first meeting of the N. Y. Section of the American Chemical Society, held on Friday evening, October 11, at the Chemist's Club was very largely attended. Professor Marston Taylor Bogert, of Columbia University, is the newly elected chairman of this Section, which, on September 30 last, entered upon the second decade of its usefulness with a membership of over four hundred. Upon the recommendation of the Executive Committee, the Section decided to award annually a medal to that member of the Section who shall have presented, during the preceding year, the best paper embodying original chemical research. The minor conditions affecting the award and a suitable name for the medal will be decided upon later.

The program of papers included a report by General Secretary Professor Hale upon 'The Recent Meeting of the American Chemical Society, at Denver.' Dr. McMurtrie gave an interesting account of a 'Short Trip among the Mines and Chlorination Works of the West.' Mr. Jacob G. Lipman, of the New Jersey Experiment Station, gave an account of his 'Studies in Nitrification.'

Professor Edward Hart, of Lafayette College, and Editor of the *Journal of the American Chemical Society*, read an interesting paper upon 'Technical Chemical Education,'

which brought forth a long discussion, participated in by prominent teachers of chemistry and industrial chemists. There seemed to be some weight of opinion in favor of the view that time may be spent in attempts to teach the details of such industries as dyeing, brewing, acid manufacture, etc., that might better be devoted to acquiring the broad general principles of chemistry, mechanics and engineering, leaving the technical training to be acquired in the factory or works.

Dr. H. W. Wiley, of the U. S. Department of Agriculture, gave a paper upon 'The Government Laboratories of Great Britain.' This was profusely illustrated by lantern photographs taken by Dr. Wiley. The director of this laboratory is Professor T. E. Thorpe, C.B., LL.D., F.R.S., past president of the Chemical Society. In regard to the equipment of this laboratory Dr. Wiley thinks we might do well to imitate its ideal system of ventilation and excellent apparatus. Solid silver flasks are used for saponification tests under pressure. On the other hand, British chemists in general will do well to imitate the American Society of Official Agricultural Chemists in regard to the adoption of standard analytical methods. In Professor Thorpe's laboratories some of the American 'official methods' have been adopted.

JOHN ALEXANDER MATHEWS,
Secretary.

THE ACADEMY OF SCIENCE OF ST. LOUIS.

At the meeting of the Academy of Science, of St. Louis, on the evening of October 21, 1901, forty-five persons present, Professor F. E. Nipher, of Washington University, delivered an address on 'Progress made in Physics during the Nineteenth Century.'

WILLIAM TRELEASE,
Recording Secretary.

DISCUSSION AND CORRESPONDENCE.

PATAGONIAN PERSONALITIES.

A RECENT article in SCIENCE was none too soon in drawing attention to the puerilities and solecisms perpetrated by some botanists in their endeavor to grapple with the mysteries of the Latin language. We scarcely like to arouse the

anger of zoologists by suggesting that they are just as bad, but at any rate some of them are not far behind. It is therefore satisfactory to hear that the International Congress of Zoologists has decided that errors of etymology, orthography and grammar are not to remain perpetual disfigurements of scientific writings simply because some would-be systematist never went to school. But there is a class of names against which there is no rule, appalling though they often are to the mind of the scholar. We allude to the monstrosities pieced up out of modern proper names, or even barbarous dialect words, often in unnatural union with a Greek or Latin suffix, e. g., *Leedsichthys*, *Koninckocidaris*, *Lapuworthura* (a polite way of showing respect truly!), *Etheridgaster* (which does not mean airy stomach), *Urobenus* (not, as some ingenious German supposes, derived from *öpa* and *βαίω*, but an anagram of *Bournerus* by which a Mr. Bourne has been immortalized).

But all previous efforts—if one can dignify with such a term the results of pure laziness or incompetence—are left far behind by the latest fantasies of Florentino Ameghino in 'Notices préliminaires sur des Ongulés nouveaux des terrains crétacés de Patagonie,' published in the *Boletín de la Academia Nacional de Ciencias de Córdoba* (July, 1901). Zoologists may retort that this gentleman is only a paleontologist; well, then he should have more sympathy with the dead languages than to burden them with such abortions as the following: *Henricosbornia*, *Guilielmoscottia*, *Oldfieldthomasia*, *Ernestokokenia*, *Josepholeidya*, *Ricardolydekkeria*, *Guilielmoftoveria*, *Henricofilholia*, *Thomashuxleya*, *Edwardocopeia*, and others too many to quote. Space, however, must be found for two gems, further enriched by footnotes: *Maxschlosseria* 'J'ai employé le prénom sous la forme germanique plus en usage, car c'est la racine du nom latin, qui est trop long,' and *Asmithwoodwardia* 'Je n'ai utilisé que l'initiale du prénom, car autrement il aurait résulté un nom excessivement long. D'ailleurs, cet auteur signe d'habitude A. Smith Woodward.' That 'd'ailleurs' is delicious; the man would actually find excuses for not giving us *Arturo-smithivoodvardia*. Will the Zoological Congress

not insist on the completed form? Why should pure latinity dread an excessive length?

Seriously, is not this a little too much—too long, but too childish? It is only 45 years since a satirical rogue in the *Annals and Magazine of Natural History* suggested that incipient paleontologists might ease their brains by adopting such combinations as *Grayoconcha* and *Gouldornis*, for they would certainly never have been anticipated by any zoologist. Such sarcasm would not carry far to-day; we have by this time rivaled the imaginary *Unclesambo-crinus* of the same critic.

Ridicule will never check people with no sense of the ridiculous. Are rules any better? Needless to say the original Strickland code never contemplated the possibility of such aberrations; it was opposed to all personal generic names in zoology. The British Association Committee of 1864 wished to reject *Cookilaria* and *Morrhua tomcodus*, and considered that 'specific names from persons have already been sufficiently prostituted, and personal generic names have increased to a large and undeserving extent'; both are classed as 'objectionable.' The rules adopted by the International Zoological Congress of 1899 say that generic names must consist of a single word (art. 5); that they may be derived from either forenames used in antiquity, or from modern surnames (art. 6 *g*, *h*); that such names should not enter into the formation of compound words (art. 9); that when a surname is compound, only one of its components is to be used, *e. g.*, *Edwardsia* not *Milne-Edwardsia* (art. 7) and certainly never *Milnedwardsia* (art. 11). But *Amilnedwardsia*—!

It is perfectly obvious that the whole spirit of these rules is totally opposed to the action of Ameghino, and if their letter is not so too it is only because there are some things so ridiculous that nobody has ever dreamed of legislating against them. It remains to be seen whether the dignity, the common sense, and the fellow-feeling of zoologists are strong enough to ignore these Florentinameghinisms, which we should expect to see in some penny-a-liner's pseudo-scientific paragraph for a Sunday paper, rather than in the publications of a National Academy.

F. A. B.

SOME REMARKS ON PRESIDENT D. S. JORDAN'S
ARTICLE ON THE GEOGRAPHICAL DIS-
TRIBUTION OF FISHES.

PROFESSOR D. S. JORDAN has called attention to a number of highly interesting points in the geographical distribution of fishes,* and I should like to add a few remarks relating to some of the questions discussed.

1. *Similarity of Japanese and European (Mediterranean) forms.*

Although, according to Professor Jordan, this similarity does not seem to be so very much pronounced among fishes, we have other groups of marine animals in which the same striking fact has been noticed. The present writer has lately called attention to this with reference to the Decapod Crustaceans,† and has expressed the opinion that the connection of Japan and Europe by a continuous shore line was along the northern shores of Siberia, in a geological past when the climate of the circumpolar regions was a warmer one, so that at least subtropical animals could exist there. The continuous circumpolar distribution of the ancestors of the respective forms was broken up by the cooling of the pole, the species retreated southward, and found only in the Mediterranean and Japanese seas a congenial climate, where they continue to exist as *relics* of a former circumpolar distribution. Professor Jordan has apparently not taken into consideration this explanation, which might possibly also be advanced for some of the fishes of Japan and Europe.

2. *The submersion of the Isthmus of Suez.*

That there was no important connection between the Red Sea and the Mediterranean after the middle of the Tertiary is a well-known view. Hull‡ has demonstrated that the faunas of both seas were disconnected since Miocene time, but that in the Pliocene there was again an incomplete connection across the Isthmus of Suez by very shallow water. This agrees well with Professor Jordan's conclusions. Before Miocene, however, there must have been a wide

* 'The Fish Fauna of Japan, with Observations on the Geographical Distribution of Fishes,' SCIENCE, No. 354, October 11, 1901.

† Bronn's 'Klassen und Ordnungen des Tierreichs.' Arthropoda. Bd. 5, Abt. 2, p. 1,267. 1900.

‡ *Nature*, Vol. 31, 1885, p. 599.

and important communication between the Indian Ocean and the Mediterranean, as is shown by several interesting cases in the distribution of Crustaceans,* although it is impossible to say whether what is now the Isthmus of Suez played an important part in this question; the connection may have been somewhere else.

3. *The Cape of Good Hope as a zoogeographical barrier.*

Professor Jordan does not believe that the Cape of Good Hope offers an absolute obstacle to a migration of tropical Indo-Pacific species into the Atlantic. I do not hold the same opinion. Indeed, we know that the tropical fauna of the Indian Ocean extends southwestward along the coast of Natal and the Cape Colony, and some elements of it go even as far as Cape Town. But if we follow the shore line from here northward, along the western coast of Africa, we meet a considerable change of the climatic conditions, for from this point almost to the equator cold water is found. While it is thus true that the fauna of the Cape of Good Hope, as President Jordan says, shows a general relation to that of India and Australia, this applies only to the southern and the southeastern shores of the Cape Colony, while the western (Atlantic) side, together with the adjoining coast of southwest Africa, about as far as the mouth of the Congo, forms an impassable barrier to this tropical fauna of the Indo-Pacific.

4. *The Isthmus of Panama.*

It is beyond doubt that the Atlantic and Pacific Oceans were once connected with each other within the tropics: this connection existed up to the middle of the Tertiary, and it was closed during Miocene times. For this general assumption we possess an overwhelming mass of evidence. The question remains: Where was this connection of the two oceans situated? Formerly it was the general trend of opinion to assume a former depression of the Isthmus of Panama, but since Dr. R. T. Hill has shown that there are serious objections to this on geological grounds, we have to modify this theory. The present writer has tried † to do so with respect to v. Ihering's Archiplata-Archhelenis theory; the connection of the At-

lantic and the Pacific in the Tertiary times was identical with the 'sea separating Archamazonas and Archiplata, that is to say, across the South American continent about where there is now the Amazonas valley'—the Cordilleras not existing then.

5. *Explanation of the distribution of Galaxias.*

The genus of freshwater fishes, *Galaxias*, is represented only in South Australia, New Zealand, South America and South Africa,* and it has been taken as one of the instances which demonstrate the former connection of these parts by land, the Antarctic continent. Professor Jordan hesitates to accept the latter, and his chief arguments are: (1) That this supposed continental extension should show permanent traces in greater similarity in the present fauna both of rivers and of sea, and (2) that geological investigation must show reasons for believing in such radical changes in the forms of continents.

As to the first point—although this connection is quite remote in time—the cases of similarity in the present marine, fresh-water and land faunas are very numerous, and there is hardly any larger group of animals where such are lacking. This fact has been discussed by a large number of writers, † and the wealth of evidence brought to light compels us to recognize this Antarctica theory as well established. As to the second point, the geological proof for existence of 'Antarctica,' I refer only to Professor J. W. Gregory, ‡ who has shown that the tectonic configuration of Australia, New Zealand, South America and Antarctica—as far as we have any knowledge of the last—only tends to support the assumption of a former connection of these parts. That there is, generally speaking, ample reason for believing in 'radical' changes in the form of continents during the earth's history, has been demonstrated by geologists long ago, although it has become almost a fashion among biologists to disregard this line of evidence.

PRINCETON UNIVERSITY. A. E. ORTMANN.

* South Africa is not mentioned by Professor Jordan.

† The most important are mentioned by the present writer in the *American Naturalist*, 35, No. 410, Feb., 1901.

‡ *Nature*, Vol. 63, 25 April, 1901, p. 609.

* See Ortmann, l. c., p. 1276.

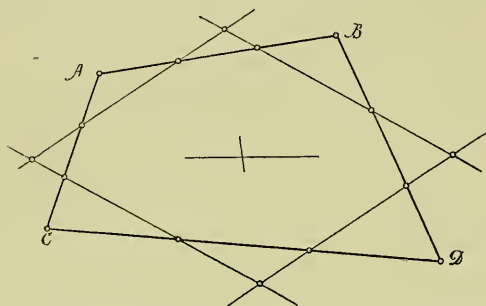
† In *SCIENCE*, No. 311, 14 December, 1900, p. 929.

SHORTER ARTICLES.

CENTROID OF A QUADRANGLE.

So far as I can ascertain, the following construction is new. If it be old, it would seem worth while to recall attention to it.

To find the centroid of any quadrangle A, B, C, D , divide each side into three equal parts, and draw lines through adjacent points of division, as indicated in the figure. It is easy to prove that the new figure is a parallelogram, the center of inertia of which coincides with the center of inertia of the original quadrangle, both occurring at the intersection of the diagonals of the parallelogram. The areas of the two figures differ.



In that admirable digest, 'Des Ingenieurs Taschenbuch herausgegeben vom Verein Hütte,' 17th edition, no less than thirteen constructions are given for finding the centroid of quadrangular figures. It would seem to me that one convenient and easily memorized construction should suffice, and that the space thus saved should be otherwise utilized.

G. F. B.

EFFECT OF DIMINISHED AIR-PRESSURE ON THE PULSE.

TO THE EDITOR OF SCIENCE: In a recent trip to the summit of Pikes Peak I made some observations on the rate of my pulse which show a rapid increase of beat corresponding with a rapid decrease of pressure. The ascent was made from Manitou on the cog railway, and as I was comfortably seated all the way and spent most of the time looking from the car window, the influence of exercise on the results was eliminated, because there was no change in this respect. The train stopped after each climb of about 2,000 feet to take on water and at these

stops I took the rate of my pulse. The heights of the different points are taken from a guide furnished by the railway company, and these with the number of observed pulse beats per minute are given in the accompanying table.

RATE OF PULSE PER MINUTE.

Name of Station.	Height in Feet.	Rate of Pulse.	
		Ascent.	Descent.
Manitou.	6,662	78	78
Half Way House.	8,907	...	83
Gulch Tank.	10,067	85	85
Windy Point.	12,233	...	90
Summit Pikes Peak.	14,147	92	92

It is seen that the pulse increased regularly to the summit and decreased to the same amount on the way down. When near the summit I asked a lady sitting near me to give me her pulse rate and she found it the same as my own, namely, 92 per minute.

The average rate of my pulse at the same time of the day (near mid-day) at sea level is about 75.

The ascent was made on September 1, and the time occupied in the ascent and return was about four hours, between noon and 4 P. M. About an hour and a half was taken for the ascent and about an hour and a half for the descent, leaving about an hour for remaining on the summit.

I did not notice any difficulty of breathing while on the summit of the Peak, or any sensations markedly different from those experienced at sea level.

On the day of my visit the Peak was between two strata of cumulus clouds. One was evidently formed over the plateau to the west of the Peak and floated over some distance above the summit. The other stratum was formed over the plains to the east and was far below the summit of the Peak.

HENRY HELM CLAYTON.

BLUE HILL OBSERVATORY,
October 7, 1901.

NOTES ON INORGANIC CHEMISTRY.

THE nature of an antimony salt described in 1882 by Setterberg has lately been cleared up by Wells and Metzger, writing in the *American Chemical Journal*. This salt was formed by the

addition of cesium chlorid to a solution containing both the trichlorid and the pentachlorid of antimony, and was considered to be a mixed salt. In recovering cesium from some residues containing antimony, the authors precipitated it as the chloroplumbate. Instead of being yellow, like the pure salt, the lead salt was bright green, and examination showed that it was colored by an antimony salt, which was isomorphous with it. This proved to be Setterberg's salt, and showed from its isomorphism that its constitution is Cs_2SbCl_6 , containing therefore quadrivalent antimony. It crystallizes in black octahedra and belongs to the series of salts of which the most familiar member is the potassium chloroplatinate. This is the first known salt in which antimony is quadrivalent, although in the dioxid this valence is accepted by many chemists.

AN interesting application of the bioscope in crystallography is described in a paper recently presented to the American Academy of Arts and Sciences, by Professor Richards, of Harvard University, in conjunction with E. H. Archibald. The authors have studied the growth of crystals by photomicrography, taking successive instantaneous photographs of the growing crystal. This was accomplished with a very considerable degree of success, after overcoming very great mechanical difficulties. The object was especially to study the birth of crystals in order to determine whether crystallization is always preceded by the separation of an initially liquid phase, consisting of a supersaturated solution of the former solvent in its former solute. A number of observers have believed that with high microscopic powers they have detected the formation of minute globules at the moment of precipitation, and that these globules have soon joined and assumed crystalline form. The problem seemed possible of solution by taking a series of photographs of a solution just at the point of crystallization, and a large number of such photographs were obtained. The enlargement was over 4,000 diameters and both common and polarized light were used. In every case the earliest appearance of the crystal was distinctly crystalline, and no signs of globules were found. Hence if these occur preceding the crystal

phase, they are too small to be detected in a microscope of the power used. Incidentally it was found that the growth in diameter in the first second of the crystal's existence was vastly more rapid than during the subsequent period. "This exceedingly rapid initial diametric growth accounts for a lack of definition noticed in the first images—a lack of definition sufficient to have misled the eye, but not enough wholly to obscure the photographic evidence of crystalline structure." The same apparatus is now being used for the study of the change in the structure of steel at high temperatures.

THAT the question of the influence of boric acid and borax upon the health has not yet been definitely settled is evidenced by two papers on the subject, which have recently appeared in the *Journal of Hygiene* and the *British Medical Journal*. The first of these, by Tunnicliffe and Rosenheim recounts a series of experiments upon children, continued for twelve days, and the authors draw the conclusion that these substances are practically harmless. The other paper by Gruenbaum combats the deductions of the former, chiefly upon the grounds that the experiments were too few, continued for too short a period and were upon children over the age when milk is the principal article of food. In the author's opinion the fact that the boric acid and borax were rapidly excreted by the kidneys is evidence of their poisonous character.

IN a recent number of the *Comptes Rendus* Chaveau and Tissot answer the question as to whether an atmosphere which has been rendered deleterious by the presence of hydrogen sulfid can act as a poison through the skin or the outer mucous membrane, in the negative. A dog, with a canula connected with the outside air in its trachea, was placed in a closed box containing more than eight per cent. of hydrogen sulfid. After an hour the dog was still in good condition, while another dog not thus protected, succumbed in the poisonous atmosphere almost instantly. The authors conclude from this experiment that hydrogen sulfid acts as a poison only when taken into the lungs.

J. L. H.

CURRENT NOTES ON PHYSIOGRAPHY.

DIKES AS TOPOGRAPHIC FEATURES.

DIKES are so generally the exclusive property of geological study that a good illustration of their topographic value is a welcome novelty. Rocky walls, shown by the removal of the weaker country rock from a vertical dike, have been occasionally mentioned in the reports of western surveys, but the finest example of the kind yet published is to be found in the Spanish Peaks (Colorado) folio of the U. S. Geological Survey, by Hills. Here a great number of dikes, arranged in a roughly radial pattern with respect to the denuded stocks of the Spanish peaks as a center, form numerous walls from 50 to 100 feet in height, stretching more or less continuously for five or ten miles or more. The weak horizontal Tertiaries have been worn away; but the dike wall retains some mark of their bedding, just as a casting shows the form of its mould. Several excellent photographic illustrations are appended; they are destined to frequent reproduction as type examples of this relatively rare class of topographic forms.

THE PLAIN OF ST. LAWRENCE VALLEY.

THE lower St. Lawrence valley is a broad and nearly level plain of post-glacial marine clays and sands, concerning which R. Chalmers gives some interesting information ('Notes on the Pleistocene Marine Shore-lines and Landslips of the North Side of the St. Lawrence Valley,' *Geol. Surv. Canada, Ann. Rep.*, XI. (1898), 1901, 63J-70J). The height of the plain seldom exceeds 15 or 20 feet along the river bank, but it increases towards the valley sides, and reaches 400 or 500 at the base of the Laurentide hills. The junction of the plain with these hills forms a very irregular line, often running up the river valleys in loops for considerable distances. Generally speaking, this line can be traced approximately on a good map by the absence of lakes on the marine area, whereas on the Laurentide area lakes are quite numerous. Occasionally the surface of the plain is seen to ascend by steps, each of which has apparently been a shore-line during the emergence of the plain from beneath the sea. Terraces and beaches occur on the hill slopes

above the plain; the highest reach altitudes of more than 800 feet.

Certain parts of the plain are subject to extensive landslips, apparently due to the sliding of water-logged silts into valleys that have been cut into the plain since its elevation. One in 1840 left a depression with a maximum depth of 30 feet below the adjoining plain over an area of 84 acres in the valley of Maskinongé river; this was described by Logan (*Proc. Geol. Soc.*, London, III., 1842, 767-769). The St. Albans landslip occurred in 1894; here the clays and sands slid bodily into the valley of the St. Anne de la Pérade for the space of $3\frac{1}{2}$ miles, leaving a depression a mile wide and averaging 100 feet deep. (See Laflamme, *Trans. Roy. Soc. Canada*, XII., 1894, 63; and Archibald and Mackenzie, *Railroad Gazette*, N. Y., June 29, 1894.) The most recent large slip occurred in the valley of Rivière Blanche in 1898, leaving a depression over 86 acres in area with a maximum depth of 28 feet. The softer material flowed out from underneath, while the upper and more coherent clay split into blocks and columns which were borne away by the sliding, surging mass. The movement continued for three hours; clay masses being then left stranded on the floor of the depression, while the mud flow spread over the valley to a depth of twenty-five feet or more for nearly two miles. Accounts of this slip have been given by Dawson (*Bull. Geol. Soc. Amer.*, X., 1899, 484-490) and Laflamme (*Rep. Comm'r Col. and Mines*, 1898, 131).

THE QUESTION OF PENEPLAINS.

DE LAPPARENT considers the origin of several peneplains in France as determined by geological evidence ('La question de pénéplaines envisagée à la lumière des faits géologiques,' *Verh. 7ten Internat. Geogr. Kongr.* (1899), Berlin, 1901, II., 213-220). It is here not a question as to the occurrence of peneplains, now more or less uplifted and dissected; the French examples of this class of forms are so striking that the author does not regard their verity as a matter open to discussion. It is only their origin that he studies. The peneplains more fully described are found in the Ardennes, Brittany, and the Central Plateau. Strati-

graphic evidence leads to the conclusion that these regions have repeatedly been land areas, and that the successive invasions of the sea found the lands so low and flat as to offer no scarps for the sea to work upon. Regarding Brittany, it is remarked that littoral deposits somewhat to the north (bordering the Cotentin) have been produced in the same neighborhood and at altitudes differing only by a few meters during eleven different periods beginning with the Trias, thus indicating an astonishing stability of this region during the time of its denudation to the peneplain form. Marine erosion is therefore excluded, and the peneplains are ascribed to subaerial denudation.

W. M. DAVIS.

RECENT ZOO-PALEONTOLOGY.

Fossil Reptiles of Europe.

THE latest paper upon the *Pterosaurs* is by Dr. Felix Plieninger.* Dr. Eberhard Fraas† proposes the name *Thalattosuchia* as a new group of marine crocodiles of the Jurassic formation, differing widely from all others in the extreme adaptation for aquatic life, especially in the total disappearance of the dermal armature and in the complete conversion of the limbs into paddles. The three chief genera *Metriorhynchus*, *Geosaurus* and *Dacosaurus* were placed by von Zittel in the family *Metriorhynchidae*, of the suborder *Eusuchia*. But according to Fraas they deserve a wider separation, since while most nearly related to the long-snouted crocodiles (*Longirostres*), they by no means present a transition to the short-snouted (*Brevirostres*), but represent an entirely independent group, exclusively adapted to marine life. The superficial resemblance of the skull to that of Ichthyosaurs is intensified by the reduction of the characteristic crocodylian sculpture and by the ossification of the sclerotic coat of the eye. The details, however, are quite distinctive. This constitutes the fifth independent group of marine reptiles, the others being the Plesiosaurs, Ichthyosaurs, Mosasaurs and Chelonians.

* 'Palæontographica,' Vol. XLVIII., 1901.

† 'Jahresb. d. Ver. f. vaterl. Naturk. in Württ,' 1901, p. 408.

MARSH'S COLLECTION OF BRIDGER MAMMALIA.

THIS unique collection of Eocene mammalia has been placed by Professors Beecher and Dana, of the Peabody Museum, in the hands of Dr. J. L. Wortman for systematic description.* As Dr. Wortman remarks, "The importance of the subject to the student of mammalogy can scarcely be overestimated, since these epochs witnessed the beginnings and branching off of many groups destined to play such a prominent part in succeeding mammalian development. This fact was fully appreciated by Professor Marsh, and he spared neither pains nor expense in making the collections as complete as possible." In the first part, on the Carnivora, Dr. Wortman proposes an important and what may prove permanent change, in grouping with the modern Carnivores all the Creodonta that are closely related to them under the new suborder Carnassidentia, and retaining the suborder Creodonta (Cope) only for the ancient types that are entirely aberrant. Valuable notes are given upon the ancestral foxes of Wyoming, and the evolution is traced as far as the Uinta. The author believes that all the placentals had a direct marsupial ancestry, not far removed from the mesozoic carnivorous marsupials. Attention may be called to the fact, opposed to this view, that all the mesozoic marsupials known have a highly specialized character, with inflected jaw and aborted milk dentition, so that they cannot be considered ancestral to the placentals. The value of these papers for future reference would be increased by the insertion of the museum numbers in connection with all descriptions and figures.

PLEISTOCENE HORSES OF NORTH AMERICA.†

IN the preglacial sands of the west and the cave and gravel deposits of the east, remains of horses are extremely numerous; no less than twenty-five species have been proposed and the nomenclature has been in a state of dire con-

* 'Studies on Eocene Mammalia in the Marsh Collection, Peabody Museum,' Part I. Carnivora, *Amer. Jour. Sci.*, May and June, 1901.

† Tooth Characters and Revision of the North American Species of the Genus *Equus*. By J. W. Gidley. *Bull. Amer. Mus. Natural History*, Vol. XIV., Art. IX., pp. 91-141, May, 1901.

fusion. At the suggestion of Professor Osborn, Mr. J. W. Gidley, of the American Museum, has undertaken a complete revision of all the types. It is found that the chief characters used in definition by Owen, Leidy and Cope are largely invalid. The teeth patterns only subject to a wide range of individual variability, and it is an absolute law that the upper portion of the crown is not only more complex, but differs absolutely in proportion from the lower portion; the molar teeth of a young horse thus present essentially different characters from those of an old horse, and ignorance of this fact has vitiated most of the previous definitions. This very careful revision results in the apparent determination of the valid species as follows: *Equus fraternus*, a small horse from the southeastern States; *E. complicatus*, about the size of an ordinary draught horse, from the southern and middle western States; *E. occidentalis* from California, of the same size as the above; *E. pacificus*, a very large animal characteristic of middle California and Oregon; *E. conversidens* from the Valley of Mexico and *E. tau* the smallest true horse, also from the Valley of Mexico; *E. semiplicatus* from western Texas, closely resembling *E. asinus*; *E. pectinatus* from the Port Kennedy bone cave of eastern Pennsylvania. *E. scotti* from the Staked Plains of Texas. The latter is a long-faced type of horse about the size of the largest western pony, but with a longer body, a much larger head, a shorter neck and back and steeply sloping sides, shaped very much as in the ass or quagga. The type of this species is now mounted in the American Museum of Natural History (see Fig. 1). It is the first complete skeleton of a Pleistocene horse discovered in America. It was found in association with four other skeletons, remarkably well preserved. The largest species of horse herein recorded is *E. giganteus* Gidley; sp. nov., the teeth exceeding by more than one third the diameter of those of the largest draught horses.

H. F. O.

THE BICENTENNIAL COMMEMORATION OF
YALE UNIVERSITY.

THE imposing exercises celebrating the two hundredth anniversary of the foundation of Yale College took place last week in accordance

with the program already published in this Journal. As President Northrop pointed out in his address, one hundred and five graduates of Yale have been president of a college; and eighty-five different colleges have at some time had a Yale graduate for president. Yale furnished the first president of at least eighteen colleges—Princeton, Columbia, Dartmouth, Georgia, Williams, Hamilton, Kenyon, Illinois, Wabash, Missouri, Wisconsin, Beloit, Chicago, California, Cornell, Western Reserve and Johns Hopkins. One of the most interesting addresses, given by Dr. Daniel C. Gilman, of the class of '52 and for twenty-five years president of the Johns Hopkins University, is published above.

The doctorate of laws was conferred on President Roosevelt and forty-six others, including the following men of science and college presidents:

John Harvard Biles, Professor of Naval Architecture in Glasgow University.

John Shaw Billings, Director of the New York Public Library.

Charles William Dabney, President of the University of Tennessee.

David White Finlay, Professor of the Practice of Medicine in Aberdeen University.

Jacques Hadamard, Adjunct Professor in the Faculty of Science at the University of Paris.

Samuel Pierpont Langley, Secretary of the Smithsonian Institution.

Albert Abraham Michelson, Professor of Physics in the University of Chicago.

William Osler, Professor of Medicine in Johns Hopkins Medical School.

Henry Smith Pritchett, President of the Massachusetts Institute of Technology.

Ira Remsen, President of Johns Hopkins University.

Ogden Nicholas Rood, Professor of Physics in Columbia University.

Wilhelm Waldeyer, Professor of Anatomy in the University of Berlin.

James Burrill Angell, President of the University of Michigan.

William Peterson, Principal of McGill University.

Seth Low, ex-President of Columbia University.

Jacob Gould Schurman, President of Cornell University.

Franklin Carter, ex-President of Williams College.

William Rainey Harper, President of the University of Chicago.

William Curtis Harrison, Provost of the University of Pennsylvania.

Francis Landey Patton President of Princeton University.

Benjamin Ide Wheeler, President of the University of California.

SCIENTIFIC NOTES AND NEWS.

THE National Academy of Sciences will hold a scientific session at the University of Pennsylvania, Philadelphia, beginning on Tuesday, November 12, at 11 a. m. A special stated session for the transaction of business will be held on November 13.

PROFESSOR GEORGE J. BRUSH, emeritus professor of mineralogy and formerly director of the Sheffield Scientific School of Yale University, received a loving cup from some of the former graduates, on the occasion of the recent bicentennial exercises.

THE first autumn meeting of the American Academy of Arts and Sciences was held at the house of Mr. Alexander Agassiz, president of the Academy, in Cambridge, Mass. After an introduction by the president and a statement for the Rumford Committee by Professor Cross, the Rumford medals were presented to Professors Barus and Thomson who responded with brief remarks. Mr. Agassiz then gave an account of the *Albatross* expedition to the tropical Pacific. George Wharton Pepper, of Philadelphia, was elected an associate fellow of the Academy.

THE Franklin Institute, of Philadelphia, has awarded to Dr. Porter Shimer, of the department of chemistry, Lafayette College, the John Scott legacy medal and premium for his improved jacketed crucible.

THE second annual Huxley lecture of the Anthropological Institute was delivered by Dr. Francis Galton, F.R.S., on October 29, his subject being 'The Possible Improvement of the Human Breed under the Existing Conditions of Law and Sentiment.'

THE Council of the London Mathematical Society for the ensuing year is as follows: *President*, Dr. Hobson; *vice-presidents*, Professor W. Burnside and Major MacMahon, R. A.; *treasurer*, Dr. J. Larmor; *honorary secretaries*, R. Tucker and Professor Love; *other members*, J.

E. Campbell, Lieut.-Colonel Cunningham, R. E., Professor Elliott, Dr. Glaisher, Professor M. J. M. Hill, H. M. Macdonald, Professor L. J. Rogers, A. E. Western, E. T. Whittaker and A. Young.

DR. C. H. GILBERT, of the department of zoology at Stanford University, has been appointed to take charge of the deep-sea investigations of the United States Fish Commission about the Hawaiian Islands. He will leave on the Government ship *Albatross* about December 1.

THE Navy Department has selected Lieut.-Commander W. H. H. Southerland to succeed Capt. C. C. Todd as chief hydrographer of the navy, and orders have been issued detaching him from the command of the *Dolphin*.

WE regret to learn that Mr. Thomas Meehan, the well-known horticulturist, is seriously ill.

DR. THEODORE HOUGH, of the Biological Department of the Institute of Technology, is at his Virginian home convalescing from a long attack of typhoid fever.

AN intercollegiate geological excursion was made to the Westfield valley in Central Massachusetts on Saturday, October 19, for the purpose of studying the formation of river terraces and the influence of rock ledges on their development. The excursion was under the leadership of Professor W. M. Davis, and was attended by forty-six teachers and students from twelve institutions—Yale, Amherst, Wesleyan, Williams, Mass. Institute of Technology and Harvard; Milton and Worcester Academies; Springfield High School and Westfield, North Adams and New Britain Normal Schools. Professors B. K. Emerson, H. E. Gregory, W. N. Rice, and R. T. Jackson were members of the party.

MRS. STANFORD has returned to San Francisco after a journey to Egypt, where she purchased for the Stanford Museum a valuable collection of Egyptian antiquities.

MR. H. KATO, of the Japanese Department of Agriculture, is at present in the United States, with the purpose of studying our fisheries.

DR. D. MORRIS, the British commissioner of agriculture for the West Indies, has returned to Barbadoes after a visit to London.

WE learn from *Nature* that Mr. J. R. Jackson, who for a period of forty-three years has been associated with the Royal Gardens, Kew, has resigned the keepership of the Museum of Economic Botany, and is succeeded by Mr. J. M. Hillier, whose place, in turn, has been taken by Mr. J. H. Holland, late of the botanic station at Old Calabar.

MR. KEITH LUCAS, B.A., of Trinity College, Cambridge, has been nominated to occupy the university table at the laboratory of the Marine Biological Association at Plymouth.

DR. OLIVER LODGE, formerly professor of physics at University College and now the principal of Birmingham University, delivered the opening address to the medical students of University College, Liverpool, on October 12. At the close of the proceedings a bust of Dr. Lodge was unveiled by Professor W. A. Herdman.

THE death is announced of Dr. Vonkrafft, of the Geological Survey of India.

MR. ANDREW CARNEGIE has offered to provide libraries at San Juan, Porto Rico and Nashville, Tenn., each at a cost of \$100,000. He has also given £37,000 for libraries at Dundee.

MRS. BLACKSTONE, widow of T. B. Blackstone, has offered to give the city of Chicago a \$100,000 library building, to be conducted as a branch of the public library.

DR. FREDERICK PETERSON offers a prize of \$200 for the best original unpublished contribution to the pathology and treatment of epilepsy. Papers received will be submitted to a committee, consisting of three members of the New York Neurological Society, and the award will be made upon its recommendation at the annual meeting of the board of managers of the Craig Colony, October 14, 1902. Manuscripts should be sent to Dr. Frederick Peterson, 4 West Fiftieth street, New York City, on or before September 30, 1902. The successful essay becomes the property of the Craig Colony and will be published in its medical reports.

FOR a number of years archeological expeditions to Iceland and Greenland have been conducted at the expense of the Danish 'Carlsberger Funds.' The directors have now decided to defray the expenses of Dr. Kinde in making excavations on the Island of Rhodes,

especially in the neighborhood of the ancient Acropolis.

ARRANGEMENTS have been made at the Millport Marine Biological Station, Scotland, for the erection of a research laboratory and also of a private boarding house. The site for the new buildings has been promised by the Marquis of Bute, and a gentleman who prefers to remain anonymous has given £3,000 towards their erection.

THE German Society of Men of Science and Physicians will hold its meeting next year at Carlsbad under the presidency of Dr. Hans Chiari, professor of pathological anatomy at the German university at Prague.

THE annual trip of the German Agricultural Society in 1903 will be made to the United States.

FOREIGN papers report the formation at Cape Town of a 'South African Association for the Advancement of Science,' to work as far as possible on the lines of the British Association. In July last a meeting was held to establish a congress of engineers, when an influential committee was appointed. The proposal gradually widened until at length it was found feasible to establish a local 'British Association,' and a meeting for that purpose was largely attended. Sir David Gill, the Astronomer Royal at the Cape Observatory, who presided, mentioned that in November last he had attended a meeting of the council of the British Association, at which a very strong desire was expressed to have a meeting of the British Association held in South Africa. He was sure, he said, that in the event of such a visit the hospitality of Cape Town and Kimberly and other centers would be quite equal to the strain which would be put upon it by the visit of distinguished men of science. Of course in the existing state of political affairs it was impossible to contemplate such a matter seriously, and they must leave the fuller consideration of the matter until the country was settled and they were in a position to exercise that hospitality. But if they founded some association of the kind now indicated, the year that the British Association came to South Africa they should naturally merge their meeting into that of the British Association, and their organization would natu-

rally facilitate matters and aid them in making a successful meeting when the British Association came there. Their primary object would be to found an association as far as it was practically possible on the lines of the British Association. The formation of the association having been decided upon by formal vote, the title was discussed, 'South African' being carried by 31 votes against 19 for 'African.'

THE Spanish minister of education has ordered that hereafter all museums shall be open the year round free, and any one allowed to make copies of photographs. He also requested teachers to take their pupils frequently to the museums.

A REPORT of the committee of the metric system has been presented to the British Association of Chambers of Commerce. The committee has unanimously adopted the following resolutions: "(1) That, after considering various suggestions, this committee is unanimously of opinion that the chambers should unite in urging upon the government the compulsory adoption of the metrical system of weights and measures, leaving matters of detail to be considered later. (2) That the committee is unanimously of opinion that a British decimal system of coinage must be on the basis of retaining the sovereign, with the florin as a unit, divided into a hundred cents or farthings. (3) The committee recommends that there should be nickel coins of five and ten cents, and bronze coins of one, two and four cents or farthings."

THE greatest steamship of the time, the *Celtic* of the White Star Line, has made her 'maiden' passage across the Atlantic and back, and her first record—8 days, 9 hours, 46 minutes running time, excluding the time lost by fog, which happened to be in this case 15 hours. This is, for the present at least, the largest steamship in the world. The *Oceanic* of the same line is five and a half feet longer but of less beam and tonnage. The *Celtic* is 700 feet 'over all,' of 75 feet beam and 49 feet depth, measuring 20,880 tons. The *Great Eastern*, for a half century the largest ship on the lists of the fleets of the world, was 680 by 84 by 48 feet, registering, gross, 18,000 tons. The *Celtic* is the first ship to exceed that, at the time,

wonder of the world, largely the basis of the fame of Brunel and Russell. The total weight—the 'displacement'—of the new ship, at maximum computed draft, 36 feet 6 inches, would be nearly 38,000 tons, as compared with about 32,000 tons for the *Great Eastern*. The largest naval vessels are of about one-half this last weight. The *Campania* registers about 13,000 tons, the *Kaiser Wilhelm der Grosse* 17,000, the *Deutschland* 16,500 and the *Oceanic* 17,250. The engines are of the quadruple-expansion type, 33, 47.5, 68.5 and 98 inches diameter of cylinders and 5 feet piston-stroke. Steam-pressure is carried at 210 pounds per square inch by gauge, and is produced by 8 double-ended 'Scotch' boilers, each 15.5 by 19.5 feet. The two smokestacks are each 14 feet in diameter. The ship has capacity for 2,700 passengers or more and for 12,000 tons weight of merchandise. The cost of this ship was \$2,500,000. The builders were Messrs. Harland and Wolff.

A REUTER telegram reports that the Liverpool School of Tropical Medicine has now completed the necessary arrangements for the dispatch of an expedition at once to the Gold Coast, and to the mining districts there. The school has secured the services as leader of this expedition of Dr. Charles Balfour Stewart, who will sail for West Africa this month. He will proceed first to Sierra Leone in order to study the methods now being employed there by Dr. Logan Taylor. After leaving Freetown, Dr. Stewart will proceed at once to Cape Coast Castle to attack the insanitary conditions there, as the mortality amongst the Europeans in that town is at present most serious. He will employ workmen for draining the ground and clearing the houses of broken water vessels and otherwise attacking the breeding-grounds of the mosquitoes. The expedition has been rendered possible owing to the generosity of a private individual who desires to remain anonymous. Anti-malarial operations will shortly be in full swing in Gambia, Sierra Leone, the Gold Coast and Lagos, the operations in the three first-named colonies being organized by and under the complete control of the Liverpool School of Tropical Medicine. Dr. Stewart received his professional

education at Cambridge, the Liverpool Royal Infirmary and Guy's Hospital, London. After qualification, he studied specially at Vienna and Freiburg. He was then invited by the Secretary of State for India to proceed to India for plague work; and labored both up country and also as an assistant to M. Haffkine in the Imperial Research Laboratory at Bombay. He then returned to England and has been constantly engaged in the Thompson Yates Laboratory, Liverpool, on research and the preparation of plague prophylactic, by the request of the Secretary of State for War and the Agent-General of Cape Colony.

UNIVERSITY AND EDUCATIONAL NEWS.

MR. T. JEFFERSON COOLIDGE, late Minister to France, has given a fund of \$50,000 to the Jefferson Physical Laboratory of Harvard University for physical research. The income is to be expended at the discretion of the director, Professor John Trowbridge. Among the terms of the gift is the following: The income of this fund shall be used primarily for laboratory expenses of original investigations by members of the laboratory staff; but the director, at his discretion, may award therefrom an honorarium, of not more than \$500 per annum, for the private use of any person who—although receiving no salary from the university—may wish to carry on original investigations under his direction at the Jefferson Physical Laboratory.

THE General Electric Company has agreed to give \$12,500 for the establishment of a school of electricity at Schenectady, provided that an equal amount is secured from other sources. The school would be affiliated with Union College. It will be remembered that the New York legislature was asked last year to establish this school.

AT the final meeting of the committee engaged in founding a fellowship at the New York University, in memory of the late Oswald Ottendorfer, held recently, plans were made for turning over the amount of subscriptions to the University. The treasurer, James Speyer, reported that the fund aggregated \$20,199.85.

MR. GEORGE A. ARMOUR has given \$2,500 a year for five years for the maintenance and de-

velopment of the classical seminary at Princeton University. The university is the residuary legatee of the estate of Dr. John Sayre of Missouri, \$15,000 of which is now available. It has also lately acquired, through the gift of an unnamed donor, the property of the late Professor Guyot.

MR. EDWARD B. PAGE, of New York, has given to the Sheffield Scientific School of Yale University, \$6,000 to found scholarships.

ON the occasion of the laying of the corner stone of the new medical building of the University of Michigan, Dean Vaughan announced that a few prominent medical alumni of the university had established a fellowship in connection with the medical department, to be known as the Corydon L. Ford Fellowship, in memory of the first professor of anatomy in the university.

PRESIDENT ANGELL, of Michigan University, announces that an instructor in forestry is soon to be appointed.

PROFESSOR W. D. GIBBS, of the Ohio State University, has been elected professor of agriculture and director of the experiment station at the New Hampshire College of Agriculture and the Mechanic Arts at Durham, N. H.

PROFESSOR ARTHUR W. SMITH, who was at Tulane University last year, has been appointed professor of electricity and electrical engineering at the University of Mississippi.

MR. ANDREW CARNEGIE has accepted the Lord Rectorship of St. Andrew's University for the ensuing three years.

DR. JOHN PURSER, for forty years professor of mathematics in the Belfast Queen's College, has retired.

PROFESSOR W. SOMERVILLE, having accepted post at the Board of Agriculture, will resign the chair of agriculture at Cambridge University at the end of the present term.

PROFESSOR RÜDORFF, director of the Laboratory of Inorganic Chemistry in the Technical Institute of Berlin, has retired on account of his health.

PROFESSOR MAX WOLF, of Heidelberg, has declined the call to the professorship of astronomy at the university at Göttingen.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

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FRIDAY, NOVEMBER 8, 1901.

SUPPLEMENTARY REPORT ON NON-EUCLIDEAN GEOMETRY.

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WHEN at the Columbus meeting of the American Association I had the honor of making a 'Report on Non-Euclidean Geometry,' it was mentioned that my own 'Bibliography of Hyper-space and Non-Euclidean Geometry,' in the *American Journal of Mathematics* (1878), giving 81 authors and 174 titles, when reprinted in the collected works of Lobachevski (Kazan, 1886) gives 124 authors and 272 titles; while Roberto Bonola had just given (1899) a 'Bibliography of the Foundations of Geometry in Relation to Non-Euclidean Geometry,' containing over 350 titles with some repetitions.

Bonola in 1900 finished a second part of this bibliography, in which the single section headed 'Historical, Critical and Philosophical Writings' gives 96 authors and 150 titles. It thus becomes very evident that a most important function of your reporter is the selection of what writings to bring forward for especial mention as of paramount importance and typical of the main stream of advance.

In the Columbus report I particularly stressed the work of two authors whom I brought forward together and to whom I devoted about a quarter of that report.

The report first appeared in *SCIENCE* for October 20, 1899, and you may imagine

that it was reassuring when on October 22 (old style), 1900, the Commission of the Physico-Mathematical Society of Kazan found the scientific merits of the works of these authors, A. N. Whitehead and Wm. Killing equal for the great Lobachevski prize and had to decide between them by the drawing of lots.

In his report on the work of Whitehead, Sir Robert Ball says of the 'Universal Algebra':

"Several other writers, to whom of course Mr. Whitehead makes due acknowledgment, have approached the study of non-Euclidean geometry by the aid of Grassmann's methods, but the systematic and most instructive development of the subject in book VI. is, I believe, new, as are also many of the results obtained.

"The superiority of Whitehead's methods appears to lie in the two following features:

"1°. That he can treat n dimensions by practically the same formulæ as those used for two or three dimensions.

"In this I think he has made a considerable advance upon the methods, ingenious and beautiful as some of them no doubt are, which have been used by previous investigators.

"2°. The various kinds of space, parabolic, hyperbolic and elliptic (of two kinds), present themselves in Whitehead's methods quite naturally in the course of the work, where they appear as the only alternatives when certain assumptions have been made.

"Moreover the results have been obtained in such a way that it is easy for the reader to develop for one of the other spaces properties treated out in full for one space only.

"The book deserves in the highest degree the attention of the student of modern mathematical methods, and it marks so great an advance that it is, in my judgment, well worthy of the important prize in view of which this report is prepared.

"Mr. Whitehead's memoir on geodesics in elliptic space appears to me to indicate great power in dealing with a very difficult problem. I believe it to be of much importance, as the geodesics in the generalized space conceptions had been but little studied."

In the corresponding report on the work of Killing, Professor Engel, of Leipsic, says of the 'Grundlagen der Geometrie':

"This work is, from the first to the last page, a justification and detailed development of the circle of ideas which we are accustomed to understand under the expression 'non-Euclidean geometry.'"

"Already so many preliminary questions have been settled," said Killing in the preface to his first volume, "that the final solution can be hoped for at a not too distant time."

"These words written in 1893," says Engel, "have meanwhile most recently (1899) found a highly striking confirmation in many directions through Hilbert's investigations.

"The geometries possible with the Euclidean, namely the Lobachevski-Bolyaian, the Riemannian and the elliptic, Killing develops, each for itself, in Euclidean way up to a certain grade.

"Also it should not be forgotten that Killing was the first, who (1879, *Crelles Journal*, Bd. 83) made clear the difference between the Riemannian and the elliptic space (or as he calls it, the Polar form of the Riemannian).

"The fourth section treats the Clifford-Klein space-forms, in whose investigation Killing himself has taken a conspicuous part (by a work in Bd. 39 of the *Mathematische Annalen*, 1891). The great importance of these space-forms rests upon this, that they show with especial clearness, what a mighty difference it makes whether we, from the beginning, assume the geometric axioms as valid for space as a whole

or merely for an every way bounded piece of space. In the first case we obtain, besides the Euclidean, only the three previously mentioned non-Euclidean space-forms.

"In the second case appears also a manifoldness, at present not yet dominated, of different space forms.

"The treatment of continuity and the ratio-idea in Euclid gives occasion for a nearer investigation of the so-called Archimedes' Axiom.

"Finally, as the first attempt to illuminate in conjunction all the different questions which have grouped themselves about the problem mentioned, and to collect all the means, which numerous mathematicians, and not least the author himself, have made for solving the problem, this work will for long retain its value.

"That precisely the founding of geometry since the appearance of this book has been advanced in a wholly unexpected way by Hilbert, cannot lessen Killing's merit. His work remains still by far the best means for mastering the researches which have appeared in this realm up to 1898." These interesting extracts I take from the Russian pamphlet just issued at Kazan and furnished me by my friend Professor Vasiliev.

In his paper 'Ueber Nicht-Euklidische und Linien-Geometrie' (Greifswald, 1900), Professor E. Study voices a profound truth when he says: "The conception of geometry as an experimental science is only one among many possible, and the standpoint of the empiric is as regards geometry by no means the richest in outlook. For he will not, in his one-sidedness, justly appreciate the fact that in manifold and often surprising ways the mathematical sciences are intertwined with one another, that in truth they form an indivisible whole.

"Although it is possible and indeed highly desirable, that each separate part or theory be developed independently from the others and with the instrumentalities

peculiar to it, yet whoever should disregard the manifold interdependence of the different parts, would deprive himself of one of the most powerful instruments of research.

"This truth, really self-evident yet often not taken to heart, applied to Euclidean and non-Euclidean geometry, leads to the somewhat paradoxical result that, among conditions to a more profound understanding of even very elementary parts of the Euclidean geometry, the knowledge of the non-Euclidean geometry cannot be dispensed with."

That the world has caught one deduction from this deep idea, is shown by the fact of the almost simultaneous appearance of two text-books, manuals for class use, to make universally attainable this necessary condition for any thorough understanding of any geometry, even the most elementary; two intended, available popular treatises on this ever more essential non Euclidean geometry.

One of these, just being issued by G. Carré et C. Naud, 3 rue Racine, Paris, is 'La géométrie non Euclidienne,' by P. Barbarin, professor at Bordeaux, a place made sacred for non-Euclidean by the memory of Hoüel. How great and practical is the interest of this book can be gathered from the headings of its chapters.

I. 'General and historical considerations.' How the non-Euclidean doctrine was born and gradually developed.

II. 'Euclid's definitions and postulates.' Study of the rôle that they play in the principles of geometry.

Simple and elementary exposé of the three geometries after the method of Saccheri.

III. 'Distance as fundamental notion.' The definitions of the straight and the plane according to Cauchy. The works of M. De Tilly.

IV. 'General geometry in the plane and in space.' Résumé of the principal general propositions.

V. 'Trigonometry.' Elementary demonstration, after Gérard and Mansion, of the formulas for triangles and quadrilaterals.

VI. 'Measurement of areas and volumes.'

VII. 'The contradictors of the non-Euclidean geometry.' The principal objections made against the non-Euclidean geometry. Answers to be made thereto.

VIII. 'Physical geometry.' How we might attempt to find out if the physical world is not Euclidean; how angles and distances could be measured with a much greater approximation, for example, angles with an error much less than $\frac{1}{100}$ of a second.

A brief article by Professor Barbarin, 'On the utility of studying non-Euclidean geometry,' which appears in the May (1901) number of Professor Cristoforo Alasia's new Italian journal *Le Matematiche*, shows that Hoüel had reached the weighty insight which we have quoted from Study, namely, that knowledge of non-Euclidean geometry is essential for any mastery of Euclidean geometry.

Says Barbarin :

"I. The question of the source of the theory of parallels has been one of the most interesting scientific preoccupations of the century; it has made to flow torrents of books, and given theme to remarkable works. Thanks to the theorems of Legendre, to the discoveries of the two Bolyai, of Lobachevski and of Riemann; thanks to the original researches of Beltrami and of Sophus Lie, of Poincaré, Flye Ste. Marie, Klein, De Tilly, etc., we cannot any more be mistaken as to the true scope of the celebrated proposition which bears the name of Postulate of Euclid.

"1°. This is not in any way contained in the classic definitions of the straight and the plane.

"2°. This is, among three hypotheses equally admissible, and which cannot all be rejected, only the most simple.

"Is it perhaps chance alone which gave to the great Greek geometer the choice of his system of geometry? or did he perceive, at least in part, the difficulties and the greater theoretic complication of the other two? We shall never know with certainty.

"But in the presence of his work, so perfect and so rigorous, one thing, however, appears not to be doubtful: the place which he assigned to his proposition, the enunciation which he gave of it, attest that this proposition had to his eyes only the value of an hypothesis; otherwise he would have formulated it in other terms and would have attempted to demonstrate it.

"The ideas of Lobachevski and of Riemann were diffused only very slowly. They were so, above all, thanks to the translations of Hoüel.

"This scientist, whose activity and power of work were prodigious, could not resist the desire to master all the European languages, with the aim of being able to read in their original text, and then make known to his contemporaries the most celebrated mathematical works.

"He admired Lobachevski, whom he sur-named the *modern Euclid*, and in his course professed at the scientific faculty of Bordeaux, he did not let pass any occasion to put him in evidence.

"II. Hoüel was persuaded that the knowledge of the non-Euclidean geometry is indispensable for thoroughly mastering the mechanism of the Euclidean geometry.

"Despite its paradoxical form, this idea is most just.

"General geometry or *metageometry* contains in fact a great number of propositions common to all the systems, and which ought to be enunciated in the same terms in each

of these. If the general proposition can be demonstrated in terms general for these, such should be preferred, even if, to attain this, it be necessary to subject the ordinary form to some modification. To cite only one example, we take the convex quadrilateral inscribed in a circle.

"In Euclidean geometry, *the sum of two opposite angles is constant and equal to two right angles; in non-Euclidean geometry this sum is variable.* Notwithstanding this, the two forms may be reconciled, since in both cases *the sum of two opposite angles equals that of the other two*, and this is sufficient for a convex quadrilateral to be inscriptible.

"Confronting the proposition with that which concerns the circumscribed quadrilateral, we put in full light a correlation which, *à priori*, ought evidently to exist.

"This correlation, which is the very heart of general geometry, and which does not always appear in the ordinary geometry with the same clearness, can be utilized for finding new properties of the figures.

"*Example: Every conic is the locus of the points such that the sum of the tangents from these drawn to two circles is constant; every conic then will also be the curve envelope of the straights which cut two given circles under angles of which the sum is constant.* (Excellent problem for investigating directly.)

"III. Is it expedient to associate the non-Euclidean geometry with instruction, and in what measure?

"If we treat of higher instruction, with ardor we respond affirmatively.

"In the courses of higher geometry of the universities the names of Bolyai, Lobachevski, Riemann have their assigned place, and there are still divers unexplored domains on the road which these scientists have opened.

"In so far as it refers to secondary instruction, the question is more delicate. The programs of preparatory courses at the high schools contain all, or almost all,

special mathematics and spherical geometry.

"It would not be then a great inconvenience to there make opportunely a discrete allusion to general geometry: on the contrary, the attention of the students and their critical spirit would be held awake by the necessity of investigating if such proposition which is expounded to them is of order particular or general.

"At least two indispensable conditions should be satisfied; it is requisite:

"1°. *That in all the books put in the hands of the students, the hypothetical and wholly factitious character of the Euclidean postulate be put well into relief.*

"In my classes I have recourse with success to the simple procedure which follows, and which I recommend. Take the straight AB and the two equal perpendiculars AB, BD : the angles ACD, BDC are equal, and may be right, acute or obtuse. But whichever be the one among these three hypotheses which we assume for this particular quadrilateral, we must conserve it for all the other like quadrilaterals. We choose the system of geometry in which these are right angles, and which corresponds to the Euclidean hypothesis.

"2°. That the invertibility of the postulate of Euclid be completely given up in all the demonstrations in which it can be done without and where nevertheless it is wrongly used.

"See, for example, the theorem on the face angles of a trihedral or polyhedral angle.

"We should recognize that great advances have been made in these latter years in the sense indicated.

"If the ideas of general geometry tend to become popularized, the honor of it is due above all to the periodicals which have given their hospitality, and in special manner to *Mathesis*, so ably edited by our excellent confrère, P. Mansion of Ghent.

"In the course of the last eight or ten years this journal has published numerous articles on Metageometry, written with as much competence as good sense. We counsel their perusal."

It will be seen from our quotation, that Professor Barbarin bases his exposition on the method of Saccheri as the simplest.

The same is true in the other new textbook, 'Manning's Non-Euclidean Geometry.' (Boston, Ginn & Co., 1901, 8vo, pp. v+95.)

Saccheri's first proposition is (*American Mathematical Monthly*, June, 1894, Vol. I., p. 188):

"If two equal straight, AC, BD , make with the straight AB angles equal toward the same parts: I say the angles at the join CD will be mutually equal."

On the next page is "Proposition II. The quadrilateral $ABCD$ remaining the same, the sides AB, CD are bisected in points M and H . I say the angles at the join MH will be on both sides right."

Professor Manning paraphrases these two together on page 5.

"If two equal lines in a plane are erected perpendicular to a given line, the line joining their extremities makes equal angles with them and is bisected at right angles by a third perpendicular erected midway between them."

Under the heading 'Definitions,' Saccheri says: "Since (from our first) the straight joining the extremities of equal perpendiculars standing upon the same straight (which we will call base), makes equal angles with these perpendiculars, three hypotheses are to be distinguished according to the species of these angles.

"And the first, indeed, I will call hypothesis of right angle; the second, however, and the third I will call hypothesis of obtuse angle, and hypothesis of acute angle." This Manning paraphrases as follows, under the heading 'The Three Hypotheses':

"The angles at the extremities of two equal perpendiculars are either right angles, acute angles, or obtuse angles, at least for restricted figures. We shall distinguish the three cases by speaking of them as the hypothesis of the right angle, the hypothesis of the acute angle, and the hypothesis of the obtuse angle respectively."

Saccheri's Proposition III. is: "If two equal straight, AC, BD , stand perpendicular to any straight, AB : I say the join CD will be equal, or less, or greater than AB , according as the angles at CD are right, or obtuse, or acute."

This Manning paraphrases as follows: "The line joining the extremities of two equal perpendiculars is, at least for any restricted portion of the plane, equal to, greater than or less than the line joining their feet in the three hypotheses respectively."

In the same way is paraphrased Saccheri's Prop. IV., the converse of III.

Saccheri's corollary about quadrilaterals with three right angles is given by Manning on page 12.

Saccheri's Prop. V. is: "The hypothesis of right angle, if even in a single case it is true, always in every case it alone is true."

In giving this, Manning has: 'If the hypothesis of a right angle,' etc., evidently a slip for his usual *the* right angle. Of course the Latin original, of which I have, so far as I know, the only copy on this continent, has no article.

Prop. VI. and Prop. VII. are combined by Manning on p. 13.

Prop. IX. is reproduced on p. 14.

Prop. X. is given on p. 9.

In Prop. XI. Saccheri with the hypothesis of right angle demonstrates the celebrated Postulatum of Euclid, thus showing that his hypothesis of right angle is the ordinary Euclidean geometry.

Manning says, p. 27: "The three hypotheses give rise to three systems of geom-

etry, which are called the parabolic, the hyperbolic and the elliptic geometries. They are also called the Geometries of Euclid, of Lobachevski, and of Riemann." Now Saccheri in his demonstration of Prop. XI. makes, almost in the words of Archimedes, an assumption, introduced by the words 'it is manifest,' which we now call, for convenience, Archimedes' Axiom. In his futile attempts at demonstrating the parallel-postulate, Legendre set forth two theorems, called Legendre's theorems on the angle-sum in a triangle. They are:

1. In a triangle the sum of the three angles can never be greater than two right angles.
2. If in any triangle the sum of the three angles is equal to two right angles, so is it in every triangle.

In addition to assuming the infinity or two-sidedness of the straight, in his proofs of these theorems Legendre uses essentially the Archimedes Axiom. Thence he gets that the angle-sum in a triangle equaling two right angles is equivalent to the parallel-postulate, all of which is really what Saccheri gave a century before him, now just reproduced by Barbarin and Manning, as before by De Tilly. Even Hilbert in his 'Vorlesung ueber Euklidische Geometrie' (winter semester, 1898-99), for a chance to see Dr. von Schafer's Authographie of which I am deeply grateful to Professor Bosworth, gives the following five theorems and then says: "Finally we remark, that it seems as if each of these five theorems could serve precisely as *equivalent of the Parallel Axiom.*" They are

1. The sum of the angles of a triangle is always equal to two right angles.
2. If two parallels are cut by a third straight, then the opposite (corresponding) angles are equal.
3. Two straights, which are parallel to a third, are parallel to one another.
4. Through every point within an angle less than a straight angle, I can always

draw straights which cut both sides [not perhaps their prolongations].

5. All points of a straight have from a parallel the same distance.

But since then a wonderful discovery has been made by M. Dehn.

It was known that Euclid's geometry could be built up without the Archimedes axiom. So arises the weighty question: *In such a geometry do the Legendre theorems necessarily hold good?*

In other words: Can we prove the Legendre theorems without making use of the Archimedes axiom?

This is the question which, at the instigation of Hilbert, was taken up by Dehn.

His article was published July 10, 1900 (*Mathematische Annalen*, 53 Band, pp. 404-439).

Dehn was able to demonstrate Legendre's second theorem without using any postulate of continuity, a remarkable advance over Saccheri, Legendre, De Tilly.

But his second result is far more remarkable, namely, that Legendre's first theorem is indemonstrable without the Archimedes axiom.

To prove this startling position, Dehn constructs a new non-Euclidean geometry, which he calls a 'non-Legendrean' geometry, in which through every point an infinity of parallels to any straight can be drawn, yet in which nevertheless the angle sum in every triangle is greater than two right angles.

Thereby is the undemonstrability of the first Legendre theorem without the help of the Archimedes axiom proven.

Dehn then discusses the connection between the three different hypotheses relative to the sum of the angles [the three hypotheses of Saccheri, Barbarin, Manning] and the three different hypotheses relative to the number and existence of parallels.

He reaches the following remarkable propositions:

From the hypothesis that through a given point we can draw an infinity of parallels to a given straight it follows, if we exclude the Archimedes axiom, *not* that the sum of the angles of a triangle is less than two right angles, but on the contrary that this sum may be (a) greater than two right angles, (b) equal to two right angles.

The first case (a) is proven by the existence of the non-Legendrean geometry.

To demonstrate the second case (b), Dehn constructs a geometry wherein the parallel-axiom does not hold good, and wherein nevertheless are verified all the theorems of Euclidean geometry; the sum of the angles of a triangle is equal to two right angles, similar triangles exist, the extremities of equal perpendiculars to a straight are all situated on the same straight, etc.

As Dehn states this result: There are non-Archimedean geometries, in which the parallel-axiom is not valid and yet the angle-sum in every triangle is equal to two right angles.

Such a geometry he calls '*semi Euclidean.*'

Therefore, it follows that none of the theorems, the angle-sum in the triangle is two right angles, the equidistantial is a straight, etc., can be considered as equivalent to the parallel-postulate, and that Euclid in setting up the parallel-postulate hit just the right assumption.

This is a marvelous triumph for Euclid.

Finally Dehn arrives at this surprising theorem:

From the hypothesis that there are no parallels, it follows that the sum of the angles of a triangle is greater than two right angles.

Thus the two non-Euclidean hypotheses about parallels act in a manner absolutely different with regard to the Archimedes Axiom.

The different results obtained may now be tabulated thus:

The angle-sum in the triangle is:	Through a given point we can draw to a straight:		
	No parallel.	One parallel.	An infinity of parallels.
$> 2R$	Elliptic geometry	(Impossible)	Non-Legendrean geometry
$= 2R$	(Impossible)	Euclidean geometry	Semi-Euclidean geometry
$< 2R$	(Impossible)	(Impossible)	Hyperbolic geometry

Riemann, Helmholtz and Sophus Lie founded geometry on an analytical basis in contradistinction to Euclid's pure synthetic method.

They elected to conceive of space as a manifold of numbers. In the Columbus report is an account of the Helmholtz-Lie investigation of the essential characteristics of space by a consideration of the movements possible therein.

This is notably simplified if we suppose given *à priori* the graphic concepts of straight and plane, and admit that movement transforms a straight or a plane into a straight or respectively a plane. Killing determines analytically the three types of projective groups, but the same results are reached in a way geometric and purely elementary by Roberto Bonola in a beautiful little article entitled, '*Determinazione, per via geometrica, dei tre tipi di spazio: Iperbolico, Ellittico, Parabolico* (*Rendiconti del Circolo Matematico di Palermo*, Tomo XV., pp. 56-65, April, 1901).

In 1833 was published in London the fourth edition of an extraordinary book (3d Ed., 1830) by T. Perronet Thompson of Queen's College, Cambridge, with the following title:

'Geometry without Axioms.'

"Being an attempt to get rid of Axioms and Postulates; and particularly to establish the theory of parallel lines without recourse to any principle not grounded on previous demonstration.

"To which is added an appendix containing notices of methods at different times proposed for getting over the difficulty in the 'Twelfth Axiom of Euclid.'" Svo, pp. x + 148. This dissects most brilliantly twenty-one methods of getting rid of Euclid's postulate; so brilliantly that it deserves to be reprinted and could scarcely be improved upon. Then, nothing daunted by the failure of every one else of whom he has ever heard, the brave Thompson adds one of his own, which perhaps he also afterward impaled upon the point of his keen dissecting scalpel, for he lived long and prospered. In 1865 De Morgan, whose unknown letters to Sylvester I had the pleasure of publishing in the *Monist*, writes:

"With your note came an acknowledgment from General Perronet Thompson, B.A. of 1802, and Fellow of Queen's before he was an ensign. And he works at acoustics as hard as ever he did at the Corn Laws."

But even in 1833, had he but known it, the question of two thousand years, as to whether Euclid's Parallel-Axiom could be deduced, had been settled at last by the creation and indeed publication, by Bolyai, and also by Lobachevski, of a geometry in which it is flatly contradicted.

The newly created methods, which thus settled this old, old question, give entirely new views concerning the investigation of axioms in general; and this diamond mine has been masterfully preempted by Hilbert, of Göttingen. His wonderful 'Grundlagen der Geometrie' is ablaze with gems from this non-Euclidean mine.

After Bolyai and Lobachevski, Hilbert's closest forerunner is Friedrich Schur, of Karlsruhe. One of the most fundamental advances of this decade is the strict rigorous reduction of the comparison of areas to the comparison of sects.

This was first given on January 23, 1892, by Schur before the Dorpater Naturforscher-Gesellschaft.

The account printed in Russia in the society's *Proceedings*, a *Referat* given by Schur, is of course almost inaccessible, nor is this inaccessibility much lessened for us by the fact that it has been translated into Italian (*Per. di Mat.*, VIII., p. 153).

The essence of the matter is the proof that, a certain sect being taken as the measure of the area of a triangle, the *sum* of these sects is *the same* for any set of triangles into which a given polygon can be cut, and so gives a sect which may be taken as the measure of the area of the polygon. The *Referat* begins as follows:

"On the surface content of plane figures with straight boundaries, by Friedrich Schur.

"So simple a problem as the measuring of plane figures with straight boundaries as it seems from the literature to me accessible, has not yet been set forth with the rigor and purity of method herein possible.

"Not to mention the introduction of endless processes, still general magnitude-axioms are used unjustifiably, which are only then immediately clear when these magnitudes are straight sects, their comparison therefore capable of being made by superposition.

"Such a general magnitude-theorem, which is used in all text-books of elementary mathematics known to me in proving the theorem of the equal area of two parallelograms with common base and equal altitude, is, *e. g.*, this, that the subtraction of equal magnitudes from equal magnitudes gives again equal magnitudes.

"If the sides of the two parallelograms lying opposite the common base have a piece or at least a point in common, then the two parallelograms can at once be cut into parts such that each part of the one parallelogram corresponds to a part congruent to it of the other parallelogram.

"On the contrary, if those two sides have no point in common, then it has been be-

lieved that this method of proof for the equality of area, simple and standing upon a sharp definition, must be renounced, and it has been replaced, as is known, by this, that each of the two parallelograms is represented as the difference between the same trapez and one of two congruent triangles.

"But before the measurement of plane surfaces by sects has been attained, which just first becomes possible through the theorem to be proven, the application of the above magnitude-theorem is justified by nothing.

"We must therefore throw away this method of proof, and that so much the more, as in every case each of two parallelograms with common base and equal altitude in very simple way comprehensible to every scholar can be so cut into a number of parts that to each part of the one parallelogram corresponds a part congruent to it of the other.

"One may find that, *e. g.*, set forth in 'Stoltz's Vorlesungen' ueber allgemeine Arithmetik, I. Theil (Leipzig, 1885), S. 75 ff.

"We can still somewhat simplify this method, and lessen the number of parts. Draw, namely, through each of the two end-points next one another of the sides lying opposite the common base, parallels to the sides of the other parallelogram, and prolong these to the two outer of the sides not parallel to the base. The join of the two end-points so obtained is then parallel to the base, and cuts from the two parallelograms two new parallelograms which without anything further are divided into triangles every two congruent to one another.

"If then the sides opposite the common base of the remaining parallelograms again have no common point, then we proceed just so with them, and come thus, after a finite number of repetitions, to a pair of

parallelograms, to which the customary procedure can be applied.

"If the distance of those two neighboring end-points of the sides opposite the base is greater than the n fold of the base, on the other hand at the highest equal to the $(n + 1)$ fold of the base, then is each parallelogram cut into a trapez (respectively triangle), three triangles and n parallelograms, and each of such parts of the one parallelogram corresponds to a part congruent to it of the other." Now it so happens that I myself had reached this method and published it seven years before Schur in my 'Elements of Geometry' (John Wiley & Sons, New York). It may be described more concisely as taking away pairs of congruent triangles each with base equal to the common base of the two parallelograms and sides respectively parallel to their other pairs of sides, until we have left two parallelograms to which the customary dissection into a triangle and trapezoid will apply, to finish with congruent parts.

But this demonstration, though the very simplest possible, yet postulates the Archimedes axiom, though neither I myself, in 1885, nor Schur, seven years later, in 1892, said a word about this assumption. However, before 1898 Schur became conscious that elementary geometry can be built up without the Archimedes axiom. He states this in the preface to his remarkable 'Lehrbuch der analytischen Geometrie' (Leipzig, Veit & Comp., 1898), referring to his article 'Ueber den Fundamentalsatz der projectiven Geometrie' *Math. Annalen*, Bd. 51), where he proves the theorems of Desargues and of Pascal without using either the parallel postulate or the axiom of Archimedes, proving that the ordinary sect-calculus can be built up independently of number-measure and the Archimedean postulate.

Professor Anne Bosworth, of Rhode

Island, has followed this up by actually constructing in her doctor's dissertation at Göttingen (1900), under Hilbert, a sect-calculus independent of the parallel-axiom.

This is a beautiful piece of non-Euclidean geometry, and is, so far as I know, the first feminine contribution to our fascinating subject.

In 1899 appeared Hilbert's 'Grundlagen der Geometrie,' in which the remarkable contributions of Schur are all retouched by a master hand.

In Schur's proof of the Pascal theorem the space axioms are used. Hilbert replaces them by the parallel-axiom, thus proving Pascal as a theorem of plane Euclidean geometry.

Schur makes a sect-calculus, and shows that the theory of proportion can be founded without the introduction of the difficult idea of the irrational number. He indicates that this could be done without the Archimedes axiom.

Hilbert actually does it.

Schur proves for the first time the fundamental theorem for a rigorous treatment of area.

Hilbert simplifies this proof, and proceeds to treat this whole subject without the Archimedes axiom, making here the new distinction between *flächengleich* and *inhaltsgleich*.

Two polygons are said to have *equal surface* when they can be resolved into a finite number of triangles congruent in pairs.

Two polygons are said to have *equal content* if it is possible to add to them polygons of equal surface, so that the two new compound polygons have equal surface.

Thus Euclid only tried to treat *equal content*, and Hilbert is here a return to the great Greek.

The intense interest in all these unexpected developments is voiced in a handsome volume: 'Questioni riguardanti la geometria elementare' (Bologna, 1900, 8vo,

pp. vii + 532), edited by Federigo Enriques, who has been chosen to contribute the part on the foundations of geometry to the great German Encyclopædia of the Mathematical Sciences, and who contributes the first article (28 pages) to this Italian work. It is entitled 'On the Scientific and Didactic Importance of the Questions which Relate to the Principles of Geometry.'

The whole book may be properly described as an outcome of the non-Euclidean geometry, but more specifically, the longest of the fourteen articles which make it up is by Bonola: 'On the Theory of Parallels and on the non-Euclidean Geometries' (80 pages, 26 figures).

The first fifty of his eighty pages are devoted to an historico-critical exposition; the last thirty to general theory, hyperbolic geometry, elliptic geometry. Though the article was published only last year, it is in certain respects antiquated. The proofs freely use the Archimedes postulate, without saying anything more about it than I did in 1885, that is, nothing at all. His § 7 is headed 'Postulates Equivalent to the Postulate of Euclid,' and gives those adopted by Proclus, Wallis, Bolyai Farkas, Carnot, Legendre, Laplace, Gauss. But now we know that all these men failed in attempting to rival the choice of Euclid. Their axioms are not the equivalent of his immortal postulate.

In this section the name Legendre is misspelled, and in § 5 Bonola says, "The attempts of Legendre for the demonstration of the Euclidean hypothesis, published in the various editions of the 'Elements' of Euclid, which appear under his name," etc.

Of course Legendre never published any edition of Euclid. It was on the contrary Legendre's geometry which cursed the subject with that definition, "A straight line is the shortest distance between two points,"

which still disgraces the beautifully illustrated book of Phillips and Fisher of Yale.

Again, in § 12 Bonola misquotes in a very important particular the title of the only thing Bolyai János ever published, his renowned appendix, in which title, instead of 'Johanne Bolyai de eadem,' Bonola has 'Johanne Bólyai de Bólya.' Again in § 8 Bonola is still expressing the hope that the examination of the unedited manuscripts of Gauss may show some ground for the pretence that Gauss had some part, however minute, in the creations of Bolyai, Lobachevski and Riemann. But these manuscripts have already been most sympathetically edited by Professor Paul Staeckel, their publication making a goodly quarto, in a review of which for SCIENCE under the heading 'Gauss and the non-Euclidean Geometry,' I find they only strengthen the already existing demonstration that neither of the creators of the non-Euclidean geometry owed even the minutest fraction of an idea or suggestion to Gauss.

This is reproven by the correspondence of Gauss and Bolyai Farkas, so sumptuously published in royal quarto by the Hungarian Academy of Science, edited by Staeckel and Franz Schmidt, chiefly valuable for its references to the immortal boy, Bolyai János, of whom unfortunately no portrait exists.

And now a word in conclusion.

Thinking is important for life. So much so that evolution in thinking has dominated all other evolution. In all thinking enters a creative element. There is not any pure receptivity. Nothing can be described except in terms of a precreated theory. The business of science is the making of these theories, and the continual remaking and bettering of these theories. The higher races of mankind, and chiefly the Greeks, created and elaborated a scheme for dominating what a popular terminology

calls the facts and laws presented by the spatial relations of things.

This scheme was only one of an indefinite number of possible schemes, but as coordinated and systematized by a great constructive genius, Euclid, the first professor of mathematics at the University of Alexandria, it proved so efficient, so effective for life, that all educated men accepted it as part of their common equipment.

Though it promises no heaven, though it threatens no hell, though it mentions no angels, no devils, yet Euclid's elements of geometry, simply as conveying a necessary instrument for the conduct of civilized life, has appeared in more than one thousand four hundred different editions [Professor Riccardi: *Saggio di una bibliografia Euclidea* (Bologna, 'Memorie' (5), I., 1890)].

Euclid gave to educated mankind a common language for description of the spatial, a common mental basis for thought about extension. Euclid's geometry is a certain theory for a specific natural science, a mental construction to explain, to master, to communicate or transmit, and to prophesy certain physical phenomena, the spatial or extensive phenomena. Therefore, the body of its doctrine is a system of theorems deduced in a logical way from certain unproven and in part absolutely and finally indemonstrable assumptions. Such a one is the world-renowned parallel-postulate, which is absolutely incapable of being proved in any way whatsoever, mental or physical, speculative or experimental, deductive or inductive. Therefore, to substitute for it a contradiction of it, in Euclid's scheme of fundamental assumptions, is to get with certainty another equally logical theory to do all that Euclid's geometry has ever done.

Of such systems each may throw light on the other, each may possess special advantages for particular applications.

But more than that: three such systems

used simultaneously may be able to accomplish what no one of them could do. This is beautifully illustrated in a theory communicated to me by F. W. Frankland, using a cosmic medium in which small regions of elliptic and hyperbolic space alternate, given a strain toward parabolic space which produces an elasticity or resilience simulating the properties with which physicists have endowed their hypothetical ether.

GEORGE BRUCE HALSTED.

UNIVERSITY OF TEXAS.

THE AMERICAN ASSOCIATION FOR THE
ADVANCEMENT OF SCIENCE.

SECTION H, ANTHROPOLOGY.

THE effect of environment on the success of a meeting was well demonstrated at Denver. Local interest in the Section of Anthropology, fostered by the Colorado Cliff Dwellings' Association, had reached such a pitch even in advance of the opening session that the small room originally intended for the Section was abandoned for one with a seating capacity of 200. This large room was converted into a bazaar of rare aboriginal ceramics, Navajo blankets, basketry and pictures of Indian scenes by a committee from the Cliff Dwellings Association consisting of Mrs. J. D. Whitmore, Mrs. G. T. Sumner and Mrs. W. S. Peabody, all of Denver.

The meeting was memorable for sustained interest. The attendance was unprecedented, averaging at least 150 for the morning sessions; the afternoon audiences were also large.

Section H was organized on Monday morning, August 26, after the adjournment of the General Session, in accordance with the provisions of the constitution. The officers for the Denver meeting were as follows:

Vice-President, J. Walter Fewkes.
Secretary, George Grant MacCurdy.

Sectional Committee: A. W. Butler, vice-president, Section H, 1900; Frank Russell, secretary, Section H, 1900; J. Walter Fewkes, vice-president, Section H, 1901; George Grant MacCurdy, secretary, Section H, 1901; Mrs. M. L. D. Putnam, Frank W. Blackmar, G. A. Dorsey.

Member of Council, W. J. McGee. *Member of General Committee*, Mrs. W. S. Peabody.

Retiring Vice-president Butler's address, entitled, 'A Notable Factor in Social Degeneracy,' was delivered Monday afternoon. It was printed in SCIENCE of September 20.

The titles of papers presented before the Section are accompanied by brief abstracts in so far as it has been possible to secure these from the authors.

1. 'Exhibit of Curves of Speech': E. W. SCRIPTURE.

An exhibit of a series of plates containing the curves of vibration traced from a gramophone plate containing Rip Van Winkle's Toast spoken by Joseph Jefferson. In the absence of the author, the paper was presented by Mr. MacCurdy. It will be printed in Scripture's 'Elements of Experimental Phonetics.'

2. 'Influences of Racial Characteristics on Socialization': FRANK W. BLACKMAR.

Racial characteristics are the great barriers that prevent a complete socialization of the human race; the race idea, or consciousness on the part of two groups of people that they are different in origin and structure is a detriment to perfect social union; a transition from the old family, or ethnographic, status to the modern, or demographic, society has been exceedingly difficult; the race idea has been the hindering cause in the progress of democracy; the historical examples of the social difficulties of Greece, Rome the Iroquois tribes and the Aztec federation; the difficulties of socialization appear in the development of homogeneous society in large cities; difficulties arising from an attempt to socialize widely divergent races; when common marriage relations are pro-

hibited by law, custom or prejudice the basis for social amalgamation is wanting; the inter-marriage of superior and inferior races results in an offspring inferior to the lowest of the united races. It is possible, however, through artificial selection, to unite the best elements of each race and hence raise the standard of the lower race. The variation in results from the inter-marriage of widely differentiated races as observed in the characteristics of the offspring.

It must be observed then, first, that a perfect social union is not possible between races that cannot intermarry; second, that intermarriage is not probable among widely divergent races if once included in the same social system; third, that intermarriage is not desirable between widely divergent races because controlled by lower sentiments and usually practiced by the lower elements, thus leading to degeneration; fourth, that race prejudice, so far as it prevents the union of widely divergent races, is good rather than evil. When different races, widely separated as to origin or widely divergent in culture, live under the same government, each must have its place; a government founded on justice must protect the weaker race and preserve its rights; examples from studies of the social and political status of the African race in America; examples from studies of the social and political status of the American Indians; a plea for a more careful study of races as a basis for socialization and a means for procuring rational legislation.

Discussion: Butler pointed out the necessity of understanding the psychic standpoint of a people in order to understand the influences of race or culture. McGee emphasized the invigorating influences of blood-blending when the stocks are not too greatly diverse, as shown, for example, by the British and American peoples, and then

mentioned culture as a factor of paramount importance in ethnic and demotic development. This paper was also discussed by Russell and Dorsey.

3. 'The Anthropological Collections of Yale University Museum': GEORGE GRANT MACCURDY.

An abridged statement relative to the size and character of the collections which, it is hoped, may be of service to students making a comparative study of museums of anthropology. They comprise from 15,000 to 18,000 specimens representing geographically thirty-six states and territories, Hawaii and the Philippines, besides forty foreign countries. The greater part of the material is archeological. The antiquities from Central America alone number over 3,000, including fifty-three gold ornaments from the Province of Chiriqui. The collection of Missouri pottery, more than 1,000 pieces in all, is one of the largest and best in the country. A representative series from the Quaternary and cavern deposits of western Europe, the Swiss Lake Dwellings, and the shell heaps and dolmens of Scandinavia has recently been installed. In respect to physical anthropology, the museum possesses several hundred crania, chiefly Amerindian, Hawaiian and New Guineaian.

4. 'Report on Work recently done by the Department of Anthropology, Field Columbian Museum': by the curator, GEORGE A. DORSEY.

Discussion: J. Walter Fewkes.

5. 'Political and Social Conditions in the Hawaiian Islands': DAVID STARR JORDAN.

6. 'Notes on Criminal Anthropology': AMOS W. BUTLER. A study of the individual family characteristics of inmates of the Indiana Reformatory. The results of four years of operation of the indeterminate sentence and parole law in that State.

7. 'The Nature of Sun Worship': J. WALTER FEWKES.

The two chief gods of the Pueblos are the sky god and the earth goddess. The sky god has a variety of names, some of which are the same as his attributes, as: wind, lightning, rain, etc.; others are simply clan names for the same god. The sun god is a being symbolized by the sun. The sun is a shield carried by the sky god. This sky god or sun god (the names are interchangeable) is the male principle—*i. e.*, the god of germs. His house is in the underworld. The female principle is the earth goddess, the goddess of germs. The god of fire was a god of life which practically originated as sky god. Differentiation came later. Inasmuch as the underworld was the home of the sky god and also regarded as the home of the dead, the sun as ruler of the underworld was regarded as the god of death. The sky god and earth goddess are personated by animal forms and the names of these animals are sometimes applied to them, *e. g.*, the sky god is often called the thunder bird. So the earth goddess is called the spider woman. Thus, in popular stories, they say the spider woman created man. Creation, as we understand it, is a foreign conception to primitive man; it is always akin to birth. The sky god and earth goddess are father and mother to all men, and animals as well. The earth is preexisting in their belief. Religious beliefs and practices are simply magical. Primitive man believes that everything has a magic power. The earth has magic power. The sky is regarded as a solid body and has its magic power. Every man, animal and object has its magical power, and the object of worship is to make use of this magical power to bring about desired results. For example, suppose a man wishes to bring rain. He owns certain fetiches whose magic power is great enough to compel the magic power of the sky to make it rain. He knows certain songs or prayers which will do the same.

He exerts this power in the form of a rite or ceremony.

8. 'Some Remarks upon the Attitude of the Citizens of the Southwest toward Archeology': FRANK RUSSELL.

A paper based upon observations made during an extended archeological reconnaissance in Arizona and adjoining territories. This research developed the fact that the average ranchman or miner takes an active interest in the antiquities of his locality, and usually formulates theories that are sometimes startling to the archeologist. The author also discussed the attitude of the Mormons, the extent of unscientific exploration and vandalism; besides relating personal experiences.

Discussion: Dorsey, Fewkes and Hewitt.

9. 'The Proposed Cliff Dwellers' National Park': EDGAR L. HEWITT.

The following is a summary of Mr. Hewitt's paper:

(a) The geological conditions of Pajarito Park, illustrated by photographs and an archeological map. (b) Nature and extent of the ruins thereon; illustrated by photographs of cavate lodges; ground plans of ruins known as Tchrega, Navakwa, Tsankawi and Otowi; maps of mesas on which these ruins are situated, and restorations in water-color of Tchrega and one section of cliff showing cavate lodges. (c) The pictography of the ancient inhabitants, illustrated by series of photographs from Puye and Pajarito. (d) Historical sketch of the movement providing for the setting aside of the Pajarito region as a national park. (e) Discussion of House Bill No. 13,071, known as the Lacey Bill.

Discussion: Blackmar, Fewkes, Dorsey and McGee. The last named emphasized the necessity of preservation of antiquities. He had drafted a general law for the preservation of antiquities on lands belonging to the United States. Had it passed, it would be easy to have states act on lands belong-

ing to them. The Public Lands Committee has recommended the setting apart of Pajarito Park as a national park to be called 'The Cliff Dwellers' National Park.'

One of the direct results of Mr. Hewitt's paper was the appointing of the following committee to draft resolutions on the preservation of the ancient monuments of the Southwest:

Edgar L. Hewitt, Chairman,
Amos W. Butler,
George A. Dorsey,
George Grant MacCurdy.

The report of this committee, after being accepted by the Section, was adopted by the Council and read in general session Friday morning.

10. 'Some Pawnee and Wichita Games':
GEORGE A. DORSEY.

Discussion: Russell, Culin, McGee and Fewkes.

11. 'The Teaching of Anthropology in the United States': GEORGE GRANT MAC-CURDY.

Information relative to the teaching of anthropology in our institutions of learning, collected at the request of the 'Committee on the Teaching of Anthropology in America.' It was found upon investigation that thirty-one universities and colleges now offer instruction in anthropology. They are: Beloit College, Beloit, Wis.; Bellevue College, Bellevue, Nebr.; Boston University; Brown University; Clark University; College of Physicians and Surgeons, Boston; Columbia University; Columbian University, Washington, D. C.; Creighton University, Omaha, Neb.; Dartmouth; Georgetown University, Washington, D. C.; Harvard; National University, Washington, D. C.; New York University; Niagara University, Niagara County, N. Y.; Phillips Academy, Andover, Mass.; Ohio State University, Columbus; University of California; University of Chicago; the Universities of Illinois, Indiana, Kan-

sas, Minnesota, Missouri, Nebraska, Pennsylvania, Vermont, and Wisconsin; Western Reserve University; Willamette University, Salem, Oregon; Yale University. Of the thirty-one institutions offering anthropology, it is found to be an adjunct of sociology in nine, of philosophy in five, of psychology in three, of geology and zoology in five, and of medicine in one; while in five instances it stands practically alone and in three it is unclassified.

Discussion: Blackmar, McGee, Dorsey and Farrell.

This paper will be printed in SCIENCE.

12. 'Current Questions in Anthropology':
W J MCGEE.

Discussion: Russell, Dorsey and others.

13. 'Analogy between Writing and Speech': ROBERT ARMSTRONG.

(a) All alphabetic characters are analogous, in (1) *material* and in (2) *function*, to the voice elements. (b) Written or printed letters have usually no analogy of character to the sound elements they represent. (c) Perfect analogy between graphic signs and spoken sounds is not attainable. But in proportion as alphabetic signs can be modeled from the sound elements they respectively represent, written or printed words will approach spoken words in character, and hence, in facility, economy and all that is desirable in written or printed words.

Charts were used in illustration of the subject.

14. 'Notes on the Archeology of Cuba':
STEWART CULIN.

15. 'The Problem of the Cliff Dwellers':
J. WALTER FEWKES.

A discussion of the relation of ancient Cliff Dwellers to modern Pueblos, showing a kinship in culture which does not, however, imply a kinship of blood. There was at least some kinship of blood. Some of the cliff houses in the Cañon de Chelly have been inhabited in historic times. There is a clan living now at Moki whose ancestors

once lived in the Chelly cañon. A very old woman of Moki still lives whose mother was born in a Chelly cañon cliff house. The cliff house may have been very old at that time, however. There are some very old cliff houses, while others are comparatively modern.

Discussion: Dorsey, Holsinger and ex-Governor Prince, of New Mexico. Governor Prince said the territory of New Mexico had offered the Old Palace in Santa Fé as a branch of the Smithsonian Institution.

A paper by J. Crawford on 'Sculptured Stone Images of Man by the Aborigines in Nicaragua,' and one by Charles E. Slocum, entitled, 'A Plea for Greater Simplicity and Greater Accuracy, in the Writings of the Future, regarding the American Aborigines,' were read by title.

On Tuesday, at 4 p. m., Section H adjourned to hear Mrs. John Hayes Hammond's lecture on 'The Cliff Dwellings of Colorado,' illustrated by lantern slides.

Dr. Fewkes's lecture Friday evening, on 'The Moki Snake Dance,' illustrated by lantern slides, was also of special interest to anthropologists, though not a part of the regular program.

A letter was read from Miss Alice C. Fletcher, who, in her enforced absence on account of illness, sent greetings to the Section; also a letter from Mrs. Daniel G. Brinton, to the effect that a new edition of 'The American Race' would appear in September of this year.

The report of the 'Committee on the Teaching of Anthropology in America,' which was read before Section H by Dr. McGee, was printed in SCIENCE of September 6, p. 353.

The report of the 'Committee on Anthropometric Measurements,' including the request for a grant of \$50, was recommended and later adopted by the Council.

Section H was authorized to hold a winter meeting, the time and place to be decided

upon by the Sectional Committee. The winter meeting will be held in Chicago during Convention Week of 1901-02.

The newly elected officers for the Pittsburg meeting are:

Vice-President, Stewart Culin, of the University of Pennsylvania.

Secretary, Harlan I. Smith, of the American Museum of Natural History, New York.

The invitation extended to Section H by Mr. and Mrs. Gilbert McClurg, of Colorado Springs, to inspect their cliff dwelling collection on Monday, September 2, was very generally accepted. The same week, a party of anthropologists visited the cliff dwellings of the Mesa Verde in southwestern Colorado as guests of the ladies of the Directorate of the Colorado Cliff Dwellings Association, of which Mrs. McClurg is Regent.

GEORGE GRANT MACCURDY,
Secretary of Section H.

EARLY WINTER COLORS OF PLANT FORMATIONS ON THE GREAT PLAINS.*

ONE who has not been upon the Great Plains in the early winter, after the autumn frosts have changed the prevailing green of the landscape, can have little conception of the variety of the colors which meet the eye. These include several shades of red, two or more of orange, one or more of yellow, two of green, a dark blue, a purple, several browns and blacks, and many grays. With a little practice the eye can distinguish from twenty to twenty-five shades of color, sometimes blending into one another almost insensibly, or standing out in marked contrast upon the landscape picture.

It does not require long study to show that so far as the natural vegetation is concerned these colors conform to the distribution of the various plant formations, and

* Read before the meeting of the Botanical Society of America, in Denver, August, 1901.

that we have here a natural color-scheme in which the plant formations are mapped on the landscape. Let me attempt to reproduce some of the color pictures I have seen.

First, give the picture a general gray tone, which may include the sky as well as the earth surface. In the background where the hills slope away to the horizon are great patches of dull red or purple, bordered by the silvery gray of the buffalo grass. Here in the foreground may be a stretch of light yellow marking the area of a field of maize stalks still standing where they grew, and there may be a gray, velvet-like meadow of buffalo grass, with dashes of brick-red now and then on its surface where the bunch grasses stand, or where the red stems of the knotweeds mark the winding course of a 'draw.' Here and there the landscape shows a black spot where the farmer has plowed up the rich soil in readiness for the spring's plantings. Crossing a ravine we find the sloping sides red with the bunch grasses, below which is a belt of yellow 'prairie grass' bordering the dry bed of the brook, the latter marked here and there with red-twigged willows. In the distance, where a stream winds its way along, is a black line of cottonwood trees, whose trunks and larger branches show black against the gray background, and on nearer approach we note the silvery sheen of their twigs contrasting with their dark stems and branches. A plum thicket in a ravine forms a dark-blue patch, with a background of dull red knotweeds, or bunch grass, further back shading into the silvery gray of the buffalo grass.

Now we see a silvery gray meadow of buffalo grass with faint patches of reddish color scattered over it; back of it a fringe of cottonwood and box elder trees with dark trunks, the latter loaded with their light brown fruits, and still back of these the slopes with alternating silvery gray patches of buffalo grass and the dull red of the

bunch grasses, running up to the sky line of light ochre where a field of maize is still standing. To complete the picture add a few stacks of alfalfa, now dark brown or black, and a spectral windmill here and there outlined in somber colors.

Allow me to show you one more picture seen near Minden, under the ninety-ninth meridian. Here is a little valley framed in with a brick-red border of bunch grass which grew on its sloping sides: next to it are patches of yellow switch grass and silvery gray buffalo grass, and a rich, velvety maroon spot where the ripe fruits of the smooth sumach give their color to the scene. The floor of the valley is covered with the red knotweed whose red is deepened in a central strip to a rich purple-red where a water course has encouraged the red-stemmed *Polygonums* to grow.

I need not attempt to place before you more of these general views. In all cases the picture has a basis of gray, and on this are laid reds, yellows, blues, purples, browns and blacks, etc. Let us inquire into the meaning of these strips and patches of color.

When the autumn drought and the early winter frosts stop the growth of vegetation the green shades of summer, themselves by no means uniform, are replaced by the hues indicated in the preceding paragraphs. The practiced eye can distinguish the plant formations on the open plains by their shades of green when the vegetation is in its vigor, and it appears that the early winter coloration is in a measure related to this fact. The boundaries of the formations are more sharply defined in the early winter, since the color differences are emphasized. I have not, however, been able to determine any law of color change in the plants of different formations. In fact it appears that each plant is a law unto itself. Thus the light green of the low bunch grass (*Andropogon scoparius*) gives place to a red,

as does the still lighter green of the tall knotweed (*Polygonum ramosissimum*), while the nearly similar pale green of the buffalo grass (*Bulbils dactyloides*) turns to a silvery gray. On the other hand, the richer green of the switch grass (*Panicum virgatum*) turns to a red orange below and a light yellow above, and the dark green of stinkweed (*Dysodia papposa*) as seen in the summer is replaced in early winter by a pronounced brick-red. Yet in the midst of these changes the clumps of dagger weed (*Yucca glauca*) and the bunches of cactus (*Opuntia humifusa* and *O. polyacantha*) retain their green color, and in fact, are the only green things in the landscape.

I may summarize the facts so far as I have observed them by grouping the plants under the colors they assume, as follows :

RED.

Bunch grasses (*Andropogon furcatus*, and *A. scoparius*).

The first (tall bunch grass) is sometimes of a rich orange-red running to dull red, and the second (low bunch grass) is from brownish red to brick-red and purple, fading out sometimes to a dull gray.

Knotweeds (*Polygonum ramosissimum* and *P. emersum*), with the stems of various shades of red, in the second species running to purple red.

Willows (*Salix fluviatilis*) with red twigs.

Stinkweed (*Dysodia papposa*), whole plant becoming brick-red.

ORANGE.

Bunch grass (*Andropogon furcatus*); as noted above, this species sometimes assumes a rich orange-red color.

Switch grass (*Panicum virgatum*) the lower portions of the seeding plants are often of a red-orange color.

YELLOW.

Maize fields during the autumn and early winter assume many shades, from the deepest yellow to a pale straw color.

Switch grass (*Panicum virgatum*); the upper portions of the seeding plants are often of a light yellow color.

GREEN.

Dagger weed (*Yucca glauca*) and prickly pear cactus (*Opuntia hemifusa* and *O. polyacantha*) constitute the only green vegetation on the plains in the winter.

BLUE.

Plum thickets (*Prunus americana*), seen at a little distance are distinctly of a dark blue color.

PURPLE.

Sumach fruits (*Rhus glabra*), ranging from a dull purple to a rich maroon-purple.

Low bunch grass (*Andropogon scoparius*), as noted above this species ranges from dull red to purple.

Knotweed (*Polygonum emersum*) although usually red, sometimes it becomes a purple-red.

BROWN.

Russian thistle (*Salsola tragus*), brown to blackish-brown, and the same may be said for weed fields in general.

Plum twigs (*Prunus americana*); although plum thickets when seen at a little distance are dark blue, the twigs when seen near at hand are reddish brown.

Box elder fruits (*Acer negundo*), light brown, and as they are very abundant they give the trees their color when seen near by.

BLACK.

Cottonwood tree trunks and branches (*Populus deltoidea*) seen at some distance are brownish-black to black.

Plowed land, burned areas and wagon trails all show black or nearly so on the landscape.

GRAY.

Buffalo grass (*Bulbils dactyloides*), from a light or silvery green in the summer, this species changes to a light gray or silvery gray in the winter.

Grama (*Bouteloua oligostachya*), gray.

Beard grass (*Aristida* sp.) light gray.

Tickle grass (*Panicum capillare*), silvery gray.

Low bunch grass (*Andropogon scoparius*); as indicated above, this may fade out to a dull gray.

Cottonwood twigs (*Populus deltoidea*), grayish-white.

I may close this paper with a couple of sections observed between Oxford and Minden, Nebraska.

In the one case (Figs. 1 and 2) a ravine, with moderately abrupt but regularly sloping sides, was observed to have a central band

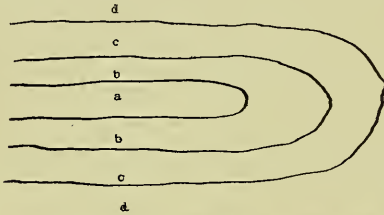


FIG. 1. Ground plan of ravine. *a*, yellow; *b*, red; *c*, gray; *d*, red.

(*a*) of yellow (switch grass) which occupied the entire floor. On each side was a belt (*b*) of red (bunch grass) which occupied the lower and more sloping part of the side of the ravine. On the shoulder of the ravine, running down to the more precip-



FIG. 2. Section of ravine; *a*, yellow; *b*, red; *c*, gray; *d*, red.

itous part and back to the edge of the level ground was a broader belt (*c*) of gray (buffalo grass and grama), and back of this again came the red of the bunch grass (*d*) which colored the general surface of the plain.

In another case (Fig. 3) a gentle slope with somewhat terraced surface was ob-

served with a peculiar distribution of color. There were three steps on the slope, each not more than twenty to thirty centimeters

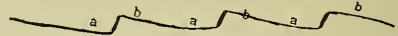


FIG. 3. Section of terraced slope; *a*, *a*, *a*, red; *b*, *b*, *b* gray.

in height, and a couple of meters apart, the surface sloping gently from step to step. On each terrace the upper edge near the step (*a*) was red with bunch grass, while the lower portion (*b*) was gray with Buffalo grass and grama. This was repeated exactly upon each terrace, giving the whole view a very singular appearance.

CHARLES E. BESSEY.

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RUDOLPH KOENIG.

ON the second day of October, 1901, Rudolph Koenig passed away at his home in Paris in his sixty-ninth year. He had been in failing health for several years.

Rudolph Koenig was born in Koenigsberg, Prussia, on the 26th of November, 1832. At his home he received nothing beyond the usual high school training given in the local gymnasium, in which his father was the teacher of mathematics and physics. He went to Paris at the age of nineteen years, and in the French metropolis he spent most of his manhood. Here he began life as an assistant in the manufactory of a celebrated violin maker, Vuillaume, where he manifested unusual aptitude both as a mechanic and as the possessor of an extraordinarily delicate and correct ear for music. Such leisure as he could command was devoted to the study of mechanics and physics.

Within a half-dozen years the young acoustician was enabled to undertake business on his own account, having already attracted the notice of men of science by his ingenuity, patience and accuracy. In 1859 he issued his first catalogue of acoustic

apparatus. From that day to the present Koenig's instruments, and especially his tuning forks, have been generally recognized as standard.

Koenig was not satisfied to fill orders and maintain his reputation as a constructor of instruments. He early perceived the value of the graphic method for the study of harmonic motion, and to this he devoted much time and labor during the first few years after establishing himself independently. Wertheim and Duhamel had already used the tuning fork with style attachment for the registration of simple vibrations, as suggested a half century previously by Dr. Thomas Young in England. Koenig extended it to the study and registration of compound harmonic motion for both parallel and rectangular vibrations. The mathematical analysis of wave motion had been abundantly brought out in technical treatises, and Lissajous had but recently excited admiration by his optical method of presenting rectangular vibrations. Koenig devised the method of recording these directly from the sounding tuning fork. At an international exhibition held in London in 1862 he exhibited an album containing a large variety of such phonograms, recorded with apparatus of his own device, and accompanied with the tracings of the corresponding theoretical curves. This was the starting point for the use of the graphic method of self-registration which has since been so extensively employed in laboratories of physics, physiology and psychology.

It was at the same exhibition that Koenig made known a wholly new method of causing the effects of sonorous vibration to become visible by utilizing the delicate sensitiveness of flame to variations of atmospheric pressure. The suggestion had come from America, where Le Conte had published, in 1858, his observations on the effect of sound waves upon naked gas flames.

Koenig devised the manometric capsule, and resorted to Wheatstone's application of the revolving mirror for spreading the flame images. The last improvements on this method have been made by the application of instantaneous photography to perpetuate the images, some of the best of this work having been done within the last few years by Hallock in New York and Merritt in Ithaca. The manometric flame is not equal to the tuning fork curve as a means of studying the composition of vibration, but the novelty and attractiveness of the method quickly made its author famous. He received a number of medals, and in 1868 the honorary degree of doctor of philosophy was conferred upon him by the university of his native city, Koenigsberg, in acknowledgment of his meritorious original work in science.

Prior to 1882 Koenig had published about sixteen scientific papers, some in the *Comptes Rendus*, but most of them in the *Annalen* of Poggendorff and Wiedemann. These were gathered into a volume entitled, 'Quelques expériences d'acoustique.' Since that time he has published a number of contributions to *Wiedemann's Annalen*, the last of which appeared in the summer of 1899. Failing health had already put a check upon his activity, but his passion for experimental research continued long after the time when most men lose their enthusiasm for abstract investigation. All his research work was the outcome of the love of science without the promise of pecuniary reward. It was done, moreover, with full knowledge that as a branch of pure science acoustics had been forced to the background by such subjects as heat, and more especially electricity, in which the field has become widened almost without limit during the last two or three decades.

In the absence of systematic university training in early manhood Koenig as an investigator in physics was compelled al-

ways to work at some disadvantage. He had an abiding faith in experiment, and was not afraid to proclaim the results of his careful, painstaking work, even if it seemed to contravene the conclusions of those whose theoretic preparation was better than his. The subject of musical quality was one which he attacked with characteristic patience. With the mathematical theory of combination tones, as brought out by Helmholtz, and the two subdivisions of difference tones and summation tones, Koenig was not prepared to grapple. With his naturally acute and highly trained ear he sought in vain to perceive the summation tones for which theory provided, and he reached the conclusion that they had no objective existence. Difference tones, or beat tones, as he called them, are easily perceived, and he spent much time in the investigation of such tones due to the interference of upper partials. It was in furtherance of this investigation that he invented the wave siren; and as a result of experiment with it he concluded, in opposition to the view of Helmholtz, that musical quality is determined not only by the number, the orders and the relative intensities of the upper partials which accompany a given fundamental tone, but also by their mode of phase combination. To test this the wave siren was certainly better than the apparatus employed by Helmholtz; but the perception of the result requires an experienced ear. The experiment is more psychological than physical. Upon the present writer, while cooperating with Koenig in his laboratory, and upon others also, the decided impression was that Koenig's conclusion was correct. But the subject is still one for investigation.

A monumental piece of mechanical work accomplished by Koenig was his great tonometer, consisting of hundreds of accurately adjusted and properly labeled

tuning forks arranged in a series, each making a definite and small number of beats with the preceding and following ones, so that the frequency of any source of sound approximately simple can be at once ascertained by direct comparison. The range extends through all the tones ordinarily employed in music. To have access to this tonometer the late Professor A. M. Mayer spent the summer of 1892 in Paris, where he secured the cooperation of Koenig in his research on the variation of the modulus of elasticity of different metals with change of temperature, as indicated by the pitch obtained by transverse vibration of bars. Koenig's keen ear was applied also in Mayer's investigation regarding the duration of the residual auditory sensation when beats are produced by neighboring tones in different parts of the musical scale. The author's conclusion was that, between the limits of 100 and 4,000 vibrations per second, there was closer accordance between the results of calculation and observation than in the case of any other physiological law for which the attempt had been made to express sensation mathematically. So well trained was Koenig's ear that in the tuning of the standard forks issued from his laboratory there was little need for any better guide than his own auditory sensation. After the pitch had been provisionally attained in this way it was corrected by other and more exact methods, but the correction was always very small.

It seems scarcely probable that Koenig will have any successor. For a man now to devote his whole life to the science of acoustics would be a piece of specialization for which but little reward can be expected. The progress of science has its phases of relative importance and that of acoustics seems now to be past. Koenig is dead, and his friends will remember him with affection and respect. His devotion to acous-

tic science was unique. His life was that of the recluse bachelor, and his later years brought anxiety and privation because his science had lost its value as a means of support. He will not soon be forgotten; but likewise no one will aspire to take his place.

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SCIENTIFIC BOOKS.

1. *Hygiene and Public Health*. By LOUIS PARKES, M.D., D.P.H., London University, and HENRY KENWOOD, M.B., D.P.H., F.O.S. Sixth edition, 1901. Philadelphia, Pa., P. Blakiston's Son & Co., publishers. With numerous illustrations. Pp. 732. Price, \$2.50.
 2. *The Theory and Practice of Military Hygiene*. By EDWARD L. MUNSON, A.M., M.D., Captain, Medical Department, U. S. Army. First edition, 1901. New York, Wm. Wood & Company, publishers. Illustrated by eight plates and nearly four hundred engravings. Pp. 971. Price, extra muslin, \$8.00; leather, \$8.75.
 3. *A Manual of Practical Hygiene*, for students, physicians and medical officers. By CHARLES HARRINGTON, M.D., Assistant Professor of Hygiene, Medical School of Harvard University. First edition, 1901. Philadelphia and New York, Lea Brothers & Co., publishers. Illustrated with twelve plates and one hundred and five engravings. Pp. 729. Cloth, \$4.25 net.
 4. *The Principles of Hygiene*; a practical manual for students, physicians and health officers. By D. H. BERGEY, A.M., M.D., First Assistant, Laboratory of Hygiene, University of Pennsylvania. Philadelphia, W. B. Saunders & Co., publishers. Pp. 495. Price, cloth, \$3.00 net.
 5. *School Hygiene*. By EDWARD R. SHAW, Professor of the Institute of Pedagogy, New York University. First edition, 1901. New York and London, The Macmillan Company, publishers. Pp. 260. Price, cloth, \$1.00.
- In view of the act that hygiene is not an independent science, but a correlation of the teachings of physiology, chemistry, physics, meteorology, pathology, epidemiology, bacteriology and sociology, it is not surprising that the progress of this branch has been phenomenal. Over twenty text-books have been issued during the last ten years, and all but Parkes's in the above list are products of the present year. Indeed, this science was scarcely taught in any of our medical schools twenty years ago, and has received such an impetus during the past two decades that many regard it of modern origin. Such, however, is not the case, for on turning to early history, we almost invariably find that the health of the population has been made the subject of legislation. Hygiene was practiced by the Egyptians, the old Indians and Hebrews, and a study of the habits of the primitive peoples shows that a desire to prevent disease is innate to all men. The Greeks and Romans paid special attention to the physical culture of their youth, public water supplies and baths, and Athens and Rome were provided with sewers at an early period of their history. During the Middle Ages sanitation received a decided check; ignorance and brutal prejudices appear to have been the ruling spirits, and for many reasons it was the most unsanitary era in history. About this time most of the towns in Europe were built in a compact form, surrounded with walls; the streets were narrow and often winding for defensive purposes, shutting out light and air from the houses. The accumulation of filth was simply frightful. Stables and houses were close neighbors, human filth was thrown on the streets or manure heap. The dead were buried within the church-yards. Sewers and aqueducts having been permitted to fall into disuse, the inhabitants were compelled to resort to wells with polluted subsoil water. All the conditions were favorable for the spread of infectious diseases, and in the fourteenth century alone the oriental or bubonic plague, according to Hecker, carried off one-fourth of the population of Europe. The mortality in towns was greater than their birth rate, and the city population until the close of the eighteenth century had to be recruited continually from the country. The repeated invasion of pestilential diseases, however, compelled everywhere some sanitary efforts in the way of

widening streets for the purpose of supplying more air and light to habitations, better methods for the collection and removal of the wastes of human life, improvement in connection with infant and orphan asylums and in the management of schools and prisons.

The nineteenth century can boast of many advances in hygiene, particularly since the European invasion of cholera in 1830. English towns which had been visited by this disease, and those fearing similar scourges, freely instituted sanitary reform in the establishment of sewers, public water supply, sanitary homes for wage-earners, etc., but even during the Crimean War, the medical officers of the army evinced a shameful ignorance of the principles of sanitation and induced Edmund A. Parkes to write his manual of Practical Hygiene, and his teachings have borne ample fruit, especially in the improvement of the air we breathe and the water we drink. The question, has human suffering been mitigated and human life greatly prolonged by efforts in sanitation, can be emphatically answered in the affirmative. The average length of human life in the sixteenth century was only between 18 and 20 years; at the close of the eighteenth, it was a little over 30 years, while to-day it is over 40 years. Indeed, the span of life since 1880 has been lengthened about six years, as shown by statistics in Mulhall's Dictionary of Statistics (4th Edition, London, 1899). Mr. William A. King, Chief Statistician in the U. S. Census Office, informs the writer that from the results of the mortality returns for the twelfth census, for the States in which the returns were secured from registration records in both 1890 and 1900, there appears to be an absolute decrease in the general death rate of about 1.8 per 1,000 of population. This decrease seems to be most marked in the rate due to scarlet fever, whooping cough, diphtheria and croup (combined), typhoid fever, malarial fever, consumption, diarrheal diseases and diseases of the nervous system, the decrease in the mortality in diphtheria and croup amounting to more than 50 per cent. On the other hand, the rate due to cancer and tumor (combined), Bright's disease, heart disease and dropsy (combined) and pneumonia is apparently greater than in 1890, the increase be-

ing most marked in the case of Bright's disease, cancer and tumor and pneumonia. The results in the decreased rate of diphtheria, croup, scarlet fever, typhoid fever, whooping cough, consumption, malarial fever and diarrheal diseases are the direct outcome of preventive medicine and are as gratifying as they are striking. We note with regret the increased rate in Bright's disease, heart disease, dropsy and pneumonia, and may well pause to inquire whether our ever-increasing annual 'national drink bill,' averaging 17.68 gallons per capita, may not be a factor in the development of these diseases, especially since there is reason to believe that the habitual and immoderate use of alcohol, apart from increasing the connective tissue and causing cirrhosis, also produces fatty degeneration, especially of the heart, liver and arterial coats, probably because it promotes the conversion of albuminoids into fats. Since our knowledge of the nature of infectious diseases has been more and more defined, scientific methods for their prevention have been applied. We have learned, too, that in addition to the germ there must be a suitable soil for its proliferation, and that sanitation will not only destroy the environments for its development without the body, but also place the system in the best possible condition to resist its toxic action. The application of this knowledge has saved millions of lives, besides an incalculable amount of human suffering and distress, not to mention the economic aspect of the question. When we remember all this and the fact that Jenner's discovery, at the close of last century, of a fundamental and practical method of producing artificial immunity has been far eclipsed in the last 20 years, and that we possess to-day not only curative but also protective sera for diphtheria, erysipelas, tetanus, plague and possibly cholera, tuberculosis, typhoid fever, pneumonia and a number of other immunizing agents for diseases of man and the lower animals, we have reason to believe that the solution of the problem of immunity is only a question of time and we may indeed expect great possibilities in our battle against infectious diseases. Great as our progress has been, much remains to be done. While every scientific physician familiar with biological research knows full well that if the

methods of prevention recommended by sanitarians, including the prompt disinfection of the dejecta of every typhoid fever patient, the expectoration and excretion of diphtheria and tuberculosis patients, for example, were adopted, these diseases would be reduced to a minimum and probably eradicated in the course of a few years. The facts are, these recommendations have not been generally adopted, because the knowledge gained by experimental medicine is not sufficiently diffused even among physicians. We hail, therefore, with special delight the appearance, in 1901, of five American text-books on this important subject. Dr. Louis Parkes's book is the sixth edition of a very popular text-book, in both England and America. It contains 12 chapters on water; the collection, removal and disposal of excretal and other refuse; air and ventilation; warming and lighting; soil and building sites; climate and meteorology; exercise and clothing; food, beverages and condiments; communicable diseases and their prevention; hospitals; disinfection; statistics; sanitary law and administration. The work is authoritative, and until the appearance of the American Text-books, by Rohé, Egbert and Coplin, enjoyed great popularity in our medical schools.

Dr. Munson's royal octavo volume of 948 pages is the best work in the English language on military hygiene. He has handled the subject in a masterly style. His literary skill, thoroughness and painstaking research, practical experience and expert knowledge of sanitary chemistry have combined to produce a treatise of rare merit. The work is divided into 27 chapters, and, in addition to the subjects treated of by Parkes and other authors in the general principles of hygiene, deals, of course, also with the selection and development of the recruit, the march in campaign, camp sites, the sanitary administration of the camp, post barracks and hospitals, diseases of the soldier, military mortality and morbidity, the habits of a soldier as affecting his efficiency, the hygiene of hot and cold climates, the hygiene of the troop-ship, etc.

Every chapter in the book is encyclopedic in character and contains a mine of the latest information of great value not only to the student of military hygiene, but to the general student

as well. So, for instance, the chapters on the selection and development of the recruit are of equal importance to those interested in personal hygiene and physical training. The chapter on water contains 150 pages, and is in many respects superior to the standard works exclusively devoted to the consideration of this important requisite. The chapter on the ration with his article on food in the hygiene of hot and cold climates covers over 160 pages and is practically a comprehensive treatise on food, dietaries, the preparation and preservation of food and its relation to health and disease. It contains facts not to be found in any other work.

The chapter on camp sites and the sanitary administration of camps is most admirably disposed of. Had the knowledge contained therein been more generally diffused among medical men and especially among the officers of the line, the disgraceful unsanitary scenes of our military camps during the recent Spanish-American war would not have been observed.

Chapter XV., on diseases of the soldier, is of extreme interest, especially the consideration of infective diseases, such as typhoid fever, which the author very properly considers as being the most important disease affecting soldiers. It is to be regretted that the lessons of the civil war and the note of warning sounded by Surgeon-General Sternberg at the outbreak of the Spanish-American war had made so little impression upon those entrusted with the care of our troops.

The chapter on excreta, sewage and refuse is very complete. The author's conclusion that typhoid cases are much more numerous in communities where fecal matters are collected in pits, pails, earth closets, etc., than among those provided with water-closets and sewers, was emphasized by the writer in his report on the prevalence of typhoid fever in the District of Columbia in 1895, and a probable explanation was offered by him in stating "these makeshifts, even if there were no wells, are still a source of danger in so far as they favor the transmission of germs by means of infected flies, nor can the possibility be ignored that the germs in leaky or overflowing boxes may reach the upper layer of the soil and with pulverized dust gain access to the system." It is a matter

of regret, therefore, that while 41 per cent. of our population live in towns having public water-supplies, only 28.7 per cent. are supplied with sewers, the neglect of which compels recourse to these makeshifts and leads to soil pollution and the evils referred to.

Space will not permit the presentation in detail of all the salient features of this excellent treatise. Our experience in the past shows the absolute necessity of sanitary training on the part of officers of the line. This work should be in the hands of every officer in the army and accessible to every enlisted man. We also venture to express the hope that a chair of hygiene will be created in connection with the military and naval academies. Such a step with men like Dr. Munson as professors would prove of incalculable value to the nation; indeed, the principles and practice of hygiene should be taught in every high school and college of the land, for nothing will contribute more to the sum total of human happiness than the preservation of health and eradication of preventible diseases.

Professor Harrington's manual is also complete, authoritative, practical and modern. It is divided into seventeen chapters, and we are pleased to note that a chapter on the 'Hygiene of Occupation' has been introduced and disposed of in a very satisfactory manner. The relations of occupation to health and life were studied as early as 1700 by Ramazzini, an Italian physician, and since then numerous monographs have appeared. We know to-day that persons habitually engaged in hard indoor work present a higher mortality than persons more favorably situated, and that the character of occupations influences to a great extent not only the average expectation of life, but also the prevalence of certain diseases. We know, for example, that tuberculosis is much more frequent among persons engaged in dust-inhaling occupations, and that the sharp angular particles of iron and stone dust are more liable to produce lesions of the respiratory mucosa than coal, flour, grain and tobacco dust. We know, too, that certain establishments are more or less productive of noxious and offensive gases, and that workers in lead, mercury, arsenic, phosphorus, poisonous dyes, etc., suffer especially from the injurious effects, and that other occu-

pations, such as mining, railroading and contact with moving machinery involve special danger to life and limb. For all these reasons the laboring classes need special protection, and in order to render this efficient, it must be provided by the enactment and enforcement of suitable laws. In 1864, 1867 and 1878, England enacted the so-called factory laws, while the first law as regards factory safety and sanitation in this country was enacted in Massachusetts in 1877, since which time 32 states have enacted similar laws. As a result of these laws, the majority of which were enacted during the past decade, commendable progress has been made in the way of ventilation, heating, lighting, removal of dust and injurious gases, means of escape in case of fire and prevention of injuries by moving machinery.

Dr. Harrington is quite right in saying: "It is often difficult or impossible, in the study of the effects of occupation, to eliminate outside influences which may affect the health of the worker as much or more than the circumstances of his trade. A hundred men, for example, from different strata of society, some married, others single; some living in comfortable houses, others in cheerless unsanitary tenements; some spending their evenings in wholesome recreation amid wholesome surroundings, others doing evening work in places of public entertainment and elsewhere, or spending their time and wages in the paths of vice; some naturally robust, and others inclined to disease, engage in the same occupation at the same time."

The writer has always felt that these and other factors, such as faulty nutrition, the result of badly prepared food and cold lunches, cannot fail to lower the power of resistance to disease, especially when the individual, in consequence of these very causes, has also become a victim of the alcohol habit, and has advocated the erection of sanitary homes for wage earners at reasonable rentals, the encouragement of cookery schools, the establishment of sanitary lodgings, model eating-houses and other betterments of industrial conditions. Dr. Harrington's book is well illustrated and will meet the needs of the student.

Dr. Bergey's book has just appeared and has been prepared, in the author's language, 'to

meet the needs of students of medicine in the acquirement of knowledge of those principles on which modern hygienic practices are based ; to aid students in architecture in comprehending the sanitary requirements in ventilation, heating, water supply and sewage disposal, and to aid physicians and health officers in familiarizing themselves with the advances made in hygienic practices in recent years.' The volume, while not exhaustive, is accurate and will meet the demand in a very satisfactory manner. We regret, however, that neither this book nor Harrington's volume refers to the important subject of sexual hygiene and the prevention of venereal diseases, which affect not only the offender, but innocent wives, the offspring and not infrequently other innocent persons. According to Fournier, one-seventh of the population of Paris is syphilitic, and Morrow, from statistics gathered in New York, believes it is quite possible that Fournier's figures may apply to New York. Neisser holds that gonorrhoea is, with the exception of perhaps measles, the most widespread of all diseases. Other authorities have computed that 80 per cent. of all deaths from disease of the uterus and its annexes are of gonorrhoeal origin, while according to Professor S. M. Burnett, of Georgetown University, 15,000 of the 50,000 blind persons in the United States lost their sight from blennorrhoea in the newborn, which, according to his calculation, involves a financial loss to the commonwealth of seven and one-half millions annually.

The measures which have been proposed for the control of the social evil and the prevention of its consequences are numerous enough, but not so easy of practical application. On the whole, it is believed that the remedy lies in public education. Public lecturers on the purity of man commit a serious mistake, however, when they picture the consequences of the social evil, without offering a suitable remedy. We should make a strong plea in favor of continence, and tell our young men that while the sexual passion is very strong, it can be accelerated or delayed, excited or lowered, by the influence of the will. We should assure them that by the cultivation of pure thought, removal of temptation, normal

mental and vigorous physical exercise, continence may not only become possible, but easy.

None of the books in the above list will fulfill a more important mission than the modest volume on School Hygiene, by Professor Edward R. Shaw, of the New York University. It is a timely book belonging to the Teachers' Professional Library series, and it is hoped it will enjoy a wide circulation, because, as the author very properly says, "The home may be educated to a great extent through the school. As the school, therefore, reacts closely upon the home, a knowledge of that which is hygienically best can in no other way be so quickly and thoroughly diffused."

The chapters treat of the school room, the school building, school grounds, warming and ventilation, sanitation, school baths, school furniture, posture and physical exercise, eyesight and hearing, handwriting, conditions conducive to healthful mental work, and diseases which concern the school. Every chapter is replete with information of great value and should be thoroughly absorbed by architects, school boards, teachers and parents. The book is accurate and reliable and the style clear and convincing.

During the year ending June 30, 1900, there were 15,341,220 children enrolled in the common schools of our country. When we consider that the mental and physical vigor of a nation depends largely on the environments of childhood and youth, it seems strange that up to within forty years little or no attention should have been paid to the hygiene of schools.

The author treats this important subject in a systematic and comprehensive manner, and no one can overestimate the practical results of his valuable teachings. Chapters IV. and V. are especially important, treating as they do of warming, ventilation, latrines, out-houses for country schools, plumbing, water supply, drinking-cups, daily cleaning of the school building, the cleaning of desks and seats, the disinfection of pencils and books, etc. Chapter VI., on school baths, should attract widespread attention, and shows what has been done in Europe, where the idea originated, and also in Boston, New York, and Chicago. According to the author, two distinct aims are held in view in the

provision which is made by school systems for bathing. The first aim is for physical exercise and health; when this is the aim a swimming tank is provided.* * * The second aim is to produce cleanliness and to teach cleanliness. The most satisfactory means to attain the second aim seems to be that of the shower-bath. In some schools a bath-tub is employed, but this cannot be used as economically in regard to time as the shower-bath; it must also be cleaned after each using. It will be understood, of course, that dressing rooms are necessary in connection with the baths. * * * The testimony of those who, under the conditions above mentioned, have instituted school baths is strong with reference to the physical and moral results arising therefrom. * * *

The writer is strongly in favor of swimming tanks in all high schools; such baths, after an ordinary cleansing shower bath, apart from bringing into play every muscle of the body, exert a general tonic effect and could be thrown open in the afternoons and evenings to adults, and thus subserve the purpose of public baths, of which there is a lamentable lack.

The chapter on eyesight and hearing is especially strong and suggestive of good results. The author, after referring to proper and sufficient lighting of the school room, points to the interesting investigations of Iaval, Cattell and Sanford, how vision may be impaired by texts printed in too small letters, the alterations needed in the forms of letters, the proper size of type for school books, color and surface of the paper for school books, the size of writing on the blackboard, the objection to the use of slates, color of writing ink, postures, use of fine maps, duty of parents in preventing children at home from reading excessively at night, or in the waning light, or sewing with black thread on black cloth with defective illumination.

The author's views on defective hearing are also extremely sound when he says, "if we are to educate children, it is supremely wise to know as many of their physical defects as possible, and especially is this true as regards defects of the two most important avenues of sense, the eye and the ear; for only by means of this knowledge can the teacher work intelligently and avoid unnecessary strain on the part

of the pupil and waste of effort on his own part. Careful investigations point to the broad fact that about 20 per cent. of school children possess some defect of hearing. It will be seen that the child of average ability who has some undetected defect of hearing will frequently be done an injustice and rated as dull or inattentive, not through any fault of his own, but because of a lack of knowledge on the part of the teacher of the true cause."

These abstracts sufficiently indicate the thoroughness which characterizes this most useful book.

GEO. M. KOBER.

GEORGETOWN UNIVERSITY,
WASHINGTON, D. C.

Manual of the Flora of the Northern States and Canada. By NATHANIEL LORD BRITTON, Ph.D., Director-in-Chief of the New York Botanical Garden; Emeritus Professor of Botany in Columbia University; Vice-President of the New York Academy of Sciences. New York, Henry Holt and Company. 1901. Duodecimo. Pp. x + 1080.

The appearance of a new manual of botany is an event of no small moment when it comes from the hand of one recognized as an authority in systematic botany. The 'Illustrated Flora of the Northern United States, Canada, and the British Possessions,' by Dr. Britton and Judge Brown, in 1896-7-8, marked an epoch in North American botany, and at once created an imperative demand for a handy field manual in the form of an abridgment of the large work. It is to meet this demand that the work before us is intended. In its preparation Dr. Britton has availed himself of the descriptions in the 'Illustrated Flora,' which are transcribed with little or no modification excepting the necessary one of changing English to metric measurements. Many species not described in the 'Illustrated Flora' are added, and not a few genera, bringing the total number of species to about 4,500 as against 4,162 in the original work. When we remember that the latest edition of Gray's 'Manual' contained descriptions of 3,298 species, and Coulter's 'Manual,' 1,881 species, it is evident that the utmost brevity has been imperative. Abbreviations are freely

used, although not to the extent so familiar in similar German manuals. Practically all synonyms are omitted, and this, while inconvenient for some users of the book, is no doubt the better policy in a compact manual. In this the author follows the wise example of Gray's 'Manual.' Synonymy, with all its confusing difficulties, need not be brought to the beginner's notice, and for the older botanist, anything short of full citations (impossible in such a manual) is of little or no use.

Students will be interested in noticing that 'Order' and 'Family' are not identical groups, but that they stand in their proper relation in this book, as in zoological manuals. The full citation of authorities for species, including double citation where necessary, and the citation of the author of each family name, are welcome novelties in an American botanical manual. As to the nomenclature used, the statement is made in the preface that "the principles adopted by the botanists of the American Association for the Advancement of Science at a meeting held in Rochester, N. Y., in 1892, and in Madison, Wis., in 1893, supplementary to the Code of Nomenclature adopted by the International Congress of Botanists held in Paris, France, in 1867, have been followed." Accordingly, we have here a manual in which the much-discussed 'Rochester Rules' are in force, and from this time forward young botanists will be taught this nomenclature from the first. There will henceforth grow up a generation of botanists for whom the names here given are orthodox.

This book must at once find its way into the schools and colleges, to which it may be commended for the students in systematic botany.

It remains to be said that the publisher has met and successfully solved the difficult task of bringing so large an amount of matter within the compass of a book not too large for easy carrying into the field. It might easily have been made still smaller and lighter by the use of still thinner paper, and a little closer trimming of the margins. As compared with the pocket edition of Gray's 'Manual' this is a much larger and heavier book; if printed on the same paper and trimmed as closely, this book would weigh but twenty ounces, instead of thirty as

it does now. We suggest that in future editions the printer and binder try to make some improvement in this respect.

CHARLES E. BESSEY.

SCIENTIFIC JOURNALS AND ARTICLES.

The American Naturalist for October contains the third and concluding part of W. M. Wheeler's 'Compound and Mixed Nests of American Ants,' the three forming an excellent compendium of our knowledge on the subject. Bashford Dean presents some interesting 'Notes on Living Nautilus' and Charles C. Adams has an article on 'Base-leveling and its Faunal Significance,' with illustrations taken from the topography and distribution of mollusks in the southeastern United States. The balance of the number is taken up with numerous reviews of scientific literature.

The Journal of Comparative Neurology for October. 'The Cranial Nerves and Cutaneous Sense Organs of the North American Siluroid Fishes,' by C. Judson Herrick. This is a detailed exposition of the components of the cranial nerves of the catfish and of the structure and innervation of the cutaneous sense organs. Of the latter there are four types, three classed as neuromasts (Merkel's *Nervenhügel*) and one as terminal buds (*Endknospen*), the former innervated by lateralis nerves, the latter by communis. 'The Psychological Theory of Organic Evolution,' by H. Heath Bawden, is an attempt to put some meaning into the term mental evolution without falling into the error of talking about unconscious mental states. Natural selection may in some instances be a survival of the fittest among accidental variations, but in many cases natural selection takes place in and through the conscious adaptation of means to ends. The condition of consciousness is organic tension. The evolution of consciousness has followed the path of critical stress in adaptation of organic forms. Hence the criterion for the presence of consciousness is not simply adaptation of means to ends, but adaptation under conditions of organic tension, *i. e.*, the ability to vary the use of means in the attainment of an end.

The Popular Science Monthly for November has for frontispiece a portrait of Charles Darwin

and the first article is taken from the *Journal of the Linnean Society* for 1858, being the now historic paper 'On the Tendency of Species to form Varieties; and on the Perpetuation of Varieties and Species by Natural Means of Selection' by Charles Darwin and Alfred Wallace. A. E. Verrill tells 'The Story of the Cahow' an unknown and probably extinct bird found abundantly on the Bermudas at the time of their discovery. The use of the bird and its eggs for food was the cause of its speedy extermination. Under the caption 'Psychiatry—Ancient, Medieval, Modern,' Frederick Lyman Hills gives a brief history of the methods employed for the treatment of the insane from early times to the present. John E. Gorst makes a plea for 'The National Control of Education' and Edward L. Thorndike discusses 'The Evolution of the Human Intellect.' Bradley Moore Davis considers 'The Origin of Sex in Plants' and David Starr Jordan has a brief article on 'The Fishes of Japan' with observations on the distribution of fishes. Paleontologists will hardly accept Dr. Jordan's three laws governing animal distribution as all-sufficient. The final paper is by A. C. Haddon on 'The Omen Animals of Sarawak' and contains much interesting information.

The Auk for October opens with a welcome article by William Brewster entitled 'An Ornithological Mystery' describing the notes and nest of a bird found in the vicinity of Cambridge, Mass., which so far has not been seen, but is presumably the little black rail. A. C. Bent describes, with photographs, the 'Nesting Habits of the Anatidæ in North Dakota' and Arthur H. Howell gives 'A Preliminary List of the Summer Birds of Mount Mansfield, Vermont,' including 86 species. J. A. Farley tells of the 'Alder Flycatcher (*Empidonax trailii alnorum*) as a Summer Resident of Eastern Massachusetts,' and Outram Bangs has a paper 'On a Collection of Birds made by W. W. Brown, Jr., at David and Divala Chiriqui' including descriptions of several new species and subspecies. Hubert Lyman Clark treats of 'The Classification of Birds,' as based on their pterylosis, an excellent paper, but one which will impress many as an additional piece of evi-

dence that birds may not be classified by one character only. William Alanson Bryan gives a 'List of the Hawaiian Birds in the St. Louis College Collection, Honolulu, H. I,' and finally, Francis J. Birtwell describes the 'Nesting habits of the Evening Grosbeak (*Coccothraustes vespertinus*).' The notes and reviews are numerous.

Bird Lore for September–October has a frontispiece showing the fine 'Bird Rock Group' of sea birds recently placed on exhibition in the American Museum of Natural History. H. W. Henshaw concludes his 'First Impressions of Hawaiian Birds,' Ralph Hoffman tells of 'A Chebic's Second Brood' and we have the regular instalment of 'Birds of the Season,' discussing the bird life of October and November in various parts of the United States. For young observers we have an account by A. V. Kidder of 'A Bittern at Close Range,' and we have Notes from Field and Study, Reviews, and the section devoted to 'The Audubon Societies.'

The Plant World for September has articles on 'Notes on Trees of Cuba,' by Valery Havard, a biographical sketch of the late 'Dr. Charles Mohr,' by S. M. Tracy; 'The Pasque Flower,' by John M. Holzinger, and many interesting briefer items. The instalment of the 'Families of Flowering Plants,' by Charles L. Pollard, continues the description of various families of the order *Sapindales*.

Popular Astronomy for November continues the study of the light curve of the new star in Perseus, by Dr. H. C. Wilson, and includes a chart of this curve which has been compiled with great care from many sets of observations. Dr. Lewis Swift, who has but recently given up the directorship of Mount Lowe Observatory on account of failing sight, permits the publication of a photograph of his various medals. This is accompanied by a brief résumé of his life as an astronomer, and of the discoveries for which the medals were awarded. Dr. T. J. J. See, of the Naval Observatory, contributes 'Preliminary Investigations of the Probable Diameters, Masses and Densities of those Satellites which have Measurable Discs,' and W. F. Denning, of England, writes of 'The Motion of the Great Red Spot and other

Markings on Jupiter.' Other articles are: 'The Astronomy of the Nebulæ,' by W. W. Payne; 'The Coming Opposition of Eros,' by Mary Clark Traylor; 'The Limits of Vision,' by Edwin Holmes, and 'The Brightness of Star Light,' by J. E. Gore.

DISCUSSION AND CORRESPONDENCE.

THE UNIVERSITY OF WEST VIRGINIA.

WITH the final resignation of Jerome Hall Raymond, last March, from the presidency of West Virginia University, and the election of Dr. Purinton, of Denison, to succeed him, another turbulent period in the history of that institution has come to an end.

It is worth noting that no one of the six men who have served as presidents of the West Virginia University since its foundation in 1867 has proved generally acceptable to the people of the State, and that no one has been less acceptable than President Raymond. And yet, according to a statement made to the writer by one member of the University faculty who has always lived in Morgantown, no other president began his work under more auspicious circumstances. The board of regents had a good working majority of intelligent men who were deeply interested in the welfare of the University and who were anxious to give a hearty support to their enthusiastic young president. The people in the surrounding community and the members of the faculty were also more friendly and more inclined to be pleased with Mr. Raymond than they had been with any of his predecessors.

Notwithstanding all this, trouble was inevitable. The president was young, aggressive and thoroughly saturated with the spirit of unlimited, rushing expansion which had prevailed in the University of Chicago during the preceding five years. The faculty of the West Virginia University, on the other hand, did not at that time (1897) contain a single Ph.D. from any reputable university. Some of the professors were therefore naturally unfit to be in charge of any department in a modern college or university, and their unfitness became especially glaring through the new president's vigorous attempts to convert the old Morgantown institution into a miniature copy of the

University of Chicago. Several of the professors, moreover, not only lacked the training necessary to make them competent instructors in a university, but were in addition so addicted to financial schemes and to politics as to be a hindrance to the peaceful development of any state institution of learning.

Unhampered and alone, Mr. Raymond succeeded for a time in carrying out his plans in the management of the University. The University catalogue was entirely remodeled on the plan of the University of Chicago catalogue, and the studies were correspondingly rearranged; the summer quarter was added, and the four-quarter system with the 'quarterly convocations' was introduced; an unlimited elective system of studies leading to one degree only (B.A.) was adopted; faculty meetings were abolished, and the president's plans and changes were all carried out by means of committees of his own appointment.

All these changes and many others less fundamental, though scarcely less irritating to one or another among the professors, followed in rapid succession. One by one the older members of the faculty came to feel that they were entirely unsatisfactory and that the president would like nothing better than to replace them as soon as possible by men of his own selection. This led to a tacit or open combination of the greater number of the professors against the president—a result which might have been expected, especially considering the records of forced resignations, reappointments and quarrels of various kinds which formed a part of the previous history of the University. The opposition spread rapidly not only among the students and the people of Morgantown but also throughout the State, where it unfortunately developed into a narrow-minded support of 'West Virginians' as against 'foreigners.' The temper of some of the crudest of Mr. Raymond's enemies is well illustrated by the extravagant vulgarity of the attacks which were made upon him during the winter and spring of 1900 by the *Clarksburg News* and the *New Dominion* of Morgantown. The unpopularity of the president alike among the faculty, students and the people, especially the local people, was in addition much increased by his

pronounced antagonism toward smoking, drinking and dancing. His unflinching and uncompromising defence of the doctrine of evolution in season and out of season further brought him into sharp antagonism with the strong church-going element of the State.

Nor did the new members of the faculty whom the president brought to the university serve to strengthen his position, partly because the local animosity against the president was turned into suspicious reserve toward these who were supposed to be his friends, and partly because there was probably not a single one among them who did not disapprove of the president's policy in one or another essential point. It must be noted that the president did his utmost to secure the most able and well-trained young men that the salaries offered could procure; but the policy of the university was not in the least affected thereby, because President Raymond continued to settle all questions himself, and the new professors as well as the old were distributed among the various committees so as to insure a majority in favor of the president's views.

No fair-minded person can doubt that President Raymond worked as only a man in his best years can work for the advancement of the university. To be sure considerable energy and some money were wasted on untimely features, such as the premedical course, the domestic science, the department of pharmacy, the work for Ph.D., and the correspondence courses. But after all this has been admitted there can be no doubt that the standard of scholarship was raised through Dr. Raymond's efforts far above what it had ever been before in West Virginia.

The most striking illustration of this general advancement is perhaps to be found in the equipment and management of the university library at the beginning and at the end of Mr. Raymond's administration. Before his arrival the books were all inside an iron railing, and in charge of a lady who did not pretend to know anything about the classification of books. Her chief function was to see that the books did not disappear. The place was open less than six hours a day, and during those hours the space outside the iron railing is said to have been the noisiest and most disorderly place on the

campus. This fall a thoroughly modern library building is being finished, and, what is more to the point, the library has been as pleasant, orderly, and well arranged as any one could wish during at least the last two years, that is, ever since the present librarian was able to bring order out of the previous chaos. The library is now open from 8 a. m. to 10 p. m., every week-day, and from 4 to 6 p. m. on Sundays and holidays. The amount of money which was spent for current literature and books under President Raymond's regime was also about all that could reasonably have been asked for, and this money was largely spent under the direction of the young instructors whom he had brought there, because there seemed to be very little demand for more literature from the older professors. Several departments of the university are now fairly well equipped with standard and recent literature.

Another striking illustration of how Mr. Raymond endeavored to raise the standard of the work done in the university is found in the changes which he introduced in the scientific departments. At the beginning of his administration botany, zoology, physiology, anatomy, and materia medica were taught by one man (an M.D.). During the last two years anatomy was not taught, and the other four subjects were represented by two Ph.D.'s and one M.D. Another Ph.D. was appointed assistant professor in chemistry. The department of physics was not changed, but it was well known that this was due only to the fact that the president could not change everything at once.

The climax came in the spring of 1900 when the president asked the board of regents for the resignation of five of the old professors, and in addition formally expressed his disapproval of two others as well as of the director of the experiment station. This step, bold and ill-advised as it seemed, was partly a measure of self-protection, for some of the men whose resignations were demanded were then openly doing everything in their power to bring about the downfall of Mr. Raymond. The board of regents did not grant the president's request, because four of the nine members composing the board were at this time opposed to the president, and further, because to grant such a request then

would almost certainly have brought the University into the politics of the State during the elections of last fall. The failure of the board to support the president on such an important matter left him, on the other hand, no other dignified course than to resign. The following letter of resignation was indeed promptly sent to the board :

TO THE HONORABLE BOARD OF REGENTS.

Gentlemen : I hereby place in your hands my resignation of the Presidency of West Virginia University.

I am moved to do this, and thus to give up some of the most deeply cherished hopes of my life, because I see no prospect of final success in my work.

It is impossible to build up a university save on the basis of sound morals and sound scholarship with the generous cooperation of those engaged in the work. I have asked the removal of certain men known to you and to me and to the community to be grossly deficient in one or all of these regards. This demand your honorable Board has refused to grant for reasons which I cannot deem sufficient. I therefore ask you to relieve me of my responsibility for the conduct of the University, this act to take effect June 2, 1900.

Respectfully,

JEROME H. RAYMOND.

The board refused to accept this letter of resignation by a vote of five to four. President Raymond's friends on the board thereupon persuaded him to withdraw the letter.

As soon as the fall elections were over two of the resignations which Mr. Raymond had asked for were demanded by the board of regents (by a vote of five to four). The men refused to resign, and the subject was brought into the courts. The right of the board to dismiss the professors was sustained by the court by a vote of two to one, the judge who voted against the board being a relative of one of the dismissed professors. A private libel suit was at the same time instituted by one of the dismissed men against the president. This suit is still pending and is not expected to be dropped, because the prosecuting attorney is as bitter an enemy of the president as is his client.

The last chapter of President Raymond's career in West Virginia followed in the spring. The legislature was in session, and appropriations had to be asked for by the board

of regents. The report which they submitted to the legislature is a strong, well-written statement of how the University affairs were managed. Nothing could, however, stem the tide of feeling which had been worked up against the president. The legislature ordered an investigation into the affairs of the University. The essential points of the report which was submitted to the legislature by the committee appointed to carry out this investigation are contained in the following paragraph closing the report :

Your committee was at great pains to investigate the criticisms that have been generally made through the state in regard to the executive head of the University. A great deal of testimony was before the committee upon this subject. The president of the University is to be commended for his zeal and energy and devotion to the work of his office. We, however, regard some of his views and policies as not suited to the conditions as they exist among us. This together with his youth and inexperience and want of tact in dealing with men lead us to the conclusion that the best interests of the University would be subserved by a change in the presidency thereof. We are led to this conclusion by the overwhelming force of the evidence before us in our investigation, and we, therefore, recommend that such change shall be made.

Along with this change, it is the further opinion of your committee that there should be a complete reorganization of the board of regents, and that in such reorganization there should be no local regent appointed upon the new board.

There can be no doubt that the report of the committee reflected the prevailing sentiment in the legislature. The investigation could, however, not have been very thorough since it lasted but two days; nor could the report submitted have been exclusively intended to improve the management of the affairs of the University. This is clearly shown for instance in the following paragraph.

In view of the great prominence given in colleges to physical exercise, the committee is of the opinion that the instructor in the gymnasium, who now receives a salary of only eight hundred dollars, should receive the salary of a full professor.

The instructor in question was an undergraduate student whose record of scholarship

during at least one quarter of the year '99-'00 fell below the average necessary for permission to continue his studies.

Mr. Raymond's administration ended precipitately after this report had been presented to the legislature. To the bill providing funds for the maintenance of the University was added a clause which stipulated that none of the funds could be used until Mr. Raymond's resignation had been accepted by the board of regents. Both the president and the board that had supported him were thus legislated out of office.

The new board met in June and elected Dr. Purinton, of Denison, to the presidency of West Virginia University. The following additional changes have since been made in the management of the instruction at the University: The professor of botany was dispensed with on economic grounds, and the department of botany was left in charge of the professor of zoology. The professor of philosophy was given the department of economics, the new president taking charge of the department of philosophy. The premedical and the domestic science departments were abolished, and the head of the domestic science, a Ph.D. in sociology, was made assistant professor of sociology. One of the two professors who had been compelled to resign in the fall by the old board of regents was reelected for one year, and for that year was given a leave of absence without pay. The departments of English literature and rhetoric were divided, and the English literature was given to a Morgantown lady without university training, who had attained some local literary distinction as secretary of the Morgantown Fortnightly Club. The assistant in rhetoric was offered an assistantship in mathematics, and on refusing to teach mathematics was dropped. The professor of German the following day went before the board in regard to their action on the assistant in rhetoric, and as a result the latter was reinstated with an increase of salary of three hundred dollars.

In view of all that has happened at West Virginia University during the past year, it is not easy to foresee what will be its history in the immediate future.

* * *

CANNONADE AGAINST HAIL STORMS.

TO THE EDITOR OF SCIENCE: My attention has been called to an article by Professor W. S. Franklin, in your esteemed journal of September 27, page 496, on the control of the weather.

Professor Franklin's argument for the rational plausibility and possible effectiveness of cannonading with vortex rings 'for *inaugurating* at will the storm movements of atmosphere' is very surprising in view of two facts: 1st, Stiger and his followers do not maintain that the rising vortex rings *initiate* storms, but that they *destroy* storms, at least hail storms, turning them aside from their intended paths or converting the hail to rain; 2d, the cannonade against hail has been prosecuted for centuries, and the special vortex ring cannonade has been practised by tens of thousands during the past three years, and yet thus far there has not been reported a single case where cannonading has been logically demonstrated to have been effectual. Hail storms move, divide and pass by on either side, develop and decay, just the same whether the cannons are fired or no! The popular faith in cannonading that seems to prevail among the peasantry of southern Europe is a craze that has no scientific basis whatever. If Professor Franklin has any faith in this process he has but to submit it to a thorough experimental trial: Get a dozen of his neighbors to load their rifles with five ounces of gunpowder, which is the charge recommended by Stiger, leave off the wad so as not to burst the guns, and all fire away as fast as possible when a hail storm is approaching. After actually witnessing the failure of this process let him sit down and calculate approximately the relative amounts of energy in the explosions and in the hail storm.

The importance of unstable equilibrium in the atmosphere is a matter that has been so thoroughly investigated since the days of Espy, that Professor Franklin has only to study the modern literature of meteorology and the mechanics of whirlwinds in order to realize the folly of his argumentation.

The Weather Bureau needs, and hopes to obtain, the hearty cooperation of the best men in American science in order to overcome the dif-

faculties inherent in the study of meteorology, but I believe that such suggestions as those of Professor Frauklin are not the best that science has to offer.

CLEVELAND ABBE.

THE SACRAMENTO FOREST.

TO THE EDITOR OF SCIENCE: In south central New Mexico, capping the scarp of the great monoclinal mountain known as the Sacramento, and overlooking to the west the Tularosa desert, is a unique and beautiful forest tract. It forms a detaining mat of vegetation which supplies a large group of running streams and their dependent agriculture. It is, also, a moist and forested resort for the vast desert which encircles it for hundreds of miles. Already 150 miles of railway carry many tourists north from El Paso to picturesque Cloudcroft from all parts of Texas, Arizona and New Mexico; when the scenic beauties of the place are more widely known, the place will become a Mecca for lovers of nature.

The forests consist of pines, firs and balsams, of many species and of great size, trees twenty-five feet in diameter being quite common.

In all there are about twenty-five townships of forested land, some of which is included in the Mescalero Indian reservation.

Saw mills are already at work devastating this little-known but beautiful forest area. The importance of preserving this watershed cannot be too strongly insisted upon and it is hoped that all friends of forestry will use their influence to this end.

ROBERT T. HILL.

October 19, 1901.

THE WORK OF THE BEAUFORT LABORATORY OF THE U. S. FISH COMMISSION.

UNDER the administration of the present commissioner, Hon. Geo. M. Bowers, the facilities for biological investigation at the Beaufort (N. C.) Laboratory of the U. S. Fish Commission are constantly increasing. During the past season the laboratory was open from the middle of May until the end of September, and every reasonable request for equipment was granted. Tables were occupied by the following gentlemen, grouped under the institutions

with which they are connected: *Bryn Mawr College*, Professor T. H. Morgan. *Columbia University*, Professor E. B. Wilson, Mr. H. B. Torrey, Mr. J. C. Torrey. *Dartmouth College*, Dr. J. H. Gerould. *Johns Hopkins University*, Professor W. K. Brooks, Dr. Caswell Grave, Mr. R. P. Cowles, Mr. D. H. Tennent, Mr. O. C. Glaser, Mr. R. E. Coker, Mr. J. A. E. Eyster. *University of Alabama*, Professor J. Y. Graham. *University of Missouri*, Professor Geo. Lefevre, Dr. W. C. Curtis. *University of North Carolina*, Professor H. V. Wilson, Mr. C. A. Shore. *Washington and Jefferson College*, Professor Edwin Linton, Mr. C. W. Stone. The investigations carried on were of a varied character, embracing such diverse problems as the systematic zoology and natural history of parasites in edible fish; the effect on the tissues of the oyster of a prevalent trematode parasite; the nature of the food and the rate of growth of planted oysters; the cell-lineage and embryology of *Thalassema*; the embryology of *Chaetopterus*, of the oyster, of *Ascidia*, of *Phoronis*; regeneration in *Phoronis*; the metamorphosis of echinids and ophiurans, of barnacles; the systematic zoology of tunicates, of sponges, of echinoderms; cell phenomena in the formation of organs in half and quarter larvæ of sea-urchins.

Many zoologists will be glad to hear that *Phoronis* (*P. architecta* Andrews) turns out to be very abundant at Beaufort. Mr. Cowles has found the form to be a tractable one, living easily in the laboratory and depositing eggs freely. Biologists who are occupied in the study of the fundamental morphogenetic activities of protoplasm will be interested to learn that the delicate striæ which have been described (Conn) as radiating from the surface of the *Thalassema* egg were found (by several observers) to be fine threads, which in places branch and anastomose. With a Zeiss 2 mm., such filaments may easily be seen over the surface of the egg after the formation of the egg membrane, and later over the free surfaces of the first blastomeres. The filaments give every evidence of being protoplasmic, and clearly belong in the category of the 'filose processes' discovered by Mrs. E. A. Andrews ('Spinning Activities of Protoplasm,' *Journ. Morphology*, VII., 2, 1897).

The work of the past season was carried on in the rented building which has served as temporary quarters for the laboratory since its inauguration three years ago. Ground was broken for the new building in September, and another year should see the station in its permanent home.

H. V. WILSON.

UNIVERSITY OF NORTH CAROLINA,
October 21, 1900.

EXHIBITION OF A STUDENTS' SOCIETY OF SCIENCE.

THE Students' Society of Science, formed by and of students in the New York City high schools, held its second annual exhibition on October 11, 1901, at the home of the president. Exhibits were shown in the departments of botany, zoology, conchology, mineralogy, paleontology, geology and anthropology.

The exhibits were in every case explained and described by printed cards. Colored plates prepared by the boys accompanied each collection and showed how the various classifications were made. The collections themselves were prepared so as to show variations of certain properties which defined each group. Thus there were separate divisions in the department of mineralogy, which described and explained each of the several properties of hardness, cleavage, color, refraction and crystallization.

The department of biology presented collections and plates explanatory of the morphological differentiation and evolution of animals, the progressive specialization of the cell, and interesting cases of plant and animal reproduction. Special studies were shown of marine invertebrate zoology, the Arthropoda, and of the structure and anatomy of birds.

The Jones conchological collection, comprising several thousand specimens from all parts of the world, and a large number of selections from the Hawley herbarium, were of particular interest and beauty.

Several large colored plates descriptive of the American fossil beds accompanied the paleontological collection, the gaps in the collection being filled by sketches and plates, which showed a remarkable degree of ingenuity and correctness of knowledge on the part of the young collectors.

The entire exhibition showed what can be done by a few earnest young students of nature who take the trouble to go below the surface of mere collecting for sport. When we consider that the oldest member of this young society is but fifteen years of age, and that they received no outside aid whatever in the preparation of their collections, the result of their work is truly remarkable.

SCIENTIFIC NOTES AND NEWS.

A MEMORIAL meeting in honor of the late Henry Augustus Rowland was held at the Johns Hopkins University, on October 16. The principal address was made by Dr. T. C. Mendenhall.

THE Sociedad española de Historia Naturel of Madrid has established a new class of *socios honorarios*, limited to ten in number and at a special meeting in March last elected the following eight persons: Sir Archibald Geikie of London, Ph. van Tieghem of Paris, Adolph Engler of Berlin, Santiago Ramón y Cajal of Madrid, Carl Brunner von Wattenwyl of Vienna, Lord Avebury (Sir John Lubbock), of England, Albert Gaudry of Paris and Samuel H. Scudder of Cambridge, Mass.

ON the occasion of the celebration of Virchow's eightieth birthday last month, his bust in marble was presented to the Pathological Institute at Berlin.

DR. CHARLES E. MUNROE, professor of chemistry and dean of graduate studies in Columbian University, has been appointed by the Swedish Academy of Sciences one of the representatives to recommend candidates for the Nobel prize in chemistry.

DR. and Mrs. T. C. Mendenhall sailed from New York for the Azore Islands on October 29.

DR. L. O. HOWARD, chief entomologist of the Department of Agriculture, returned to Washington on October 27 from a protracted tour of California, Oregon, Washington, Idaho, Mexico and Texas, where he has been conducting field investigations and examining the work of field agents.

DR. ANDREW D. WHITE, ambassador to Germany and ex-president of Cornell University, returned to his post in Berlin on October 31.

PROFESSOR WILLIAM LIBBEY, of Princeton University, and his family have sailed for Europe and will be absent for a year.

It is reported that the Duke of the Abruzzi will visit the United States next February, with a view to arranging for another expedition to the North Pole.

DR. WILHELM WALDEYER, professor of anatomy at Berlin, was entertained at dinner in New York City on October 26. Addresses were made by Drs. George W. Jacobi, A. Jacobi, William H. Welch and Carl Beck.

DR. OTTO NORDENSKJÖLD, leader of the Swedish Antarctic expedition, was entertained by Sir Clements Markham, president of the Royal Geographical Society at the Royal Society's Club, London, on October 25. The *Antarctic* left Falmouth the following day for Buenos Ayres and the Falkland Islands.

DRS. BEYER, Formento and Salomon, of New Orleans, have been appointed civilian members of the government Yellow Fever Institute.

DR. R. G. PERKINS has been given an appointment to carry on research at Western Reserve University under the Rockefeller Institute for Medical Research. Similar appointments at McGill University have been given to Dr. G. A. Charlton and Dr. P. G. Wooley.

PROFESSOR HUGO MÜNSTERBERG, of Harvard University, will give a series of eight Lowell lectures at the Massachusetts Institute of Technology, beginning on November 11, on 'The Results of Experimental Psychology.'

MR. GEROW D. BRILLE, a graduate of Cornell University, has been appointed director of the Agricultural School and Experiment Station, to be established by the United States Government on the island of Negros in the Philippines.

W. D. STRAIGHT, instructor in drawing in Cornell University, has resigned to accept a position in the customs service in China.

PROFESSOR LAWRENCE BRUNER and a party from the department of entomology and ornithology of the University of Nebraska, as we learn from *The Auk*, spent during the early summer some time in the Pine Ridge region of northwestern Nebraska, investigating the birds of the region and making collections.

DR. REID HUNT, associate professor of pharmacology in the Johns Hopkins Medical School has spent the summer at the Montana Agricultural Experiment Station, Bozeman, investigating certain poisonous plants for the U. S. Department of Agriculture. Part of the work was done in conjunction with Mr. V. K. Chesnut, of Washington. Considerable attention was given to one of the so-called 'loco' or crazy weeds, and some progress was made in discovering the mode of action of this plant, which has baffled investigators for so many years.

THE *Revue générale des sciences*, as we have already noted, organized this year a scientific excursion to Asia Minor and Palestine. The party sailed from Marseilles on September 14 on the steamship *Senegal*, chartered for the excursion. Shortly afterwards two members of the crew were found to be affected with the plague, and the steamship returned. There were a number of scientific and medical men in the party.

SIX deaths from the bubonic plague have occurred at Liverpool, and the disease has reappeared in Glasgow.

DR. CALMETTE, director of the Pasteur Institute at Lille, was, as we recently reported, bitten in the hand by one of his rattlesnakes while he was making experiments. Dr. Calmette immediately inoculated himself with his antivenomous serum, but it was found necessary to amputate one of his fingers.

THE Royal University of Ireland has conferred its D.Sc. on Mr. Walter Noel Hartley, F.R.S., professor of chemistry in the Royal College of Science for Ireland.

SURGEON-GENERAL W. TAYLOR, M.D., C.B., has been appointed Director-General of the British army medical service.

THE fund which is being raised to found a memorial to the late Dr. D. J. Leech, for twenty years professor of materia medica and therapeutics at the Owens College, Manchester, has now reached the sum of £1,230.

PRIVY COUNCILOR MAERCKER, professor of agricultural chemistry at the University of Halle, died on October 20.

CANNON ISAAC TAYLOR, the author of an excellent work on 'The Alphabet' and other archeological books, died on October 18 at the age of seventy-two years.

THE eleventh congress of Russian Naturalists and Physicians will meet at St. Petersburg on January 2, and will remain in session for ten to eleven days. The sections into which the association is divided are mathematics and mechanics, astronomy and geodesy, physics, physical geography, geography and statistics, agriculture, chemistry, geology and mineralogy, botany, zoology, anatomy and physiology, scientific medicine, and hygiene. Three days are to be devoted to general sessions and seven days to the meetings of the sections.

AT the recent International Congress of Criminal Anthropology at Amsterdam it was decided that the next congress will be held at Turin in 1906.

AN Australasian Ornithologists' Union is about to hold its first meeting at Adelaide. The society will publish a magazine called *The Emu*.

A COMMISSION, under the presidency of M. Léon Bourgeois, has recommended the addition of new laboratories to the Conservatoire des arts et métiers at a cost of about \$100,000.

THE Berlin correspondent of the *British Medical Journal* writes that the 'Virchow Day' lengthened out to a 'Virchow Week,' for the series of ovations that began on Saturday, October 12, did not find their close until Friday, October 18. On Monday evening, October 14, the Imperial Chancellor and Countess von Bülow gave a dinner in honor of Virchow, at which many of the foreign delegates and Berlin notabilities were present. On Tuesday evening an imposing public meeting gave evidence of the enthusiasm felt by the Berlin Liberals for Virchow as a politician. Eugen Richter, the great radical orator, made a flaming speech, in which sharp hits at the present political situation alternated with expressions of deepest gratitude for Virchow's untiring, courageous and lifelong labors in the cause of political freedom. That Virchow's political career has been one of real work can be best illustrated by the fact that for twenty-five years he was presi-

dent of the parliamentary audit committee. On Friday evening the town council and magistrates gave their great Virchow banquet in the city hall. What Virchow has done for public hygiene and town sanitation is known all over the world. No one could have put into better words the debt our generation owes him than did Virchow himself, when, in returning thanks for the speech in his honor, he said—without mock humility and without vanity either—that if he was proud of any achievements it must be the achievements in the domain of public health, since it was by his efforts, through the establishment of the system of drainage which he had recommended and the sewage farms constructed under his directions, that Berlin had become the healthiest city in the world. All the medals, addresses, pieces of statuary and paintings presented to Professor Virchow by learned societies and public personages are on view in the Central Hall of the Industrial Art Museum.

THE London *Times* states that the Crystal Palace authorities have decided to hold an American exhibition next year. It will be strictly confined to a display of the wealth, industry, science and art of the United States. The space of the palace will be divided so as to allow the exhibits to be ranged into ten classes, which will be found to cover exhaustively the vast resources, instructive and interesting, of that country. During the exhibition some of the leading American entertainments and shows will be introduced, in addition to the regular palace program, and in the grounds characteristic American sports will be conducted by representative teams. An important feature in connection with the exhibition will be the institution of a commercial bureau, under the direction of a committee of representative American and British firms. An American advisory committee has been formed, consisting of the officers, general committee and many prominent members of the American Society in London, who are working in co-operation with Mr. Henry Gillman to make the exhibition the most complete and representative one ever held. The English advisory committee includes the Lord Mayor, Earl Grey, the Earl of Crewe, Sir Douglas Fox, Viscount Dun-

cannon, Sir Henry Irving and Mr. Winston Churchill, M.P. Mr. Ernest Schenk, chairman of the Crystal Palace Company, has been for some time in America in connection with the arrangements, and has everywhere met with most cordial approval of the project. The American exhibition will extend from May to September.

THE Department of Agriculture is in receipt of a communication from Mr. R. J. Alfonso, agronomical engineer in Cuba, and secretary of the provincial 'Junta' of agriculture, commerce and industries of the Province of Puerto-Principe, in which he expresses his desire to be brought in contact with some of the leading manufacturers of agricultural implements in the United States in the hope that some of them may be induced to contribute to the agricultural museum his association is in process of organizing some of their implements, or models of the same. He expresses the hope that their enterprise and liberality in this respect would not go unrewarded, as such exhibits would serve a very useful purpose in the way of advertising their manufactures.

WE learn from the London *Times* that the committee appointed by the Board of Trade to inquire and report as to the best means by which the state or local authorities can assist scientific research as applied to problems affecting the fisheries of Great Britain and Ireland has met for the purpose of taking evidence. Sir Herbert Maxwell, M.P., presided. Dr. T. Wemyss Fulton, scientific superintendent to the Scottish Fishery Board, and Mr. E. W. L. Holt, scientific adviser to the fisheries branch of the Department of Agriculture, etc., Ireland, were examined, and Mr. G. C. Bompas and Professor G. B. Howes gave evidence with regard to the Buckland fish collection at South Kensington. Professor E. Ray Lankester, the president, and Mr. E. L. Allen, the director of the Marine Biological Association, and Mr. R. A. Dawson, superintendent under the Lancashire and Western Sea Fisheries Committee, also attended. Professor Herdman, F.R.S., a member of the committee, submitted a scheme for fishery investigations in the Irish Sea.

A BRITISH foreign office report gives some information regarding the bill on the subject of

the draining of the Zuyder Zee recently introduced in the Second Chamber of the States-General by Mr. Lely, the Minister for the Waterstaat, who likewise furnished the Chamber with a memorandum in explanation of the measure, giving a historical retrospect of all former proposals of this nature, as also the most complete details concerning his own proposal. It appears from the London *Times* that the plan consists of first enclosing and afterwards gradually partially reclaiming the Zuyder Zee, the pumping out of the water to be effected by steam pumps. The first work will be the construction of a dam from Wieringen, in North Holland, to Piaam, in Friesland. This dam will have sluices into the North Sea. The next works will be the creation of two polders, or areas of dry land reclaimed from the Zuyder Zee; the first, between Wieringen and Medemblik, to be called the 'North-West,' or 'Wieringen Polder,' and the second, between Hoorn and Marken, to be called the 'South-West,' or 'Hoorn-Polder.' The rest will remain a fresh-water lake, at all events in so far as Mr. Lely's plan is concerned, but should the latter prove successful, his ministerial successors may in days to come create two more polders on the northeast and southeast of the lake. The two polders will be of the following area, viz., the Wieringen Polder, 21,700 hectares, containing 18,700 hectares of fertile land; and the Hoorn Polder, 31,520 hectares, containing 27,820 hectares of fertile land. The entire work is to be completed in 18 years. The enclosing dyke from Wieringen to Piaam will be finished in the ninth year. In the eighth year will be commenced the works for dyking the Wieringen Polder, which in the 14th year will be dry and ready for sale. In the 11th year the similar works on the Hoorn Polder will be begun, and will be completed in the 18th year, when an area of upwards of 46,500 hectares of fertile soil will have been reclaimed. The cost of this gigantic work is estimated in round numbers at 95,000,000*fl.* (£7,916,667), which amount is to be raised by loans, and it is proposed to pay off the principal and interest by an annual increase of the Budget of 2,000,000*fl.* (£166,667) during a *maximum* period of 60 years.

UNIVERSITY AND EDUCATIONAL NEWS.

THE Council of Birmingham University have authorized the preparation of plans for buildings to cost about \$1,000,000.

THE engineering departments of Leland Stanford University have been granted \$50,000 for equipments.

A BACTERIOLOGICAL laboratory is to be erected at the State Agricultural College, Lansing, Mich., at a cost of \$50,000. This sum does not include the cost of the equipment, which will be the best attainable.

NORTHWESTERN University has received an anonymous gift of \$15,000.

GEORGE C. FRENCH, of Mexico, Oswego County, N. Y., has given \$4,000 to Syracuse University toward founding a chair of mathematics as a memorial to his brother, the late Dean, John R. French, of that institution.

THE professors at the Paris School of Anthropology offer the following courses for the year 1901-1902: M. Papillault: Anatomical anthropology, external form and proportions of the human body; special study of variations due to social environment. M. Capitan: Prehistoric anthropology, bases of prehistoric studies: petrography, paleontology, industry. M. André Lefevre: Ethnography and linguistics, France during the fourteenth century. Charles V. and Charles VI., the hundred years' war, letters, art, language. M. Georges Hervé: Ethnology, ethnology of Europe, Alsace. M. Adrien de Mortillet: Ethnographic technology, the industry of modern primitive races compared to tertiary and quaternary industry. M. J. V. Laborde: Biological anthropology, biological introduction to criminal anthropology. The predisposition to crime in the organic and functional evolution of man. M. Franz Schrader: Anthropological geography, terrestrial laws and human customs. M. L. Manouvrier: Physiological anthropology, comparative study of the sexes; view point of sociology. M. Charles Letourneau: Sociology [history of civilizations]; the conclusions of ethnographic and comparative sociology. M. P. G. Mahoudeau: Zoological anthropology, ori-

gin of man; genealogy of the hominidæ. The courses began on November 4 and are public; there are no tuition fees.

PROFESSOR WILLIAM S. ALDRICH, late of the University of Illinois, has entered upon his duties as director of the Thomas S. Clarkson Memorial School of Technology, Potsdam, N. Y. Among other recent appointments to the staff of the Clarkson School are Professor Edwin Haviland, Jr., B.S. (Swarthmore), M.A. (Cornell), who will occupy the chair of civil engineering, and Mr. W. S. Graffan, B.S. (Worcester Polytechnic Institute), who has been appointed superintendent of shops.

THE Ontario Government has appointed Dr. T. L. Walker, at present assistant superintendent of the Indian Geological Survey and curator of the Calcutta Museum of Geology, to the chair of mineralogy and petrography in Toronto University. Dr. Walker is a graduate of Queen's University, Kingston.

DR. D. S. KIMBALL has resigned the chair of machine design in Cornell University to accept a position with an electric company, and is succeeded by Dr. C. E. Coolidge. At the same university Mr. William Riley has been appointed instructor in entomology.

DR. A. E. SHUTTLEWORTH has resigned the chair of chemistry in the Ontario Agricultural College to accept a technical position. He is succeeded by Dr. Harcourt.

THE following changes in the science faculty of Syracuse University were announced at the opening of the year: C. B. Thwing, Ph.D. (Bonn), has been elected professor of physics, filling the vacancy caused by the resignation of Professor Eugene Haanel. At the time of his election Dr. Thwing was professor of physics in Knox College, Galesburg, Ill. F. A. Saunders, Ph.D. (Johns Hopkins), has been elected instructor in physics; H. C. Cooper, Ph.D. (Heidelberg), instructor in chemistry and E. H. Kraus, Ph.D. (Munich), instructor in mineralogy.

J. O. QUANTZ, Ph.D. (Wisconsin, 1897), has been called to the chair of psychology at the State Normal School at Oshkosh, Wisconsin.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

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FRIDAY, NOVEMBER 15, 1901.

THE GEOLOGY OF ORE DEPOSITS.*

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I.

I SHOULD hardly have ventured to talk on the subject of ore deposits to an audience which contains many men much more familiar with mines than I, if I had not approached the subject from a different point of view. The point of view from which the subject of ore deposits has been most frequently considered has been that of a study of ore deposits themselves. A geologist or mining engineer has studied this or that ore deposit, or a number of ore deposits in different districts, and has then generalized concerning the ore deposits of other districts, and perhaps of the world. I also have considered the subject of ore deposits to some extent from that point of view, but if I had done this only, I should not have ventured to give a general address upon the subject.

A number of years ago I began the study of the alterations of all rocks, by all processes and by all agents, in order, if possible, to ascertain how it is that the rocks change from one form to another. That rocks are metamorphosed has been known for many years. It has been realized that one mineral changes into another mineral;

*The Popular Scientific Lecture of the American Association for the Advancement of Science, complimentary to the citizens of Denver, delivered at Denver, Col., in the High School Auditorium, Monday evening, August 26, 1901.

that one rock changes into another rock; that rocks may have different textures, structures and compositions from those they originally had. The chief immediate agent producing these changes is underground water. Everywhere underground water permeates the rocks. Everywhere it is the medium of exchange by means of which the mineral particles are changed from one form to another.

In order, therefore, to understand this matter of the alterations of rocks, it became necessary to consider the flowage of the underground water; to attempt to ascertain, if possible, how it moves through the rocks, in what directions, to what depth it penetrates, whence it comes, whither it goes. After a certain number of principles and conclusions had been reached upon the alterations of all rocks, by all processes—and especially by the work of underground water with the help of heat derived from the igneous rocks, from dynamic action, and the increment due to depth—it seemed to me that many of the principles of ore deposition followed as corollaries from these general principles. Therefore, it is from this general point of view that the question is discussed tonight; not from that of a particular ore deposit or particular district.

For many years ore deposits have been classified into those which are produced (1) by the direct action of igneous agencies, (2) by the process of sedimentation and (3) by the action of underground water. There is no difference of opinion as to the existence of all these three classes; but there is a difference of opinion as to their relative importance. Some hold that deposits of igneous origin are of very great importance. By this I mean ore deposits which have been directly formed by some of the strange processes of vulcanism. Also it is certain that large quantities of ore, and especially the placer gold deposits, are largely

the result of the process of sedimentation. But I hold that the greater number of ore deposits, those which contribute most to the wealth of Colorado, to the entire Cordilleran region, to the Lake Superior region, to the Mississippi Valley, to the Appalachian region, are those deposited by underground water; that is, they are the direct result of the work of the permeating solutions, which go for at least a considerable depth below the surface of the earth; and are taking material into solution all the time, depositing material from solution all the time. During the journey these underground waters take up from igneous, aqueous and metamorphic rocks the sparsely disseminated metallic material which is of consequence to man. This material is deposited in the openings of the rocks and within the more easily replaced rocks in sufficient abundance to form ore deposits. With the exception of iron, the quantity of metal which is contained in an ore is ordinarily small; in the case of gold, usually an exceedingly small fraction of one per cent.; in the case of silver, usually less than one per cent.; in the cases of copper, lead and zinc, from one per cent. to a rather high percentage, but in the great majority of instances less than 20 per cent. It therefore appears that the majority of so-called ores consist mainly of deposited materials other than the metals which are extracted from them. This predominant material is known as gangue, and plainly was deposited simultaneously with the ores, in the openings of the rocks, or else replacing rock material.

In a given instance to attempt to answer the question as to the source of the gold or the silver or any other metal, without at the same time considering the minerals with which it is associated, is futile. If we can answer the question as to where the gangue minerals came from, and how they got into the positions they now occupy, the question is in large measure answered as to

how the metal got there, and how it was deposited.

I shall not attempt to give all the evidence that the metallic ores and gangue are deposited by underground waters; but I wish to call attention to certain structures of veins which seem to favor this view. [At this point a number of lantern slides were used, illustrating the following statements.]

A massive rock may be produced by direct igneous agencies; sediments are arranged in strata and beds. But material showing a comb structure—or, as Posepny calls it, crustification—and the filling about particles of rock, is usually produced by underground water. No agent other than water can penetrate between the grains throughout a sandstone formation, or a conglomerate formation such as that of the Calumet and Heckla, or between the fragments of a great tuff formation such as that of the San Juan district of Colorado, and deposit material so as to transform them to hard rocks by cementing the particles. Many cracks and crevices, great and small, form in the rocks by the deformation to which they are subjected. Igneous material can intrude the rocks in a most intricate fashion and occupy these openings; yet in the great majority of instances the extremely intimate introduction of material is accounted for by transportation and deposition of material by underground waters. Those in this audience familiar with Colorado ore deposits know that many of the valuable minerals are in veins, many of them narrow, or between very small fragments within the rocks. Not only do the ores occur in the larger openings, but they frequently occur for some distance from the veins in the extremely minute, often subcapillary, openings of the wall rocks, or even replacing the individual particles of the wall rocks. But farther from the veins, if the metals are

present at all, they are only in exceedingly minute quantities. In the larger openings and adjacent to these openings the values are chiefly found. These facts are beautifully illustrated at Cripple Creek. No known agent except underground water is capable of penetrating the very small, and especially the subcapillary, openings, and depositing material.

My primary assumption is, therefore, that the great majority of ores are deposited by underground waters at the places where they are now found. Nearly all that follows is confined to this class of ores. Ores directly produced by igneous processes, and those formed by processes of sedimentation, are only indirectly considered this evening.

The second fundamental principle which I shall try to develop is that the waters derived the ores from the outer part of the crust of the earth—the part which I have called the zone of fracture. Even as late as 1893, at the World's Fair Congress, at Chicago, it was argued by Posepny that the ores came from the barysphere, or heavy-sphere, from well down within the earth; although even Posepny conceded that the agent which transported and deposited the metals at the places where they are now found was underground water. Posepny's theory of the derivation of the ores from deep within the earth is a very attractive one; because, if it be true, the deeper a mine, the richer an ore deposit is likely to become. Indeed, it is the belief of 90 per cent. or more of prospectors that if they only could get deep enough, deposits of surpassing richness and magnitude would be developed. But it seems to me that the hypothesis that the ores are derived by the underground waters from deep within the earth has no foundation in fact. It is alike opposed to the principles of physics and to observations in the field.

It must be remembered that gravity is a gigantic force ever at work pulling toward

the center of the earth. And it must be remembered that all rocks are limited in strength. The strongest rock tested has a crushing strength of something more than 40,000 pounds per square inch. A column of such a rock 10 or 12 miles high would be crushed by its own weight. It is easily calculable that if we suppose the outer part of the crust of the earth to be composed only of the strongest rocks, and we imagine openings to exist in these rocks, then at a certain depth these cracks must be closed by the pressure. And this deduction has been experimentally proved. Professor Adams, of Montreal, has shown that rocks subjected to pressures in all directions greater than their crushing strength may be mashed, and no perceptible openings produced. Therefore, openings of great size cannot be assumed to exist below a very limited depth in the crust of the earth. This conclusion is fully verified by observation. By examining the rocks in the cores of mountain ranges where there has been deep denudation, we may see what has happened to them when well below the surface. In the Front Range of Colorado, and at various places in the world, where the rocks have been deformed at considerable depth below the surface of the earth (ignoring recent fractures which have been produced since the rocks came near or to the surface), the process has taken place without the formation of openings larger than those discernible only with the microscope. Therefore, from the point of view of pure physics, from the point of view of experiment, and from the point of view of observation alike, we reach the conclusion that no large or continuous cracks or crevices exist except for a very limited depth below the surface of the earth.

In order to deposit the metals and gangue of an ore deposit, a vigorous circulation is required. The vigorous circulation of underground water is necessarily confined

to that part of the crust of the earth where there are continuous cracks and crevices of considerable size. As the openings decrease in size, the resistance due to friction increases rapidly; and where the openings are subcapillary, it is enormous, being in fact sufficient to practically check circulation. In Colorado a common gangue material is quartz. Springs have been analyzed, and it has been found that the water issuing from such springs bears perhaps one part in one hundred thousand, or one part in a million, of silica. It is probably rather uncommon for a solution to deposit as much as one part by weight in one hundred thousand of the gangue and ore material. If this be so and the gangue be quartz, in order to fill an opening with ore and gangue, at least 260,000 times as much water must have passed through it.

It therefore follows that if the majority of ore deposits are placed where they are by underground waters—and from this there seems no escape—the processes of their gathering and deposition must be mainly confined to the outer few miles of the crust of the earth. This is called the zone of fracture. *Therefore my second fundamental conclusion is that the ore deposits are derived from the zone of fracture.*

But is there an adequate source of supply of metallic material in the outer part of the crust of the earth? In answer to this question, it may be said that calculation clearly shows the relatively small quantities of ore which exist could have been derived from the zone of fracture, even if the rocks contain an exceedingly small fraction of one per cent. of metal. To illustrate, Mr. Buell has calculated for Professor Chamberlin, for the Wisconsin lead and zinc district, that if the richest portion of the district be taken, and it be assumed that the supply extended only one-half as far beyond the deposits as the radius of the productive area, and the depth of vertical distribution be confined

to 100 feet, one fourteen-hundredth of one per cent. of the metals in the rocks could supply all the lead and zinc which has been or is likely to be taken from the district. It is therefore not necessary to suppose that there is more than a minute quantity of metallic material in the zone of fracture, to furnish a supply adequate many times over to account for all the deposits which have been mined or are likely to be mined.

So far as the specific work of underground water is concerned, we have already seen that the metals for the ores are derived from the zone of fracture. But it does not follow that important supplies of metals to be later yielded to the water may not come from deeper within the earth. As a result of various causes, which cannot be discussed this evening, the igneous rocks rise from an unknown depth below the surface of the earth into the zone of fracture or even quite to the surface. Such igneous rocks bear materials out of which many important ore deposits are largely or wholly derived. Indeed, if we go far enough back in the history of the earth, all rocks were probably derived from the igneous rocks. So, directly or indirectly, the ultimate source from which ores are derived by underground water is igneous rocks, either ancient or modern. On this point there are no differences of opinion.

But there are differences of opinion as to the manner in which the ores are derived from the igneous rocks. Some geologists hold that the direct processes of igneous action produce many ores. They say that during the process of crystallization of the igneous rocks the ores are segregated by magmatic or pneumatolitic processes. There are cases in which this is probably true, as, for instance, the unimportant titaniferous iron ores of the Adirondacks and the Lake Superior region. Certain ores, as the tin

ores, possibly have this origin. But it is yet unproved that the great mass of ores, which are known as the oxidized ores, the carbonate ores, the sulphide ores, and the tellurid ores, have been thus derived. We know of these classes of ores that a large part have been taken from the rocks and brought to their present positions by underground water. Why, then, assume some other process of segregation for which there is no adequate evidence, when we have a wholly adequate agent in underground water? In the great majority of cases the ores are taken from the igneous, sedimentary and metamorphic rocks by the underground waters; are carried to their present positions by the underground waters, and deposited by the underground waters at the places where they are now exploited.

The next question which naturally arises is the source of the underground water. It is believed that the water is predominantly of meteoric origin; in other words, is the water which falls from the atmosphere upon the valleys and hills and mountains of Colorado and other parts of the world. It is true that each igneous rock usually carries a small amount of water; and in the aggregate this amount may be very great. Indeed, it may be that all the water upon the surface of the earth and that in the openings of the zone of fracture was originally derived from the igneous rocks. But even if this be true, it does not follow that in a given district, at the particular epoch in which the ore deposits were formed, the water directly derived from the igneous rocks is adequate or even important in accounting for this deposition. As already explained, it is necessary to consider not only the ore but the gangue material with which it is related; and it has been seen that in order to deposit an ore and its accompanying gangue probably required tens of thousands or even hun-

dreds of thousands of times as much water. The vast quantity of water necessary cannot be derived from the igneous rocks present at a given time and place, although they may have contributed a portion of it. But it is held that the major portion of this vast quantity of water could only have been derived from the rainfall. *My third fundamental premise is, therefore, that the circulating underground water is mainly of meteoric origin.*

The question which now arises is the cause of the flowage of underground water. Why does it move? Until we know the force which drives it, we cannot know the manner in which it circulates. Geologists have frequently appealed to the great energy of the subterranean heat, due to depth or to igneous rocks, to drive this water. But this is not enough. How does this subterranean heat act in producing this circulation? A few miles west of Denver are the crystalline or core rocks of the Front Range. To the east of these there is a series of sedimentary beds, some of which are water-carriers, and which dip below impervious strata. The water rises to the surface at Denver. Why is this so? Simply because the water is at a higher level where it enters the formations than where it issues at the surface. The force which drives the water is gravitative stress. Gravitative stress is everywhere and all the time at work. The longer column is pulled downward with greater force than the shorter column. The difference in the height of the two columns is called head. Therefore, the water in the longer column moves downward, and that in the shorter upward. *We now reach my fourth fundamental premise: That gravitative stress is the chief cause of the circulation of underground water.*

The flowage of water in the Denver artesian basin does not require the force of the subterranean heat below. But there is a way in which the subterranean heat can

promote the circulation of underground water; and, indeed, does. This is by heating it. When the water is heated as a result of the contact with igneous rocks, or heated because it penetrates deep into the earth, it expands. If it expands unequally, as it is likely to do, one column may become lighter than the other, even if they are of the same height. If so, circulation would be set up. This is the principle of hot-water systems of heating buildings. The heat of the fire expands the water and forms two columns of unequal density. Under this condition of affairs gravity pulls the denser column harder, and a circulation takes place. Therefore, the heat of the igneous rocks acting upon the underground solutions, or the heat of the rocks due simply to depth, provided the circulation be of sufficient speed, may result in flowage. Thus there are two causes which result in the underground circulation, which may work separately or together—(1) head, and (2) variable temperature. But in either case continuous movement of the water in a definite direction, or its circulation, is due to gravitative stress.

Therefore, we have these four fundamental premises: (1) *The chief class of ore deposits is segregated by underground water;* (2) *the source from which the water derives the metals is the zone of fracture;* (3) *the circulating underground water is mainly of meteoric origin;* (4) *the force which drives the water in its circulation is gravitative stress.*

It is now necessary to consider in some detail the manner in which underground water moves. For a long time I have realized that if underground water had a difference in head it might penetrate to a great depth and rise again to the surface; but I did not realize that it was not necessary to assume exceptional openings for such a circulation. I assumed that where such a circulation took place exceptionally favorable channels were available;

but a recent paper by Professor Slichter* upon the motion of ground waters showed me that this was an entirely unnecessary assumption, and gave me the additional data needed upon this point. This chart (Fig. 1) is a horizontal diagram. A repre-

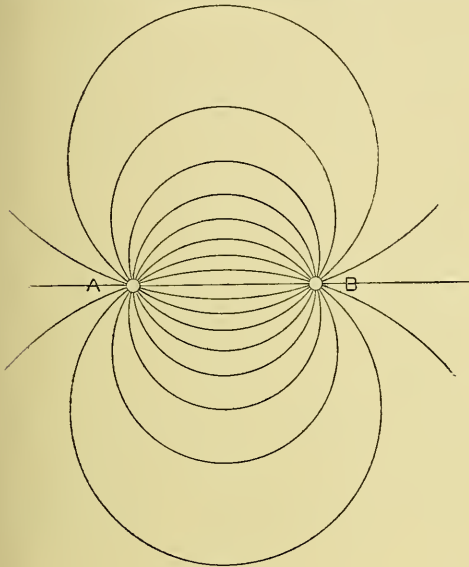


FIG. 1.

sents one well and *B* another well, separated by a homogeneous porous medium. Into the well *B*, I pour water. In the well *A* there is no water at the outset; and the water flows from the well *B* to the well *A* through the medium. What is the path of the water? Its flowage is represented by the curved lines. Some of the water goes in a nearly direct course. Another part takes a somewhat curved course. Still other parts of the water follow a very indirect course, represented by the longer curved lines. All the available cross section is utilized. If, for instance, this room were filled with water, and water were running in at one place in the front end of the room and were escaping at one place in

the rear end of the room in equal quantity, would the water simply follow the direct line between the two openings? You know perfectly well it would not. The entire available cross section of the room would be utilized, although the more direct course would be utilized to a greater extent than the more indirect course. This is intended to be illustrated on the chart (Fig. 1) by the lines representing the nearly direct courses being close together, and the lines representing the indirect courses being farther apart.

This chart (Fig. 1) then represents the horizontal circulation. If we pass to the vertical circulation the flowage is represented by this chart (Fig. 2). The water is being poured into the well *B* and passes to the well *A*. The water follows the course of the curved lines, so that with a difference in head equal to the difference in the level of the water in the two wells, a considerable part of the water being poured into *B* and passing through the homogeneous porous medium to *A* penetrates a considerable depth, from which it rises and enters the well *A*. Now what will be the limit in nature of the downward search of underground water? We have already given it. Manifestly the lowest limit of effective circulation at any place is the bottom of the zone of fracture at that place. The zone of flowage below is practically impervious. However, an impervious limiting stratum may exist at depths far less than the bottom of the zone of fracture. An impervious limiting stratum, perhaps a shale, may be found at a depth of 300 feet or less, or at any depth intermediate between this and the bottom of the zone of fracture for the strongest rocks. Where there are one or more pervious strata which are inclined, and above, below and between which are impervious formations, there may be two or more nearly independent circulations. To illustrate, at Denver, the

* 'Theoretical Investigation of the Motion of Ground Waters,' by C. S. Slichter, Nineteenth Ann. Rept. U. S. Geol. Surv., 1899, Pt. II., pp. 295-384.

porous strata of the Fox Hills, Laramie and Arapahoe formations have more or less independent circulations. If a limiting stratum be supposed to be half way down on the chart (Fig. 2) the lines of flow above

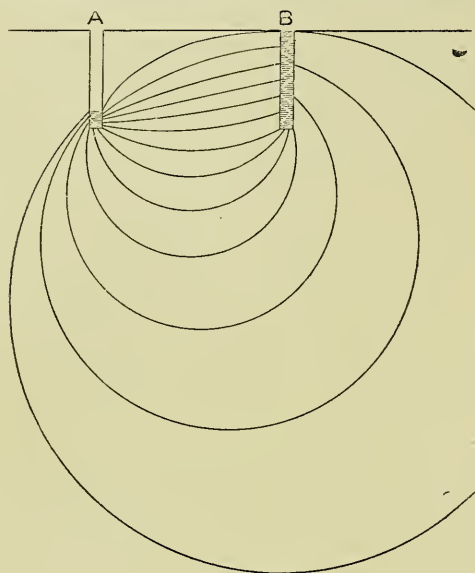


FIG. 2.

this stratum would not be as they are now, but would be flatter and would be limited by the impervious rock.

Under natural conditions, wherever there is an impervious rock there is a limit of some particular circulation in that direction. A limiting stratum may, therefore, be very near the surface, at the bottom of the zone of fracture or at any intermediate depth; and theoretically a moderate head is sufficient to do the work of driving the water to any of these depths. Indeed, there is no escape from the conclusion that at least some circulation does occur in the deeper parts of the zone of fracture with a very moderate head. Of course, in proportion as the head is great the circulation at depth is likely to be vigorous. But it may be objected that a deep circulation, while theoretically possible, must be exceedingly small in quantity, and consequently of

comparatively little account in the deposition of ores. But the consideration of the underground circulation in reference to the Denver artesian wells shows that this objection has little weight. Moreover, the deeply circulating water, if less in quantity than that near the surface, takes a longer journey and is longer in contact with the rocks through which it is searching for the metals. Not only so, but it is at a higher temperature than the water at higher levels; and this also is favorable to taking mineral material in solution. And, finally, because it has a higher temperature, it has less viscosity. While the variable viscosity of water is not so very important in reference to circulation in supercapillary tubes, in capillary tubes, which constitute a very large fraction of underground openings, and especially those at considerable depth, the viscosity is important—the flowage increasing directly as the viscosity decreases. The viscosity of water at 90° C. is only one-fifth as much as it is at 0° C.; and, therefore, with a given head of water in capillary tubes, if the temperature be considerably increased—and but a moderate depth is required to give considerable increase—the water moves several times as fast as it would at the surface under conditions similar in all respects save temperature. Therefore, because of these three factors, long journey, high temperature and low viscosity, we cannot exclude the deep circulation from consideration. This circulation is, indeed, believed to be very important in the deposition of ores.

We are now prepared to consider the actual journey of underground water. Where water falls upon porous ground it finds innumerable openings through which it enters and begins its underground journey. This circulating water, as far as practicable, under the law of the minimum expenditure of energy, follows the paths of easiest resistance. But these are the larger

openings, because resistance due to friction along the walls and within the current is very much less per unit circulation in large than in small openings. While, therefore, water enters the ground at innumerable small openings, as it goes down it more and more seeks the larger openings. Once found, it holds to them. The farther it continues its journey, the greater the proportion of the water which follows the larger openings. But if this be true, the water in its descending course is more likely to be widely dispersed and in the smaller openings; and in its upward course more likely to be concentrated and in the larger openings.

We can now follow the course of underground water in detail, but in doing this it is necessary to consider the elements of the problem separately. It is only by passing from a simple case to the very complex one of nature that we can understand the latter. Here is a chart (Fig. 3) which shows the

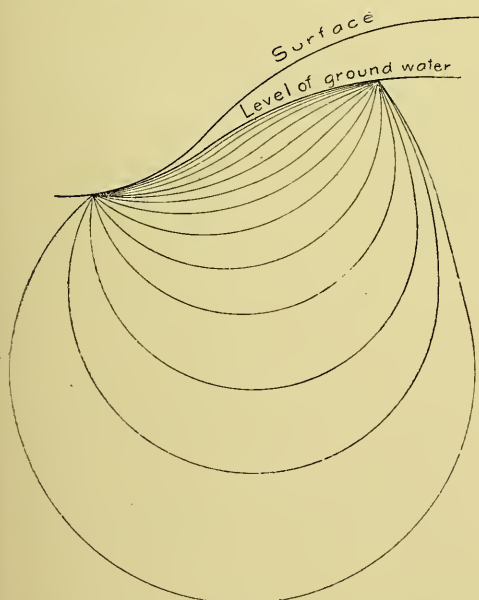


FIG. 3.

imaginable case. In this illustration we have represented the surface of the earth and the level of ground water. By the level of ground water is meant the depth at which the water saturates the rocks—that is, where the water remains at practically a permanent level. Above this level the paths of circulation are practically vertical; below this level the paths are curved. Of the water which enters the slope of a hill and issues in the adjacent valley, a portion flows along the slope of the hill, a portion in a less direct route, and a portion in a very circuitous route. Below the level of ground water all the openings in the rocks, great and small, are filled with water. In the case represented I have supposed that all the water enters at a single point, *A*; and that all of it issues at a single point, *B*. The curved lines represent the flowage of the water through a homogeneous porous medium.

In the next chart (Fig. 4) I have supposed water to enter at three points

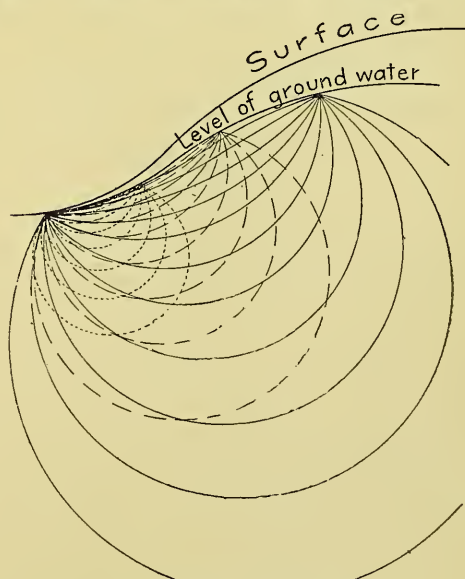


FIG. 4.

surface of a slope, the level of ground water and the flowage of water in the simplest

and issue at one; and I have supposed the flowage from each point of entrance

to occur just as if no water were entering anywhere else, and, therefore, the systems of flowage to be superimposed. Of course this is not a real case. Underground water does not diverge from a single point and converge at another point in independence of the water entering at other points. The water entering at innumerable points in vertical section and in horizontal section mutually interferes, and makes the course for any given particle of water rather simple. This I have tried to represent by another chart (Fig. 5). In this chart I

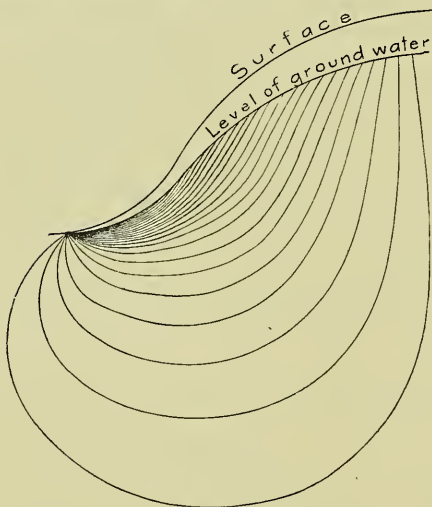


FIG. 5.

have supposed particles of water to enter at equal horizontal intervals, and issue at a single point. You note that the water near the crest begins its journey by almost vertical descent. In proportion as the entering water is near the valley the horizontal component becomes more important. The water near the valley follows a comparatively shallow course; but this water uses all the available space near the surface, and consequently the water entering at the higher ground necessarily follows a long, circuitous and deep course. The chart (Fig. 5), therefore, represents the flowage with many points of entrance and

a single point of exit, where there is interference of the circulating waters.

A portion of the water follows an approximately direct path; a portion of it less direct paths; and a portion of it a very roundabout path. That is, the underground water, following the lines of least resistance, takes not only the direct passages, but also the indirect passages. The lines in the more direct path are closer together, and the indirect path farther apart. These facts have been ascertained by experiment and by mathematical analysis. But everywhere gravitative stress is the driving force. The case represented by the diagram (Fig. 5) is an ideal one. Under the complex conditions of nature there is usually great departure from the simplicity represented; but in some districts this ideal simplicity must have been approached. For instance, except for the disturbance due to cutting dikes, the circulation in the past in the San Juan district of Colorado must have been very nearly like that represented in the diagram. Early in Tertiary time there was in that district a great volcanic plateau. Early in the erosion history of this plateau, the conditions must have been the same as at present in the Yellowstone Park and other volcanic plateaus of the West. At the stage when the San Juan plateau was still the dominating topographic feature, but cut by canyons, the conditions were practically identical with the conditions represented by the diagram. The water sank into the ground upon the hills and the plateau; it issued at the valleys, much of it having first penetrated far below the level at which it issued. The water carried on its search for metals through the volcanics, almost as shown in the diagram, except in so far as it was influenced by larger cracks or crevices, or by cutting dikes, or by impervious layers.

The principles illustrated by these diagrams show it is not necessary that

there shall be a difference of elevation of thousands of feet between where the water enters and where it issues, in order that the rocks shall be searched for depths of thousands of feet. A few hundred feet is sufficient. Therefore, the underground waters, falling on the slopes, passing through the areas where they may gather material, and issuing at various places in the valleys, have an opportunity to pick up the ores, provided the metals exist in the rocks traversed. By the water the metals are carried to the places where they now are.

Thus far it has been supposed that the ground is uniformly porous, like an evenly grained sandstone without joint or fracture of any kind, in which the water can go in all directions with equal ease. But absolute uniformity does not exist in nature. The openings in rocks are never of uniform size; they are never equally distributed.

It is now necessary to take up the final important point in the circulation of underground water. So far as it can, it passes from small openings to large openings. Where the openings are small the resistance per unit area is very large. Where the openings are exceedingly small, the resistance is very great. Where the openings are large, the resistance is slight; and the water, following the lines of least resistance, travels to the extent that space permits in the trunk channels. To illustrate, every engineer knows that if water be carried in pipes from the hills to the mines, one pipe will carry vastly more water in a given time with a given head than many smaller pipes of the same aggregate cross section. This is because of friction, which increases rapidly as the cross section decreases. And water does the same thing in natural as in artificial pipes. Therefore, the underground water more and more follows the larger courses. It falls everywhere on the slopes of the hills; it enters the ground everywhere. Therefore, in its earlier course it is

widely disseminated, and thus dispersed can most effectively pick up the valuable metals with which it comes into contact. But as the journey is continued, it collects more and more into the larger channels. But in the early part of the journey of ground water its vertical component is apt to be downward. But as it must sooner or later reach the surface, in the later part of its journey its vertical component is apt to be upward. However, it has just been seen that the early part of its course is apt to be in small openings, and the later part in larger openings. As it collects in the larger channels, it is more likely to be ascending. Therefore, upon the average—I say upon the average—descending water is mainly in the small openings, and ascending water mainly in the large channels.

It is now advisable to consider the circulation in definite vertical large, or trunk channels. Suppose half way down the slope there is a vertical opening of unusual size

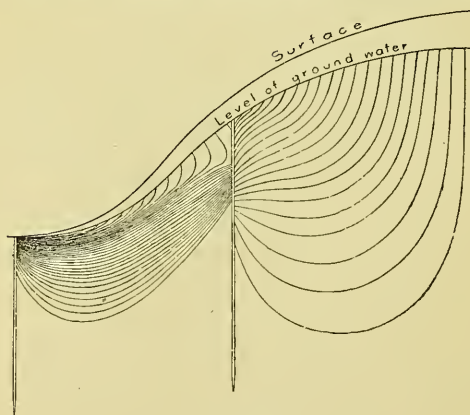


FIG. 6.

transverse to the plane of the chart (Fig. 6), and another similar opening below the valley. If you please, we will call them fissures. These fissures, because large openings, will be fully utilized by the underground water. We readily see that ground water will enter the higher fissure at many points and from various directions.

Ordinarily it will enter the upper part while it is still descending; it will enter the central part laterally; it will have begun its ascent before it enters the lower part. Therefore, a fissure upon the middle of a slope will be very likely to receive water from above, from the side and from below. But at a certain area of a fissure well up on the slope the water continuously received at the upper side of the fissure will escape laterally at the lower side. This water and that entering the ground below the upper fissure will make its way to the fissure below the valley. But here the level of ground water is at the surface. Consequently all the water entering this fissure will ascend quite to the surface, and issue as a spring. If there be a fissure at the crest we can see that the descending water will go a long way down; but the waters will nowhere be ascending. If there be a fissure on the slope, both descending and ascending waters will ordinarily be active; although it is of course recognized that in fissures thus located the conditions may be such that the waters will ascend or descend only. If there be a fissure below a valley where the level of ground water is at the surface the water will all be ascending; and there will be no descending water. At such places we have springs. Springs do not issue from the tops of mountains, but from slopes and valleys, most frequently the latter. Illustrating this are the Yellowstone Park springs of the Firehole River. The waters which feed the springs fall upon the crests and slopes of the mountains adjacent; on their way to the valley go deep below the surface, and at the Firehole ascend as hot springs and geysers. The water is driven by gravity due to a considerable head and the lower temperature of the descending column.

You are all doubtless aware that three theories are maintained as to the course of the waters which deposit ores. Some hold

that the waters doing the work are descending; others that they are laterally moving; others that they are ascending. The first is known as the descension, the second as the lateral-secretion, and the third as the ascension theory. If my argument be correct as to a limit to the zone of fracture, fissures, as well as all other openings, must gradually become smaller and smaller, and finally die out altogether. Water in a fissure may descend or may ascend for a considerable distance; but it is perfectly clear that, so far as fissures are concerned, except for the small amount entering the surface openings, the water must enter laterally. Consequently, if we apply the lateral-secretion theory broadly enough, we may say that all the waters which feed the fissures are lateral-secreting waters. But if we are descensionists, and consider only the upper part of a fissure on the slope—and that is what many very naturally have done, because this is the part of the fissure most easily observed—we may say that the waters which are doing the work are descending waters. Or, if we are in such a district as that of the Comstock lode, in which are found great volumes of ascending water, we may say that the waters which are depositing the ores are ascending. All may be correct. But in the past Sandberger held that lateral-secreting waters in the narrowest sense did all the work, and he refused to believe that ascending and descending waters were of importance; and Posepny held that ascending waters did nearly all the work, and gave small consideration to the lateral-secreting and descending waters; whereas you see with perfect clearness that each theory is incomplete. All are needed; they supplement one another.

The next point to consider is why the metals are precipitated in veins. The salts of the valuable metals may come from any of the places visited by the oc-

cupping waters. If one take a number of chemical solutions in the laboratory, and dump them together in a beaker, probably precipitation will occur. These conditions are precisely those of underground solutions in trunk channels. The water from one source meets the water from another source in the trunk channels. Analyses show that waters from different sources have different compositions. They bear different metals and precipitating agents. When they come together in the trunk channels, and mingle, precipitation is likely to take place. You, who are practical mining men, like your veins to intersect, or two veins to unite. The explanation of the frequent increased values at or adjacent to an intersection is simply that the different trunk channels bear solutions of different kinds, and when they mingle at or near the intersections, ore precipitation is likely to occur. One solution may bear its mite of silver or gold, and the other the precipitating agent, or both solutions may carry the metals, and when the two come together the ore be thrown down. However, this is not the only way in which precipitation may take place. In many instances the precipitation is due to the wall rock. The wall rock, or the solutions furnished by it, react upon the solutions coming from somewhere else, and precipitation occurs. These two causes for precipitation are not the ones which are ordinarily mentioned in treatises on ore deposits. The causes commonly assigned in text-books for precipitation are the diminishing temperature and pressure of the rising solutions. While these are real causes for precipitation, I believe them to be subordinate to the influence of the mingling of solutions from various sources in the trunk channels, to the influence of the wall rocks, and especially to the first.

C. R. VAN HISE.

(*To be concluded.*)

THE PHYSICAL SCIENCES AT THE BRITISH ASSOCIATION.

THE meeting last September at Glasgow, which was attended by nineteen hundred persons, was smaller than the last two meetings held in that city, and fell slightly below the average of the British Association gatherings. This was chiefly the result of the unexpectedly small number of local associate members enrolled, accounted for by the fact that an International Exhibition with several collateral congresses had satisfied whatever desire the inhabitants of the Scotch metropolis may have had to increase their knowledge of scientific matters. The foreigners numbered only twenty-one, but some who might have attended this meeting had already been in Glasgow early in the summer as delegates to the jubilee celebration of the University. Since the president of the Association this year is one of the most distinguished physicists in Great Britain, it was natural to expect a large gathering of workers in his branch of science, but here also certain well-known names were missed from the list of members, which may likewise be attributed to the above cause. The meetings of all the sections were very conveniently held in the splendid University buildings on Gilmore Hill, the Physical Section holding its sessions in the Natural Philosophy Class Room, rendered famous by Sir William Thomson, now Lord Kelvin. The only criticism that could be made of the local arrangements was the absence of notices at the doors of each section indicating what paper was being read, but the same complaint has frequently been heard at our American Association meetings.

Professor Rucker's presidential address, which has already appeared in SCIENCE, was a scholarly defense of the atomic theory of matter, but some disappointment was manifested that the objections of its opponents were not definitely stated. Lord Kelvin, who seconded the vote of thanks to the

speaker by a short address of his own (as is customary in England), was rather bitter in his denunciation of those who did not accept the theories advanced. Hence it seems doubtful if the popular audience carried away a fair appreciation of the question. The two evening lectures were noteworthy because given by men whose names are household words in the scientific world. Professor Ramsay's topic was 'The Inert Constituents of the Atmosphere,' and though the unfortunate failure of the light prevented some of his diagrams from being visible at the proper time, the lucid explanations made the discourse entirely intelligible. Especially interesting was the description of the long and painstaking experiments and researches which resulted in the famous discovery of argon in 1894, followed in 1895 by that of helium, and in 1898 by that of three other elements to which the names of neon, krypton and xenon were applied. The second lecture, on 'The Movements of Plants,' by Mr. Francis Darwin, was a beautifully simple exposition of a most abstruse subject, namely, how gravity acted to force plants to grow along vertical lines. While the lecturer thought that plants might be classed as vegetable automata, yet he was inclined to believe that mind was always implicated in life, and that, with a fuller knowledge of consciousness, we should admit that the rudiments of the psychic element existed even in plants. There follows an abstract of the presidential addresses and of the work of the Sections of Mathematics and Physical Science, Chemistry and Engineering.

MATHEMATICS AND PHYSICAL SCIENCE.

The president of this Section was Major P. A. MacMahon, F.R.S., and his address dealt first with the position that mathematical science occupied at the beginning of the nineteenth century in the British Isles and on the continent of Europe. As

regards organization and cooperation in mathematics, Germany, he thought, stood first now. The illustration offered by international cooperation in astronomy afforded a useful object lesson to all men of science, and might encourage those who had the ability and the opportunity to make strenuous efforts to further progress by bringing the work of many to a single focus. In pure science a free interchange of ideas was possible, but in applied physics the commercial spirit exercised an influence, and it was the duty of the Association to take an active attitude toward this blot on the page of applied science. The importance of science teaching in secondary schools had been overlooked. Those concerned in our industries had not seen the advantage of treating their workshops and manufactories as laboratories of research, and the Government had given too meager an endowment to scientific institutions and had failed adequately to encourage scientific men. At the present time, the number of workers is so large, the treatises and scientific journals so numerous, the ramifications of investigations so complicated that it was scarcely possible to acquire a competent knowledge of the progress being made in the many divisions of science. Hence the so-called specialist has come into being, and the word was often used as a term of opprobrium or as a symbol of narrow-mindedness. What is required is not the disparagement of the specialist, but the stamping out of narrow-mindedness, and of ignorance of the nature of the scientific spirit and of the life-work of those who devote their lives to scientific research. The specialist who wishes to accomplish work of the highest excellence must be learned in the resources of science and have constantly in mind its grandeur and its unity. Lord Kelvin and Professor Rucker offered the motion for a vote of thanks, and then the regular work of the

Section was begun. Papers were read by Professors A. Gray, F.R.S., J. S. Dunlop and A. Wood, on 'Elastic Fatigue as shown by Metals and Woods'; by Professor G. Quincke, of Heidelberg, on 'The Clearing of Turbid Solutions and the Influence of Light on the Motion of the Suspended Particles'; by Professor A. Gray, F.R.S., on 'The Relation between Temperature and Internal Viscosities of Solids'; by Professor W. Ramsay, F.R.S., and G. Senter, on 'Hydrostatic Pressure'; by E. H. Griffith, F.R.S., on 'The Freezing Points of Certain Dilute Solutions'; and by Dr. R. T. Glazebrook, F.R.S., on 'The Buildings of the National Physical Laboratory.' Dr. Glazebrook, who is the director of this new institution, gave a history and description of the building now being fitted up in Bushy Park, ten miles southwest of London, and described the objects for which it had been founded, as reported on pages 662-663 of SCIENCE.

On September 13 the Section was divided into two parts, Physics and the newly organized subsection of Astronomy. In the former Dr. Glazebrook read the report of the Committee on Electrical Standards, which stated that no evidence of any marked change in the relative values had shown itself. Mr. S. Skinner read a note on 'A Comparison of the Deposits in Silver Voltameters with different Solvents,' and Professor A. Schuster, F.R.S., presented one on 'The Conduction of Electricity through Mercury Vapor.' Dr. V. Crémieu, of Paris, spoke on 'The Magnetic Effects of Electric Convection' in which he showed that an electrically-charged body in motion has not the same electromagnetic properties as an electric current, but, as Lord Kelvin remarked, if these experiments are regarded as conclusive the present electromagnetic theory must be rejected. Other papers were by G. M. Minchin, F.R.S., on 'Photoelectric Cells'; by B. Hopkinson, on 'The Ne-

cessity for Postulating an Ether'; and by Professor F. C. Bose, on 'The Change of Conductivity of Metallic Particles under Cyclic Variations of Electromotive Force.' The Astronomical subsection met under the presidency of Professor H.H. Turner, F.R.S., of Oxford (who took the place of Dr. Copeland, Astronomer Royal for Scotland, detained by illness), and he delivered an address on cooperation in astronomical work, with special reference to the astrographic chart. While agreeing with Major MacMahon as to the value of cooperation, Professor Turner called attention to the harm that might result from undertaking too much and through the checking of original research. The most important astronomical papers were by Professor G. Forbes, F.R.S., on 'The Position of a Planet beyond Neptune,' and by Father A. L. Cortie, of Stonyhurst, who proved that the faculæ on the sun's surface followed the same law of drift as the spots. Professor Turner exhibited a copy of the first photograph of the spectrum of a lightning flash obtained by Professor E. C. Pickering, of Harvard Observatory.

At the next meeting of the Physical Section two papers, by Professor E. W. Morley and Mr. C. F. Brush, of Cleveland, were presented by the former gentleman, the first being on a new gauge for small pressures, designed especially to measure the pressure of aqueous vapor (which will be described in the *American Journal of Science*), and the second on the transmission of heat through water vapor. Other papers were by Messrs. C. Bedford and C. F. Green on 'A Method of Determining Specific Heats of Metals at Low Temperatures'; by Professor H. L. Callandar, F.R.S., on 'The Variation of the Specific Heat of Water'; two papers on the Lippmann electrometer by Messrs. F. G. Cottrell and J. A. Craw and one by Dr. M. W. Travers and G. Senter on 'A Comparison of Constant Volume and Con-

stant Pressure Scales for Hydrogen between 0° and 190° C.' The Committee on Radiation in a Magnetic Field also reported. The mathematicians of the Section met with the Educational Science Section in a joint discussion on the teaching of mathematics, opened by Professor J. Perry, F.R.S., of the Royal College of Science, South Kensington, and participated in by Professor A. R. Forsyth, F.R.S., of Cambridge, Professor A. W. Rücker, now principal of the University of London, Professor S. P. Thompson, F.R.S., of the same university, and others.

On Monday, the 16th, the Section again met in two departments—Mathematics and Physics. In the former, with Major MacMahon as chairman, there were papers by Professor G. Mittag-Leffler, of Stockholm, by Professor G. H. Darwin, F.R.S., by Professor A. G. Greenhill, F.R.S., and others, besides the report of the Committee on Tables of Certain Mathematical Functions. In the department of Physics, under Dr. Larmor, F.R.S., two interesting reports were presented, by Professor J. D. Everett, F.R.S., for the Committee on Underground Temperature, in which the temperatures recorded in the Calumet and Hecla mines were compared with the temperatures in the deepest shaft in the world, situated in Upper Silesia, and the sixth report of the Committee on Seismological Investigations, drawn up by Professor J. Milne, F.R.S., which stated that there were 36 seismological stations abroad and in Great Britain provided with seismographs recommended by the Committee. Among the physical papers, Dr. Crémieu offered one on 'Gravitation' and Dr. C. E. Guillaume, also of Paris, sent as a basis for discussion a proposition for a new unit of pressure, called the megadyne per square centimeter, which differs little from the present atmospheric unit. Considering the status of meteorology in Scotland, surprisingly few communications in

this science were offered, and these suffered from being scattered through two sections. In the Physical meeting just mentioned, there were two suggestive papers by Mr. W. N. Shaw, F.R.S., secretary of the London Meteorological Office, and Mr. R. W. Cohen on 'The Seasonal Variation of Air Temperature in the British Isles and its Relation to Wind Direction,' and on 'The Effect of Sea Temperature on the Seasonal Variation of Air Temperature of the British Isles.' The next day the department of Meteorology met under Professor Turner, but, excepting the report of the Committee on the Ben Nevis Observatory, which was drawn up, as usual, by that Nestor among meteorologists, Dr. Alexander Buchan, F.R.S., the sole paper was by Mr. F. N. Denison, of Victoria, B.C., on 'The Seismograph as a Sensitive Barometer.' The author concluded that since the earth is depressed under areas of high barometric pressure and elevated under areas of low pressure, horizontal pendulums might warn the advent of great Atlantic storms before they reached the west coast of Ireland, but in the discussion that followed, doubt was expressed as to whether the observed effect had been assigned to the right cause. On account of the interest of the president of the Geographical Section, Dr. H. R. Mill, and of its recorder, Mr. H. N. Dickson, in meteorology, their Section also received three papers relating to this science, including one by Mr. Dickson on 'The Mean Temperature of the Atmosphere and the Causes of Glacial Periods.' 'The Systematic Exploration of the Atmosphere at Sea by Means of Kites,' illustrated by the first meteorological records high above the Atlantic, was discussed by the writer who, being a member of two sectional committees, was able to urge the grant of money appropriated for conducting meteorological researches with kites in Great Britain. Mr. W. N. Shaw exhibited to the Geographical Section a series of

twenty-three daily weather maps that were published in various parts of the world at the commencement of the twentieth century. With the exception of Africa, only a small portion of the north of which continent was mapped, South America and a part of eastern Asia, every part of the world has charted each day the weather conditions prevailing over it.

The communication that attracted the greatest popular interest in the Physical Section was by Lord Kelvin on 'The Absolute Amount of Gravitational Matter in any Large Volume of Interstellar Space.' This was a summary of his article in the *Philosophical Magazine* for August (see also *Nature* of October 24), the conclusion being that the matter contained in the universe could not be much more than a thousand million times the mass of the sun, the number of these bodies, estimated at one thousand million, occupying only twenty-seven thousandths of the proportion of space in the universe. Dr. Glazebrook then opened a discussion on optical glass and explained the assistance which the National Physical Laboratory might render in determining the properties it should possess and the best forms of lenses for various purposes. After the reading of several optical papers, Dr. W. J. S. Lockyer, assistant director of the Solar Physics Laboratory at South Kensington, spoke on the evidence of a thirty-five-year period in the occurrence of sunspots, which coincided with the climatic variations indicated by Professor Brückner, of Berne, and with the frequency of auroras and magnetic storms observed since 1833. The closing session of the Section on September 18 was mostly devoted to the magnetic papers. A report presented by the Committee on the Determination of Magnetic Force on board Ship related to the instruments supplied to the English antarctic ship *Discovery* and to the German antarctic ship *Gauss*. Captain E. W. Creak, F.R.S., described a

new form of instrument for observing the magnetic dip and intensity at sea which was designed to replace Fox's apparatus. Lloyd's needles are applied to an instrument that can be used on a gimbal-table on board ship and the *Discovery* and the *Gauss* have been so fitted. The numerous communications to the Physical Section were of a high order and, considering the technical and special nature of many of them, the attendance was well maintained.

CHEMISTRY.

Professor Percy F. Frankland, F.R.S., Professor of Chemistry in the University of Birmingham, delivered the inaugural address, as president of the Section, on the subject of 'The Position of British Chemistry at the Dawn of the Twentieth Century.' He first pointed out that the history of British chemistry, as indeed of British science in general, was remarkable in that it was made up almost entirely of achievements which were the result of private enterprise. The foundation of University College, and other institutions for higher education, by private initiation, and without a particle of assistance from the public exchequer, was quite in keeping with the history of a country in which it was recognized that the Government did not lead, but only followed where it was drawn or propelled. There could be no doubt that the extended cultivation of scientific chemistry in Great Britain, which was such a noticeable feature of the concluding years of the nineteenth century, has been greatly assisted by the research scholarships open to all branches of science and paid with the income produced by the surplus from the Exhibition of 1851. Until recently it had been the feeling of a powerful majority that public money should only be spent in such a way as directly to benefit very large numbers, and in the case of educational funds, therefore, it was only their utilization for

the benefit of the masses that would be entertained. Now, in the matter of higher scientific education, at any rate, it was becoming more and more widely recognized that its starvation, through attention being exclusively directed to the low-level education of the masses, was defeating the very ends which this policy had in view. It was rapidly dawning upon many that 'the greatest Empire which the world has ever seen' could not be maintained unless Englishmen cast off insular prejudices and traditions and made a careful study of those points in which other nations were their superiors, with a view to intelligent adaptation and development, as distinguished from mere initiation, of their methods to particular needs of the British Isles. If the higher teaching of science was to be really encouraged, the first necessity was that this higher teaching should offer a sufficiently attractive career to the man of ambition as well as to the enthusiast. It was not reasonable to fix a definite stipend to a particular chair, and should the best man be required the best price must be paid for him, while, if the British universities were to keep abreast of those of other countries, the chair must be thrown open to all the world. The period of academic study should be extended from three years to five, and the migration of students from one university to another ought to be encouraged. Higher education and true universities were among the most potent factors in breaking down the hereditary stratification of society and in minimizing the advantages depending upon the accident of birth, so that, with the greatly enhanced facilities which must be provided for students without means, they should afford in the future, even more than they had done in the past, an avenue for the humblest boy of talent to that position which he was, by natural endowment and by his own exertion, best fitted to fill in the interests of

the state. British chemical work at the dawn of the twentieth century is satisfactory in many ways, for while almost all the great problems are being worked at, some of the recent progress of chemical science is more or less specifically British, *e. g.*, the isolated labors of Dr. Perkin in the field of magnetic rotatory power; Sir William Crookes's exploration of the phenomena occurring in high vacua; the researches of Abney, Russell and Hartley on the absorption spectra of organic compounds; the investigations of Harold Dixon and Brereton Baker of the behavior of substances in the complete absence of moisture; the extension by Pope and Smiles of asymmetric atoms; the near approach to the absolute zero of temperature by Dewar; and those marvelous discoveries of Rayleigh and Ramsay which have not only introduced us to five new aerial elements, but have revealed the existence of a hitherto unknown type of matter, which is apparently incapable of entering into chemical combination at all.

After the usual vote of thanks, moved by Sir Henry Roscoe, F.R.S., and seconded by Dr. T. E. Thorpe, F.R.S., the Section proceeded to the reading and discussion of papers. Dr. W. T. Lawrence brought forward the question of duty-free alcohol for chemical laboratories. He pointed out that workers in England were placed at a great disadvantage in comparison with workers in Continental laboratories, owing to the charge made on alcohol which was required in very large quantities in research. Abroad, when duties were exacted, they were remitted in the case of chemical laboratories so as not to impede the progress of the work of investigation. It was stated by others that some researches had been stopped half-way on account of this extra expense. Professor A. Michael, of Tufts College, Mass., explained that in the United States the duties were remitted when application was duly

made by the president of an educational institute. As a result of the discussion a committee was appointed to take what steps it could to procure duty-free alcohol and ether for chemical research. Dr. A. G. Green read a paper on 'The Decadence of the Coal Tar Industry in Great Britain and its Growth in Germany' of which an abstract was given on page 663 of SCIENCE. The report of the Committee on preparing a new Series of Wave-length Tables of the Spectra of the Elements was presented. The next day, after papers by Professor A. Brown on 'Enzyme Action,' and by Professor W. Marckwald, of Berlin, on 'Radium,' with demonstrations, the Section resolved itself into parts, one, under the president, considering sanitary and allied matters; the other, under Sir William Roberts-Austen, F.R.S., hearing metallurgical papers. In the former subsection, Professor E. A. Letts read a paper by himself and Mr. R. F. Blake on 'The Chemical and Biological Changes occurring during the Treatment of Sewage by the so-called Bacteria Beds,' in which it was pointed out that in the bacterial treatment of sewage in contact beds the organic nitrogen in the crude sewage was not all converted into the oxidized form of nitrate, this loss being partially due to the formation of free nitrogen, which was either evolved as gas or carried away dissolved in the effluent, and partly due to nitrogen absorbed into the tissues of animals and plants that feed on the sewage. Dr. S. Rideal in the next paper pointed out that the loss of nitrogen was caused in part by a black humus substance, allied to peat, which he had found was formed in all the present methods of bacterial process. This substance contained seven per cent. of nitrogen and was so stable that it did not decompose or give rise to smell, even if it was broken. Dr. Rideal also contributed a paper on 'Sulphuric Acid as a Typhoid

Disinfectant,' in which he said that the outbreak of enteric fever among the troops in South Africa had led Dr. Porter and himself to try to find a chemical salt that could be added to infected water by soldiers on the march and would insure the death of the typhoid germ, if present. Such a salt is sodium bisulphate, and a gram to the pint, after fifteen minutes, purified the water, while four grams of sulphuric acid to the gallon freed sewage or drainage water from typhoid organisms. Mr. Wm. Ackroyd read a paper on 'The Inverse Relation of Chlorine to Rainfall,' in which he showed that when daily estimations of the amount of chlorine were made it clearly appeared that minimum amounts of rainfall were marked by maximum amounts of chlorine contents and *vice versa*. Mr. Ackroyd also detailed the results of his investigation of the distribution of chlorine in Yorkshire. A report was made by the Committee on the Relation between the Absorption Spectra and Chemical Constitution of Organic Substances.

Among the papers before the Metallurgical subsection, one of the most interesting was on 'The Minute Structure of Metals,' by Mr. G. T. Beilby, from which it appeared that the microscopical examination of metallic surfaces, produced in various ways, showed that the metal substance appeared in them as minute granules or scales, or as a transparent glass-like substance. The persistence of these minute scales under all kinds of mechanical and thermal treatment, the remarkable uniformity of their size and appearance in metals of all the leading groups, their disappearance into the transparent form and their reappearance again, apparently unchanged in size or otherwise, all these seemed to afford fair ground for the conjecture that they were in some way definite units in the structure of metals. Mr. Beilby also submitted a joint paper by

himself and Professor G. G. Henderson on 'The Action of Ammonia on Metals at High Temperatures,' which stated that the physical effect of the treatment in every case was to disintegrate the metals completely, while a large proportion of the ammonia was resolved into its elements. Three papers on aluminum and its alloys, together with the report of the Committee on the Nature of Alloys, were presented.

The papers on organic chemistry, to which September 16 was devoted, drew but a small audience, owing to their highly technical nature. The reports of the Committees on Isometric Naphthalene Derivatives and on Isomorphous Derivatives of Benzene were taken as read. Professor A. Michael, of Tufts College, contributed three papers, one being on 'The Genesis of Matter,' in which he assumed that at the birth of matter there were two forms of 'protyle' corpuscles endowed with opposite polarity and only two forces—gravitation and chemical affinity—the temperature being near the absolute zero. Gravitation acted on these corpuscles, and when they came within the sphere of chemical affinity they united, converting part of their chemical energy into heat. It was probable that the non-metals in the genesis of matter would be first formed, and that as the temperature decreased the metallic elements began to form. At the next meeting of the Section the papers on general and physical chemistry were so numerous that it was necessary strictly to limit the time of each speaker. Professor J. Sakurai, of Tokio, speaking on 'Some Points in Chemical Education,' said that chemical education, as at present carried on, was inefficient and unsatisfactory. Chemical education was a sound course for those who would become chemists or for those who applied that science in special directions, but it was no less important for its educational value in secondary schools. Nevertheless, modern

chemistry was still taught largely in the same dry and descriptive way as in the old days. He deprecated the term 'physical chemistry' as misleading and suggested that 'general chemistry' be used in its stead. Chemical laboratories in universities and colleges, he thought, should be institutions which contributed to the sum total of the knowledge in which men were trained and not mere workshops for apprentices. In the discussion that followed it was the general opinion that a thorough training in analysis should precede research work. Mr. W. Thomson read a practical paper on the 'Detection and Estimation of Arsenic in Beer and Articles of Food,' and Dr. E. F. Armstrong discussed 'The Equilibrium Law as Applied to Salt Separation and to the Formation of Oceanic Salt Deposits.' Its application to the formation of deposits, of potash and other salts, formed by the gradual drying up of ancient seas, is of interest and from a model, representing the successive changes observed on concentration of solutions containing several inorganic salts, it was possible to forecast the order in which salts would separate on concentration, and also the relative amounts deposited at any stage. The Committee on the Bibliography of Spectroscopy reported. At the closing session of the Section Dr. J. Gibson read a paper on 'The Electrolytic Conductivity of Halogen Acid Solutions,' in which he showed that there was a marked difference in the chemical behavior of the solutions of acids, according as the concentrations were above or below the concentrations corresponding to their respective maximal specific conductivities. Mr. P. J. Hartog, in describing 'The Flame Coloration and Spectrum of the Nickel Compounds,' said that nickel acetate produced an evanescent purple tinge and a persistent red coloration in the Bunsen flame. Professor Smithells remarked that, although experiments with nickel had been made for

years this property had not been observed, and the coloration perhaps might not be due to nickel. After papers by Dr. Farmer, on 'The Methods of Determining the Hydrolytic Dissociation of Salts, and by Dr. J. S. Patterson, on 'The Influence of Solvents on the Rotation of Optically Active Compounds,' the meeting terminated, having been less well attended, in spite of the interesting papers, than was the case at Bradford last year.

ENGINEERING.

This Section suffered severely in coming immediately after the assembling at Glasgow of the important International Engineering Congress, the Congress of Naval Architects and the Electricians' Association, all of which detracted from both papers and members. As a consequence, not a single paper on marine engineering, and only two papers pertaining to electricity were offered to the Section this year.

The president, Col. R. E. Crompton, M.Inst.C.E., in his address discussed first some of the interesting problems presented by recent development in means of locomotion on land, which demand the best thought, not only of our engineers, but of every one interested in the improvement in the means of traveling and in the more rapid transportation of goods. During the past few years a great improvement in the speed of trains and in the comfort of passengers on the American and Continental railways has been made, and while it appears that England has now been beaten in the matter of extreme speed on railways, it is probable that the English railways still provide a larger number of rapid trains than do either the American, German or French. The speed limit of railways of the present system of construction is reached at about sixty-five or seventy miles an hour, and it is improbable that anything greatly in excess of seventy miles an hour will be attained

until an entirely new system of construction is instituted. The high speed service contemplated intends to obtain speed exceeding one hundred miles an hour by providing electrical means of haulage sufficient to propel light trains consisting of a single or, at most, a few cars run at short intervals of time. In the United Kingdom there are only a few journeys of sufficient length to make saving of time of great importance, but the case is far different in America and on the Continent where the business centers are much farther apart, and this topographical question would cause our English engineers to be at a disadvantage. A most important problem in locomotion is that caused by the congestion of street traffic in towns, and although the provision of electric tramways is undoubtedly an economical means of carrying passengers, yet these tramways could not be laid in existing thoroughfares without considerably reducing the total road-carrying capacity at times of heavy pressure of traffic, and so both for ordinary and pleasure transportation it appears probable that a motor-car service carried out on well-made roads would compete favorably with, and in many ways might be preferable to, tramway service. One of the topics that has been most strongly discussed during the past year is the position which Great Britain holds, relatively to other countries, as regards supremacy in engineering matters. The chief difference between the manufacturer here and the manufacturer in America is that the latter invariably makes goods in large quantities to standard patterns, which is much less the case in England. Many years ago, Sir Joseph Whitworth impressed on the world the importance in mechanical engineering of extreme accuracy and of securing the accurate fit and interchangeability of parts by standard gauges, but these ideas have not been acted upon to the extent that they should. Up to the present time the

Board of Trade has dealt with the simple standards of weight, capacity and length, but in other countries national standardizing laboratories have been provided. At last, through the exertion of the council of the Royal Society, the British Government has been moved to give a grant in aid and to cooperate with the Royal Society to establish a National Physical Laboratory. The vote of thanks to Col. Crompton for his address was moved by Sir Alexander Binnie and seconded by Sir Frederick Bramwell.

Mr. D. H. Morton, M.Inst.C.E., spoke on 'The Mechanical Exhibits of the Glasgow Exhibition,' which he said were, in general, disappointing, because in many departments the international character to which the Exhibition, as a whole, laid claim, was entirely wanting; because some of the most important developments in recent years were illustrated inadequately or not at all, and because the Exhibition failed to give any full idea of the magnitude and the variety of those enterprises which have made the city of Glasgow, with its surroundings within a radius of thirty miles, one of the world's great centers in metallurgy, mechanical engineering and shipbuilding. The collection of ship models historical and contemporary, was probably the finest demonstration of Clyde naval architecture ever seen, although marine engineering was so inadequately represented elsewhere. Nevertheless, the dominant Exhibits were the trophies in steel, and the exhibition might, indeed, be said to mark the triumph of steel, and particularly of cast steel. Mr. John R. Wigham explained a method of employing petroleum as an illuminant for beacons and buoys, to give a continuous light for a month or longer without any attention whatever. He exhibited also a 'New Scintillating Lighthouse Light,' by which the sailor was not deprived of the benefit of the powerful flash of the revolving

lense, and yet did not have to pick it up at intervals, for this light is continually visible, the lenses being so placed with regard to each other and so revolved that the impression of the flash of one beam remains on the retina of the observer's eye till that of the succeeding beam takes its place, the practical effect produced being a continuously visible scintillating light. Mr. J. E. Petavel described a recording manometer for high-pressure gas explosions, in which elastic compression of metal replaces the spring of the ordinary indicator, a movement of a thousandth of an inch, corresponding to a pressure of 1,200 pounds per square inch, being shown by a ray of light deflected on to a recording cylinder. On the following day Mr. Norman D. MacDonald, of Edinburgh, read a comprehensive and interesting paper on 'Railway Rolling Stock, Present and Future.' Outside Great Britain it appeared settled that the compound locomotive would be the engine of the future. The boiler pressures, both in America and on the Continent, are much higher than in England, and for English roads the American type of engine, with equalizing levers and water-tube grate, offered advantages. In the discussion of the paper the progressive character of railway engineering in the United States was attributed to the attention paid by American universities to the testing of locomotives, and also to the good work done by the various railway clubs in spreading the knowledge of locomotive practice among young engineers. Mr. P. Bunau-Varilla, formerly engineer-in-chief of the Panama Canal, spoke on the relative advantages of the Nicaraguan and Panama routes for a canal from the Atlantic to the Pacific, favoring the latter on account of the masonry dam, which, with the locks, must be built and maintained in a country subject to frequent earthquakes, if the former be chosen. Moreover, ships would there encounter violent gales, strong

river currents, constant changes of depth, and many curves of short radius.

Monday is usually devoted to electrical engineering but, as already remarked, there were but two papers approaching that character this year. Mr. Killingworth Hedges contributed a paper on 'The Protection of Public Buildings from Lightning,' remarking that in 1888 the subject had been discussed jointly by the Physicists and Engineers of the Association, but that there had been no official report as to the effect of lightning strokes upon buildings protected by conductors since the Lightning Rod Conference of 1882. In the discussion it was said that architects could not be expected to pay more attention to protection of buildings from lightning until engineers had definitely decided what practice should be followed, there being at present many conflicting views. - 'The Commercial Importance of Aluminium' and 'Aluminum as a Fuel,' were discussed respectively by Professor E. Wilson and Sir Roberts-Austen, F.R.S., the former considering chiefly its advantages as an electrical conductor. Mr. J. Dillon described a method of recording soundings by photography, for the use of engineers; Dr. Vaughan Cornish discussed the height and length of waves observed at sea, and Mr. R. L. Jack showed pictures of native bridges in Western China.

Two reports of committees were presented to this Section. Professor H. S. Heleshaw made a preliminary report for the Committee on Resistance of Road Vehicles to Traction, from which it appeared that some work had been done with a motor-car and experiments had been made on an artificial track so as to test the resistance of various materials. Mr. W. H. Price reported for the Committee on the Small Screw Gauge that, while it had been recommended last year that the thread of the British Association screw-gauge should be altered in certain particulars, and the proposals had

attracted much attention, yet so far the recommendations had had no practical results. Professor G. Forbes explained a portable folding range-finder, for use with infantry, based on the instrument of Adie and utilizing stereoscopic vision. After papers by Mr. Mark Barr, describing his ingenious machines for engraving the matrices used in type-founding, by Mr. C. R. Garrard, on 'Recent Development of Chain Driving,' by Mr. T. A. Hearson, on 'Measurement of the Hardness of Materials by Indentation by a Steel Sphere,' by Mr. E. T. Edwards, on 'The Critical Point in Rolled Steel Joists' and by Mr. J. W. Thomas, on 'Air Currents in Churches' the Section adjourned a day before the other sections. Notwithstanding the paucity of papers, they were of fair quality and covered a wide range of subjects.

A. LAWRENCE ROTCH.

BLUE HILL METEOROLOGICAL
OBSERVATORY.

SCIENTIFIC BOOKS.

Smokeless Powder, Nitro-cellulose and Theory of the Cellulose Molecule. By JOHN B. BERNADOU, Lieutenant U. S. Navy. N. Y., John Wiley & Sons. 1901.

This work consists of eighty pages of new matter and of one hundred and thirteen pages of translation and reprints. The newly presented portion treats of: (1) Origin of the cellulose nitrates; the names by which they have been sometimes designated; and the meanings that the author gives to the terms he employs; (2) to 'the earlier views as to nitro-cellulose composition and constitution'; (3) to 'the conception of progression in relation to composition and constitution'; (4) to 'solutions of nitro-cellulose' and 'theory of the cellulose molecule.' It will be observed that in this brief space the author has set for himself a most ambitious program, especially as he applies himself to the solution of one of the unsolved problems of chemistry and one which chemists have regarded as presenting the most profound difficulties. Naturally those chemists into whose hands this book may come would turn at once

to the author's 'theory of the cellulose molecule,' curious to ascertain the data upon which the author's theory is based, the methods of reasoning by which he arrives at his conclusions, and the form that his theory takes. He will find that it is based on the statements of Cross and Bevan that in mercerizing cellulose with sodium hydroxide a definite reaction takes place 'in the molecular ratio $C_{12}H_{20}O_{10} : 2 NaOH$ accompanied by combination with water (hydration)'; that the compound thus formed is decomposed on washing with water, 'the cellulose appearing in a modified form, viz., as the hydrate $C_{12}H_{20}O_{10} \cdot H_2O$ '; that by treatment with alcohol 'one half of the alkali is removed * * * the reacting groups remaining associated in the ratio $C_{12}H_{20}O_{10} \cdot NaOH$ '; that the process of mercerization is accelerated 'on exposure to a lye of 1.225 - 1.275 sp. gr.' * * * 'by reduction of temperature,' which, Bernadou states, presents 'an analogy to the increased solubility of nitro-cellulose in ether and ether-alcohol upon application of cold'; that the quantitative regeneration of cellulose from thio-carbonate solutions and the saline character of aqueous solvents of cellulose led Cross and Bevan to express the belief that cellulose yields only under the simultaneous strain of acid and basic groups, and to assume, 'that the OH groups in cellulose are of similarly opposite function,' but 'that apart from any hypotheses, we may lay stress on the fact that these processes (of dissolving cellulose) have the common feature of attacking cellulose in the two directions corresponding with those of electrolytic strain.'

With these data and some few experiments of his own on solubility at low temperatures, Bernadou sets out to demonstrate the constitution of the cellulose molecule. He finds it necessary, however, at the outset to assume that ethyl hydroxide has the constitution which chemists have assigned to dimethyl oxide, and then taking as his empirical formula $C_{12}H_{20}O_{10}$, without giving any experimental data for doing so, he writes the constitutional formula for cellulose as a closed chain with double bonds for the central carbon atoms, notwithstanding that Cross and Bevan (the authority he quotes) in speaking of the celluloses say, on page 2 of 'Cellulose,' 1895: "Their reactions are those of 'sat-

urated' compounds. Their empirical formulæ and relationships to the carbohydrates of lower molecular weight further indicate 'single-bond' linking of their C atoms as exclusively prevailing." On page 81 of 'Researches on Cellulose,' 1901, Cross and Bevan give a ring formula for cellulose as proposed by Vignon, but it is quite different from any given by Bernadou and the recent experimental data which suggest such an arrangement are cited. Having thus obtained a 'satisfied' molecule, Bernadou notes that the existence of the 'double central carbon bonds' permits the formula for the molecule, 'on its entering into combination,' to be written with its four 'ethylene' bonds as linking, and then that, 'without radical modification,' these median bonds may be terminal. By now splitting this last molecule transversely he obtains the formula for his $C_6H_{10}O_6$, which he states 'is the simplest expression for cellulose' and 'represents not the molecule, but the type unit of cellulose as it enters into combination through its four free single carbon bonds,' and with this 'type unit' he proceeds to build 'polymers' exhibiting his 2-phase and 5-phase molecules, the latter being a cycle.

Of these he says, "It is evident that under such an assumption the molecule may possess an infinity of phases. On this assumption, and, it seems to me, on this assumption only, may we account for definite chemical composition of the cellular form in the plant structure. For we may regard the cell as built up from an aggregate of molecules of identical composition but of progressively varying numerical phase. The cell may begin with molecules of low phase and end with molecules of high phase, or conversely."

Again, "The conventional ring-formed combination of elemental particles shown in the polyphase molecule strongly suggests the vortex-ring theory of the composition of matter (as applicable to the *molecule*)."

And again, "Such a molecule would increase in amplitude according to the number of elemental particles entering into its composition; and the thought suggests itself that *progressive variation in the amplitude of the molecular ring is a characteristic of organic life*. Or, conversely, we may state that we may seek for the beginnings

of organic life—or at least of plant life—in the polymerization of the carbohydrates.”

Lieutenant Bernadou seems to misconceive the meaning and value of graphic formulæ, for while chemists hold that they are simply convenient conventional methods for expressing the ascertained facts of chemistry, and true only to the extent that they express those facts, Lieutenant Bernadou appears to regard them as original sources of information.

The useful portions of this book are the translations of the papers of Vieille and of Bruley on the Nitration of Cotton, and that of Mendeléef on Pyrocollodion Smokeless Powder, though the value of the last is lessened by the omission of all reference to the source from which it is drawn, especially as the author states in the preface that these are only ‘translations of certain portions of their works on explosives.’ It should be understood that while translations are a convenience, one who differs from an author should not rely upon a translation, but should first consult the original publication before expressing this difference, and the translator should be willing to have this comparison of his translation readily made by giving his sources.

The record of the results of a few experiments on the solubility of cellulose nitrates at low temperatures in continuation of the work of McNab is interesting. If Lieutenant Bernadou had but multiplied these experiments and reported them in a simple manner he would have produced something more useful to mankind than the speculative essay he has chosen to present.

CHARLES E. MUNROE.

Select Methods of Food Analysis. By HENRY LEFFMANN and WM. BEAM. Philadelphia, Pa., Blakiston's Son & Co.

It is stated by the authors that “this book is intended to be a concise summary of analytic methods adapted to the needs of both practicing analysts and advanced students in applied chemistry.”

The first part of the work, pages up to 68, is occupied with a brief description of the principal analytic methods employed, including spectroscopy, microscopy, polarimetry, methods of determining melting and boiling points and other general operations.

In the part given to applied analyses, comprising the rest of the book, are articles devoted to general methods for the examination of poisonous metals, colors and preservatives, while under special methods are treated the processes for determining carbohydrates, fats and oils, milk and milk products, tea, coffee and cocoa, condiments and spices, alcoholic beverages and flesh foods.

An appendix contains tables of specific gravities of water, conversion tables for thermometric degrees, tables of elements, symbols, and atomic weights, and plates showing the structure of tea leaves and starches.

In regard to the analytical methods the authors say: “The bulletins of the United States Department of Agriculture (Bureau of Chemistry) and of the Association of Official Agricultural Chemists are now nearly all out of print and scarce. The present work contains a large amount of the data and processes given in those publications, together with data from reports of some of the State agricultural experiment stations.”

In addition to this general acknowledgment, the articles copied directly from the above publications are credited in the text in most cases. The authors have reproduced the plates of tea leaves and starch granules of the Bureau of Chemistry, of the Department of Agriculture, stating that the originals in many cases have been retouched by Dr. Beam.

The work is illustrated with 53 figures in addition to the plates of leaves.

This work will prove of great help to analysts who do not have access to the literature of the subject or who have not the time to make their own investigations thereof. The matter is well arranged and classified and in convenient form for reference.

H. W. WILEY.

The History of Medicine in the United States, etc., to the Year 1800. By FRANCIS RANDOLPH PACKARD, M.D. J. B. Lippincott Co., Philadelphia. 1901. 8vo. Pp. 542. Illustrated.

The difficulties to be encountered in writing a history of early medicine in America have hitherto deterred authors from attempting this really herculean task, and it is not surprising, therefore, that we find Dr. Packard, in this hitherto untrodden field, claiming for his work

rather the rôle of a series of essays and compilations than of a continuous historical work. The thirteen original colonies were so scattered, so remote from and so independent of each other, that each formed a community to itself, and any attempt at a general history must deal largely and directly with these separate centers. A vast amount of research must therefore be made into records, many still in manuscript, from New Hampshire to Georgia, and this would take more time and means than medical historians—whose work must always be largely, as Dr. Packard says, a labor of love—can give. It is an encouraging circumstance that these records are gradually being made known through individual research, as evidenced by papers appearing from time to time in the journals and even by more pretentious works; and the time is probably not far distant when sufficient material will be at hand for a comprehensive historical work. But even now we can hardly feel that Dr. Packard has exhausted all readily available sources of information. In the writer's own community for example he has entirely overlooked such sources that are at his very elbow in the library of the College of Physicians and Surgeons of Philadelphia. And it is in no invidious spirit that we are led to remark that whilst Philadelphia was the chief medical metropolis of the colonies, there were other medical centers even then, and even in rural sections there were physicians of wide repute and influence whose names and records cannot be omitted from such a work. The South particularly furnished many such men educated abroad and endowed with all the learning of their day. An item of page 156 of Dr. Pepper's work would seem indeed to indicate that the physicians of the Middle and Southern States had better training than those of New England. It is there stated that of the 63 Americans who graduated in medicine at the University of Edinburgh between the years 1758 and 1788, *but one* came from the New England colonies. When we recall that Edinburgh was the chief place of resort for medical students going abroad, and that a large proportion of the 63 came from Southern States, it seems strange that this section should be comparatively so ignored by Dr. Packard. Take

the state of Maryland, for example, one of the oldest and most important of the thirteen colonies. I find in the list of authorities 'chiefly consulted' by Dr. P., 67 in number, but *one* from Maryland, viz., 'McSherry's History of Maryland.' And in the 16 pages of index there are *but 13* references bearing in any way upon this state and its doctors. It would be easy to show that Maryland does not deserve this slight.

There are several errors and omissions to be noted, but we have only space for the following: At pages 11 and 12 Mr. Pratt is appointed surgeon to the plantation in 1632 and perishes in a shipwreck in 1645 (!). At page 90 vaccination is said to have been announced by Jenner in 1779. At page 432 inoculation is said to have been 'introduced' in 1712. In the copy of Dr. John Archer's diploma, the first conferred in America, page 161, there are several inexcusable errors, in one place nearly a whole line being omitted. At page 62 it is stated that the first recorded autopsy in America occurred in 1674, whereas several recorded in Maryland preceded this by about thirty years. We also know of at least two medical societies not included in the 17 stated to have existed prior to 1800. These facts could have easily been ascertained by Dr. Packard. At page 36, it is said the degree of M.D. was conferred at the University of Aberdeen in 1650, which we feel sure is a mistake. The omissions, as we have noted, are many, but surely the author should have referred to Drs. Henry Stevenson, James Smith and Gustavus Brown, of Maryland, the first maintaining for many years the only inoculating hospital in America, the second doing more perhaps for the introduction of vaccination over the United States than any other person whomsoever, the third, besides eminence in other respects, having the distinction of being called in consultation in the last illness of George Washington.

Dr. Packard has given full and graphic descriptions of the yellow fever epidemics in Philadelphia and has thrown much light on the medical development of the continental army during the Revolution. In an interesting account of the introduction of anæsthesia, he gives due credit for the discovery to Dr. Craw-

ford Long, of Georgia, who first used sulphuric ether to produce unconsciousness in surgical operations in 1842, four years before its use at the Massachusetts General Hospital.

In conclusion, if in our rôle as critic and reviewer we have said anything to make the reader think ill of Dr. Packard's book, we desire now to take it all back and to assure him that it is a most interesting and valuable contribution to American history and literature.

E. F. C.

SCIENTIFIC JOURNALS AND ARTICLES.

THE *Botanical Gazette* for October contains the following papers: F. L. Stevens publishes the third and last part of his paper entitled, 'Gametogenesis and Fertilization in *Albugo*.' A multiple fertilization was unknown before its discovery by the author in *Albugo Bliti*, the only species of *Albugo* previously investigated exhibiting simple fertilization. The present paper includes *A. Portulacæ*, *A. Tragopogonis* and a reinvestigation of *A. candida*, and shows that these species, together with *A. Bliti*, form a series differing in the prominence of the 'receptive papilla,' the development of the cœnocentrum, and in the functional egg nuclei. The conclusion is reached that the primitive forms were multinucleate, and that the uninucleate condition is a derived one. In its ontogeny *A. Tragopogonis* indicates this, its oosphere in early stages being multinucleate, and later becoming uninucleate by degeneration of supernumerary nuclei. The cœnocentrum, an organ of hitherto unknown function, is shown to serve in the nutrition of the surviving female nucleus. Many conditions are noted which tend to confirm Strasburger's theory regarding kinoplasm and its relation to sexual differentiation.

W. L. Bray completes his paper on 'The Ecological Relations of the Vegetation of Western Texas.' It is a general discussion and analysis of this interesting field, and is designed primarily to form the basis of a detailed botanical survey of the State. The author considers at some length the relation of the vegetation to the climatic factors of temperature, moisture, winds and sunlight; and to the so-called edaphic factors of physiography, soil structure and other geological phenomena.

The greater part of the paper, however, is given to a discussion of the plant formations of the region under the following general heads: (1) Grass formations; (2) woody formations, including numerous types of arborescent and chaparral formations; (3) water storage formations; (4) formations of cryptogamous xerophytes; and (5) halophytic plants. The following propositions summarize the main features of the discussion: (1) The climatic conditions conspire to make the west Texas region a typical 'grass plains country'; (2) in its temperature relations the vegetation ranges from the tropical to the transition zones; (3) the region is marked by several climatic types which are enumerated; (4) the original formations are undergoing profound changes due to human agencies, the tendency being to break up the grass formations and to permit the encroachment of woody vegetation; but areas of arborescent vegetation are being denuded of valuable timber, thus forcing the question of water supply and control of floods.

Mr. James B. Dandeno points out the confused usage of physiologists in designating the solutions with which they have worked. The term 'normal solution' has been used by some for solutions containing a gram equivalent per liter of solution, by others for those containing a gram equivalent per liter of water, and by still others for gram molecule per liter solution. After defining these three carefully and calling attention to the usage of chemists, he cites examples of confused usage by physiologists, and urges that care be taken to distinguish between different sorts of solutions and to avoid misuse of the term 'normal.'

Mr. Burton E. Livingston adds to his previous contribution on the same subject an account of several lines of experimentation, which extend his previous results and confirm his conclusions already expressed. In the new experiments upon *Stigeoclonium tenue* he has used solutions of non-electrolytes (in this case sugars), and also solutions containing both sugar and mineral salts; further, he has cultivated these plants on porous plates, in gelatin, in darkness, and under conditions where evaporation would concentrate solutions. He finds in all cases that osmotic pressure is the deter-

mining factor for the form of the plant, whether the cells are immersed in solution or supported upon gelatin or upon porous plates; and as darkness has no effect upon the form of this plant, its polymorphism does not depend upon photosynthesis. His physiological experiments have been supplemented by a considerable series of physico-chemical tests in order to determine whether error had been introduced into his experiments by assumption that complete ionization occurred in his solutions of electrolytes. He finds that the osmotic pressure calculated by the freezing point method, and in some cases also by the boiling point method, conforms so closely to the osmotic pressure calculated on the assumption of complete ionization, that no error had been introduced, the differences between the calculated and determined pressures lying entirely within the range of the pressure limits found for the several responses of the plant.

T. C. Johnston publishes some results in connection with intramolecular respiration, and Dr. J. Schneck records some interesting observations on *Aquilegia Canadensis* and *A. vulgaris*.

SOCIETIES AND ACADEMIES.

AMERICAN MATHEMATICAL SOCIETY.

A REGULAR meeting of American Mathematical Society was held at Columbia University on Saturday, October 26, extending through the usual morning and afternoon sessions. The first part of the afternoon session was devoted to a joint meeting with the American Physical Society at which a paper 'On the Theory of Elastic Plates' was read by Professor J. Hadamard, the representative of the University of Paris at the recent Yale Bicentennial. About forty persons were present at the joint session, which was presided over by President Michelson, of the Physical Society. At the separate session of the Mathematical Society, at which Vice-President Thomas S. Fiske occupied the chair, thirty-three members of the Society were in attendance. Twelve persons were elected to membership: Mr. C. H. Ashton, Harvard University; Professor H. Y. Benedict, University of Texas; Dr. William Findlay, Columbia University; Dr. W. B. Fite, Cornell University;

Professor G. W. Greenwood, McKendree College; Professor F. W. Hanawalt, Iowa Wesleyan University; Dr. E. V. Huntington, Harvard University; Professor H. W. Kuhn, Ohio State University; Dr. I. E. Rabinovitch, New York City; Professor W. D. Tallman, Montana State Agricultural College; Mr. H. M. Tory, McGill University; Mr. A. H. Wilson, Princeton University. Seven applications for membership were received. The By-laws of the Society were amended to provide that the presidential address shall hereafter be delivered at the last meeting of the presidential term. As the amendment takes effect at once, President Moore's address will be postponed to the annual meeting of December, 1902.

The following papers were presented at this meeting:

PROFESSOR G. A. MILLER: 'On the abelian groups which are conformal with non-abelian groups.'

DR. H. F. STECKER: 'Concerning the elliptic \wp ($g_2; g_3; z$)-functions as coordinates in a line complex, and certain related theorems.'

MISS I. M. SCHOTTENFELS: 'Generational definition of certain groups of order 960.'

PROFESSOR OTTO STOLZ: 'Zur Erklärung der Bogenlänge und des Inhaltes einer krümmen Fläche.'

DR. L. P. EISENHART: 'Conjugate rectilinear congruences.'

PROFESSOR S. E. SLOCUM: 'The symbols of the infinitesimal transformations which generate the parameter groups corresponding to all possible types of structure of two-, three- and four-parameter complex groups.'

DR. E. V. HUNTINGTON and DR. J. K. WHITTEMORE: 'Some curious properties of conics touching the line infinity at one of the circular points.'

PROFESSOR J. HADAMARD: 'On the theory of elastic plates.'

PROFESSOR E. B. VAN VLECK: 'On the zeros of fundamental integrals of regular linear differential equations of the second order, with a determination of the number of imaginary roots of the hypergeometric series.'

DR. E. J. WILCZYNSKI: 'Reciprocal systems of linear differential equations.'

DR. I. E. RABINOVITCH: 'On some contradictions involved in the elliptic geometry in a point space.'

DR. EDWARD KASNER: 'Determination of the integrals in the calculus of variations leading to an assigned system of extremals.'

The members of the two societies lunched together at the University restaurant, and in

the evening several of the members dined at Mock's restaurant in Forty-Second street. These opportunities for informal intercourse are always an enjoyable feature of the meetings. The Christmas meetings of both societies extend through the two days, Friday and Saturday, December 27-28, and it is hoped that a considerable number of the members will arrange to attend the informal dinner which will be arranged for Friday evening.

F. N. COLE,
Secretary.

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

THE first meeting of the Section was held on October 21. In calling the meeting to order the chairman spoke of the loss to the Academy and to science occasioned by the deaths of Dr. T. G. White, secretary of the Section, and Professor Joseph Le Conte, corresponding member of the Academy. A committee consisting of Professors J. J. Stevenson and J. F. Kemp was appointed to draw up suitable minutes in reference to Dr. White and Professor Le Conte. Dr. E. O. Hovey, of the American Museum of Natural History, was then elected secretary of the Section.

The following program was offered: Dr. A. W. Grabau spoke on 'Recent Contributions to the Problem of Niagara.' He said that Davis has shown that the topography of the Niagara region conforms to the type generally found in ancient coastal plains, the original features of which have been more or less modified by subsequent warpings, and by glacial erosion and deposition.

The Niagara escarpment is the inface of the Niagara cuesta, traceable through the Indian Peninsula and Grand Manitoulin Island. The Ontario lowland is continued in the Georgian Bay lowland. A second cuesta—the Onondaga—has its inface slightly developed north of Buffalo, but becomes prominent in the Lake Huron valley, where its inner lowland forms the deeper part of the lake. The third cuesta and lowland (the Erie) occurs north of the second.

The Tertiary drainage is supposed to have been to the southwest, instead of the north-

east, as Spencer holds. The principal streams of that time are supposed to have been (1) the Saginaw, whose path is indicated in part by Saginaw Bay and the deep channel between the Indian Peninsula and Grand Manitoulin Island; (2) the Dundas, breaching the Niagara cuesta at Hamilton, Ont., and crossing the Erie lowland near Fort Stanley; and (3) for a time, at least, the Genesee, though this may later have had a northward course. The subsequent streams tributary to these consequents carved the various lowlands. St. Davids channel is regarded as an obsequent stream, which was accidentally discovered by the Niagara. The whirlpool gorge was probably, in part, the southward continuation of this stream, and not wholly postglacial.

Professor J. F. Kemp's first paper was on the 'New Asbestos Region in Northern Vermont.*' He said that asbestos has recently opened up on a commercial scale in the towns of Eden, Lamoille Co., and Lowell, Orleans Co., Vt. The towns are adjacent, although in different counties. The asbestos lies from 15 to 25 miles north of Hyde Park, a station on the St. Johnsbury and Lake Champlain R. R. As is quite invariably the case, it occurs in serpentine, either in veins or in matted aggregates along slicken-sided blocks. The serpentine where the best fiber is found lies on the south shoulder of Belvedere Mountain, and forms an east and west belt. It is bounded on the north and west by hornblende-schist, which forms the summit of the mountain. The contact on the west is a visibly faulted one, and that on the north is probably also of the same sort, because the hornblende-schist rises in a steep escarpment.

The serpentine seems to have been derived from enstatite, diallage and probably olivine, since unaltered nuclei of these minerals are found in it. The vein asbestos ranges from a fiber of microscopic length up to $\frac{1}{4}$ of an inch as thus far exposed. It is fine and silky and of excellent grade. It would, however, be classed as second grade according to the Canadian practice, which makes a first grade, of fiber above $\frac{3}{4}$ of an inch (about $2\frac{1}{2}$ in. being the maximum), and a second grade of $\frac{3}{8}$ in. to $\frac{3}{4}$

* Communicated by permission of the Director of the U. S. Geological Survey.

in. All below this and all fiber not vein fiber goes to the mill and is mechanically separated, as the third grade. In the Vermont localities the slip fiber is exposed on the property of the New England Co., and of its neighbor, the American Co. The vein fiber is limited, so far as yet opened up, to the property of Mr. M. E. Tucker and associates.

It is difficult, with the data in hand, which were gathered under the direction of Dr. C. W. Hayes, of the U. S. Geological Survey, to trace the geological history of the serpentine, but it must have been originally either an igneous pyroxenite or peridotite or else a richly magnesian siliceous limestone. There are such slight traces of calcium-bearing minerals, however, that the former supposition has the greater weight. The hornblende-schist consists in largest part of common green hornblende but one may also observe epidote, zoisite and some minor accessories.

Professor Kemp also gave a paper on the 'Physiography of Lake George.' The observations, extending over several years, have suggested the following conclusions: Lake George occupies a submerged valley very similar to many others in the Adirondacks which are not submerged. The valley has been largely produced by faulting, and the fault-scarps still remain in precipitous cliffs, whose sharpness has not been much affected by weathering and erosion. Before the Pleistocene the valley was probably a low pass with both a north and a south discharge. The portion rich in islands near Pearl Point and the Hundred Island House was probably the divide, and the islands represent the old hillocks near the top of the divide. At the south the water is backed up by sands and morainal matter in the valleys on each side of French Mountain, viz., at the head of Kattskill Bay and at Caldwell. On the north they are held in by Champlain clays and syenitic gneiss at the Ticonderoga outlet, and probably by morainal material at the low pass just south of Rogers Rock and leading out to the very depressed Trout brook valley, just west of Rogers Rock and Cook mountains. Trout brook is now as much as a hundred feet lower than Lake George at points south of the Ticonderoga barrier. The northern barrier is rock,

because the Ticonderoga river passes through a narrow and shallow channel in the exposed ledges a mile south of its actual first waterfall. There is here a broad flat valley buried in clays, however, beneath which an old channel may lie submerged. At the same time the marked depth of the Trout brook valley to the west makes this the natural outlet, and there is reason to believe from the general topography that the discharge passed north into the Champlain valley near the south boundary of Crown Point. It is also not to be overlooked that a valley with much drift leads eastward to Lake Champlain, from the head of Mason's Bay.

A curious feature that is common to both shores of the lake north of Sabbath Day Point (and perhaps also south of it) is the presence of pot holes of great perfection and as high at times as 80 feet above the present level of the lake. These are best developed on Indian Kettles Point, about two miles north of Hague. They were doubtless excavated by lateral or subglacial streams when the ice filled the lake valley, because in no other conceivable way could flowing water be forced into such unnatural situations.

There is great need of a good hydrographic survey of the lake, and of detailed pilot charts, with soundings. They would be of great service, not alone to navigators, but to science as well. So far as could be learned from local fishermen, whose deep trolling for lake trout gives them familiarity with the bottom, there appear to be channels whose general trend is parallel with the long dimension of the lake, and which have precipitous sides, precisely like the valleys and gulches now visible. The lake is relatively shallow as compared with Lake Champlain. In Lake George, the greatest depth is believed to be near Anthony's Nose, and to reach 190 feet. Elsewhere the deep parts are placed at about 100 feet, more or less. All this, however, requires confirmation by soundings. With regard to the physiography of the bottom one cannot say to what extent the valley has been filled by drift, but the islands to which physiographic importance has here been given are rock.

RICHARD E. DODGE,
Secretary pro tem.

BOTANICAL SEMINAR OF THE UNIVERSITY
OF NEBRASKA.

AT the regular meeting on November 1, Dr. Roscoe Pound read a paper on 'The Purpose and Force of Botanical Laws,' directing attention to the fact that rules of procedure in science are as necessary as they are in civil life, and indicating that the method by which laws are obtained in the one case must be similar to those in the other. The paper was discussed by Professor Bessey (who spoke of the supposed danger of a repression of originality through the action of laws of science); Dr. Wolcott (who called attention to the code of laws and their successful execution in ornithology); and Dr. Clements (who discussed a proposed series of regulations in regard to the nomenclature of plant geography).

DISCUSSION AND CORRESPONDENCE.

PREGLACIAL DRAINAGE IN SOUTHWESTERN
OHIO.

TO THE EDITOR OF SCIENCE: In the issue of SCIENCE of October 4, Professor Arthur M. Miller offers an objection to the conclusions of Mr. Fowke, made from his studies on the drainage features of southwestern Ohio, in which Mr. Fowke has shown (*Bulletin of the Scientific Laboratories of Denison University and Special Paper No. 3 of the Ohio State Academy of Science*) that the preglacial drainage of the section of the Ohio river from Manchester, Ohio, to Madison, Ind., was to the northward along the line of the lower Big Miami and the Mill creek valleys to Hamilton. It has been my pleasure to have studied somewhat carefully the region under discussion in my field work, and the objections which seem so apparent to Professor Miller have not appeared so to me. While I would agree in the main with Professor Miller in his argument concerning the formation of reentrants made by up-stream cutting against an escarpment and the stratigraphic relations of stream gradient and dip, under which similar reentrants would be formed by streams flowing in the direction of the dip, I cannot see that there is much force in the application of these principles to the problem under discussion. There is no question but

that many of the reentrants found in the Clinton limestone outcrop of the region shown by Professor Miller's map were made in the manner he suggests. I have observed many of them in the field. But at the same time there are many possibilities of there being, in this same region, large valleys deeply buried under the mantle of drift running in the opposite direction from that of these reentrants which were formed by the backward-cutting streams. In all cases which I have observed of these reentrants made by backward-cutting streams, they might have as well formed part of a system of lateral tributaries to a main northward-flowing stream as to that of a southward-flowing one. Unfortunately the region which Professor Miller has chosen in his map and studies is not the same as that which furnished the data for the determination of the northward direction of the preglacial waters from the vicinity of Cincinnati and it would be hardly necessary to review these data at this time, as the full reports are easily accessible in the articles referred to and are not discussed by Professor Miller. It may be well to state, however, that the criteria used in the location of the preglacial lines of drainage are not confined to a study of comparative 'width-of-channel' of streams, but the conclusions are based upon a broader study of topographic forms, comparative erosion, distribution and direction of shingling of old gravels on the old graded valley floors, normal and abnormal stream relations and many other similar lines of evidence.

In Professor Miller's closing paragraph he speaks of the symmetry shown by the streams north and south of the Ohio river as adding force to the argument in favor of the present arrangement of the streams being also the preglacial arrangement, and he considers the Ohio as the main and parent stream. There seems to be an abundance of evidence, already published, to show that in preglacial times a strong watershed crossed the Ohio river near Manchester, Ohio, and that the section of the Ohio immediately above Manchester found its way up the reversed Scioto in preglacial times. With the Ohio river above Cincinnati reduced to a small stream (which Mr. Fowke calls Old Limestone) heading only at Manchester, it

is evident that the Miami, Licking and Kentucky rivers were all very much larger streams than Old Limestone, and if we should assume that the section of the Ohio below Cincinnati flowed, in preglacial times, in its present direction, the symmetry which Professor Miller sees in the present arrangement would appear most asymmetric.

I feel sure that a careful field study of the topographic features within a radius of twenty miles from the city of Cincinnati will convince any one of the truthfulness of Mr. Fowke's deductions.

W. G. TIGHT.

UNIVERSITY OF NEW MEXICO.

PERMANENT SKIN DECORATION.

THE July-December, 1900, issue of the *Journal of the Anthropological Institute* publishes an abstract (No. 117) of Mr. H. Ling Roth's article 'On Permanent Artificial Skin Marks, a Definition of Terms.' The author distinguishes four varieties, all collectively and rather loosely designated by travelers 'tattooing.'

I. The Tahitian punctured method—practiced also by sailors, soldiers, etc.—by which a design is pricked into the cuticle, leaving a smooth even surface of skin.

II. The Maori chiseled type, produced by an adz-like implement, in addition to the Tahitian pricker, and exhibiting when completed a fine pigmented groove.

III. The West African incised variety—usually, but not always, non-pigmented—wherein deeper and wider grooves are cut—not *tapped*—with a knife, bone or hardwood chisel.

IV. The raised scar ('*cicatrice saillante*') of Tasmanians, Australians, Central Africans, etc., resulting from the continued irritation of the original incision, the insertion of foreign matter and the over-production of reparative tissue lifting the design in welts.

Mr. Ling Roth considers it desirable that the Tahitian word 'tatu' be confined to the first-named process, the native designation 'moko' be recognized for the second; for the third and fourth respectively, the terms *cicatrix* and *keloid* are offered.

This classification, looking toward greater precision in the use of descriptive epithets, is

avowedly based chiefly on the character of the implements used and the method of their employment. The author has, however, overlooked two types as well marked as any of those included, the Dayak and the Eskimo. The former make use of a wooden block upon which the desired pattern is figured in relief. It is transferred to the skin by percussion, the block being pounded with an iron bar. Regarded from the side of its probable descent, this method must be deemed a subvariety of II. Classed by the tool producing it, it forms a distinct variety.

The other and more important omission, the inductive or line tattooing of the Eskimo seems most nearly related to type I, the latter form indeed occurring side by side with it. In the central regions, according to Dr. Boas, a needle and thread covered with soot is passed under the skin, the point of the instrument also being rubbed with a mixture of the juice of *Fucus* and soot or gunpowder. ('Central Eskimo,' p. 561.) The two processes recur more or less intimately associated over the greater part of the Eskimo habitat. The writer of this note would suggest for this inductive variety (type V.) the use of the Central Eskimo word 'kakina' (pronounced *kakeena*)='tattoo marks,' a term derived from the verb 'kakiva'='pierces it,' as in sewing, so as to make the point appear again on the same side. (See Rink, 'Eskimo Tribes,' p. 117.)

The main objection to the differentiation of these two types (II. b and V.) is the difficulty of distinguishing between II. a and II. b, and between I. and V., when neither the operation nor the implement has been observed.

H. NEWELL WARDLE.

ACADEMY OF NATURAL SCIENCES,
PHILADELPHIA, PA.

MAGAZINE ENTOMOLOGY.

TO THE EDITOR OF SCIENCE: Columns open for attack have surely room for defense—wherefore permit me to say to the critical Mr. Smith, of New Brunswick, that I fear he does not quite understand the article he criticises. The paper in *McClure's* for September is part of a book not meant in the least to be scientific, entomologic, or any other 'ologic, but simply to set down things seen, and heard, and done, by two

fairly intelligent young people, living next to the ground upon a plantation in middle Tennessee.

Now as to hellgramites—the name may not properly apply to the white grubs, or rather, grayish-white ones, which were the choicest of all bait. But local fishermen called them so, and accepted it as a matter of fact that they were larvæ of the dragon-fly. Since I was setting down things actually true of a certain limited scope, not discoursing, *ex cathedra*, upon entomology, I felt justified in putting down the local name—with no thought of *lèse majesté* against the hellgramite and his adherents. I thought if my work was to have the value of verity I must make it square with what I knew, rather than the word, the latest word, of science. I fancy if explorers—say Stanley or Baldwin—came out of strange places, recording that the popular beliefs there were consonant with the newest discoveries, their work would have less worth and gain less currency. However, that has nothing to do with this particular case. Explorers are fallible persons—almost as fallible as myself. The only infallibles are those aggrieved persons who are always trying their cases in the newspapers.

Wherefore it is with something of amazement that I read Mr. Smith's positive assertion: "Pithy stems are rarely used by locusts, if at all, and dying twigs are never attacked." Will he kindly tell me, if pithy stems are never used, what sort are? No twig or stalk within my knowledge is, in its early stages of growth, without pith. In woody plants, after the wood ripens the pith becomes a fine line, and as the twig develops into a bough, wellnigh invisible. But assuredly if there is a deciduous tree whose new growth is not, while new, pithy, I have never seen nor heard of it. And at the risk of seeming more than ever contumacious, I repeat that some locusts—Tennessee locusts—did choosedying twigs to lay their eggs in—I watched them do it through many a summer hour, in the big oak whose bough almost touched my upstairs window. The twigs were of new wood—the last spring's growth—but yellowing, and beginning to wither. I do not recall ever seeing a sound twig stung by the ovipositor. The locust, or rather the female locust, has two fine

saws, lying either side the ovipositor. With these saws she scratches the bark before depositing the egg. As to Betty-bugs three inches long—they are facts, not fiction. A Mississippi reader has just written, promising to send me one of them next season. He adds the interesting information that when one of the big Bettys falls upside down, one can see upon its under side a number of parasites. Regarding the June bug's identity, that was a matter of countryside belief, backed with pretty good olfactory proof of the transformation. And certainly plenty of true June bugs, green above, all yellow underneath, mingled amicably enough in the flights and hummings of the tumble bugs, black and green.

Let me say further—of the magazine articles, and the whole book—that my aim was not to instruct, but to record a phase of life known to me at first hand. Mr. Smith and the gentlemen of his kidney who assume that whatever is outside their own experience is necessarily false, have, without intending it, done me a real service, by showing me that before the book appears I must so elaborate its *motif*, and make it so glaring, and obvious, that even a way-faring man, almost an infallible one, if he reads at all, will be forced to read aright.

MARTHA McCULLOCH-WILLIAMS.

Very little comment on the above is really necessary. If Mrs. Williams is giving records of superstitions and country beliefs she owes it to her readers, as well as herself, to make it perfectly clear that this is the case, and that they are not intended to be received as instruction or as statements of fact. I am unable to see the bearing of some of Mrs. Williams's references to Stanley, etc., but that I presume is due to my own obtuseness. So I did not dream that an oak twig could ever be called 'pithy.' If the explanation were not made by a lady I should call it quibbling. It is a real pleasure to me to realize that I have done Mrs. Williams a favor, and I hope it will inure to the benefit of the readers of her forthcoming book. It is of course adding another to my sins; but I cannot refrain from saying that no insect to which the name 'locust' was ever justly applied in any publication known to me, has 'two

ne saws, lying either side of the ovipositor.' Nor, if a cicada is referred to, does the description of the method of oviposition accord with the fact. Finally, it might be desirable for Mrs. Williams to get the real facts concerning honey bees, that the rate of her 'fair intelligence' in middle Tennessee be not fixed unjustly low.

J. B. S.

CURRENT NOTES ON PHYSIOGRAPHY.

THE HIGH PLAINS OF COLORADO, KANSAS AND TEXAS.

THE attractions of the diversified Cordilleran region have caused the relative neglect by the geologist and the geographer of the more monotonous area of the Great plains during the last thirty years of exploration. Following the recent increase of attention to this extensive area, we now have an admirably lucid report on 'The High Plains and their Utilization,' by W. D. Johnson (21st Ann. Rep. U. S. Geol. Surv., pt. IV., 1901, 601-768, many excellent plates and figures), giving description and explanation to a stretch of the highest and smoothest part of the Plains, from 150 to 200 miles east of the mountains, in Colorado, Kansas, Texas and New Mexico. The largest continuous area here included is that of the Staked plains, between the Canadian and Pecos rivers, but more attention is given to certain smaller areas, separated by successive west-east valleys and extending through Kansas and Colorado northward towards Platte River. The strata of the High plains are chiefly silts, irregularly interstratified with gravel and sand in linear arrangement, but in lines slightly divergent and crossing. Silt is the most abundant material, yet coarser deposits are so plentiful that the whole loose accumulation is sometimes referred to as the 'Tertiary gravel.' This extensive deposit, in some places 500 feet thick, is the product of aggradation by braided or laced streams, whose load of material from the mountains could not all be carried across the gentle slope of the Plains. Evidence of this origin is found not only in variable composition and irregular stratification, but also in the trains of well-rounded gravel, derived from the resistant rocks of the mountains, stretching forward with the slope of the Plains, and be-

coming finer textured eastward. The lacustrine origin of these strata, usually advocated heretofore, but discountenanced by Gilbert and Haworth, is considered by Johnson and again rejected on good grounds. The fluvialite deposits mantle an uneven surface of older rock, eroded by an ancestral drainage system. They originally formed a vast 'débris-apron' of numerous laterally confluent river fans of long radius, with continuous slope eastward from the mountain base. The region was then a fluvialite plain of great dimensions, similar to that which to-day stretches southward from the base of the Himalayas, in northern India, and similar to the extensive piedmont fluvialite plains of mountain waste that are so commonly and appropriately associated with great mountain ranges in one or another phase of their maturity. But the High plains are now trenched by the west-east valleys worn by the successors of the streams that built the plains; this being the result of some change (preferably the increase of rainfall that accompanied the glacial period) whereby the capacity of the streams to erode was restored. Moreover, the fluvialite mantle has been worn away along two north and south belts. One is the arid belt near the mountain base, where vegetation is so scanty that the small rainfall has sufficed to wear away much of the river-made strata in the excavation of lateral valleys. The other belt begins 100 or 200 miles further east, where the rainfall is heavier and where the headward (westward) growth of many streams is pushing back a badland escarpment. Between these two degraded belts the tattered remnants of High-plains mantle are still smooth and uncut, because under their subhumid climate they have a close-knit cover of sod which has held fast under their light rainfall.

The dead-flat upland of the High plains is lightly pitted here and there by shallow circular depressions, up to 1,000 yards across. These hollows are not due to wind action, for however dusty the gales may be on the arid belt further west, the winds blow clear on the sodded plains. Some of the hollows are crater-like; many are encircled by cracks and rims of slightly settled grounds, and all except the small 'buffalo wallows' are regarded as sinks

due to some action of underground water. Being out of the reach of irrigation from the rivers, and not having enough rainfall for agriculture, the utilization of the High plains must be chiefly as cattle ranges for which water may be gained by wells and windmills.

SOUTH SHORE OF HUDSON STRAIT.

THE forbidding character of a rocky upland that has been recently and severely glaciated and that still possesses a severe climate is well portrayed in Low's 'Report on an Exploration of Part of the South Shore of Hudson Strait * * *' (Geol. Surv. Canada, Ann. Rep., XI., 1901, L.): "The rocks met with are all of great antiquity, and all are more or less altered by pressure, induced by intrusions of igneous masses which have folded the bedded series and have produced foliation in much of the otherwise massive granites, gabbros," etc. (p. 31 L.). The crystalline rocks usually form a highland which reaches altitudes between 1,000 and 2,000 feet near the sea, and is often plateau-like in the extent of its rolling uplands between deep and sharp-cut valleys or canyons. Here rock and boulders are abundant and soil is very scanty; here are abundant lichens and some flowering plants, but no trees. Elsewhere the rocks are stratified and gently inclined, forming low ridges with steep outcrop faces and gentle back slopes. Below 300 feet the surface is generally mantled with marine clays, marked with terraces. But as the land rose from its postglacial submergence, the headlands "have been smoothed and polished by the pounding of floating ice, which has removed nearly all the drift from the points, leaving the solid fresh rock always exposed."

THE ORIGIN OF WATERFALLS.

THE 'Festschrift des Geographischen Seminars der Universität Breslau zur Begrüssung des XIII. Deutschen Geographentages' contains, among various essays, most of which turn toward historical geography, an article on the Origin of Waterfalls, by F. Sturm (pp. 122-132, Breslau, 1901). Besides the numerous rapids and falls which originate at points where a young stream passes from a more to a less resistant rock, or where a new course has been taken in consequence of drift barriers, a num-

ber of special cases are instanced, such as rapids in a main stream where side streams form boulder dams, illustrated by the Colorado in its canyon; rapids occurring where travertine is deposited in a stream channel, as illustrated at several points in Bosnia, and falls over fault escarpments, such as those of the Oxara in Iceland. The order in which different kinds of falls are presented is empirical rather than genetic.

Falls at the mouths of hanging valleys are explained as resulting from the faster erosion of the main than of the side stream; strong glacial erosion of the main valleys in excess of that in the side valley is discredited. It is not noted in this connection that hanging side valleys with falls leaping from their mouths into broad-floored main valleys are known only in glaciated districts; and that in non-glaciated areas, side streams 'hang' above their masters only in the earliest stage of a new cycle; accordant junction of side and main stream being developed about as soon as the main stream has graded its channel, and long before it has broadly opened its valley floor.

W. M. DAVIS.

CURRENT NOTES ON METEOROLOGY.

METEOROLOGICAL EQUIPMENT OF THE 'DISCOVERY.'

THE meteorological equipment of the British Antarctic exploring vessel *Discovery* is described by Dr. H. R. Mill in *Symons's Meteorological Magazine* for September. The Stevenson screen contains a wet and dry bulb thermometer, a mercurial maximum, and a Six's maximum and minimum thermometer. A barometer, on the Kew pattern, is in the magnetic house, and a barograph is kept in one of the companions. A thermograph and a hair hygograph are placed on the outer wall of the magnetic house. The three recording instruments are kept running to Greenwich time. The temperature readings are checked by means of an Assmann Aspiration Psychrometer, and sling thermometers are also provided for comparison. Rainfall observations are to be made with a marine rain-gauge and evaporator of Dr. Black's pattern. For carrying out observations in the free air, a captive balloon is carried, and kites

are to be used for greater elevations. Meteorographs after the Blue Hill pattern are to be sent up with the kites. Spirit thermometers, for dry and minimum readings, graduated to -90° F.; special screens; low-reading thermographs; sunshine recorders adapted to the peculiar conditions which are to be met with in the high latitudes; earth thermometers, etc.—are also provided. A Dines pressure anemometer and an anemograph of similar pattern are to be used at land station on the Antarctic continent.

CHARLES MELDRUM.

THE death, on August 28 last, of Dr. Charles Meldrum, for many years director of the Royal Alfred Observatory, Mauritius, should not be passed by without at least a brief mention in these Notes. Dr. Meldrum did a work of the greatest importance for meteorology in connection with the cyclones of the Indian Ocean, to the study of which he devoted a large part of his life. His name will also always be associated with the question of the relation of sun-spots and rainfall, a subject in which he was much interested. Dr. Meldrum was one of the founders of the Meteorological Society of Mauritius, Government Meteorological Observer, Director of the Royal Alfred Observatory, and, during the last ten years of his life, a member of the Government Council of Mauritius.

BIBLIOGRAPHY.

THE annual bibliographical number of the *Annales de Géographie* (No. 10, for the year 1900) contains the usual notices of climatological publications bearing the date 1900. The reviews are arranged by subjects as well as by countries, and there is an author and a subject index. This bibliography is chiefly geographical, but climatology is given its proper share of attention.

R. DEC. WARD.

HARVARD UNIVERSITY.

SCIENTIFIC NOTES AND NEWS.

THE Elisha Kent Kane Medal of the Geographical Society of Philadelphia has been presented to Dr. A. Donaldson Smith, the African explorer.

PROFESSOR E. RAY LANKESTER has been elected a corresponding member of the Göttingen Society of Sciences.

DR. RICHARD P. STRONG has been appointed director of the Government Biological Laboratory recently established in Manila.

SIR WILLIAM WHITE, since 1885 director of naval construction in the British Navy and the author of important publications on naval architecture, is about to resign.

IT is said that Dr. Wolf Becher, of Berlin, is preparing a biography of Professor Rudolf Virchow.

A LECTURESHIP in moral science will be established at Cambridge University as a memorial to the late Professor Sidgwick. The sum of £2,450 has been subscribed for this purpose.

A DIFFICULTY has arisen, says *Nature*, concerning the site on which the new Pasteur statue in Paris shall be erected. The use of a space in the Square Médicis in the Quartier Latin has been granted, but this spot is being tunneled for a railway, and it is feared, in consequence, that the statue may be too weighty for it. Other places, such as the Place du Panthéon, the Place de la Sorbonne and the entrance of the Avenue de l'Observatoire, are under consideration.

CHARLES A. BACON, professor of astronomy at Beloit College and director of the Smith Observatory, died on November 6, aged forty-one years.

PROFESSOR M. MAERCKER, director of the agricultural experiment station at Halle, Germany, and professor of agricultural chemistry in the Agricultural Institute, died on October 19, 1901.

THE preliminary plans have been accepted for a new building for the Department of Agriculture at Washington. These plans contemplate a magnificent marble structure of classic design, something over 300 feet long, with wings at either end extending to the rear to accommodate the various laboratories of the department. It is expected that the details of interior arrangement will need to be changed to some extent to suit the needs of the various bureaus and divisions of the department, but these plans will serve as a working basis. About 158,400 square feet of space are provided. Lord & Hewlett, of New York, are the architects.

THE American Morphological Society will meet in Chicago in affiliation with the American

Society of Naturalists, beginning on Wednesday, January 1.

THE American Psychological Association has fixed the first day of its Chicago meeting for December 31. The Western Philosophical Association will this year meet in conjunction with the American Psychological Association. Professor Josiah Royce, of Harvard University, is president of the Psychological Association, and Professor Frank Thilly, of the University of Missouri, is president of the Philosophical Association.

THE Society for Plant Morphology and Physiology will hold its fifth annual meeting at Columbia University, New York City, on December 31 and January 1 and 2.

THE Association of American Agricultural Colleges and Experiment Stations meets in Washington on November 12, 13 and 14. It will be followed by the meeting of the Association of Official Agricultural Chemists on November 15, 16, and 18.

THE sixth celebration of Founder's Day at the Carnegie Institute, Pittsburgh, took place on November 7. The principal speaker was Ex-President Grover Cleveland. The occasion was made memorable by the opening of the Sixth International Exhibition of Contemporary Paintings and by the display of a larger number of new exhibits in the Carnegie Museum. Among the latter are the skeleton of *Titanotherium*, and portions of the skeleton of *Diplodocus Carnegii*, recently restored under the care of Professor J. B. Hatcher, a fine specimen of *Rhinoceros simus* Burchell, a collection of petroglyphs from western Pennsylvania, and large additions to the collections of mammals and birds, as well a long array of exhibits in other departments of the Museum.

MR. C. W. GILMORE, who has been employed during the past summer in continuing the excavation at Camp Carnegie, on Sheep Creek, Wyoming, begun two years ago by the Carnegie Museum, completed his work last week. A carload of fossils, consisting principally of the remains of a very large and perfect specimen of *Brontosaurus* has been shipped to Pittsburgh and will shortly be delivered at the Museum.

THE collection of land, marine and fresh-

water shells, belonging to the estate of the late W. D. Hartman, M.D., of West Chester, Pa., has been purchased by the Carnegie Museum in Pittsburgh. Over nine thousand species are represented in the collection, which contains many types and cotypes. It is particularly rich in North American species and in the species found on the islands of the Southern Pacific. The addition of the Hartman collection to the other conchological collections which have in recent years been secured by the Carnegie Museum gives this institution one of the largest assemblages of conchylia in the United States.

IN September the Wisconsin Natural History Society sent two expeditions to the neighborhood of the Fox River in Waukesha County for the purpose of making surface surveys of a number of still unrecorded mound groups which are liable to be destroyed when the land is put under cultivation as is to be done next year. The first expedition surveyed and plotted four groups and several isolated works in the vicinity of Big Bend. One of them is indicated on Dr. Laphan's map, but no description is given by him. The second expedition was sent to the neighborhood of Mukwanago, about four miles from the first party. It surveyed a number of burial and oblong mounds. Nearly all the burial mounds were found to have been disturbed by farmers and others living in the region.

THE Russian Imperial Geographical Society has received news from the Kozloff expedition, sent out to explore the headwaters of the Hoang River. It is said that valuable collections have been obtained.

A COPENHAGEN despatch says that Dr. Nansen, the Arctic explorer, is arranging for biological research in northern waters; Norway, Sweden, Denmark, England, Holland, Russia and Germany to take part in it. The Danish Government has resolved to invite the interested states to hold a conference at Copenhagen to discuss the subject.

THE Twentieth Century Club of Boston has arranged for six lectures on 'The Needs of Popular Education in the United States.' The opening lecture was delivered by President Eliot, of

Harvard University, on November 9, with a general introduction and survey. The succeeding lectures will be as follows: 'The Public School System,' Dr. William DeWitt Hyde, president of Bowdoin College, November 16; 'Supplementary Educational Agencies,' Dr. George Harris, president of Amherst College, November 23; 'The Place of Industrial and Technical Training in Popular Education,' Dr. Henry S. Pritchett, president of the Massachusetts Institute of Technology, December 7; 'The Place and Function of Science in Popular Education,' Dr. Ira Remsen, president of Johns Hopkins University, December 14; 'Comparison of American and Foreign Systems of Popular Education,' Dr. G. Stanley Hall, president of Clark University, December 21.

THE National Geographic Society has issued its program of lecture courses for the coming season. The popular course consisting of thirteen lectures will be delivered in the National Rifles Armory, on Friday evenings at 8 o'clock, commencing November 8, and alternating with the Technical Meetings which will be held in the Assembly Hall of Cosmos Club. The following dates have been definitely assigned:

November 8, 'The Twelfth Census,' HONORABLE FREDERICK H. WINES, Assistant Director of the Census.

November 22, 'The Interior of Borneo,' PROFESSOR A. C. HADDON, Cambridge University.

December 6, 'Peary's Progress toward the Pole,' HERBERT L. BRIDGMAN, Vice-President Arctic Club of America.

December 20, 'The Trans-Siberian Railway,' HONORABLE E. J. HILL.

January 3, 'The New Mexico,' HONORABLE JOHN W. FOSTER, Ex-Secretary of State.

January 17, 'American Progress and Prospects in the Philippines,' GENERAL A. W. GREELY, Chief Signal Officer, U. S. A.

Arrangements have also been made for the following popular lectures, at dates to be announced later.

'The Appalachian Forest Reserve,' HONORABLE JAMES WILSON, Secretary of Agriculture.

'The Warship and its Work,' REAR-ADMIRAL W. S. SCHLEY.

'Fifty Years of Immigration,' HONORABLE E. F. MCSWEENEY, Asst. Com. Immigration.

'Cliff Dwellings of Mesa Verde,' MRS. JOHN HAYS HAMMOND.

'Explorations in New York City,' MR. JACOB A. RIIS.

'Finland,' MR. GEORGE KENNAN.

Provisional arrangements have been made for lectures on Pacific Cables, Actual and Proposed; Our Coming Oceanic Canal; America before the Advent of Man; Chinese Problems; Lands and Life in Ocean Depths; Columbia; Danish West Indies, and Afghanistan—the Buffer State. Regular meetings of the Society for the reading of technical papers and discussions will be held in the Assembly Hall of Cosmos Club on Friday evenings, at 8 o'clock, and alternating with the popular lectures. The following are announced:

November 1, 'Symposium on the Growth and Prospects of the Society,' President A. GRAHAM BELL followed by Professor Heilprin and others.

November 15, 'The Lost Boundary of Texas,' MARCUS BAKER, Cartographer, U. S. Geological Survey.

November 29, 'The Best Isthmian Canal Route,' ARTHUR P. DAVIS, Chief Hydrographer, Isthmian Canal Commission.

THE Christmas course of six lectures to young people, at the Royal Institution, will this winter be delivered by Professor J. A. Fleming, F.R.S., professor of electrical engineering in University College, London. His subject is 'Waves and Ripples in Water, Air and Ether.' Sir H. Trueman Wood will deliver the next Christmas Juvenile Lectures at the Society of Arts, the subject being 'Photography and its Applications.'

A STATEMENT concerning the vital statistics of the city of Havana for the month of September, 1901, compiled from official reports on file in the division of insular affairs of the War Department and abstracted in the daily papers, shows that the health conditions were decidedly the best attained in any month. The least number of deaths occurring in any previous September since 1889 was 496 in 1899; the greatest number, 2,397, in 1898; average, 877. For September, 1901, there were 339 deaths. The least number of deaths occurring in any one preceding month during the last eleven years was in February, 1901, when there were 408 deaths. The lowest death rate for Sep-

tember in the years referred to was in 1899, when the death rate was 34.48 per thousand. For September, 1901, the death rate was 15.64 per thousand. Taking the yellow fever year as commencing April 1, the record of the past eleven years shows that for the six months up to the first of October the smallest number of deaths from this disease occurred in 1899, when there were 36 deaths; the greatest number in 1897, when there were 659 deaths—average, 296 deaths. This year, during the same period, there were only five deaths.

SIR CLEMENTS A. MARKHAM, president of the Royal Geographical Society, has given out for publication a communication stating that despatches received from the Cape give details of the voyage of the *Discovery* and announce the departure of the Antarctic expedition from Simon's Bay on October 14 on the voyage to Lyttelton, the last port of call before entering the ice. Experience of the performances of the ship has been acquired during a voyage of 58 days—33 under steam and 25 under sail. She might make a reasonably good passage under sail with a fair wind, but she makes excessive leeway when close hauled; her canvas area is too small, and she must be accounted a poor sailer. She is, however, an excellent sea boat, which is the main point, and in a fresh breeze with a heavy sea she is very stiff and dry. She has, on the whole, done as well as can be expected for a vessel of her type. Her coal consumption is, however, disappointing. The economy of the engines is less than expected, and the necessity for nursing coal in future operations is proportionately increased. Officers and men have had a very trying time in the tropics. The ship leaked, from causes which can no doubt be obviated. But as the provision cases were stowed in the holds down to the keelson and the water rose amongst them it was necessary to clear the holds, to construct floors with an amply sufficient bilge space beneath and to restore the holds again—all this under a tropical sun. The engineering department had still more severe work, owing to the long spell of steaming with the thermometer at 140° F. in the engine-room, and the engines, being new, required more than ordinary care and adjustment.

UNIVERSITY AND EDUCATIONAL NEWS.

THE council of New York University has decided to celebrate the seventy-fifth anniversary of the founding of the University in October, 1905. An effort will be made to collect \$2,000,000 for an endowment fund.

DR. OSLER, of the John Hopkins University, has given to the medical library of McGill University a number of rare books on medicine. The medical library has been much improved in the alterations of the building.

THE Library of the Chemical Department of the University of Vermont has just been augmented by the addition of some 400 volumes, chiefly German chemical journals. These are mainly the gift of F. W. Ayer, of New York, who subscribed \$1,000 to the special fund.

IT is announced that Andrew Carnegie will give \$500,000 to build and equip a technical college in southern Scotland. The institution will probably be located at Galashiels, counties of Roxburgh and Selkirk.

THE widow of the late professor of the history of medicine at Vienna, Dr. Puschmann, has bequeathed her entire property, about a quarter of a million dollars, to the University of Leipsic.

THE Liverpool City Council has unanimously resolved to make application to Parliament for powers to enable the council to contribute money from the rates toward the formation and maintenance of a university in the city.

BEGINNING with the academic year 1905-06 all students desiring to enter the first year of the medical course of the University of California, and all new students seeking advanced standing must present evidence of having completed at least two full years of preliminary training in the undergraduate department of a college or university of recognized standing. Satisfactory evidence must also be presented that during these two years the applicant has completed courses in chemistry (12 hours for a year), physics (13 hours), biology (6 hours), and has a reading knowledge of French and German.

THE new chemical laboratory of the University of Oregon, for which appropriations

were made during the last two sessions of the Legislature, has been completed and equipped, and is now occupied by the department of chemistry. The building is a three-story brick structure, finished with Roman cement, and is 100 feet long by 46 feet deep. It contains sixteen rooms, of which thirteen are now in use. Four large laboratories are for student use, and will accommodate over 200 students working in sections. The lecture room has a seating capacity of one hundred and fifteen persons; it is completely equipped with separate preparation room, rear hood, 28 foot table provided with down draught, projecting spectroscope and polariscope, etc. The building also contains four private laboratories, two store rooms, a dark room, a balance room and a private office for the director. The three rooms not yet fitted up are all of large size. The laboratories are ventilated by a large Sturtevant centrifugal exhauster, driven by an electric motor; all the rooms are wired for light and for power, and are heated by steam. Gas is furnished by a 100-light Detroit combination machine. The total cost of building, furniture, apparatus and chemicals was \$22,500.

THE trustees of Williams College met in New York City on November 8, with a view to selecting a president for the College, but were unable to come to a decision. Of the fifteen trustees in attendance it is said that five voted for Dr. E. H. Griffin, professor of the history of philosophy at the Johns Hopkins University and dean of the college faculty, and three for Dr. Henry Lefavour, professor of physics at Williams College and dean of the faculty.

IN the Medical Department of the University of Pennsylvania Dr. Charles Mills has been appointed clinical professor of nervous diseases, in the place of Dr. Horatio Wood, resigned; Dr. W. G. Spiller, assistant professor of nervous diseases, and Dr. Charles Burr, professor of mental diseases.

ASSISTANT PROFESSOR S. LAWRENCE BIGELOW has been made acting director in charge of general chemistry at the University of Michigan during Professor Freer's absence in the Philippines. Mr. A. M. Clover has been appointed acting instructor in chemistry. R. T.

Sanford and N. F. Harriman have been appointed assistants in the chemical laboratory.

A. B. MACALLUM, Ph.D., has been promoted to a full professorship of physiology in the University of Toronto.

THE following appointments have been recently made at the University of Oregon: E. D. Ressler, A.M. (Ohio State University), assistant professor of education; Henry D. Sheldon, Ph.D. (Clark), assistant professor of philosophy and education; Richard H. Dearborn, B.S. (Cornell), instructor in electrical engineering; Charles W. M. Black, Ph.D. (Harvard), instructor in mathematics; Orin F. Stafford, A.B. (Kansas), instructor in chemistry; Percy P. Adams, A.B. (University of Oregon), assistant instructor in civil engineering; Archibald A. Atkinson, A.B. (Pacific University), assistant instructor in biology; P. Irving Wold, B.S. (University of Oregon), assistant instructor in physics; R. R. Renshaw, scholar and assistant in chemistry.

PROFESSOR J. B. GARNER, of the Bradley Institute at Peoria, has been appointed professor of chemistry in Wabash College.

MR. LYMAN F. MOREHOUSE, an assistant in the physical department of the University of Michigan, has accepted a position as an instructor at Washington University, St. Louis. Mr. Lindley Pyle will fill the vacancy at the University of Michigan.

PHILIP B. HAWK, M.S., has been elected to succeed W. D. Cutler, A.B., as assistant in the department of physiological chemistry of Columbia University, at the College of Physicians and Surgeons.

CLARK WISSLER, A.B. (Indiana), Ph.D. (Columbia), has been appointed instructor in psychology in the School of Pedagogy of New York University, and Dr. J. E. Lough has been promoted from an instructorship to an acting professorship.

PROFESSOR HUGH L. CALLENDAR, F.R.S., has been appointed to the professorship of physics in the Royal College of Science, vacant by the resignation of Professor Rücker, who has become principal of the University of London.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

EDITORIAL COMMITTEE: S. NEWCOMB, Mathematics; R. S. WOODWARD, Mechanics; E. C. PICKERING, Astronomy; T. C. MENDENHALL, Physics; R. H. THURSTON, Engineering; IRA REMSEN, Chemistry; CHARLES D. WALCOTT, Geology; W. M. DAVIS, Physiography; HENRY F. OSBORN, Paleontology; W. K. BROOKS, C. HART MERRIAM, Zoology; S. H. SCUDDER, Entomology; C. E. BESSEY, N. L. BRITTON, Botany; C. S. MINOT, Embryology, Histology; H. P. BOWDITCH, Physiology; J. S. BILLINGS, Hygiene; WILLIAM H. WELCH, Pathology; J. MCKEEN CATTELL, Psychology; J. W. POWELL, Anthropology.

FRIDAY, NOVEMBER 22, 1901.

THE GEOLOGY OF ORE DEPOSITS.

II.

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WE have now traced the metals of many ores to their first positions in the veins. In order to understand other cases, we must recall the facts as to the relations of 'richness with depth.' At this point I take my illustrations from regions outside of Colorado. James Douglass says that in the Appalachian region every copper mine has diminished in richness with depth. Near the surface rich oxidized products were found. Near the level of ground-water rich belts of sulphides occurred—in some instances extraordinarily rich. Below the level of rich sulphides every old mine has passed into cupriferous pyrrhotite, a sulphide of iron bearing a very small percentage of copper. In the Sierra Nevadas, of California, Mr. Lindgren states that near the surface the values range from \$80 to \$300 per ton; but a little way below the level of ground-water these values fall to \$20 or \$30 per ton, and no exceedingly rich deposits are found. You all know the history of the Comstock lode; and of the great bonanzas found above or about the 2,000-foot level, and which did not extend deeper. In the Lake Superior region the greatest iron-ore mines in the world occur; fourths or more of the entire product of iron of the United States comes from that region; but at the present time vastly more

iron has been taken out above the 1,000-foot level than below it. If time sufficed, similar instances from all the old mining regions of the world could be cited.

I by no means assert that the above illustrations represent an invariable rule. Indeed, this is not the case. But the illustrations undoubtedly do represent the average relation of richness and depth.

Now this story is an entirely different one from the illusion of increased richness with depth based upon the supposition that the metals for the ores are derived from the unknown depths of the earth. If that theory be true, it is natural to believe that ore deposits upon the average will become richer with depth. But if it be a pure unverified hypothesis, not supported by any facts, it is of vital importance for practical mining men to know this, since the knowledge will save them vast sums of money expended in exploration under a false theory. So far as I am aware of the facts, I do not know of a mining region in the world which supports the theory of increased richness with depth, if the unit of measure be taken as one thousand feet, if the first thousand feet be compared with the second thousand, and the second thousand with the third, and so on. In fact, nine mines out of ten, taking the world as a whole, are poorer the second thousand feet than they are the first thousand feet, and are poorer the third thousand feet than they are the second thousand feet. Many ore deposits have been exhausted or have become so lean as not to warrant working before the 1,000-foot level is reached; a large proportion before the 2,000-foot level is reached; while comparatively few ore deposits have been found to be so rich as to warrant working at depths greater than 3,000 feet.

There are, however, some ore deposits which are not known to gradually decrease in richness with depth so far as yet ex-

ploited. There are a considerable number of deposits which perhaps after a first rapid decrease in richness maintain their tenor pretty well to the depth of 1,000, 2,000 or even 3,000 feet, and some few deposits maintain their richness at even greater depths. But we cannot reasonably hope that a deposit will get richer with depth, provided we use a 1,000-foot unit for measurement. The most sanguine view which is ever justified for any deposit is that, using a 1,000-foot unit, the second shall be as good as the first, and the third as good as the second. While the above is true, there are very great irregularities in the richness of ore deposits, both favorable and unfavorable, due to multifarious causes, which I cannot possibly discuss to-night, but which I considered somewhat fully in my Institute paper.* These irregularities are especially marked in the upper 1,000 feet of a deposit; so that in many cases, if the unit of measurement were 25 feet or 100 feet, or in a few cases 500 feet even, it might be said that deposits are becoming richer with depth; although the reverse also occurs in many cases. The truth is that in the upper parts of ore deposits the variations in richness with depth are extreme, and no definite rules can be laid down in reference to them.

This rule of the diminution of richness with depth is one of averages only when considerable depths are taken into account. The factors entering into the production of an individual ore deposit are so numerous, and the irregularities are so great, that the rule cannot be asserted in advance of development of an individual mine without a study of the conditions there obtaining.

Now what is the explanation of these irregularities and of the very general diminution of richness with depth? What is the

* 'Some Principles controlling the Deposition of Ores,' by C. R. Van Hise: *Trans. Am. Inst. Min. Eng.*, Vol. XXX., 1900, pp. 102-112.

explanation in some cases of the relatively even values at different depths? The last question will be first considered.

In those instances in which the tenor is maintained or practically maintained from the surface to a great depth, the ore is believed to be the result of a single concentration by ascending waters. Such ore deposits may continue without any appreciable diminution in richness to the lowest limits to which man may expect to penetrate the earth; but these are exceptional cases. Even ore deposits which are the result of a single concentration by ascending water may diminish in richness at considerable depth. It has been seen that in the fissure at the bottom of the valley on this chart (Fig. 6) the water ascends to the surface. It is evident that the upper part of the fissure receives the greatest supply of water, and this water to a large extent does not penetrate any great depth; while the lower part of the fissure receives less water, but this water penetrates to a considerable depth. It may happen that the water relatively near the surface traverses the rocks containing the main supply of metals and, therefore, brings the chief contributions of valuable material, or such waters may carry the precipitating agent. In such instances the ore deposits produced by ascending water alone would diminish in richness with depth; but such decrease would not be likely to be very rapid. Upon the other hand, if the above conditions be reversed, a deposit may increase in richness for a considerable depth; but as a matter of fact this appears to be a very infrequent case.

As illustrations of the ore deposits of the class produced by ascending waters alone are the copper deposits of Lake Superior. These deposits, while very bunchy and extremely irregular in the distribution of copper, are wonderfully persistent in depth. The copper of the ore was deposited in the

metallic form. As compared with sulphides, this material is not readily oxidized. In this district the rocks above the level of ground-water are not appreciably weathered. Doubtless there was a belt of weathered material before the glacial epochs, but if so, it has been swept away by ice erosion; and since the glacial period sufficient time has not elapsed to weather appreciably the rocks which now lie within the theoretical belt of weathering. If there once were in this district an upper belt of weathering in which there were deposits of exceptional richness, this material has been removed. However, in this district, a first concentration by ascending waters was adequate, but it is not often that a first concentration produces deposits of such richness as those adjacent to Calumet and Houghton on Keweenaw Point; and, indeed, this is exceptional even in the Keweenaw of the Lake Superior region; for while concentrations of copper have occurred at many points in the rocks of this period, as yet at no other locality have those concentrations been found to be so abundant and rich as to warrant exploitation on a large scale.

I now turn to the question as to the cause of frequent diminution of richness of ore deposits with depth. The explanation of the very frequent diminution of value with depth seems to me to lie in the secondary effect of descending currents upon deposits first deposited by ascending waters. Many or most of such ore deposits are believed to be the products of two concentrations, the first by ascending, the second by descending waters. In this connection it is necessary to call attention to the fact that a large proportion of the deposits which are being exploited are below part of a slope. It may be said that the reason for this is that the low grounds are more difficult to explore and work; but giving due allowance for this,

it still seems to me that the majority, perhaps the great majority, of very rich deposits are below slopes and crests, and not below the valleys. I believe the richer deposits are below the slopes, because at these places a second concentration is possible and probable.

Returning now to this chart (Fig. 6), we shall direct our attention to the fissure on the slope. This fissure once extended up through the overlying rocks which have been removed by denudation. What has become of the ore in the part of the fissure which has been worn away? If, for instance, it carried five per cent. of copper, what has become of it? A part of it would have been scattered far and wide through erosive action; but a part of it would have been taken into solution and redeposited in the same vein deeper down. In the belt of weathering oxidized salts, such as sulphates, would form; the descending waters would carry these products downward; and it is my belief that they would react upon the solid, lean sulphides below with the result of precipitating the metals from the descending solutions. Now this has been held to be a mere unverified assumption by some geologists, but it seems to me that they have not fully considered the certain effects of the chemical laws concerned. We know if in a laboratory a solution of copper sulphate or other copper salt be placed in contact with iron sulphide, that copper will be thrown down as copper sulphide. If the copper solution be placed in contact with a lean copper-iron sulphide, a sulphide richer in copper will be produced. And if these reactions occur in the chemical laboratory, will they not as certainly occur in the laboratory of nature, although perhaps more slowly?

At this point it is to be recalled that in many ore deposits above the level of ground-water oxides and carbonates occur, while below the level of ground-water are sul-

phides. Moreover, at high levels these sulphides are rich in valuable metals, and usually become poorer in these metals and richer in iron sulphide at the lower levels. You will remember at Butte, Mont., at and for a distance below the level of the ground-water, are rich copper sulphurets which grade at depth into leaner copper sulphides containing correspondingly large amounts of iron sulphide. You will remember the same is true of the entire Appalachian region. You will remember that frequently above the level of the ground-water gold lodes are exceedingly rich. What is the explanation of these similar facts? What is the explanation of the exceptional or even extraordinary richness of the deposits at and near the level of ground-water, and of the low grade of galena, blende or pyrites deep below the level of ground-water? In my opinion the only plausible explanation is that the rich parts of the deposits have received two concentrations, the first by ascending waters and the second by descending waters. The metals of the rich portions of the deposits were largely contributed by the parts of the deposit above, or once above, the rich parts. In some cases portions of the depleted veins remain, as at Butte; but frequently the depleted parts of the veins have been removed by erosion. The remote source of the material was, therefore, the metals deposited by the first concentration. But let us follow the matter still further. In the majority of cases, as denudation continued, the parts of the ore deposits produced by the second concentration rise into the belt of weathering. They may there be partly or wholly transformed into rich oxidized products, or they may be depleted to extend the rich deposits below. In the concentration by descending waters the chief chemical reactions are believed to be between the oxides or salts of the valuable metals and the sulphide of iron; although, of course, similar reactions

occur between the salts of silver and gold and other metals, and the sulphides of lead and zinc.

Time does not permit the consideration of the various reactions which result in the re-concentration by descending waters. These I shall be obliged to take for granted this evening, but those who care to follow the subject further may find a treatment of this part of it in my full paper upon the deposition of ores, published in Volume XXX. of the *Transactions of the American Institute of Mining Engineers*.

During the process of re-concentration erosion steadily goes on, perhaps to a depth of 1,000 or 5,000 or even 10,000 feet, or more. As denudation steadily lowers the surface of the country, the material deposited by the first concentration is picked up and gradually carried down along the vein by the descending waters. This material reacts upon the other materials, and is largely reprecipitated.

In the foregoing statements the second concentration of metals by solution, downward transportation and precipitation by reactions upon the sulphides of an earlier concentration has been emphasized. However, it is not supposed that this is the only process which may result in enrichment of the upper parts of ore deposits by descending waters. The enrichment of this belt may be partly caused (1) by reactions between the downward-moving waters carrying metallic compounds and the rocks with which they come in contact, and (2) by reactions due to the meeting and mingling of the waters from above and the waters from below.

1. The metallic compounds dissolved in the upper parts of the veins, carried by descending water, may be precipitated by material contained in the rocks below. This material may be organic matter, ferrous substances, etc. So far as precipitating materials are reducing agents, they

are likely to change the sulphates to sulphides, and precipitate the metals in that form. While sulphides may thus be precipitated either above or below the level of ground-water, they are more likely to be thrown down below the level of ground-water. Other compounds than reducing agents or sulphides may precipitate the downward-moving salts in other forms than sulphides.

2. In a trunk-channel, where waters ascending from below meet waters descending from above, there will probably be a considerable belt in which the circulation is slow and irregular, the main current now moving slowly upward and now moving slowly downward, and at all times being disturbed by convectional movements. Doubtless this belt of slow general movement and convectional circulation would reach a lower level at times and places of abundant rainfall than at other times and places, for under such circumstances the descending currents would be strong. The ascending currents, being controlled by the meteoric waters falling over wider areas, and subject to longer journeys than the descending currents, would not so quickly feel the effect of abundant rainfall. Later, the ascending currents might feel the effect of the abundant rainfall and carry the belt of upward movement to a higher level than normal. However, where the circulation is a very deep one, little variation in ascending currents results from irregularities of rainfall.

In the belt of meeting ascending and descending waters (see Fig. 6) convectional mixing of the solutions due to difference in temperature would be an important phenomenon. The waters from above are cool and dense, while those from below are warm and less dense. In the neutral zone of circulation the waters from above would thus tend to sink downward, while waters from below would tend to rise, and thus

the waters would be mingled. Still further, even if the water were supposed to be stagnant at the neutral belt, it is probable that by diffusion the materials contributed by the descending waters would be mingled with the materials contributed by the ascending waters.

Ascending and descending solutions are sure to have widely different compositions, and precipitation of metalliferous ores is a certain result. As a specific case in which precipitation is likely to occur, we may recall that waters ascending from below contain practically no free oxygen and are often somewhat alkaline, while waters descending from above are usually rich in oxygen and frequently contain acids, as at Sulphur Bank, described by Le Conte.* The mingling of such waters as these is almost sure to result in precipitation of some kind. Le Conte further suggests † by the mingling of the waters from below with those from above that the temperature of the ascending column will be rapidly lessened, and this also may result in precipitation.

The metals precipitated by the mingling of the waters may be contributed by the descending waters, by the ascending waters, or partly by each. In so far as more than an average amount of metallic material is precipitated from the ascending waters, this would result in the relatively greater richness of the upper part of veins independently of the material carried down from above.

In all the cases considered the precipitation and enrichment of the upper parts of deposits follow from the reactions of downward-moving waters. Their effect may be to precipitate the metals of the ascending water to some extent, and thus assist in the

first concentration. But the results of these processes cannot be discriminated from the concentration resulting from an actual downward transportation of the material of an earlier concentration. In concluding this part of the subject, *it is held that the downward transportation of metals already in lodes is the most important of the causes explaining the character of the upper portions of ore deposits; and that their peculiar characters are certainly due to the effect of descending waters.*

The concentrations by ascending and descending waters have been considered as if they were mainly successive. In some instances this may be the case; but it is much more probable that ascending and descending waters are ordinarily at work upon the same fissure at the same time, and that their products are, to a certain extent, simultaneously deposited. For instance, under the conditions represented by this chart (Fig. 6) a first concentration by ascending waters is taking place in the lower part of the fissure, and a reconcentration by descending waters is taking place in the upper part of the fissure. Between the two there is a belt in which both ascending and descending waters are at work. The rich upper part of an ore deposit which is worked in an individual case may now be in the place where ascending waters alone were first acting, where later, as a consequence of denudation, both ascending and descending waters were at work, and still later, where descending waters alone are at work. The more accurate statement concerning ore deposits produced by ascending and descending waters is, therefore, that ascending waters are likely to be the potent factor in an early stage of the process, that both may work together at an intermediate stage, and that descending waters are likely to be the potent factor in the closing stage of the process.

Also, for the sake of simplicity in the consideration of the concentrations I have

* 'On the Genesis of Metalliferous Veins,' by Joseph Le Conte, *Am. Jour. Sci.*, 3d ser., Vol. XXVI., 1883, p. 9.

† Le Conte, *op. cit.*, p. 12.

disregarded the lateral elements of the moving water. In many cases superimposed upon the vertical movements in the fissures or other openings are lateral movements, as a result of which the deposits, instead of being in vertical positions, are inclined, often much inclined, and indeed may be horizontal. Moreover, the horizontal extents of the deposits may be much greater than the vertical extents. Reduced to a simple and broad statement, *the first concentration of many ore deposits is the work of a relatively deep-water circulation, while the reconcentration is the result of reactions upon an earlier concentration through the agency of a relatively shallow water circulation. Commonly the deep-water circulation is lacking in free oxygen and contains reducing agents, and the shallow water contains free oxygen. The deep water is, therefore, a reducing, and the shallow water an oxidizing agent.*

In addition to the general factors already considered there are many special factors which have a most important, indeed, very often a controlling influence in the production of ore-chutes and in the localization of ore in certain areas and districts. Some of these factors are the complexity of openings, the presence of impervious strata at various depths, the presence of pitching folds, the character of the topography. I see, however, that my time is nearly gone, and I shall not take up their discussion this evening, but must refer those especially interested in this phase of the subject to my full paper already mentioned.* I must, however, note that impervious strata are frequently of controlling importance in the underground circulation. Often deep and shallow water circulations are separated by such strata. Often also, as the result of the removal of impervious strata by denudation, the previous deep circulation

ceases and the action of the shallow circulation is inaugurated.

At this point it may be well to briefly recall the most fundamental features of the water circulation which produces the ore deposits. First comes the downward-moving, lateral-moving waters of meteoric origin which take into solution metalliferous material. These waters at depth are converged into trunk channels, and there, while ascending, the first concentration of ore deposits may result. After this first concentration many of the ore deposits which are worked by man have undergone a later concentration, not less important than the earlier, as a result of shallow descending or lateral-moving waters. In other cases, a concentration by descending, lateral-moving waters alone is sufficient to explain some ore deposits. It thus appears more clearly than heretofore that an adequate view of ore deposits must not be a descending-water theory, a lateral-secreting water theory or an ascending-water theory alone. While an individual ore deposit may be produced by one of these processes, *for many ore deposits a satisfactory theory must be a descending, lateral-secreting, ascending, descending, lateral-secreting theory.*

But there is no question in my mind that this theory is still insufficient to fully explain many of the ore deposits. No knowledge is ever complete. We move step by step, carrying a theory nearer and nearer completion. If, however, a theory be based on good work, it usually will not prove to be false; it will be found to be incomplete. Sandberger was not wrong when he said lateral secretion explained many things in reference to ore deposits. He was wrong only when he excluded other factors. He became unscientific when he carried his theory further than his observations justified. While the theory here proposed is believed to make an important advance, it will sooner or later be found to be incom-

*'Some Principles controlling the Deposition of Ores,' by C. R. Van Hise, *Trans. Am. Inst. Min. Eng.*, Vol. XXX., 1901, pp. 112-146.

plete. I trust it will not be found to be false. But the most that I can hope for it is that it is approximately correct as far as it goes.

It is believed that the principles which have been presented lead to a new and natural classification of the ore deposits produced by underground water. As already noted, ore deposits may be divided into three groups: (1) Ores of igneous origin, (2) ores which are the direct result of the processes of sedimentation, and (3) ores which are deposited by underground water.

Since the ores produced by igneous agencies and those produced by processes of sedimentation have not been considered in this paper, a subdivision of these groups will not be attempted.

Ores resulting from the work of ground-water, group (3) above, may be divided into three main classes:

(a) Ores which at the point of precipitation are deposited by ascending waters alone. These ores are usually metallic or some forms of sulphurets; but they may be tellurides, silicates or carbonates.

(b) Ores which at the place of precipitation are deposited by descending waters alone. These ores are ordinarily oxides, carbonates, chlorides, etc., but silicates and metals are exceptionally included.

(c) Ores which receive a first concentration by ascending waters and a reconcentration by descending waters. The concentration by ascending waters may wholly precede the concentration by descending waters, but often the two processes are at least partly contemporaneous. The materials of class *c* comprise oxides, carbonates, chlorides, and rarely metals and silicates, above the level of groundwater, and rich and poor sulphurets, tellurides, metallic ores, etc., below the level of ground-water. At or near the level of ground-water, these two kinds of products are more or less intermingled, and there is

frequently a transition belt of considerable breadth.

How extensive are the deposits of class *a* I shall not attempt to state. Indeed, I have not such familiarity with ore deposits as to entitle me to an opinion upon this point. However, a considerable number of important ore deposits belong to this class. This class is illustrated by the Lake Superior copper deposits.

The ore deposits of class *b* are important. Of the various ores here belonging probably the iron ores are of the most consequence. All of the iron ores of the Lake Superior region now being exploited are of this class.

It is believed that the ore deposits of class *c* are by far the most numerous. I suspect that a close study of ore deposits in reference to their origin will result in the conclusion that the great majority of ores formed by underground water are not the deposits of ascending waters alone, but have by this process undergone an early concentration, and that descending waters have produced a later concentration, as a result of which there is placed in the upper 100 to 1,500 or possibly even 3,000 feet of an ore deposit a large portion of the metaliferous material which originally had, as a result of the early concentration, a much wider vertical distribution.

The depth to which rich deposits of the classes produced or concentrated by descending water extend is a very important question; but time does not permit adequate discussion of it. The factors entering into the problem are very numerous and complicated. Only a single one of these will be briefly considered, and this is the topography. Where the relief is small, the vertical effect of descending solutions extends upon the average to less depths than where the relief is great. But even where the relief is moderate the descending solutions may be effectual to a considerable

depth, as shown by the Lake Superior iron mines. And where the topographic forms are those of great and sharp relief, there the descending waters go to very great depths. In the San Juan region, for instance, are wonderfully steep slopes and very great canyons. Here the water descends a long way on its downward course before it turns laterally and upward on its way to the valleys. I have visited the San Juan region during the past week with other geologists, and in some cases we saw the effect of descending water to a depth of 3,000 feet below the surface. It has already been explained that in the early history of this region the conditions were ideal for a first precipitation of ores by ascending waters. They are now no less ideal for a re-concentration by descending waters.

If the classification advocated be based upon facts, it gives valuable criteria to mining men for the exploration and exploitation of their mines. Many millions of dollars have been lost needlessly in exploitation by not understanding or paying attention to this matter. In many cases it can be ascertained to which of these three classes an ore deposit belongs.

The character of a deposit in most cases will determine this. Where the ores are deposited by ascending waters alone it has been pointed out that this is favorable to their continuity to great depth. Therefore, where a given ore deposit has been shown to belong to this class, the expenditure of money for deep exploration may be warranted, although, as already pointed out, such deposits may decrease in richness with depth. Where a deposit is produced by descending waters alone, the probable extent in depth is much more limited. In such cases, when the bottom of the rich product is reached, it would be the height of folly to expend money in deep exploration. Where the ore deposit belongs to the third class, that produced by

ascending and descending waters combined, there will, again, be a richer upper belt composed of rich oxidized and sulphureted deposits which we cannot hope will be duplicated at depth. To illustrate: It would be very foolish, at Ducktown, Tenn., to sink a drill hole or shaft into the lean cupriferous pyrrhotite with the hope of finding rich sulphurets such as those which were mined near the level of groundwater. Those who have spent money in deep prospecting of the lean pyrrhotite in the Appalachian range will doubtless agree to this statement. Deposits produced by two concentrations may grade into the class produced by ascending water alone, and after the transition the deposit may be rich enough to warrant exploitation at depth; but if such work be undertaken it must be done with the understanding that the rich upper products will not be reduplicated at depth. It therefore appears to me that the determination to which of the classes of ore deposits produced by underground waters a given ore deposit belongs has a direct and very important practical bearing upon its exploration and exploitation.

In conclusion, I hold if mining engineers and superintendents understand the work of underground water, understand why and how ore deposits are made, less money will be expended in fruitless exploration; money will not be wasted in searching for deposits at places where nature never placed a deposit. Therefore, it seems to me to be the part of wisdom for a mine owner or manager to make a complete scientific investigation of a deposit of which he has charge in order to ascertain to which of these three classes the deposit belongs; and then to carry out the exploration and exploitation according to the principles which apply to the particular case.

C. R. VAN HISE.

UNIVERSITY OF WISCONSIN.

SECTION E, GEOLOGY AND GEOGRAPHY.

ABSTRACTS of papers read before the Section on August 26-29, 1901, are as follows:

'Some Problems of the Dakota Artesian System': JAMES E. TODD.

This paper presents some of the unsolved problems found in several years' study of the artesian wells of South Dakota. The artesian system shows four or five aquifers, or water-bearing strata, more or less completely separated from one another. Our first problem is, how is this separation accomplished? By sheets of clay wholly, or in part by mutual precipitates between two kinds of water? Again, artesian waters may be divided into soft and hard, and both kinds are found in the same aquifer in different localities. This presents the question, what decides the mineral content of the water at any place? Is it what is brought from its original source, or the composition of the rock in which it is found? The latter seems most accordant with the facts. Again, though from the hydraulic gradient the flow seems to be uniformly towards the southeast, the soft waters in each aquifer are found toward the northwest, and the hard to the southeast. Therefore, another problem is, how can we explain the lime and less soluble salts replacing the soda and more soluble salts in the same stream? Again, a prominent content of the water about Pierre, and extending westward indefinitely, is natural gas, and this gas has been identified with the water itself and not with any carbonaceous stratum above. What then is the origin of the gas? The high temperature with which it is associated, 92° to 102° F., and its intimate mixture with the water, suggest a chemical origin, but nothing in that line, which has been hinted by any chemist, can be conceived to occur in this region. There is no trace of volcanic or crustal disturbance, but from geological relations there is strong ground for believing that extensive carbon-

aceous deposits may have been formed in the Carboniferous period a little west of Pierre, the eastern edge of which the Dakota formation, which bears the water, directly overlaps. Subterranean heat may distill the gas into the overlying water stratum, carrying the higher temperature from below, and perhaps adding to it by condensation. But, perhaps more strange, a few miles east of Pierre the gas disappears and the temperature of the water declines 20 degrees or more. We have, therefore, another very obscure and difficult problem. What becomes of the gas? This problem in some respects resembles the disappearance of soda ingredients in the water, mentioned above. Perhaps the readiest suggestion is that the gas escapes from the water to the surface, by its greater penetrating power, but no gas springs have been found, and only a little at higher levels, which has been discovered in shallow wells. We have already alluded to the phenomenally high temperature of some wells. This has been well discussed by Darton in the 18th Annual Report U. S. G. S. The oxidation of pyrites he considers inadequate, yet as the higher temperatures are connected with the presence of sodium chloride and gas, so far as we know, it is strongly impressed upon us that some chemical reactions yet undiscovered have something to do with the high temperature, origin of gas, and disappearance of sodium salts in the great eastward-flowing streams of artesian waters.

'Interpretation of Some Drainage Changes in Southeastern Ohio': W. G. TIGHT.

This paper traces some old river valleys and indicates the sequence of events during the changes and the time of the inauguration of the changes.

'Moraines and Maximum Diurnal Temperature': JAMES E. TODD.

It has been noted that the moraines in the James River valley are frequently

wider and rougher on the west side of the valley than on the eastern. This is particularly true of those later than the first, for they are formed on a quite smooth plain. The first is much influenced by pre-glacial topography. Moreover the western sides of the loops are apt to be at lower altitudes. In seeking for an explanation for this, we find nothing more satisfactory than the fact that the maximum diurnal temperature is uniformly considerably higher after noon, hence the western half of an ice lobe will receive more heat and consequently be more active, *i. e.*, move faster, bring more débris, melt more rapidly, be more apt to detach and bury more ice blocks. The lower altitude may result from the melting back of the ice farther on a concave surface, such as is apt to be left by the former ice sheet. A corollary of this general proposition is that in the northern hemisphere the southern side of an east- or west-flowing glacier will tend to exhibit similar phenomena for a similar reason, *viz.*, because of the southern position of the sun. Instead of curving such glaciers toward the north, as argued several years ago in one of our prominent scientific journals, it will rather tend to quicken the motion in the ice toward the south, though at the same time, because of greater melting, it may not widen the ice, but the contrary. If the débris transported is abundant it may turn the course of the glacier northward, somewhat as the deposition of sediment in a delta or an alluvial fan may divert the stream which forms it. Of course the influence here recognized is not all-powerful, but may be counteracted in certain cases by other conditions.

'On *Campodus*, *Edestus*, *Helicoprion*, *Acanthodes*, and other Permo-Carboniferous Sharks': C. R. EASTMAN.

The genus *Campodus*, known only by fragmentary remains from the Coal Measures, was shown by St. John and Worthen, and later by Max Lohest, to have possessed

a typical Cestraciant dentition. The researches of these authors were based upon a unique example of the left ramus of the lower jaw, from which the anterior and posterior extremities were missing. Two specimens are now known, belonging respectively to the Museum of Comparative Zoology at Cambridge and the State University of Nebraska, which exhibit the symphyseal series of teeth and incidentally throw new light on the relations of *Edestus*, *Helicoprion* and the like. In one jaw of *Campodus*, presumably the lower, there was one arcuate, median azygous series of symphyseal teeth, opposed to which in (presumably) the upper jaw were two corresponding series separated by a slight interval. As successional teeth were developed the functional ones became coiled in a regular arc like *Edestus*, with the coronal buttresses directed inward (posteriorly). The complete whorls of *Helicoprion* are believed to represent a more advanced stage of an entirely homologous dental structure. A new and very large species of *Acanthodes*, represented by a pectoral fin, numerous spines and shagreen, was reported from the Coal Measures of Mazon Creek, Illinois, and reference made to the occurrence of *Phoebodus* in the Keokuk Limestone of Iowa and Permian of Nebraska. The large variety of *Ctenacanthus* spines occurring in the Kinderhook Limestone of Iowa fall into two principal categories, one long and slender and gradually tapering, the other short and blunt. These are probably to be correlated with the first and second dorsal fins of the same individual, instead of being regarded as distinct species.

'Note on Certain Copper Minerals': ALEXANDER N. WINCHELL.

Chalcopyrite has been found more than once as an accidental product in metallurgical operations, but bornite has never been described as formed in the same way, nor as produced artificially by sublimation.

Both these minerals form at the smelter of the Butte and Boston Consolidated Mining Co., at Butte, Montana. They form slowly, attaining their maximum thickness of about four inches in the course of six months to a year. They form in the Allen-O'Harra calciner along the rails in the bed of the furnace. In fact, they not only form beneath the flanges of the rails, but also slowly replace the rails themselves. When the rails are taken out they have only a thin upper surface layer of iron remaining; all the rest has been transformed into chalcopyrite and bornite, with the exception of that portion of the rails completely embedded in the brick bed of the furnace. An examination of these sulphides shows that, while they are somewhat impure from mechanically admixed quartz and perhaps some other foreign matter, they exhibit the true characters and chemical composition of chalcopyrite, coated in places with films of bornite. Both minerals have been formed by sublimation, and not by fusion, since the temperature of the furnace never rises high enough to fuse the ores present. Since these minerals replace and destroy the iron rails of the calciner, their formation leads to the necessity of removing and replacing the rails with new ones once every ten or twelve months.

'Note on the Minerals Associated with Copper in Parts of Arizona and New Mexico': GEO. H. STONE.

In the mountain ranges of southeastern Arizona and southwestern New Mexico are numerous copper-bearing veins in limestones and shaley limestones of Carboniferous age. In respect to the kinds of copper compounds and the occurrence of quartz and hydrous gangue minerals, these veins are not very different from the copper-bearing veins of Colorado and the States northward. Fluorspar is rare, and the sulphates scanty. It is in respect to the kind and quantity of their anhydrous silicates that

they are notable. One of the common gangue minerals is pyroxene. Occasionally it occurs as distinct and easily recognizable four-sided needles. Generally it forms small columnar or stellate crystallizations that are scattered through the decomposed and partially replaced lime rock, or it may be enclosed in quartz. Sometimes it forms slabs of asbestos up to two inches in thickness having their fibers parallel and at right angles to the surface of the slab. In a few cases I noticed these slabs having their fibers interlaced in all directions, and then they are very tough and elastic. The pyroxene occurs both in limestones and in porphyry dikes that penetrate the limestones. Asbestos occurs as a gangue mineral at Ward, Boulder County, Colorado, and in some others of the mountain districts, but I have never seen it so abundant as in the Chiricahua range in Cochise County, Arizona. Another common mineral in the veins in question is epidote. It occurs filling small cavities both in limestones and porphyries, and is very common as a product of contact metamorphism. But now and then it occurs in large quantities as gangue material proper. Thus in the California Mining District in the Chiricahua mountains there is a copper-bearing vein which for nearly a mile is composed of a solid mass of epidote wherever it has been opened by cuts and shafts. It is of various widths up to 5 feet. By far the most abundant of the anhydrous silicates in these veins is garnet. It is generally green, but occasionally brownish or yellowish green, and sometimes carmine or rose red. The copper is sometimes found impregnating the garnet mass, but more often occurs in porous quartz alongside of the larger garnet bodies. The garnets occur in irregular masses in the limestone, and often line drusy cavities. They are plainly a replacement of the limestone due to vein metamorphism of the country rock. In parts of the Chiricahua

mountains the copper veins are marked by belts of limestone more or less charged with garnet up to fifty or more feet in breadth.

In the region in question during the upheaval of the mountains, we find that where the strains were relieved by faulting and the uptilting of monoclinical blocks, the limestones retain their fossils and original amorphous condition. But where anticlines were formed there was much lateral (horizontal) pressure, the limestones are re-crystallized to a semi-marble, and the fossils are obliterated. This may be termed regional metamorphism. The same sort of recrystallization has taken place in the lime rock along the copper-bearing veins, and we may term it vein metamorphism.

'The Minerals and Mineral Localities of Texas': FREDERIC W. SIMONDS.

There has been, so far as the author is aware, no attempt to list in a complete form the mineral species occurring in Texas. In the 'Mineral Resources of the United States,' for 1882 (Washington, 1883), Professor John C. Smock, of the Geological Survey of New Jersey, who was charged with the preparation of the material illustrative of the 'Eastern Division,' published two tables for the purpose of showing the mineral resources of Texas. The first included 'Ores, Minerals and Mineral Substances of industrial importance and known occurrence, which are at present mined'; and the second, 'Ores, Minerals and Mineral Substances of industrial importance and known occurrence, but which at present are not mined.' Of the former, eight are mentioned; of the latter, 32. In the 'Mineral Resources' for 1887 (Washington, 1888), the same tables, with slight modification, mainly in the matter of additional localities, are repeated. In the First Annual Report of the Geological Survey of Texas (Austin, 1890), Mr. W. von Streeruwitz published a list of minerals, 63 in number, observed in the Trans Pecos

region, but the details of occurrence and localities were, unfortunately, not given (pp. 225-226). In the same volume, Dr. Theo. B. Comstock records 111 minerals collected in the 'Central Mineral Region'—the Llano country. This 'includes only those which occur as crystals or in special or rare situations,' and is regarded by him not as complete, but as affording a 'preliminary list of localities' (pp. 379-391). A list of those minerals and rocks of Trans Pecos Texas which, up to this time, could be classified by their appearance, blow-pipe tests and laboratory work, constitutes Chapter IV. of a 'Report on the Geology and Mineral Resources of Trans Pecos Texas,' by W. H. von Streeruwitz (Second Annual Report of the Geological Survey of Texas, pp. 710-713, 1890). It is, as the writer states, "far from being complete, but it comprises a number of the more important and valuable minerals, building stones and ores of west Texas, giving the localities where they were found." Unfortunately, the State does not possess a collection containing all minerals which I have thus far been able to list; and, as a consequence, the information concerning this occurrence has been derived from many sources, viz.: from a careful examination of the various reports relating to the geology of the State and its resources, keeping in mind at all times the value, as far as it could be estimated, of the observer as an authority. On the same basis, the various scientific journals have been gone over, and the 'transactions' of the different learned societies. Thus far, I have recorded as occurring in Texas one hundred and fifty minerals, varieties, and mineral substances, exclusive of rocks, of which eight are at present of economic importance, viz.: petroleum, coal, lignite, limonite, salt, gold and silver. Of localities the number has, even within the last few months, been enormously increased.

'Note on the Extinct Glaciers of New Mexico and Arizona': GEO. H. STONE.

In southwestern Colorado there were once extensive glaciers on the La Plata and San Juan mountains. The largest of these was 70 miles long and filled the valley of the Las Animas river. It deposited a terminal moraine just north of Durango, Colo., but appears not to have reached so far south as the 37th parallel of latitude. In New Mexico east of the Rio Grande the only extinct glaciers that I have been able to trace were along the high range that forms the southern extension of the Sangre de Christo range of Colorado. Each lateral valley of this range contained its glacier both in Colorado and as far south in New Mexico as a point not far north of Santa Fe. In the region south of the Galisteo are the Ortiz, San Pedro, San Dias, Pederal, Gallina and Jicarilla mountains. I have visited all these mountains and found no proof of the former existence of glaciers. South of White Oaks is a lofty north and south range—the Sierra Blanca. It is the highest range in that part of New Mexico, probably rising to near 11,000. It is a place of great snowfall, as its name signifies. In valleys of northern exposure I found large masses of snow late in June. I was not able to find moraines. West of the Rio Grande the main southeast spur of the San Juan mountains passes into New Mexico as the Conejos range. This range falls rapidly toward the south and was glaciated for not more than 30 to 50 miles south of the Colorado-New Mexico line. South of this there are no mountains in western New Mexico so high that we could expect to find traces of glaciers on them until we reach the lofty Mogollons. They have a heavy snowfall. They are rather inaccessible and I have not visited them. I have explored the higher mountain ranges that lie south of the Gila river in New Mexico and Arizona, but no moraine

or other sign of a glacier was I able to find. The farthest south and west I have found traces of extinct glaciers is at Prescott, Arizona. Around Prescott are numerous moraines. The highest part of the névé of this glacier could not have been much above 9,000 feet. The central part of the glacier is approximately in N. Lat. 34° 30'. The occurrence of an ancient glacier so far south as this was probably due to a very great snowfall owing to the proximity of the ocean. It is doubtful if there was any mountain range high enough to have had its glaciers in glacial time between Prescott and the Sierra Nevada. Probably there were then small glaciers in some of the cirques of northern exposure among the mountains directly southeast of Prescott. We may yet find that the glaciers reached their southern limit in the Mogollon mountains of New Mexico and Arizona.

'The Pre-glacial Surface Deposits of Lower Michigan': A. C. LANE.

Some years ago in working out the general system of drainage of the basin of the Great Lakes, before it was disarranged by the ice from the north, Professor J. W. Spencer drew a sketch map indicating the great streams flowing down to Lake Michigan and Saginaw Bay and joining the Laurentian River, which flows off across Canada. In this scheme of drainage he has been followed by most of the writers since, and his work has been somewhat elaborated by Mr. E. H. Mudge in an article in the *American Journal of Science*, Volume 4, 1897, page 383. There were, however, certain arguments against the idea that the center of lower Michigan drained through the Saginaw Bay. Directly in the mouth of the bay is a group of islands, the Charity Islands, which are composed of cherty, sub-Carboniferous limestone, of about the age of the Upper St. Louis. On both sides of the bay occur outcrops of the same limestone. The mouth of the bay is shallow,

and the ledges of limestone can almost be traced continuously across it not far below the lake surface, and as the elevation of the bed rock surface around in Bay County is, as Spencer and others have remarked, considerably below the present lake surface, it seems hard to assume that any river used to flow northeast out of the Bay. The results of my studies of the rock surface topography of Huron County, published in Volume 7 of our reports, based on the extensive lists of borings catalogued there, showed clearly a river system flowing southeast, gathering strength. Again when I came to discuss the general subject in Water Supply Paper No. 30, it became evident that the Saginaw lobe of ice did not advance as far, proportionately, as Michigan or the Huron-Erie, being retarded, apparently, by this limestone ridge. And, moreover, the result of borings for coal, oil, gas and salt throughout the Saginaw valley made it pretty clear that, before the ice age this valley did not drain as at present, but to the west and northwest. The evidence which I presented on this point, in Water Supply Paper No. 30, was very candidly accepted by Mr. Mudge, who at the same time pointed out some emendations in detail. Since, however, authors are still following Spencer, it may not be inappropriate to call attention to the subject once more and to present some of the elevations above tide which make it reasonably certain that the drainage of lower Michigan was to the northwest. The coal basin of Michigan is surrounded by a series of ramparts of which the sub-Carboniferous limestone, Marshall sandstone, Devonian limestone and Niagara limestone are the most important. It is probable that in the neighborhood of Saginaw Bay all these ramparts were broken down by pre-glacial rivers, except the innermost, curved to the right and left, so that finally when the ice overrode this the lobe

extended in the general direction of the ice motion, that of Saginaw Bay. The shore of Saginaw Bay has now been so completely lined with borings that it is not conceivable that any valley of the first order 300 feet below lake level can go out that way, while it is only a few miles south, in Saginaw County and west of it, that we find bed rock elevations of only 300 and 400 feet below tide. The west part of the State is so heavily covered with drift that our information regarding the bed rock surface is much more scanty, but we know that in the northwest part, bed rock surface is below sea level. The great group of lakes resembling somewhat the Finger Lakes of New York, and the bays which are associated, Great and Little Traverse Bays, require special explanation, and seem to find it in some large pre-glacial valley that had irregular pre-glacial topography, such as would be found where the escarpments of the middle and lower Devonian limestone come close to master valleys. It seems to me possible that before the last ice age the main streams connecting the valley of Lake Michigan with that of Lake Huron may have passed from just north of Petoskey to somewhere near Cheboygan; at any rate, there was a considerable stream there. So far as the present indications of levels are concerned, it would seem as though the *streams were flowing to the south rather than to the north*, but before we can settle this question, we must hear from the geologists of other States.

The following papers were also read before the American Geological Society and the Section.

1. 'Account of the Colorado Excursion': C. R. VAN HISE.
2. 'Junction of the Lake Superior Sandstone and the Keweenaw Traps in Wisconsin': U. S. GRANT.
3. 'Hydrographic History of South Dakota': J. E. TODD.

4. 'The Still Rivers of Western Connecticut': W. H. HOBBS.

5. 'Geology of the Northeast Coast of Brazil': JOHN C. BRANNER.

6. 'Classification of the Geological Formations of Tennessee': JAMES M. SAFFORD.

7. 'Horizons of Phosphate Rock in Tennessee': JAMES M. SAFFORD.

8. 'The Oscillations of the Coast Ranges of California': A. C. LAWSON.

9. 'Some Features of the Geology of Golden, Colorado' (a paper preparatory to the excursions in Morrison and Golden on Tuesday and Wednesday): H. B. PATTON.

10. 'The Geological Occurrence of Oil in Colorado': A. LAKES.

11. 'Report on Some Studies Relative to Primal Questions in Geology': T. C. CHAMBERLIN.

12. 'A Plea for Greater Simplicity in the Language of Science': T. A. RICKARD.

13. 'Sandstone Intrusions near Santa Cruz, California' (lantern illustrations): J. F. NEWSOME and J. C. BRANNER.

14. 'On the Pleistocene Deposits of Iowa' (lantern illustrations): SAMUEL CALVIN.

15. 'Problems of the Quaternary Deposits of the South Platte Valley': GEORGE L. CANNON.

16. 'Physiography of the Boston Mountains, Arkansas': A. H. PERDUE.

17. 'A Quantitative Study of Variation in the Fossil Brachiopod *Platystrophia biforta*, Schl.': E. R. CUMINGS and A. V. MAUCK.

MEMBERSHIP OF THE AMERICAN ASSOCIATION.

THE following have completed their membership in the American Association for the Advancement of Science during the month of October:

Hendery Allison, M.D., 149 Richmond Terrace, Port Richmond, N. Y.

Jacob H. Arnold, Teacher of Natural Science, Redfield College, Redfield, South Dakota.

Samuel M. Bain, Professor of Botany, Univ. of Tenn., Knoxville, Tenn.

Dr. Philip P. Calvert, Professor of Zoology, Biological Hall, Univ. of Pa., Philadelphia, Pa.

John J. Davis, Attorney-at-law, Clarksburg, W. Va.
Miss Anna M. Deens, Botany and Zoology, 216 North Ave., W., Allegheny, Pa.

Miss Abigail C. Dimou, Zoology, Radnor Hall, Bryn Mawr, Pa.

Manuel V. Domenech, Civil Engineer and Architect, Lock Box 151, Ponce, Porto Rico.

Fred. N. Duncan, Chemist, Georgetown, Texas.

Gano S. Dunn, Electrical Engineer, Crocker-Wheeler Co., Ampere, N. J.

Edward M. Ehrhorn, County Entomologist, Santa Clara Co., Mountain View, Cal.

Sumner B. Ely, Mechanical Engineer, Vandergrift Building, Pittsburg, Pa.

Robert Gauss, Editor *Denver Republican*, Denver, Colo.

Professor Chas. B. Gilbert, Educator, 106 Brunswick St., Rochester, N. Y.

Charles P. Greenuough, Attorney-at-law, 39 Court St., Boston, Mass.

Mrs. Margaret L. Griffin, Botany and Geology, Keene, N. H.

Wm. C. A. Hammel, Department of Physics, State Normal School, Baltimore, Md.

Judge Lynde Harrison, Lawyer, 52 Hillhouse Ave., New Haven, Conn.

Edwin Hebden, Principal, Group A, Public Schools, 730 Colorado Ave., Baltimore, Md.

Ray V. Hennen, Civil Engineer, care of Carter Oil Co., Sistersville, Tyler Co., W. Va.

Sidney Hosmer, Electrical Engineer, 3 Head Place, Boston, Mass.

Edward H. Kraus, Instructor Mineralogy, Syracuse Univ., 615 Butternut St., Syracuse, N. Y.

Lucinus S. McCoy, Whitten, Hardin Co., Iowa.

George D. Markham, 4961 Berlin Ave., St. Louis Mo.

Hu Maxwell, Treasurer Transallegheny Historical Society, Morgantown, W. Va.

Miss Florence Parker, Geology, 10,340 Longwood Ave., Chicago, Ill.

John Patton, Counsellor-at-law, 925 Mich. Trust Co. Bldg., Grand Rapids, Mich.

Samuel K. Reifsnnyder, Instructor Science, High School, 73 Embury Ave., Ocean Grove, N. J.

Dudley S. Reynolds, M.D., Louisville, Ky.

James F. Rhodes, Author and Historian, 392 Beacon St., Boston, Mass.

Maurice Ricker, Zoology, High School, Burlington, Iowa.

Milnor Roberts, Professor Mining and Metallurgy, Univ. of Washington, Seattle, Wash.

Sanford Robinson, Civil and Mining Engineer, Steeple Rock, Grant Co., New Mexico.

David J. Satterfield, D.D., President, Scotia Seminary, Concord, North Carolina.

Miss Clara B. Sayre, South Bethlehem, Pa.

Wm. J. Sutton, Geologist, Esquimalt & Nanaimo Ry. Co., Victoria, B. C.

E. S. G. Titus, Entomologist, Nat. Hist. Bldg., Urbana, Ill.

David M. Totman, M.D., Physician and Surgeon, 303 Montgomery St., Syracuse, N. Y.

Andrew J. Townson, President, Board of Education, Granite Building, Rochester, N. Y.

Dr. Frederick C. Waite, Assistant Professor of Histology and Entomology, Medical Dept., Western Reserve Univ., Cleveland, Ohio.

Charles R. Walker, M.D., Concord, New Hampshire.

Joseph R. Watson, Professor of Natural Science, Berea College, Berea, Ky.

Wm. G. Wilkins, Professor of Mining Engineering, Western Univ. of Pa., Westinghouse Bldg., Pittsburg, Pa.

THE AMERICAN MICROSCOPICAL SOCIETY.

THE twenty-fourth annual meeting of the Society was held in Denver, August 29 to 31. As anticipated, the attendance was not large, yet the strong series of papers presented and the completion of the Spencer-Tolles Fund make the occasion a noteworthy one. At the business session on Thursday there were read reports of the secretary, treasurer and custodian on the condition of the Society, and the usual committees were appointed. Some minor changes in the by-laws of the Society were recommended and subsequently adopted. The report of the Committee on the Spencer-Tolles Fund showed that it had finally been brought to the limit of \$1,200, set at the New York meeting, and recommended that a specific sum be set aside yearly from the income for the encouragement of such definite research of a microscopical character as shall be approved. The committee reported \$50 available for use in the current year, and the final apportionment of the amount was left to the Executive Committee.

The meeting on Thursday evening was

in charge of the Colorado Microscopical Society. After an address of welcome by the president of that organization, Dr. A. M. Holmes, and a response by the retiring president of the American Microscopical Society, Dr. A. M. Bleile, the annual address was read by the incoming president, Dr. C. H. Eigenmann, on 'The Solution of the Eel Question.' The paper was illustrated by both charts and lantern slides and proved of great interest. At the close a most pleasant informal reception was tendered the visiting society and guests by the Colorado organization, to whom most cordial thanks are due for many hospitalities.

The following papers were among those presented at the general sessions of the Society:

'The Early Morphogenesis and Histogenesis of the Liver in the Pig': D. C. HILTON, Chicago, Ill.

'The Histology of the Stigmata and Stomata in the Peritoneum': A. E. HERTZLER, Halstead, Kas.

'A Rearrangement of the Families and Genera of the Conjugatæ': C. E. BESSEY, Lincoln, Neb.

'A New Species of *Crinothrix* (*C. manganifera*): D. D. JACKSON, New York City.

'The Amount of Dissolved Oxygen and Carbonic Acid in Natural Waters and the Effect of these Gases on the Occurrence of the Microorganism': G. C. WHIPPLE and H. N. PARKER, New York City.

'Notes on Colorado Protozoa, with Description of New Species': A. E. BEARDSLEY, Greeley, Col.

'Notes on Colorado Entomostraca': A. E. BEARDSLEY, Greeley, Col.

'A Review of the American Species of *Cochleophorus* and *Curvipes*': R. H. WOLCOTT, Lincoln, Nebr.

'An Apparently New *Hydra* from Montana': M. J. ELROD, Missoula, Mont.

'Some Histological Features of *Echinorhynchi*' (Illustrated): H. W. GRAYBILL, Lincoln, Neb.

'The Debt of American Microscopy to Spencer and Tolles': W. C. KRAUSS, Buffalo, N. Y.

'Mounting Soft Tissues for Microscopical Examination': M. A. D. JONES, New York City.

'Modification of Some Standard Laboratory Apparatus': S. H. GAGE, Ithaca, N. Y.

'Laboratory Photographic Apparatus': S. H. GAGE, Ithaca, N. Y.

'The Plankton of Lake Maxinkuckee, Ind.': CHAUNCEY JUDAY.

The following officers were elected for the year 1901-02 :

President, Dr. Charles E. Bessey, University of Nebraska, Lincoln, Nebr.

First Vice-President, Dr. E. A. Birge, University of Wisconsin, Madison, Wis.

Second Vice-President, Mr. John Aspinwall, New York City.

Elective Members of the Executive Committee, Dr. A. M. Holmes, Denver, Col.; Dr. V. A. Latham, Chicago, Ill.; Mr. G. C. Whipple, New York.

Secretary, Dr. Henry B. Ward, University of Nebraska, Lincoln, Nebr.

Treasurer, Mr. J. C. Smith, New Orleans, Louisiana.
Custodian, Mr. Magnus Pflaum, Pittsburg, Pa.

Resolutions of regret at the death of ex-President E. W. Claypole, the sad news of which came to the Society as it was in session, were read and ordered spread upon the minutes of the Society.

HENRY B. WARD,
Secretary.

TOTAL ECLIPSE OF THE SUN.*

AMONG the unsolved problems for the twentieth century are many relating to the central luminary of our system. Many points of scientific interest to students of solar phenomena are still to be discovered, and it is true that when we come to consider what we do not know about the sun, we are rather startled to find our knowledge about the heavenly body which has most interest to us human beings so incomplete. The distance is not known to the accuracy which we wish it, and very little is known of the laws of motion at the surface of the sun or the manner in which light and heat are sent out. The spectroscope tells us what metals are present at the surface of the sun, but, as yet, it has not decided the question of the extent of the different gases, nor the position of the 'reversing layer.' In fact, the very existence of the 'reversing layer' has been disputed. The most beautiful of all natural

phenomena, the corona, is to us an unsolved mystery. Much time has been spent delineating its form, and in late years some connection has been established between the form of the corona and the sun-spot period; but what is the meaning of this connection? and in turn, what is the relation between sun spots and terrestrial magnetism? The spectroscope tells us that 'coronium' forms a constituent of the corona, but what is 'coronium'?

These and many other points are still to be solved by astronomers and physicists. Their solution depends almost entirely on the observations, on the average, of only a few minutes each year, for it is only when the sun is eclipsed that most of these problems can be investigated.

The United States government recognized the importance of these inquiries, and through Congress appropriated money to equip and send out an expedition to observe the eclipse of the sun visible in the island of Sumatra in the East Indies, on May 18, 1901.

This expedition consisted of thirteen, a number which would have caused terror to enter the hearts of people less sensible than astronomers. This is the largest party, we believe, ever sent out by any government for such a purpose.

The thirteen were made up of two separate parties, two members, Professor C. G. Abbot and his assistant, Mr. Draper, representing the Smithsonian Institution, and eleven the Naval Observatory. Six belonged to the staff of the observatory, and consisted of Professor A. N. Skinner, U. S. N.; Professor W. S. Eichelberger, U. S. N.; Professor F. B. Littell, U. S. N.; Mr. L. E. Jewell, Mr. W. W. Dinwiddie and Mr. G. H. Peters. The remainder of the party was made up of Professor E. E. Barnard, Yerkes Observatory; Dr. W. J. Humphreys and Mr. H. D. Curtis, of the University of Virginia; Dr. N. E. Gilbert, of Hobart College, and the writer.

* Read before the New York Academy of Sciences, November 4, 1901.

The members crossed the continent by various routes, meeting together for the first time in San Francisco. Transportation was furnished by government steamers, and on February 16, on board the army transport *Sheridan*, the expedition started to demonstrate that the earth is round by sailing west in order to reach the East Indies. The Army was to care for the party as far as Manila, and from there to Sumatra the Navy Department was to attend to us. Life on board the transport was very pleasant, many entertainments being provided by the officers, soldiers—and astronomers, too—to while away the hours.

Honolulu was reached the morning of February 25. A three days' stay there enabled the party to see most of the sights of the island of Oahu, making a most pleasant break in our voyage of thirty days to Manila. The Social Science Club of the Hawaiian Islands was exceedingly kind to the astronomers. Among the courtesies shown was a drive up the historic Pali, a huge precipice with a sheer drop of 500 feet, over which one of the old kings is said to have driven his enemies to their death. In the evening a meeting of the club was held at which Professor Barnard gave one of his interesting illustrated talks. The three days' stay was exceedingly interesting, giving an excellent opportunity of seeing how the United States was progressing in the government of his new outside dependencies.

The 180th meridian was crossed at 11:40 on the night of March 4, and as a result our day of March 5 was of only twenty minutes' duration. On crossing the line, Father Neptune and his court paid the ship a visit, the celebration of which was greatly enjoyed by soldiers, sailors and passengers.

Manila was reached on March 18, and a stop of eight days was made while arrangements were made with the Navy Department to carry us the remaining 2,200 miles

to Sumatra. The Manila observatory, which was visited several times, is doing an exceedingly important work, the value of which is recognized by the United States authorities. The predictions for typhoons come from the observatory, and in view of the enormous shipping of the port, this service is invaluable. A time service and weather bureau with 76 stations are about to be instituted by the observatory authorities. Of course, the most interesting sights to Americans were the Spanish wrecks at Cavite, monuments to the valor of Admiral Dewey.

The U. S. S. *General Alava*, a former Spanish ship, was put at the disposal of the expedition, and on March 26 we set sail for Sumatra. Pleasant weather was experienced through the China and Java Seas. The equator was crossed on March 31, and 'Neptunus Rex' was celebrated in true man-of-war style.

On April 2, the ship passed within half a mile of Krakatau, excellent opportunity thus being given to see this historic volcano. Where, before the eruption of 1883, had been a hill of perhaps 1,000 feet, bottom is now not reached at the depth of 164 fathoms.

On April 4, the *General Alava* steamed into the beautiful harbor of Emma Haven, the port of Padang, the capital of the island of Sumatra, and a first glimpse was obtained of the Malay, with whom the next two months were to make us so well acquainted. We were the first astronomical expedition to arrive, ours being, in fact, the first American ship which ever entered port there. But in a few days Professor Perrine and the astronomers from the Massachusetts Institute of Technology arrived, to be soon followed by parties from England, Holland, France, Russia, Japan and India.

It took some time to get accustomed to the East Indian ways, particularly the cus-

toms of eating and bathing, and many amusing incidents were the result. In the East Indian hotels the bath rooms are away out in the yard, a hundred yards or more from your bedroom. There is no bath-tub like ours—in fact, plumbing of any sort is unknown there—and the bath is taken by dipping water from a cistern by means of a bucket and throwing it over yourself—and a very good bath it gives, too. One of our English friends mistook the cistern for his tub, and got in, greatly to the consternation of the Malays.

The Dutch did everything in their power to make our stay in the island pleasant, with the result that everything was accomplished with remarkably little trouble and difficulty. Free passes were furnished to all astronomers, all freight was transported without charge, and laborers, consisting mainly of convict coolies, were furnished in as large numbers as were wished. In fact, too much cannot be said in praise of the courtesy and kindness of the Hollanders to all the foreign astronomers. The scientists became known so quickly to the Dutch and Malays, that 'Zoneclips' soon became the talisman that made all things work together for our good.

Before reaching Sumatra it had been decided to divide the expedition into two parts, the main portion going to Solok, near the central line of totality, and a smaller number to Fort de Koch, near the northern limit of the path; both stations being on the line of the 'Staatspoorweg op Sumatra,' the government railroad running about 100 miles inland. After two weeks' stay in the island, and in view of the fact that so much cloudy weather was experienced each day at the time of totality, it was decided best to still further divide the expedition. Consequently, another station was established at Sawah Loento, the terminus of the government railroad, twenty miles beyond Solok.

The American governmental party was thus divided into three. Everybody was hard at work by the middle of April, but as we had to depend on Malay bricklayers and carpenters, work did not progress as rapidly as was desired. These *orang tukang* are frightfully slow, always squatting down to work, and using tools of the most primitive sort. It was a sore trial, indeed, seeing everything proceed at such a snail's pace, but by dint of hard labor, and much talking of Malay on our part, with several English expletives thrown in, everything was all up and adjusted in good time.

At Solok, where the main part of the expedition was located, an almost ideal spot was found for an eclipse camp. This was an old fort recently evacuated by the Dutch, the buildings serving as most excellent sheds for storing the instruments. Professor Barnard had with him the 61½-foot lens with which he obtained such good results at the 1900 eclipse at Wadesboro. This was used in connection with a cœlostat, the telescope tube being horizontal, and ending in a dark room where the plates, in holders, were to be placed on a sliding carrier at eclipse time. One plate used by him, measuring 40 x 40 inches, was to be exposed at the middle of totality for two minutes and a half. The other plates were 30 x 30 and 11 x 14, but notwithstanding their great weight, so carefully was the construction looked after that the plates were changed remarkably quickly. True, totality lasted 5 min. 51 sec. at Solok, but the seconds are valuable, even with such a great duration.

Professor Abbot was prosecuting his researches along two lines. With a highly sensitive bolometer, which has been brought to such a high degree of excellency at the Smithsonian Institution, he was investigating the heat of the moon and the corona; and with four photographic lenses of 11 feet focus, searching for intra-Mercurial plan-

ets. A region about $20^{\circ} \times 24^{\circ}$ was covered in the vicinity of the sun, and the exposures were duplicated in order to check all suspected objects.

The spectroscopic work was under the general direction of Mr. Jewell. He himself used a 21-foot concave grating, used without slit as an objective grating. Mr. Dinwiddie employed a 6-inch prismatic camera, and Professor Littell a flat grating with slit, in order, if possible, to detect the rotation of the corona. Professor R. W. Wood's apparatus was used by Dr. Gilbert, and several small cameras by Mr. Curtis.

At Fort de Koch were two instruments, the 40-foot photoheliograph and the spectroscope in charge of Mr. Peters and Dr. Humphreys, respectively. The latter was a direct concave grating used without slit, and had a ruled surface of 8×5 inches. It was one of the last gratings ruled by Schneider under the direction of Professor Rowland, and was the largest grating ever made. Unfortunately, the diamond broke down in the middle of the ruling, and it was found necessary in Sumatra to cover up half of the grating; but notwithstanding this fact, spectra of remarkable brilliancy and definition were obtained.

At Sawah Loento were placed two instruments under the direction of the writer. The spectroscope was a 6-inch flat grating of 15,000 lines, used without a slit in connection with a quartz lens of 72-inch focus. The camera had a focal length of 104 inches and an aperture of 6 inches, which, however, was stopped down to $4\frac{1}{2}$ inches.

This was the instrumental outfit of the governmental parties.

At Sawah Loento were also situated the Massachusetts Institute party, and Mr. and Mrs. Newall, of Cambridge, England, the work of the former embracing a general photographic program, together with investigations of the magnetic disturbance during the eclipse. Our English cousins had some

very important spectroscopic problems to carry out.

The three stations situated within fifty miles of the equator had difficulties to contend with that could not be shouldered on to the backs of the Malays. The hot tropical country requires a great amount of rain, and from our experience it seems to get all it needs. At Padang, according to the meteorological reports, there is an annual rainfall of 187 inches, an average of half an inch each day. In fact there is seldom a day without rainfall. Up to the first of May, the sun had hardly been seen by us in Sumatra. The result was that great difficulty was experienced in getting enough clear weather to adjust the instruments, the nights being as cloudy as the days. Professor Barnard carried with him some portrait lenses in order to continue his photographic work on the Milky Way, and carry his investigations into the southern heavens. Those who know Professor Barnard will acknowledge that he tried hard enough to make the exposures, but he failed, owing to continued cloudy weather, to get a single fully exposed plate.

As the time approached closer and closer to the day of the eclipse, great concern was felt as to the probability of a clear sky for the all-important six minutes shortly after noon, on the day of May 18, 1901.

At Sawah Loento it dawned clearer than it had been for a week, but about eight o'clock it clouded up and dashed the hopes of everybody to the ground. About ten it cleared beautifully, and our hopes soared again. First contact was observed with a perfectly clear sky, but soon clouds began to gather, and half an hour before totality the sky was completely overcast.

A direct-vision spectroscope was employed to watch the 'flash,' but so cloudy was it that the first 'flash' passed unnoticed and the total phase had begun before we were hardly aware of it. It remained

cloudy throughout the eclipse, but was a trifle clearer than at the beginning of totality, so that the 'coronium' line was very well seen. The second 'flash' appeared stronger than we would have thought possible through the clouds. The reappearance of the sun was welcomed by a shout from the Malays assembled in the valley.

On the spectrographs taken during totality nothing of the coronal spectrum was visible. The hydrogen lines H and K appeared, but these were due to the upper chromosphere. Although an exposure was made about the time of the first flash, nothing was found of this on the photographic plate. The second flash, however, showed more than was expected, and gave results fairly well developed. The photographs of the corona showed an extent of about a diameter, but with very few details of streamers.

At Solok the weather was even worse than at Sawah Loento; so dense were the clouds, in fact, that the position of the sun could hardly be seen. Mercury and Venus, which were visible at Sawah Loento throughout totality, were seen only for a few seconds at Solok. So cloudy was it that Professor Abbot did not even attempt anything with his bolometer. With the exception of this, all other programs were carried out as if it had been clear. The results, however, were almost *nil*. Where Professor Barnard had hoped for marvelous results of detail on his large 40 x 40 plate, hardly a trace of even a prominence was seen.

One hour after the eclipse was all over, the clouds cleared away, and a beautiful blue sky remained for the rest of the day. Alas! that the eclipse did not occur at one o'clock instead of at twelve.

A few hours after the work was over at Solok, word came to the despondent people there, that at Fort de Koch the weather had been perfect and that the program had

been carried out without a hitch. This was good news indeed. Several excellent spectrographs were obtained with the concave grating; the photographs taken with the 40-ft. showed splendid detail in the polar and equatorial streamers. Thus it happened that one party of the American expedition met with perfect success, one with partial success, but the third with no results at all to show for the hard work and time spent.

The other observers in Sumatra fared about as well as did the Naval Observatory party, the clouds being general over the region covered by the scientists. Nowhere else were they as dense as at Solok, but at no place where an astronomical expedition was located were perfect weather conditions experienced except at Fort de Koch.

To meet such a perplexing state of affairs is rather disappointing after traveling half way around the world in search of scientific knowledge, but it is to be expected when the object of investigation is the sun. The conditions were not so bad as at the eclipse of 1896, when no sun at all was seen, but, coming so soon after the 1900 eclipse which was so generally observed in this country, and with such perfectly blue and tranquil skies, the contrast was anything but pleasant.

At Sawah Loento, totality lasted 5 min. 41 sec. The chromosphere and prominences at mid-totality would, it would have been thought, have been so thoroughly covered up that the atmosphere would not have been lit up to any great extent, and consequently it would be very dark during totality. This was expected, and to prepare for it lanterns were got ready to aid the time-keepers and observers to see. But the expected did not happen, and at no time during totality was it too dark to see the hands of an ordinary watch. In fact, it was hardly any darker than at the eclipse of last year, which the writer saw from

Griffin, Ga., situated near the northern edge of the path of totality and experiencing a duration of only 38 sec. The reason for the brightness of the air was evidently the sun shining on the clouds, which in turn illuminated the atmosphere. The clouds were cirro-cumulus, and, no doubt, very high.

It is almost too early to tell just how much our knowledge of the sun has been increased, but it is certain that much of scientific value will be added to science as a result of the observations of the eclipse of May 18, 1901.

To astronomers the voyage itself was interesting in showing the stars of the southern hemisphere, and in losing sight for a couple of months, of Polaris, the star that appeals to all of us as a personal friend.

Perhaps, outside the eclipse, the most striking feature of the expedition astronomically was the independent discovery on May 3 of the great comet, the honor belonging to Mr. Dinwiddie of the Naval Observatory. It was indeed a magnificent sight, appearing shortly after sunset, with a sweeping tail visible to the naked eye for more than eight degrees in length. We watched eagerly during every clear night—but unfortunately there were not very many beautiful nights—and it was photographed by Professor Barnard. But, if the great comet was seen, the sudden outburst of the star in Perseus escaped our attention. After leaving San Francisco, heavy weather and cloudy nights were experienced till after leaving Honolulu, February 28. As there is as yet no cable to the Hawaiian Islands—but this, we hope, is to come in the near future—no tidings were received of the new star until after the arrival of the party in Sumatra, when Perseus was no longer visible.

The expedition arrived in San Francisco July 16.

The next eclipse that will be generally

observed is that of August 30, 1905, which will be visible in Labrador, Spain, and northern Africa. The points of investigation will be along the same lines as carried out by the American parties, but it is to be hoped that better weather conditions will be experienced than in the Sumatra eclipse of May 18, 1901.

S. A. MITCHELL.

COLUMBIA UNIVERSITY.

SCIENTIFIC BOOKS.

Alaska: Volume I., Narrative, Glaciers, Natives, by JOHN BURROUGHS, JOHN MUIR and GEORGE BIRD GRINNELL; Volume II., History, Geography, Resources, by WILLIAM H. DALL, CHARLES KEELER, HENRY GANNETT, WILLIAM H. BREWER, C. HART MERRIAM, GEORGE BIRD GRINNELL and M. L. WASHBURN. New York, Doubleday, Page and Company. 1901. [Superimprinted] Harriman Alaska Expedition, with the cooperation of the Washington Academy of Sciences. [Edited by DR. C. HART MERRIAM.] With 39 colored plates, 85 photogravure plates, 5 maps and 240 text figures. Pp. xxxvii + 383. Price, \$15.

The Harriman Expedition of 1899 was one of the scientific events of that year; and the issue of this sumptuous summary of results is one of the literary events of the current year. Conceived as a pleasure trip, matured in mind as a summer school for a family and a few friends, the Harriman outing took final form as an expedition for research in a region of paramount present interest to science, industry, commerce and public policy. The sea trip—the essential part of the expedition—was made in the steamer *George W. Elder*, with an aggregate personnel (including officers and crew) of 126. The 'scientific party' numbered 25, and there were three artists, two photographers, two stenographers, a surgeon, an assistant surgeon and a trained nurse, besides eleven hunters, packers and camp hands. Nor was the 'scientific' corps such in name only; none were smatterers, and all ranged from distinction through eminence to preeminence in their respective lines, which included anatomy, botany,

engineering, ethnology, forestry, geography, geology, mineralogy, ornithology, paleontology and zoology. Along all these lines the researches were energetic and successful; and the more general results are incorporated in the two volumes just issued, and in a series of special memoirs now in the course of publication by the Washington Academy of Sciences, but designed for ultimate reissue in volumes supplementary to those under notice. These volumes themselves, produced as they were by leading authorities, must form a standard source of knowledge concerning Alaska; and when the series is completed it will undoubtedly command a high place among the classics of place and country.

The body of the first volume opens with a narrative of the expedition by John Burroughs; then follow chapters on the 'Pacific Coast Glaciers,' by John Muir, and on the 'Natives of the Alaska Coast Region,' by George Bird Grinnell. The second volume comprises 'The Discovery and Exploration of Alaska,' by William Healey Dall; 'Days Among Alaska Birds,' by Charles Keeler; 'Forests of Alaska,' by Bernard E. Fernow; 'General Geography,' by Henry Gannett; 'The Alaska Atmosphere,' by William H. Brewer; 'Bogoslof, Our Newest Volcano,' by C. Hart Merriam; 'The Salmon Industry,' by George Bird Grinnell; and 'Fox Farming in Alaska,' by M. L. Washburn. There is also a preface by Mr. Harriman and an introduction by Dr. Merriam, together with an opening poem by Charles Keeler; while the work ends (save for the excellent Index) with an effective poem by Dall, captioned 'The Song of the Innu' and (somewhat tautologically) listed as 'The Innu' People.' It would be impracticable to abstract the papers prepared by the several contributors; it must suffice to note that they are, without exception, excellent, authoritative, well written, and carefully edited by a participant in the expedition, himself a recognized authority in scientific matters. Merely as examples, it may be noted that the chapter on glaciers came from the pen of the world's most sympathetic student of ice fields and ice streams; that the historical chapter was written by the leading authority on Alaskan exploration; and that the account of

Alaskan geography and the accompanying maps were prepared by our foremost practical geographer. The maps, although small, show the general features of the territory satisfactorily; they are, of course, quite up to date, embracing the results of all surveys up to 1900, including those of the expedition itself, as well as those of the U. S. Geological Survey and the U. S. Coast and Geodetic Survey.

The volumes are especially notable for the beauty and fidelity of the illustrations, most of which were based on photographs. The lithograph plates have never been excelled in delicacy and refinement of both color and form; many of them are pictorial gems, displaying landscape and waterscape, mountain and valley, flower and foliage, fur and feather, with a faithfulness seldom sought and never passed. The photogravures are of corresponding excellence; while the text figures combine artistic quality and graphic fidelity in remarkable degree. The typography, paper and binding are correspondingly sumptuous; so that the book is a thing of beauty as well as an object of utility.

Perhaps the most serious defect of the work (despite evident editorial care, which might well have been more prominently acknowledged) is the discontinuity naturally growing out of the multiple authorship; another defect, which must somewhat discommode librarians and dealers as well as students, is the absence of a definite title. 'Alaska,' indeed, stands out boldly on the title-page in carmine ink, while the publisher's imprint and the expeditionary superimprint and vignette are uniform, but otherwise the title-pages are diverse—and worst of all, the title on the back is not that of the book but that of the expedition. W J M.

Ind.
The Protozoa. By GARY N. CALKINS, Ph.D.
 Columbia University Biological Series, Vol. VI. New York, Macmillan Co. Price, \$3.

It is no easy task to compress into a volume of scarcely more than 300 pages a résumé of even the more important facts and theories relating to a large group of organisms like the Protozoa. The difficulty of the task is apparent when one stops to consider that the very position of the Protozoa in the animal kingdom has of necessity enveloped them in a nimbus of

biological speculation. They have been and will long continue to be the one group about which cluster the numerous theories of biogenesis, the origin of the Metazoa, the origin and significance of sex, heredity and death, the dawn of consciousness and instinct and innumerable problems of lesser magnitude. Dr. Calkins is to be congratulated on having worthily overcome, or at any rate adroitly avoided, many of the difficulties of this task. At the same time he has upheld the high standard of scholarship set by the previous volumes in the well-known 'Biological Series.'

As Dr. Calkins informs us in his preface, "The subject-matter of the volume is treated from three points of view: (1) The historical, to which the first chapter is devoted. (2) The comparative to which five chapters are given, one to the group of Protozoa as a whole, the other four to the main classes. (3) The general, to which three chapters are devoted. One of these is given to the phenomena of old age or senile degeneration in Protozoa and renewal of youth through the union of two individuals, and to the bearing of these phenomena upon sexual reproduction in general. Another is given to the special structures of nuclei and centrosomes of the Protozoa; this, the most technical chapter in the book, is introduced because of the growing importance which the Protozoa have in the problems of cellular biology, especially with those dealing with the origin of the division-center and its accompanying structures in the cells of the Metazoa. The last chapter is devoted to a consideration of the physiology of the Protozoa, with especial reference to the Protozoa as *organisms* endowed with the powers of coordination and of adaptation, which up to the present time have eluded physical and chemical analysis."

In pursuing this general plan the author has consistently resisted the temptation of involving himself in undue detail, and it is evident that he has everywhere striven to give proper shape and proportions to his work. In some parts of the volume, however, this brevity almost borders on meagerness and obscurity. The student who has long been irritated by the unsatisfactory text book accounts of the life-

histories of the Sporozoa will certainly wish that Dr. Calkins had expanded his excellent chapter on these organisms and introduced a fuller account of recent works on the Gregariniada and Hæmosporidia. We miss, *e. g.*, an account of *Apiosoma bigeminum*, the source of Texas fever, and its transfer by the cattle-tick (*Boophilus bovis*) in a manner analogous to the transfer of *Plasmodium malarix* by the mosquito (*Anopheles*). We should also have welcomed a fuller treatment of the geographical distribution of the Protozoa in general, their modes of dissemination and the phenomena of anabiosis.

Many morphologists and physiologists will wish that the author had dealt more critically with the conception of 'rejuvenescence,' a conception which smacks of 'Naturphilosophie' and is at most only an anthropomorphic 'Photographie des Problems.' The facts of parthenogenesis, both natural and artificial, appear flatly to contradict the assumption of Maupas and others that the temporary or permanent union of two exhausted cells results in one or two rejuvenated ones. This view was repudiated by Weismann on very good grounds several years ago.

The work of Calkins contains a classification of the Protozoa carried out to the families and genera. Unfortunately it is appended to three separate chapters and printed in such a form as to violate the very first rules of taxonomy. Classes, sub-classes, orders and suborders are all introduced in the same style of type and the various groups are coordinated in such a manner as to render a rapid and easy survey of the classification difficult, if not impossible. Taxonomy is the quintessence of our present morphological knowledge, and it is time that the prejudices of the narrow-gauge morphologist be not still further fostered by negligence in tabulating the essentials of the very science to which he is devoting himself with the characteristic myopia of one who sees not the forest because he is studying the venation of its leaves.

The volume is written throughout in a good, orderly style. Words like 'mononucleate' and 'unshelled,' in the sense of 'shell less' are conspicuously rare. The illustrations are clear, though occasionally too coarse for representations of such minute organisms. This is very

noticeable when they are compared with the delicate figures of Bütschli. Scarcely more than one tenth of the figures are original, and although the author has endeavored to avoid the commonplace in his selections from other writers, there is still a goodly array of the old and tiresome figures which seem to be as immortal as the Protozoa they represent, if one may judge from their perpetual metempsychoses in our zoological charts and text-books. The volume closes with an extensive, but by no means complete, bibliography and a good double index.

There can be no doubt that the volume should and will find a place in all our laboratories as a handy compendium of a marvelous group of organisms of basic importance in all our work in zoology, physiology and comparative psychology.

W. M. WHEELER.

Annual Report of the Chief of the Bureau of Steam Engineering. 1901. Washington, Government Print. 1901. 8vo. Pp. 70.

Admiral Melville reports in this document upon the condition and progress of the engineering branch of the United States navy, its personnel and material. The report is concise, clear, frank and illuminating. This Bureau has charge of all the machinery, of the navy, designs the engines, the boilers and machinery of the naval fleet, writes the specifications and contracts for such as may be built by private constructors, supervises the construction, makes the tests of completed machinery and has charge of the maintenance and repair of all such machinery. It expends \$3,000,000 to \$4,000,000 each year, mainly in repairs and preservation of the engines and boilers of the fleet. Of this work the report gives a detailed account, which is, however, not of special interest to the layman.

The new Naval Academy buildings, now under construction, are expected to cost about \$7,000,000. Admiral Melville asks that, of this total, about \$250,000 be applied to the construction of a laboratory for research in the physical sciences having direct application in engineering and marine construction. The building is to be two stories in height and 150 by 110 feet in plan, conforming in style of architecture

to the buildings, planned for the Academy, now in progress. It is proposed to appropriate \$150,000 for its equipment. This enterprise, if perfected, is another step in the direction of conforming the plan and workings of the Naval Academy to those of the great technical colleges of the world, and especially in the incorporation into its curriculum of experimental work in research as well as professional instruction.

With the resources of the general government available, the comparatively small expenditures needed to make the military and naval academies professional schools of the highest class, not only, as previously, in their organization and administration, but also in their equipment and in a complete and thoroughly modern curriculum, should be readily obtained, and these schools should take their rightful places as ideal, representative and model professional schools, in the extra-professional departments as well as in those which are purely vocational. In the applied sciences, particularly, they should be made perfect exemplars of the type which every civil as well as naval and military institution of learning should approximate as closely as means and the character of its faculty may permit.

Admiral Melville is pioneering here as effectively as when within the arctic circle and more usefully than ever did any explorer. He demands that the scientific departments of the Naval Academy, and especially the professional engineering division, be 'placed upon an equality with several universities whose colleges of mechanic arts and science in equipment far surpass the engineering outfit of the academy plant.'

The staff for this laboratory is to be organized from cadets and their teachers with, perhaps, one of the officers of the old engineer corps as its director. It is not only to be used in the investigation of the technical problems of the engineer department and of the naval service, but in the furtherance of the schemes of inventors where promising to be useful to the government or the public, also in testing all the appliances related to naval work; the materials and apparatus purchased by the Navy Department; and in the investigation of

especially important questions, such as relate to the economy of liquid fuel, the value of the steam-turbine, the form and proportions of propellers, the use of electricity and the value of electric apparatus and transmissions, the causes and preventions of corrosion of boilers, condensers and machinery, the best forms of boiler, the balancing of engines, the development of a storage battery suitable for naval use and the use of compressed air and of gas and oil engines.

The splendid work of the laboratories of the colleges and technical and professional engineering schools of our own country and, particularly, of Germany is referred to as illustrating the promise of this enterprise.

The Chief of Bureau devotes some space to the subject of the personnel and the organization of the naval establishment, stating that the 'Personnel bill' has thus far failed of complete and satisfactory result and asserting that it can only be expected that its purpose will be effected when the officers of the navy of every class cordially unite to carry its provisions into effect completely and efficiently. He quotes Mr. Roosevelt, who, in the original report upon this plan, asserted 'every officer on a modern war vessel has to be a fighting engineer.'

The union of the engineer corps with the line of the navy, however, has not been a complete success, so far as intended to provide the service with a body of officers equally at home above and below decks and capable of efficiently handling the great 'war-engine' in its every department and detail. The young officers should be given large and responsible charge of work in the engineering departments and trained as experts; otherwise that failure which was anticipated by many friends of the navy during the discussion of the bill, as a possibility if not a probability, must be looked for as certain.

It is stated that for every three officers taken from the engine-room for duty on deck, only one has been transferred from deck to engine-room, and the vitally essential care of motive power is coming thus to be impossible; unless, indeed, a radical change of method be adopted. The 'engineer's war-engine,' according to Roosevelt, must be in the care, each in his

province, of a crew of officers and men competent, individually as well as collectively, to handle its complicated and costly machinery with efficiency and economy. Thus far the new provision of law has not insured even the maintenance of the former efficiency of the great machine. The condition is critical and the Chief of Bureau shows courage as well as discretion in his discussion of the subject.

R. H. THURSTON.

Roscoe-Schorlemmer's Lehrbuch der organischen Chemie. Von JUL. WILH. BRÜHL, Professor an der Universität Heidelberg. Sechster Theil, bearbeitet in Gemeinschaft mit Eduard Hjelt und Ossian Aschan. Braunschweig, Friedrich Vieweg und Sohn. 1901. Pp. xxxix + 1045. Price (bound), M. 24.

This is the eighth volume of the German edition of Roscoe and Schorlemmer's 'Treatise on Chemistry,' and is the sixth part of the portion dealing with organic chemistry. It includes a consideration of the vegetable alkaloids, glucosides and bitter principles, natural coloring matters, chlorophyll, lichen substances and such indifferent bodies of vegetable origin as have not been considered in previous volumes.

Somewhat more than one half of the volume is given to the alkaloids. The primary classification of these is based on the group characteristic of their structure. This gives the pyrrolidine, pyridine, quinoline and isoquinoline groups and a group containing alkaloids of unknown structure. Within each group they are further classified in accordance with the plant or family of plants from which they are derived, this latter classification depending on the well-known fact that alkaloids found in the same plant, and often those found in different plants of the same family, usually have closely related structures.

About one fourth of the book is given to the glucosides and about eighty pages are given to chlorophyll and the same number to lichen substances. The discussion of chlorophyll is especially full and satisfactory and includes a good bibliography of the subject. In this portion, especially, the needs of the biologist as well as of the chemist have been considered.

The general plan of the work includes a historical account of the discovery and study of the more important substances considered. While it lays no claim to that exhaustive completeness in detail which is characteristic of Beilstein's Handbook, it is much easier to secure from it a knowledge of the present views of the structure of particular compounds, and of the basis on which such views rest. Considerably more space is given to the alkaloids than is devoted to the same topic in Beilstein. The book covers the literature of its subject up to a very recent date and the information to be found in it is very reliable and satisfactory.

W. A. NOYES.

SCIENTIFIC JOURNALS AND ARTICLES.

THE first number of the first volume of the *American Journal of Anatomy* was published on November 7, its contents being as follows:

'The Development of the Limbs, Body-wall and Back': CHARLES RUSSELL BARDEEN and WARREN HARMON LEWIS.

'The Intralobular Framework of the Human Spleen': PRESTON KYES.

'Studies on the Neuroglia': G. CARL HUBER.

'The Normal Histology of the Human Hemolymph Glands': ALDRED SCOTT WARTHIN.

'On the Morphology of the Pineal Region, based upon its Development in *Acanthias*': CHARLES SEDGWICK MINOT.

THE editorial board, consisting of Lewellys F. Barker, University of Chicago; Thomas Dwight, Harvard University; Simon H. Gage, Cornell University; G. Carl Huber, University of Michigan; George S. Huntington, Columbia University; Franklin P. Mall, Johns Hopkins University; Charles S. Minot, Harvard University; George A. Piersol, University of Pennsylvania, and Henry McE. Knower, Secretary, Johns Hopkins University, have sent with the first number the following prospectus: *The American Journal of Anatomy* has been founded to collect into one place, and present in a worthy manner, the many researches from our investigators, now scattered through many publications at home and abroad. Human anatomy in America needs as high a standard of reference as it has in other countries. Without such a standard it fails to make for itself any proper,

satisfactory or stimulating impression. The best interests of modern scientific medicine will be greatly advanced by the upholding of such a standard in this fundamental subject through a journal of high character. Many aspects of comparative anatomy, embryology, histology and cytology are so intimately bound up with the problems of human anatomy that these subjects will be included within the scope of the new journal. It will be the aim of *The American Journal of Anatomy* to recognize this close natural relationship between the various branches of the science, and to publish results of the best original work of American students of anatomy. The most cordial assurance of support has been given by the collaborators, and this we believe is sufficient indication of the results to be expected. A number of generous persons, whose names will appear later, have given some financial support to help us in gaining a foothold in a suitable manner. The journal must, however, look to those who are to be benefited by its publication for its real and permanent support; and a good list of regular subscribers is expected and required to maintain it. It is hoped that those interested in promoting a worthy development of research in America, in the subjects included within the scope of this journal, will energetically assist us.

THE October number of the *American Geologist* contains a number of interesting articles. John A. Dresser writes on 'The Petrography of Shefford Mountain.' The mountain discussed is one of a series of volcanic hills in the St. Lawrence Valley about fifty miles east of Montreal, Canada. The author concludes that the mountain is a laccolith, and that it contains three different flows represented by three different classes of rocks, viz: essexite, nordmarkyte and pulaskite. 'Paleontological Speculations,' by S. P. Gratacap is a continuation of a discussion begun in a number of a preceding volume. Mr. Warren Upham discusses 'Niagara Gorge and Post Glacial Time,' in which he gives some reasons based on recent investigations for estimating the duration of the Niagara River at 7,000 years. It is claimed that this estimate is more in harmony with estimates from other sources by Winchell,

Andrews, Emerson and others, than the longer period usually ascribed to this work. A 'Note on Certain Copper Minerals,' by A. W. Winchell, describes chalcopyrite and bornite found as an accidental furnace product replacing the iron rails in a calciner at a copper mine in Montana. The editorial comment includes an obituary notice with a short biography of Edw. W. Claypole, of Pasadena, California.

THE first number of a journal devoted to biological chemistry, entitled *Beiträge zur chemischen Physiologie und Pathologie—Zeitschrift für die gesammte Biochemie*, and edited by Dr. Franz Hoffmeister, professor of physiological chemistry at Strassburg, was issued recently. Its appearance may be interpreted as the outcome of the increasing application of chemical methods to the solution of biological and pathological problems.

SOCIETIES AND ACADEMIES.

NATIONAL ACADEMY OF SCIENCES.

THE National Academy held its autumn meeting at the University of Pennsylvania, Philadelphia, on November 12, 13 and 14. The papers entered to be read were as follows:

'Note on Linear Force exerted by Growing Crystals': GEORGE F. BECKER.

'Note on the Orogenic Theory of Tilted Blocks': GEORGE F. BECKER.

'On the Vaso-motor Supply of the Lungs': HORATIO C. WOOD, JR. (Introduced by George F. Barker.)

'Biographical Memoir of Frederick Augustus Genth': GEORGE F. BARKER.

'On the Pseudo-catalytic Action of Concentrated Acids': JAMES M. CRAFTS.

'On the Use of the Stereographic Projection in Making Accurate Maps; with Criticism of some Recent Methods of Map Projection': SAMUEL L. PENFIELD.

'On the Logic of Research into Ancient History': CHARLES S. PEIRCE.

'Observations on Tungsten': EDGAR F. SMITH.

'The Monatomic Gases': GEORGE F. BARKER.

'Snake Venom in Relation to Hæmolysis, Bacteriolysis and Toxicity': S. WEIR MITCHELL and SIMON FLEXNER.

'The Tendency of Complex Chemical Radicals to control Crystallization because of their Mass Effect; a Study in Isomorphism': SAMUEL L. PENFIELD.

'On the Nature of the Double Halides': IEA REMSEN.

'Biographical Memoir of General John Newton': CYRUS B. COMSTOCK.

'Dolichocephaly and Brachycephaly as the Dominant Factors in Cranial Evolution': HENRY F. OSBORN.

'Cranial Evolution of *Titanotherium II.*': HENRY F. OSBORN.

'Latent or Potential Homology': HENRY F. OSBORN.

'A New Gauge for the Direct Measurement of Small Pressures': EDWARD W. MORLEY and CHARLES F. BRUSH.

'Transmission of Heat through Vapor of Water at Small Pressures': EDWARD W. MORLEY and CHARLES F. BRUSH.

'On the Newer Forms of Incandescent Electric Lamps': GEORGE F. BARKER.

'On Quadrant Electrometry with a Free Light Needle highly charged through a Conductor of Ionized Air': CARL BARUS.

'On Nuclear Condensation in the Vapor of Non-Electrolytes like Benzene; and on Graded Condensation': CARL BARUS.

'The Work of the International Association of Academies': HENRY L. BOWDITCH.

'A Method of Rearing Marine Larvæ': CASWELL GRAVE. (Introduced by William K. Brooks.)

THE ACADEMY OF SCIENCE OF ST. LOUIS.

AT the meeting of the Academy of Science of St. Louis, on the evening of November 4, 1901, Professor Alexander S. Chessin spoke 'On the Motion of a Top, taking into Account the Rotation of the Earth,' giving an abstract of his researches on the earth's rotation as manifested in the motion of bodies on its surface, the details of which he hoped to present shortly in a series of papers.

Two persons were elected to membership in the Academy.

WILLIAM TRELEASE,
Recording Secretary.

THE ELISHA MITCHELL SCIENTIFIC SOCIETY.

THE 137th meeting of the Society was held on November 12, 7:15 P. M., in the chemical lecture room, Person Hall, University of North Carolina. The following papers were read:

'A Short Cut Percentage Calculation': E. V. HOWELL.

'Cold Light': J. W. GORE.

CHAS. BASKERVILLE,
Secretary.

DISCUSSION AND CORRESPONDENCE.

PHYSIOLOGICAL EFFECTS OF DIMINISHED AIR PRESSURE.

TO THE EDITOR OF SCIENCE: In a communication published in SCIENCE for November 1 (p. 696), Mr. H. H. Clayton, of Blue Hill Observatory, gives some observations on the number of his pulse-beats, noted during a recent ascent of Pikes Peak by railroad. The pulse increased from 78 beats per minute at Manitou (6,662 ft.) to 92 at the summit of the mountain (14,147 ft.). Mr. Clayton's note recalls some similar observations made by the writer in Peru in 1897, during two ascents of El Misti (19,200 ft.), then the site of the highest meteorological station in the world, established by Professor S. I. Bailey, and operated by the southern station of the Harvard College Observatory at Arequipa. Both ascents were made on mule-back, so that no physical exertion was necessary. The first ascent was on October 7, the start being from the Observatory (8,050 ft.) on October 6. Although provided with clinical thermometers and with a sphygmograph, the writer suffered so severely from mountain sickness that he made very little use of his instruments. His temperature at 5:30 p. m., October 5, twelve hours before leaving Arequipa, was $98^{\circ}.4$; his respiration 24, and his pulse 90. On the summit of El Misti the body temperature was $96^{\circ}.4$; the respiration 34, and the pulse 110. Twelve hours after arrival at Arequipa the figures were $98^{\circ}.0$, 24 and 85 respectively. A rather unsatisfactory sphygmograph curve was obtained on the summit.

The second expedition to El Misti was made on November 9, 1897, and on this trip the writer suffered much less from mountain sickness than on the previous one. At an altitude of 15,700 ft. a short walk of about 100 yards was taken to the instrument shelter. Two stops were necessary on the way, to get breath. An hour after this exercise, the pulse was 128, the body temperature $97^{\circ}.0$, and the respiration 30. The corresponding figures twelve hours before leaving Arequipa were 91, $98^{\circ}.6$ and 20. The night was spent at 15,700 ft. The body temperature immediately after waking in the morning was $96^{\circ}.2$; the pulse 112, and the respiration 30. Twenty minutes

after reaching the summit, the temperature was $97^{\circ}.2$, the pulse 120, and the respiration 32. In an hour and a half the respiration was 35, the pulse and temperature remaining the same. In two hours the temperature was $96^{\circ}.8$, the pulse 112, and the respiration 34. Three fairly good sphygmograph curves were obtained on the summit. These curves possess some interest as being, so far as I have been able to learn, the first, with possibly one exception, to be secured at so great an altitude as 19,200 ft. At any rate, no curve from so great an altitude was reproduced until a copy of one of these tracings from the Misti summit was printed in an article by the writer in the *Journal of the Boston Society of Medical Sciences* for June, 1898.

On the second expedition to El Misti the descent was begun two hours and a half after reaching the top. At the hut at the base of the mountain (15,700 ft.), after walking to and from the shelter, the pulse was 130, but the respiration had decreased to 30. One hour after arriving at Arequipa the temperature was $98^{\circ}.2$, the pulse 116, and the respiration 22, and twelve hours after arrival the pulse had fallen to 82—about the writer's normal at the Observatory—and the respiration to 22, the normal being 20.

In counting the pulse on the summit it was quite unnecessary to place the finger on the wrist. The heart-beats could plainly be heard.

R. DEC. WARD.

HARVARD UNIVERSITY,
November 2, 1901.

PRACTICAL AMELIORATIONS OF ENGLISH GRAMMAR.

EVERY year or so a 'practical grammar' of our mother-tongue is announced as on the eve of publication, and, when the book appears, every teacher and student who had been hoping for some real progress in ridding the language of the impedimenta of barbarism and the useless paraphernalia inherited from classical schematism, experiences a keen sense of disappointment.

Perhaps the greatest intellectual feat so far accomplished by English-speaking peoples all over the globe has been to free their mind-tool so largely from the shackles of grammar. So much having been done already in this direc-

tion, we ought to make further advances toward ideal speech. All such advances will serve English well in the struggle for adoption as the world-language, for the more cosmopolitan, the less grammatical, in the classical sense, must it be.

It needed no prophet to foretell the fate of Latin as a would-be international tongue. In the nature of the case, it could never be more than the artificially propagated and sustained speech of more or less extensive and widely scattered societies, cliques, clubs and associations (political, religious, scientific, etc.), for the mind of the Aryan and Semitic races was capable of something higher than speaking through a death-mask, and other populous nations have also to be reckoned with—nations like the Chinese, Japanese, Malays, Hindus—who cannot be expected to welcome a dead language over against a live one. Evolution, too, has written a like epitaph over Greek, which some enthusiasts would fain have us accept as a universal language. No such backward step is probable or even possible. Against all competitors in the field, English is favored by its increasing degrammatization and the open hospitality it extends to new words from every language under heaven.

Phonetic spelling must triumph in the end, and as complete a victory waits also for free speaking and free writing—*i. e.*, language untrammelled by grammatical artificialities. Not a backward-looking Volapük, but English with its face to the future foreshadows the true world-language. Phonetic spelling has already made a good beginning, which suggests the possibility of similar intentional reforms in English grammar. The present writer will content himself with specifying certain ameliorations of grammar, which, perhaps, may serve, like the ten 'rules' for amended spelling proposed in 1883 by the English and American Philological Associations, or the list reported by the American Committee in 1886, as starters for more ambitious movements of reform.

The list is as follows :

1. Drop the so-called *subjunctive mood* altogether. It is moribund in much of our best prose, and can be allowed to die out of our

poetry with no injury to rhyme or reason, strength or beauty.

2. Drop *inflected forms for the past tense and past participle*, making all new verbs, whether introduced from foreign tongues or made within the language itself, conform to the type of *hit, let, etc.* In America, in particular, drop *gotten*.

3. Avoid the use of *differing forms for verb and noun*. Follow the model of *boycott*, under 'rule' 2.

4. Avoid the use of *plural forms of nouns*, making all new substantives, whether borrowed from other languages or born of the mother-tongue, conform to the model of *sheep, deer, etc.*

5. Avoid the use of *Greek or Latin names for 'new things.'* Follow the good example of certain scientists, and name them after their discoverer, the place of origin, etc. Make new words here conform to the model of *galling, ampere*, and the like.

6. Avoid the use of *feminine forms of nouns* previously employed with reference to males, letting the thought control the grammar. Drop particularly *authoress, poetess, etc.*

7. Avoid forming *adverbs by inflection*, using for all new words of this class the same form for adjective (or other word) and adverb.

8. Omit the conjunction *that* wherever possible. For example, in such cases as 'I know *that* he is dead.'

9. Use *but* and *as* as full-fledged prepositions.

10. Drop *whom*, using *who* for both cases.

11. Ceasing the attempt to distinguish between *who* and *that*, and *that* and *which*, let the fittest survive in each instance.

12. Use the pronouns compounded of *self* and their plurals, both as subjects and objects.

13. Drop the *apostrophe* in the *possessive case*.

Other suggestions might be made, but these cover sufficient ground for the present.

ALEXANDER F. CHAMBERLAIN.

CLARK UNIVERSITY, WORCESTER, MASS.

SHORTER ARTICLES.

CATALASE, A NEW ENZYM OF GENERAL OCCURRENCE.

THE study of the enzymes has been pursued with growing interest by a number of scientists during later years. These unorganized ferments being substances of a highly ephemeral

nature, the method of investigating them has departed somewhat from the paths usually followed in determining the composition, effects and rôle, of organic combinations in vegetable and animal organisms. The nature of the enzym is still a matter of much doubt. Of their action we are more sure, and it is along this line that we have become familiar with the nature of some members of this very interesting group of compounds. The rôle of the enzym in the life processes may also in some cases be defined with certitude.

Beginning with a few, the study of unorganized ferments has brought to light many others. Out of the growing number some are already put to important uses, while others bid fair to become of great value to many industries. Dr. Oscar Loew in his studies on tobacco (Rpt. No. 68, Div. of Veg. Phy. and Path. U. S. Dept. of Agr.) goes further in the study of unorganized ferments than ascribing to one a special rôle and shows the general distribution and seeks a reason for its existence of an enzym, to which he gives the name catalase.

In the work with this enzym, in which the writer took some part, the most striking characteristics were its very general dissemination, its persistence, and its ability to break down hydrogen peroxid. In the examination of a large number of animal and vegetable organs this enzym was found present, in greater or less amount, in every instance. Its differentiation from other unorganized ferments is established by a large number of tests with various reagents. Among other characteristics it was found to be more persistent than any other known enzym. This was especially noted in dried vegetable substance as seeds and leaves, being found present in a herbarium specimen of the latter examined after a lapse of over 50 years.

The ability of catalase to break down hydrogen peroxid appeared to be its most striking peculiarity, and this led the author to believe that it might perform such a service in the phenomena displayed by living matter. Tests go to show that it belongs to the class of oxidizing enzymes and its very general occurrence and uniform actions indicate that it plays some important rôle in physiological processes.

From his studies the author gives the following as the most plausible explanations of the action of catalase in vegetable organism: (1) It destroys instantly the hydrogen peroxid, probably formed in cells during the oxidation caused by the respiration process; (2) it loosens chemical affinities in certain compounds so that the protoplasm can more easily split or oxidize them. "In other words, catalase might represent an aid for fermentative as well as for respirative phenomena." D. W. MAY.

U. S. DEPARTMENT OF AGRICULTURE.

TOADS KILLED BY SQUASH-BUGS.

DURING the past summer the Entomological Department of the New Hampshire College Agricultural Experiment Station carried on investigations on the common squash-bug (*Anasa tristis*), which has been so abundant in some portions of the State the past season. Mr. Kirkland, in Bulletin 46, Mass. Agr. Exp. Sta., recorded the bug to have been found in the stomach contents of toads; Mr. Chittenden, in Bulletin 19, 1899 (New Series), U. S. Dept. Agr., states that Dr. Judd likewise found a bug in a toad's stomach. This suggested that the toad is probably an enemy of the squash-bug, and experiments, made to determine this, showed the following interesting results: When a squash-bug nymph of the fifth stage was suddenly introduced into a half pint, open, wide-mouthed specimen jar containing a half grown live toad, so that the Batrachian would get the full effects of the pungent fumes given off by the bug, the toad was thrown into a temporary stupor, the effect being similar to that of chloroform. As the number of bugs was increased the effect on the toad was increased. When as many as seven bugs were introduced the toad fell into a profound stupor and died in the course of twenty-four hours.

On September 8, an adult, that had been kept in the laboratory vivarium with a scant food supply for several days, was placed in a quart jar of the same construction as the one mentioned above, and eight bugs were introduced; these bugs, however, had been so much disturbed previously that the source of the pungent secretion had been temporarily exhausted. The toad hesitatingly devoured three, after

which she would remove with her front feet every specimen that made an attempt to ascend the wall of her enclosure; but these bugs were not eaten. The toad was then transferred to another jar of the same size and construction and eight bugs were suddenly introduced from the squash leaf so that the toad would get the first and fullest effects of the odor; the result was that the animal went through a series of contortions followed by a short period of stupor similar to that mentioned before. Upon recovery the toad was again removed to the vivarium where it now lives in partial hibernation.

A young red spotted salamander was affected and killed as easily as the half-grown toad, while for the common field frog a greater number of bugs were required to bring about similar effects, the frogs also being killed. Many experiments with snakes were tried, but no ill effects from the secretion of the bugs were apparent.

The odor that the bug gives off emanates from a clear, slightly greenish liquid expelled from the extremity of the alimentary canal; when it comes in contact with the air the odor is given off almost instantaneously while the liquid remains to evaporate.

These experiments are still in progress and when completed will be published in detail. They seem to open up an interesting field for investigation as to the protective value of the odoriferous secretions of many of the Heteroptera.

ALBERT F. CONRADI.

NEW HAMPSHIRE COLLEGE AGRICULTURAL
EXPERIMENT STATION, DURHAM,
October 29, 1901.

CURRENT NOTES ON METEOROLOGY.

THE WEATHER BUREAU.

THE address presented at the Convention of Weather Bureau officials, held at Milwaukee last August, by Professor Willis L. Moore, Chief of the Weather Bureau, is printed in the October number of the *National Geographic Magazine*. The salient facts in the history of the weather service are given, and special emphasis is laid on the tangible results of the Weather Bureau's work. It is a pleasure to see the name of Professor Cleveland Abbe, the fore-

most living American meteorologist, linked with the names of Redfield, Espy, Maury and Loomis in this article. Some of the statistics given by Professor Moore are worthy of note here. Thus, in the case of cold-wave warnings, the statement is made that 100,000 telegrams and messages are frequently distributed within a few hours. During one cold wave \$3,400,000 worth of property is estimated to have been saved as a result of the information issued by the Weather Bureau. The system of distributing warnings of gales dangerous to navigation is so perfect that "the Chief of the Weather Bureau, or the forecaster on duty at the Central Office, can dictate a storm warning and feel certain that inside of one hour a copy of the warning will be in the hands of every vessel master in every port of material size in the United States, provided that it is his desire that a complete distribution of the warning be made."

Reference is made to the important work of the Bureau in connection with measurements of snowfall in the high mountains of Montana, Wyoming, Idaho, Utah, Arizona and New Mexico, which make it possible to estimate the probable supply of water to be expected for irrigating purposes, and also to the recently inaugurated forecasts of wind direction and velocity for a period of three days after steamers sail from European or North American ports. At the conclusion of his article, the Chief of the Weather Bureau rightly criticizes the press for the attention it gives to the long-range forecast frauds, which deceive so many persons. Last year's appropriation of \$1,058,320 for the Weather Bureau was certainly small, considering the value of the work done.

MONTHLY WEATHER REVIEW.

THE *Monthly Weather Review* for July (issued in October) contains the usual number of interesting articles. In 'The Thunder-storm: A New Explanation of one of its Phenomena,' Byron McFarland gives his reasons for not accepting the common explanation of the origin of the squall wind in thunder-storms, viz., that this squall is due to the 'kick' of the rapidly ascending air, and advocates the theory that the cool air within the thunder-storm accounts for

the phenomena of the outflowing squall. A. L. Rotch contributes a short account of a meteorological balloon ascension in which he took part at Strassburg last July. Professor R. E. Dodge describes some diurnal winds in northwestern New Mexico, which are developed on very faint gradients. A translation, by Professor Cleveland Abbe, of the introduction to Marcel Brillouin's recent volume 'Mémoires Originaux sur la Circulation Générale de l'Atmosphère,' brings before American readers an excellent brief historical summary of the various important contributions made by Ferrel, Thomson, Siemens, and others, to the subject of the general circulation. 'Yukon Weather' is the title of a paper by U. G. Myers, Section Director of the Weather Bureau in Alaska. Professor Abbe, in his 'Notes by the Editor,' discusses the relation between the scientific work of the Weather Bureau and the long-range forecasts made by those who believe in lunar or stellar influences, and in this connection gives a translation of the paragraphs of Angot's 'Traité de Météorologie' which deal with this subject. An account of the Milwaukee convention of Weather Bureau officials concludes this number of the *Review*.

GEOLOGICAL CHANGES OF CLIMATE IN THE EASTERN CORDILLERAS.

A RECENT paper by Professor N. S. Shaler, on 'Broad Valleys of the Cordilleras' (*Bull. Geol. Soc. Amer.*, Vol. 12, 271-300), explains certain features of these valleys by an increased erosive action due to an ancient temporary increase of rainfall in preglacial time. The source of the larger part of the rainfall in the Mississippi valley drainage area is evidently in the basin of the Gulf of Mexico and the Caribbean Sea. When these waters were of greater extent, the evaporation from them might well have produced a much heavier rainfall over the Cordilleras than is now found there. There is evidence in the broad valleys of several oscillations of climate. At the present time the conditions of the eastern section of the Cordilleras indicate a recent return to an arid climate. The taluses are evidently increasing. "Unless the Gulf of Mexico," Professor Shaler concludes, "should again be brought over a considerable part of the southern lowlands, there seems to be no

reason to expect that there will be any increase of rainfall in this area."

TREE PLANTING ON THE PRAIRIES.

WILLIAM L. HALL, assistant superintendent of tree planting in the Division of Forestry, believes that the time has come for an extensive development of forest plantations throughout the Middle West, in consequence of the rapid diminution of the supply of natural timber in the Mississippi valley (Yearbook Dept. of Agriculture for 1900). Over extensive areas the prices of posts, telegraph poles and cross-ties much exceed the cost of growing them. This difference promises profit in timber growing. Ten years ago the area for profitable tree planting was, chiefly for climatic reasons, thought to be much smaller than it is now known to be. The past year has seen the establishment of nearly 100 plantations by individuals in co-operation with the Division of Forestry, and during the present year more trees will be planted than ever before. Mr. Hall believes that if 500,000 acres of timber, well distributed throughout the Middle West, were planted annually, the production would still be inadequate to meet the demand, and liberal profits could still be hoped for. R. DEC. WARD.

PROPOSED AMERICAN ELECTRO-CHEMICAL SOCIETY.

A MEETING was held on November 1 at the rooms of the Engineers' Club in Philadelphia, to discuss the question of the advisability of organizing a national electro-chemical society on the same general plans as the American Chemical Society and the American Institute of Electrical Engineers. Some twenty or thirty persons from different parts of this country, who were thought to be interested in the subject of electro-chemistry, had been asked to be present or to express their views by letter. Among the communications received, the majority, especially from the electrochemical industries, were in favor of the formation of such a society; the minority thought the time had not come yet for such a society, that the American Chemical Society and the American Institute of Electrical Engineers filled the needs, that there were already a number of other societies at which papers on this subject could be read, etc.

Those present included representatives from New York City, from the Cornell, Lehigh and Johns Hopkins Universities, from the American Chemical Society, the American Institute of Electrical Engineers, the Franklin Institute, etc. Professor J. W. Richards, vice-president of the American Chemical Society, acted as chairman, and Carl Hering, past president of the American Institute of Electrical Engineers, as secretary. All those present were heartily in favor; the only doubt expressed was whether a sufficient number of members could be obtained to make such a society a success. A committee was appointed, with Dr. Chas. A. Doremus, of the College of the City of New York, as chairman, to canvass for members; and if seventy-five or over pledge themselves to join, the society will be formed. In that case, certain committees which were appointed will arrange for holding a formal meeting at which the society will be founded and papers read and discussed. Anyone desiring to become a member is asked to communicate with Dr. Doremus at the above address.

It was furthermore decided to be the expression of those present that the name of the organization should be the American Electro-chemical Society; that the dues should not exceed \$5.00 per year, and that at first only a few meetings of a few days each should be held per year, and that they be held in different cities, as the society is to be a national one.

The fact that papers on the subject of electro-chemistry are now scattered over a half dozen or more existing national societies was thought to be in itself a very good reason for bringing them all together into one, where they could then be properly discussed, which is not now the case. Attention was also called to the fact that the annual electro-chemical products of this country already amount to nearly \$100,000,000, which is far greater than in all the other countries combined. Germany, which comes next with \$14,000,000, has a flourishing electro-chemical society with about 40 members in the United States.

THE UNITED STATES NAVAL OBSERVATORY.

THE board of visitors of the U. S. Naval Observatory, consisting of Professors C. A. Young,

C. F. Chandler, Asaph Hall, Jr., E. C. Pickering and Ormond Stone and President W. R. Harper, have recently held a meeting and submitted a report to Secretary Long. Extracts from the report published in the Washington *Evening Star*, are as follows:

"It is recommended that no astronomical director be appointed at present, as a dual headship has been found to work unsatisfactorily, and under the existing law the appointment of an astronomer as sole director of the observatory—which the board considers the proper solution of the question—is impracticable. Vacancies should not be filled among assistant astronomers nor among professors of mathematics in the navy without examination for each vacancy occurring. No distinction should be made between employees of the observatory and other applicants. The responsibilities of the positions of assistant astronomer and professor of mathematics are distinctly different from those of computer, although much of the required experience may properly be gained in connection with the latter position and be credited in the examinations for the higher positions. As far as is consistent with the routine needs of the institution, the duties of the computers should be so arranged as to encourage them to prepare for advancement within the observatory itself. In no case should appointments be made to the observatory merely by transfer from other bureaus or offices in the service, nor should appointments ever be made even temporarily without competitive examination."

Applying these principles to practice the board declines to name a person to fill the vacant office of assistant astronomer at the observatory and instead recommends that the appointment be made after a civil service examination under the auspices of the commission.

Coming to the more important subject of the actual head of the observatory, which involves the issue between the scientists and the line officers, the board says:

"As every other prominent observatory is under the direction of an astronomer, we wish to record our deliberate and unanimous judgment that the laws limiting the superintend-

ency to a line officer of the navy should be changed so as to provide that the official head of the observatory—perhaps styled simply the director—should be an eminent astronomer appointed by the President, by and with the advice and consent of the Senate, holding this place by a tenure at least as permanent as that of the superintendent of the coast survey, or the head of the geological survey, and not merely by a detail of two or three years' duration. Only in this way can there be a continuous and effective policy of administration which will insure astronomical work of a high order. In rank, salary, privileges and prestige he should be superior to any other official on the ground.

“The limitation in the selection of assistants should also be removed, and the assistant once appointed should be secure against detachment or removal except by the action, for cause, of the director. The institution should be related to the Navy Department, if continued under its control, in some such way as the Royal Observatory at Greenwich is related to the British admiralty. It should be put under the control of the secretary directly, and not through a bureau as at present.”

In conclusion the Board finds objection to the manner in which appropriations have been made in support of the observatory, saying that it is not easy to determine what portion of the expenditures pertains properly to astronomical work, what portion to the naval work, and what portion to the improvement and care of the grounds as a part. The cost of maintenance for the last fiscal year was \$108,428, of which amount \$21,258 was expended in salaries.

SCIENTIFIC NOTES AND NEWS.

DR. J. WILLARD GIBBS, of Yale University, has been awarded the Copley Medal of the Royal Society for his contributions to mathematical physics.

HENRY M. HOWE, professor of metallurgy at Columbia University, has been elected an honorary member of the Russian Technical Society at St. Petersburg.

DR. E. A. DE SCHWEINITZ, dean of the Columbian University Medical School and direct-

or of the Biochemic Laboratory, U. S. Department of Agriculture, has recently been elected a corresponding member of the Epidemiological Society of London, and also of the ‘Society for Combating Tuberculosis,’ of Berlin.

PROFESSOR WILLIAM F. WILLOUGHBY, recently expert in the U. S. Department of Labor and now of Harvard University, has been appointed treasurer of Porto Rico.

PROFESSOR LUIGI PALAZZO has been appointed director of the Central Meteorological and Geodetic Institute at Rome.

DR. VON WETTSTEIN, of the University of Vienna, who was sent by the government to study the flora of Brazil, has returned.

It is stated by the Berlin correspondent of the *Times* that Professor Paul Ehrlich, of Frankfurt-on-the-Main, has been enabled to devote himself to a special study of the disease of cancer in consequence of a bequest of the interest for three years of a sum of 500,000 Marks dedicated to this purpose by a Frankfurt banker, the late Herr Theodor Stern. Other sums contributed by private individuals will bring up the amount to be devoted to this special investigation of cancer by Dr. Ehrlich to 40,000 Marks, or \$10,000 a year. In Berlin there exists a special committee for the investigation of cancer, which studies pathological accounts of cases and collects statistics and medical literature on this subject. Professor von Leyden is at the head of the committee, and Professor von Kirchner, of the medical department of the Ministry of Public Instruction, is one of its members.

THE Craig Colony Prize of \$200 has been awarded to Professor Carlo Ceni, of Pavia, Italy, for an essay, entitled ‘Serotherapy in Epilepsy.’

AT the scientific meeting of the Zoological Society of London, on November 19, papers were read by Professor Ray Lankester, on ‘*Okapia*, a New Genus of Giraffidæ from Central Africa,’ and by Mr. Oldfield Thomas ‘On the Giraffe discovered by Sir Harry Johnston near Mount Elgon, Central Africa.’

THE work of putting in place at Wood’s Holl a boulder to serve as a memorial to the late Professor Spencer F. Baird is now completed.

The erection of this monument is the outcome of the action of the American Fisheries Society at a meeting held at Wood's Holl in the summer of 1900, when resolutions presented by Dr. H. M. Smith, providing for an appropriate memorial to Professor Baird, were unanimously adopted. The boulder is of granite, weighs about six tons, and was taken from the shores of Nonamesset Island by permission of Mr. J. Malcolm Forbes, whose father, the late John Murray Forbes, manifested great interest in the establishment and work of the station. The memorial will be completed when a suitably inscribed artistic bronze tablet is attached to the stone. This will probably be deferred until next spring.

A MEDALLION in memory of Dr. W. Kühne, formerly director of the Physiological Institute, was unveiled at the University of Heidelberg on October 20.

PROFESSOR RICHMOND MAYO-SMITH, since 1883 professor of political economy and social science at Columbia University, died, as the result of a fall, on November 11. He was born in Ohio in 1854 and graduated from Amherst College in 1875. Professor Mayo-Smith was the author of numerous important contributions to statistics and other departments of political economy, including books on 'Emigration and Immigration' (1890), 'Sociology and Statistics' (1895) and 'Statistics and Economics' (1899). He was the only representative of political science in the National Academy of Sciences.

THE death is announced of Professor Ralph Tate, since 1876 professor of natural science in the University of Adelaide. He was the author of numerous papers on geology and zoology and was in 1893 president of the Australasian Association for the Advancement of Science.

DR. ALEXANDER HUGHES BENNETT, the eminent physician, known for his work on diseases of the nervous system, died in London on November 1, at the age of fifty three years. On his special subjects of epilepsy and paralysis he had written largely, and was the author of the well-known 'Practical Treatise on Electro-diagnosis in Diseases of the Nervous System,' and of the smaller text-book founded upon that work.

MR. HENRY SPENCER SMITH, one of the original fellows of the Royal College of Surgeons, London, died on October 29, at the age of eighty-eight years. Mr. Smith was secretary to the first government inquiry into the pathology and treatment of contagious diseases, and was a fellow and formerly vice-president of the Royal Medico-Chirurgical Society. He contributed frequently to the medical journals and translated several works, including Professor Schwann's work on 'Microscopical Researches into the Accordance in the Structure and Growth of Animals and Plants,' which obtained for its author, in 1845, the award of the Copley Medal of the Royal Society of London.

WE also regret to record the deaths of Dr. Marcel Nencki, professor of biological chemistry in the University of St. Petersburg, at the age of 56 years; of Professor Max Märcker, director of the Agricultural Experiment Station at Halle, at the age of 59 years, and of Professor Miguel Colmeiro, director of the Botanical Gardens at Madrid, at the age of 86 years.

MR. ANDREW CARNEGIE has given \$1,000,000 as an additional endowment of the Carnegie Institute and has added \$1,000,000 to the million dollars he has already given toward an endowment of the Carnegie Polytechnic Institute, to be erected at Pittsburg. Mr. Carnegie has also offered \$50,000 to Springfield, Mo., for a free public library building.

A NEW YORK State civil service examination will be held in various cities throughout the State on or about December 7, 1901, for the position of director of the New York State Pathological Institute, with a salary of \$5,000. The subjects and weights for the examination are: Pathological anatomy of the nervous system, technique and methods of neural investigation, architecture of the nervous system and lines of research to be applied to the study of the pathology of insanity, 8; experience, 2. The position is open to non-residents of the State, subject to the provision that if the eligible list contains the names of three or more persons who are citizens and residents of New York State, such persons shall be preferred in certification over non-residents. Examinations will also be held for the positions of assistant

in the Antitoxin Laboratory, and assistant bacteriologist, both in the Department of Health, at salaries of \$750 and \$500, respectively. The former position is open only to women, and subjects of examination and their relative weights are as follows: Bacteria, their nature, position among other living objects, functions, classification, principles of bacteriological manipulations, methods of making and testing culture media, sterilization of instruments and media, preparation of diphtheria toxin, etc., 8; experience and education, 2. The position of assistant bacteriologist is open only to licensed medical practitioners of New York State. The incumbent must give half his time to the work, which must be the first charge on his time. The examination will cover general knowledge of bacteriology and special knowledge of the methods and problems of the preparation of diphtheria and other antitoxins.

THE U. S. Civil Service Commission announces that at the request of the Board of Visitors to the United States Naval Observatory, an examination will be held on December 11, 12, 13, 1901, at various places throughout the United States, for the position of assistant astronomer in the U. S. Naval Observatory, at a salary of \$1,800 per annum.

The subjects and weights are:

Pure mathematics, practical and spherical astronomy, celestial mechanics, general mechanics, optics, and French and German.....	20
Experience (a) in making astronomical observations, (b) in making astronomical computations, (c) in making and repairing, mounting and dismounting, and in caring for astronomical instruments, including auxiliary apparatus.....	40
Ability to carry on original astronomical investigations, as evidenced by printed or written memoirs, certificates, etc.....	40
Total.....	100

The examination on the technical subjects first named will be entirely of a scholastic character and will occupy three days. Under the second and third subjects applicants will be expected to submit evidence of their experience and ability. This evidence should be full and complete. Age limits, 20 to 45 years.

A TELEGRAM has been received at the Harvard College Observatory from Professor W. W. Campbell at Lick Observatory stating that from a Crossley photograph, Professor Perrine finds that four principal condensations in faint nebula surrounding Nova Persei moved southeast one minute arc in six weeks. Professor G. E. Hale, from the Yerkes Observatory, reports that from photographs of Nova Persei on November 9 Ritchey finds the nebula probably expanding in all directions, this certainly being true of the southern half.

AN international sanitary congress will be held in Paris during the week of February 15-21, 1902. Among the subjects to be discussed will be the rôle of mosquitoes in the spread of yellow fever, malaria and filariasis, quarantine, and the value of municipal sanitation in the prevention of epidemics.

THE Institution of Junior Engineers opened its winter session on November 1, at the Westminster Palace Hotel. The new President, Sir John Jackson, was installed, and delivered his inaugural address, in which he dealt chiefly with the relations between employers and employed.

THE biennial dinner of the Physical Society of London will be held at the Hotel Cecil on Friday, November 15.

WE learn from the *Journal of the American Medical Society* that it is proposed to unite the scientific institutes at Hamburg under one direction, somewhat in the form of a university, and the directors and lecturers will compose the faculty, issue reports, etc. The official title of the faculty will be the 'Professorenconvent' of the Scientific Institutes. Besides promoting individual research, the institutes will carry on research desired by men of science and advise in scientific matters generally.

PREPARATIONS are being made for the despatch of a new Norwegian expedition to determine more exactly the position of the north magnetic pole. The expedition will be under the direction of M. Amundsen, a Norwegian, who was one of the officers in M. Gerlache's Antarctic expedition.

A CABLEGRAM to the New York *Sun* states that a striking discovery has been made during

excavations which were necessary to raise one of the monoliths in the famous prehistoric group at Stonehenge in Wiltshire into an upright position. The men engaged in the work have found numerous neolithic implements, which had evidently been used in cutting and squaring the stones, and, when blunted, had been turned into the bedding on which the stones are supported. The discovery is held to prove that the unique spectacle of Stonehenge is anterior to the Bronze Age and that the structure still visible was certainly built before 1500 B. C.

FOREIGN journals give particulars respecting a new meteorological station which has been established at Achariach, in Glen Nevis, Scotland. The situation is such that a spur of Ben Nevis shuts in the valley to the west, and the height above sea-level is only 165 feet. The intention of the founder of the station—Mr. R. C. Mossman of Edinburgh—is ‘to study the thermal conditions in the valley and on the adjacent hillsides during anticyclones in winter.’ It seems that in calm, cold weather and with a high barometer it not seldom happens that the mountain summits are much warmer than the valleys which are filled with cold air chilled by radiation from the surrounding hills. The height to which this lake of cold air extends is to be the principal subject of investigation. The station is well equipped with a complete set of the best instruments.

THE London *Times* calls attention to the fact that the late M. I. C. Jacobsen presented to the State or spent for scientific or philanthropic purposes nearly 20,000,000 kroner. He created the ‘Carlsberg Fund,’ which now amounts to 12,500,000 kroner and recently celebrated the 25th anniversary of its foundation. On this occasion his son, M. Carl Jacobsen, has added as a donation his own brewery, only reserving for himself and his family one third of the income for fifty years. The value of this gift is calculated at 10,000,000 kroner. M. Carl Jacobsen two years ago presented Copenhagen with what was certainly the largest private collection of sculptures in the world—its value being 12,000,000 kroner—and with many other large donations.

WE learn from the *Auk* that the large collection of birds’ eggs, nests and skins brought together by Miss Jean Bell, of Ridley Park, Pa., has been purchased by Mr. John Lewis Childs, of Floral Park, New York. It is said to contain about 30,000 eggs and 1,000 nests, and is reported to be one of the finest and most complete private collections of North American birds’ eggs extant. It includes many rarities, and is rich in large sets of comparatively rare species, the collection having been formed through the combination of several noteworthy private collections.

THE program for the forthcoming session of the Royal Geographical Society of London is announced as follows: At the opening meeting, on November 11, Sir Harry Johnston proposed to give a paper on Uganda and the bordering countries, through which he made several journeys in his capacity as special commissioner. Not only will the paper be illustrated by a large number of slides, including a colored one of the Okapi, but Sir Harry will give phonographic reproductions of the songs of the natives. At the second meeting, on November 25, the president, Sir Clements Markham, will give a short opening address, and he will follow that with a paper on King Alfred and the geography of his time. During the evening Dr. Vaughan Cornish will give an extremely interesting cinematographic representation of the Bore of the Severn. The paper at the meeting on December 9 will be by Mr. Douglas Freshfield, on the ‘Glaciers of Kauchinjunga,’ the results of his recent expedition to that vastly interesting region; it will be illustrated by many lantern slides, mainly from photographs taken by Signor Sella, who accompanied the expedition. Among the papers to be expected after Christmas are the following: ‘An Expedition across Abyssinia, through Kaffa and the Region to the West and North,’ by Dr. Oscar Neumann; the ‘Maldives,’ by Mr. J. Stanley Gardiner; ‘Journeys in Western China,’ by Dr. R. L. Jack; ‘The Influence of Geographical Conditions on History and Religion, with Special Reference to Asia Minor,’ by Professor W. M. Ramsay; ‘Four Years’ Travel and Survey in Persia,’ by Major Molesworth Sykes; ‘An Expedition from Omdur-

man to Mombasa by Lake Rudolf,' by Major H. H. Austin; 'Southwards on the Antarctic Ship *Discovery*,' by Mr. George Murray, F.R.S., and Dr. Hugh Robert Mill; 'A Journey from Quetta to Meshed by the New Nushki Trade Route,' by the Earl of Ronaldshay; 'The Bedford Level and Experimental Demonstration of the Rotundity of the Earth,' by Mr. H. Yule Oldham; 'The Snows of Canada,' by Mr. Vaughan Cornish; 'Antarctic Glaciation,' by M. Henryk Arctowski, and 'Methods and Appliances in the Teaching of Geography,' a special lecture for teachers, by Mr. A. W. Andrews. The paper by M. Arctowski will be given at an afternoon meeting, while Mr. Andrews's lecture will be given at a special meeting on a date and at an hour likely to be convenient to teachers in and around London.

UNIVERSITY AND EDUCATIONAL NEWS.

MR. WILLIAM WYMAN announces that \$750,000 has been raised of the \$1,000,000 necessary to make available his offer to the Johns Hopkins University of 60 acres of land in the Northern Annex. Mr. William Keyser gave \$200,000 of the amount. The names of all the contributors to the fund will not, however, be announced until it is complete.

KENYON COLLEGE has received from various sources \$100,000 towards its endowment and \$50,000 for a new dormitory.

AN industrial college for women, to be called The Simmons Female College, will be shortly established in Boston, in accordance with a bequest made by John Simmons in 1875. The estate, which was subject to a life interest, now amounts to over \$2,000,000.

MR. B. F. BARGE, B.A. (Yale '57), has added \$2,500, to the same sum given by him recently to Yale University. The money is to endow a mathematical fund.

BY the will of the late E. P. Barker, Amherst College and Alfred University each receive \$1,000.

MR. and MRS. E. C. THOMPSON, of Indianapolis have added \$20,000 to the \$10,000 previously given by them to Butler College in that

city, for the construction of the Bona Thompson Library, as a memorial to their daughter.

MR. B. A. PALMER, of New York, has made a gift of \$30,000 to Union Christian College, Merom, Ind.

DRURY COLLEGE, at Springfield, has received \$8,000 from E. A. Goodnow, Esq., of Worcester, Mass., for scholarships for young women.

THE Duke of Sutherland has decided to erect a large technical school near Golspie, Sutherland. Building and equipment will cost £10,000, and in order to place the institution in an independent position it is said that Mr. Carnegie has offered another £10,000 as an endowment.

MRS. FITZPATRICK has given £2,000 to found a lectureship on the history of medicine, in the Royal College of Physicians, London, in memory of her late husband, Dr. Thomas FitzPatrick.

THE Horace Mann school building of Teachers College, Columbia University, will be dedicated on December 5. The principal address will be by ex-President Daniel C. Gilman, of the Johns Hopkins University.

EDWARD P. HYDE, A.M. (Johns Hopkins, 1900), has been given a fellowship in physics in the Johns Hopkins University.

MR. R. P. PARANJPYE, who was bracketed senior wrangler in 1899, has been elected to a fellowship at St. John's College.

DR. HANS SOLEREDER, of Munich, has been appointed professor of botany and director of the Botanical Institute at the University at Erlangen. Dr. V. Schiffner, associate professor of systematic botany in the German University at Prague, has been called to a similar position in the University of Munich. A full professorship of astronomy in the University of Göttingen has been offered to Dr. Karl Schwarzschild, docent at Munich. Dr. G. Kowalewski, docent in mathematics at Leipzig, has been called to an associate professorship in the University at Greifswald, and Dr. Julius Sommer, docent at Göttingen has been appointed professor of mathematics in the Agricultural School at Bonn-Poppelsdorf.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

EDITORIAL COMMITTEE: S. NEWCOMB, Mathematics; R. S. WOODWARD, Mechanics; E. C. PICKERING, Astronomy; T. C. MENDENHALL, Physics; R. H. THURSTON, Engineering; IRA REMSEN, Chemistry; CHARLES D. WALCOTT, Geology; W. M. DAVIS, Physiography; HENRY F. OSBORN, Paleontology; W. K. BROOKS, C. HART MERRIAM, Zoology; S. H. SCUDDER, Entomology; C. E. BESSEY, N. L. BRITTON, Botany; C. S. MINOT, Embryology, Histology; H. P. BOWDITCH, Physiology; J. S. BILLINGS, Hygiene; WILLIAM H. WELCH, Pathology; J. MCKEEN CATTELL, Psychology; J. W. POWELL, Anthropology.

FRIDAY, NOVEMBER 29, 1901.

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THE RELATION OF YALE TO MEDICINE.*

ON this fourth jubilee of Yale University, speaking, as I trust I may, in behalf of many hundreds of physicians who have received their liberal or professional education in this institution, I bring affectionate greetings to our alma mater, and offer our hearty congratulations on this happy anniversary. With all the sons of Yale we join in the prayer of President Stiles: 'Peace be within thy walls, O Yale, and prosperity within thy palaces.'

Yale is related to medicine most directly through her medical department, but also through all who have studied here and subsequently practiced the art or cultivated the science of medicine. The Medical School, although the first department added to the College, was not established until over a hundred years after the foundation of the Collegiate School at Saybrook. From the beginning, however, graduates of the College are to be found in the ranks of medical practitioners, and any account of the relation of Yale to medicine would be most incomplete without some consideration of the alumni of the eighteenth century who were physicians. Their history makes a large part of the medical history of Connecticut during that century, but it is not limited to this State.

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

* An address delivered October 21, 1901, at the two hundredth anniversary of the founding of Yale College.

EIGHTEENTH CENTURY.

Doubtless the student of universal medical history, who, after tracing the wonderful development of medicine in the century of Harvey, Malpighi and Sydenham, is engaged in following medical progress through the eighteenth century, marked by such names as those of Boerhaave, Haller, Morgagni and Hunter, would not turn aside long to note what the physicians of Connecticut or, indeed, of any part of America were doing at that time. Still the records of these early Yale physicians have the interest which attaches to the beginnings of things which have become important, and for us the special and sympathetic interest which belongs to the annals of family and country.

When the first physicians who had received their collegiate training at Yale appeared upon the scene early in the eighteenth century, the state of medicine in this country had not advanced materially beyond the primitive condition of the early colonial days. We encounter, as in the early history of medicine everywhere, three classes of medical practitioners: the priest-physician, the regular physician educated and practicing according to the recognized standards of the day, and the empiric or charlatan. What Cotton Mather called 'the angelical conjunction' of the cure of the soul and of the body was to be found most frequently and in its best type in New England. Here the regular training of physicians was almost wholly by apprenticeship for three or four years to some practitioner of repute. As vividly portrayed by a Connecticut physician, "The candidate 'served his time,' as it was then called, which was divided between the books on the shelf, the skeleton in the closet, the pestle and pill-slab in the back room, roaming the forests and fields for roots and herbs, and following, astride of the colt he was breaking, the horse which was honored with the saddlebags."

Nor was this condition very materially changed during the eighteenth century by the founding of the Medical Departments of the College of Philadelphia (now the University of Pennsylvania) and of King's College (now Columbia) in the decade before the Revolution and of those of Harvard in 1783 and of Dartmouth in 1797. During this century only two graduates of Yale College (John A. Graham, Y., 1768, and Winthrop Saltonstall, Y., 1793) had received a medical degree in course. The number of students from the New England colonies who resorted to the medical schools of Edinburgh, London or Leyden was extremely small, much smaller than that from the Middle and Southern colonies.

With the exception of a law passed in New York in 1760 and a similar one in New Jersey in 1772, there was no effective legislative control of medical practice in any of the colonies. Any one who chose could practice, and the root-doctors and Indian doctors of Connecticut had their counterparts elsewhere. More from the sparseness and poverty of the population than from the absence of disease, the remuneration from medical practice was so small that the physician often added some other occupation, most frequently agriculture, to the practice of his profession.

There were no hospitals, except pock-houses, and practically no medical organization. There was little opportunity for intercourse and interchange of views between physicians in different parts of the country, so that local peculiarities of practice were more common then than now. The only text-books were European, the most authoritative on medical practice being the works of Sydenham and of Boerhaave, later also of van Swieten, Mead, Huxham and Cullen. There was no American medical journal until near the end of the eighteenth century.

With two or three exceptions the few

original medical publications, mostly short pamphlets, by American physicians before the Revolution contained scarcely any personal observations of importance, so that the names of these physicians are remembered to-day by their reputation among their contemporaries and their influence upon their successors, rather than by any actual contributions to medical knowledge.

After this necessarily brief statement concerning some of the conditions of medical practice in the New England colonies, we are better prepared to appreciate the position and work of those graduates of Yale College in the eighteenth century who became physicians.

The course of studies at the College was planned rather for the preliminary training of ministers than of doctors, but it furnished a classical education, which was then more necessary for the study of medical books than it is to-day. There seems to have been at least some interest in the College in medical knowledge, if one may judge from the titles of some of the early theses and from the possession by the College of a human skeleton and 'paintings of the human body skin'd,' as they are inventoried. President Stiles occasionally delivered a lecture on medicine, and in his recently published 'Literary Diary' he gives an interesting outline of one of these lectures, the main headings being, I. Anatomy; II. Pathology; and III. The Methodus medendi (one of the sub-headings here being 'Efficacious medicines but few')—sufficiently comprehensive, it may be said, for a single lecture even in those days.

The success attained by the Yale physicians of the eighteenth century indicates that the College then, as ever since, supplied its graduates with a training of mind and character adapted to the circumstances of time and place, and fitting them for the work of life in any field.

Mainly by the aid of Professor Dexter's

invaluable two volumes of 'Biographical Sketches of the Graduates of Yale College,' covering the period from 1701 to 1763, and a kind personal communication relating to the remaining classes, I have been able to determine that there were at least 224 Yale graduates in course of the eighteenth century who practiced medicine. This figure, which is certainly somewhat below the correct one, is 9.7 per cent. of the entire number of Bachelors of Arts for the same period—a percentage about the same as the corresponding one for the nineteenth century.

Of the seven graduates in arts from the College in the first two decades of the eighteenth century who became medical practitioners, all, with one exception, were also clergymen, and of the seventy-two physicians graduated in arts in the first half of the century nearly one-fourth were clerical, whereas after this there are only a very few names of clerical physicians.

All who are familiar with the early colonial history of New England know what an interesting class the clerical physicians were. Not a few of them were educated, skilful physicians, who ranked among the leading practitioners and teachers of medicine in their day, while others were, on the medical side, scarcely more than 'comforters of the sick,' as they were sometimes called, rather than active practitioners. One of the earliest and most celebrated of this class of physicians was the Rev. Thomas Thacher (1620-1678), of Boston, the direct ancestor of our own honored and beloved Latin professor of the same name. His name is preserved in medical annals as that of the author of the first solely medical publication in America, a broadside folio which appeared in Boston in 1677, and is entitled: 'A brief rule to guide the common people of New England how to order themselves and theirs in the small pocks or measles.'

But of all those who combined the offices

of clergyman and physician, not one, from the foundation of the American colonies, attained so high distinction as a physician as Jared Eliot of the class of 1706, who was the first graduate of Yale College to enter upon the practice of medicine. His name is preceded in the triennial catalog by that of Phineas Fiske of the class of 1704, who was eminent both as a divine and as a physician, but whose shorter professional career did not begin until five or six years after that of Eliot.

The name of Jared Eliot is a worthy one to lead the long line of over 2,300 physicians who have received their liberal or professional education at Yale College. The grandson of the Rev. John Eliot, the Apostle to the Indians, he spent his long, twofold professional life of fifty-four years in the town of Killingworth (now Clinton) in this State, where he succeeded in the ministerial office his teacher, Abraham Pierson, the first rector of this College. Of fine bodily presence and engaging personality, for many years an influential trustee of Yale College, the library fund of which was started through his bequest, the friend and correspondent of Benjamin Franklin, Bishop (then Dean) Berkeley and other learned men, a fellow, it is said, of the Royal Society and recipient of a gold medal from the London Society of Arts, accounted in his day an excellent botanist, chemist and practical and scientific agriculturist, Eliot, as is stated by Dr. James Thacher in his *American Medical Biography* (1828), 'was unquestionably the first physician of his day in Connecticut,' and in chronic complaints "he appears to have been more extensively consulted than any other physician in New England, frequently visiting every county of Connecticut, and being often called in Boston and Newport." It is also said of him that "for forty successive years he never omitted preaching either at home or abroad on the Lord's day."

With evidences of such manifold activity one is prepared to accept the statement in his funeral sermon: "Perhaps no man slept so little in his day, and did so much in so great variety."

It is customary to speak of Jared Eliot as 'the father of regular medical practice in Connecticut,' and when one considers the number of physicians who were trained under him, and that among these were such leaders of the profession and successful teachers of medicine as his son-in-law and successor in practice, Benjamin Gale (Yale, 1733), and Dr. Jared Potter (Yale, 1760), the title seems justly conferred.

Among other clergymen noted in their day as medical practitioners may be mentioned Eliot's classmate, Jonathan Dickinson, the first president of Princeton College, whose paper published in 1740, entitled, 'Observations on that terrible disease, vulgarly called the throat distemper,' is the first medical publication by a graduate of Yale College, and the third on diphtheria by an American; Benjamin Doolittle, Yale, 1716, Northfield, Mass., 'well skilled in two important arts,' according to his epitaph; Timothy Collins, of the class of 1718, traditions of whose practice are still current in Litchfield County; Isaac Browne, of the class of 1729, an early member of the New Jersey Medical Society, the first State Society organized in this country; Moses Bartlett, 1730, the pupil and son-in-law of Phineas Fiske, described on his monument as 'a sound and faithful divine, a Physician of Soul and Body,' and the father of a son of the same name, graduated in 1763, who was one of the last of the clerical physicians; Dr. John Darbe, of the class of 1748, who received the honorary degree of M.D. from Dartmouth in 1782, and is the first graduate of Yale College to become doctor of medicine; and Manasseh Cutler (Yale, 1765), skilled in medicine as well as in many other arts.

The first non-clerical physician in the list of graduates is Jeremiah Miller of the class of 1709, who settled in New London. He seems, however, to have been more engrossed with other occupations than with medicine, so that Professor Dexter names John Griswold of the class of 1721, of Norwich, Conn., as 'the earliest graduate of the College who devoted himself exclusively to the profession of medicine.'

Among the two hundred and more eighteenth-century graduates of Yale whose principal or sole professional occupation was medicine are to be found the names of many physicians whose memories are preserved, and of whose useful lives and faithful service in their calling this College may justly be proud. Some were among the most influential and widely known medical men of their time and country. Such were Alexander Wolcott (1731), whose scholarly attainments in medicine are attested by the interesting collection of his books still preserved; Benjamin Gale (1733), one of the few pre-Revolutionary American physicians who have left published records of valuable medical observations; Leverett Hubbard (1744), incorporator and first president both of the New Haven County Medical Society and of the Connecticut Medical Society, for many years the recognized head of the profession in this city and county; Eneas Munson (1753), successful, able and learned, one of the longest-lived and most remarkable physicians of his day, the first name in the medical faculty of the Yale Medical Institution; Jared Potter (1760), described by Dr. Bronson as 'the most celebrated and popular physician in this State' in the first decade of the nineteenth century; Mason Fitch Cogswell (1780), one of the 'Hartford wits,' before the arrival of Nathan Smith, the most distinguished surgeon in this State, whose name has a permanent place in the history of

surgery; Eli Todd (1787), the first superintendent of the Retreat for the Insane at Hartford, who is honored by humanitarians and physicians alike as 'the first in this country to introduce the more humane methods of care and treatment of the insane'; John Stearns (1789), professor of medical theory and practice in the College of Physicians and Surgeons, western district of New York, president of the New York State Medical Society, who has the credit of first calling the attention of the medical profession to the use of ergot in obstetrics, and Thomas Miner (1796), whose ingenious and erudite essays on fevers and other medical subjects, written partly in conjunction with Dr. Tully, attracted wide attention and much comment both in this country and in Europe. To those familiar with this period of American medical history, particularly in Connecticut, other names will occur which might with equal propriety be mentioned, did time permit.

Some who belonged to the medical profession are better known as holders of high public office, and for their services to their country, than as physicians. Of the five medical signers of the Declaration of Independence two were graduates of Yale, both in the class of 1747—Oliver Wolcott, Governor of Connecticut, who studied medicine with his brother Alexander, already mentioned, and practiced for a short time in Goshen, in this State, and Lyman Hall, the first Governor of the independent State of Georgia, where he followed his profession with marked success. Nathan Brownson, of the class of 1761, who was Governor of Georgia, a member of the Provincial Congress and of the Continental Congress, and the holder of other high public offices, was likewise a practicing physician and was appointed by Congress deputy purveyor of hospitals and later to the charge of the southern hospitals in the revolutionary war.

The importance of the services of Yale graduates as surgeons and surgeons' mates in the French and Indian war and the Revolutionary war is not to be measured only by the passing mention which I find it possible to give to them here. I have found the names of ten graduates who served in a surgical capacity in the former war, headed by the doughty clerical physician, Timothy Collins (1718), the first Yale army surgeon.

In 1776 the General Assembly of Connecticut appointed a committee of eighteen of the leading physicians of the State to examine candidates for the positions of surgeons and surgeons' mates in the Continental Army, and some idea of the standing of Yale graduates then in medical practice in Connecticut may be gained by the facts that this Committee was headed by Alexander Wolcott and contained ten graduates of the College.

The earliest Yale graduate who held a commission in the American Revolution was a physician, Joshua Babcock of the class of 1724, Major General of the Rhode Island militia. He had walked the hospitals in London in 1730, being the first graduate of the College to study medicine in Europe, and for nearly twenty-five years was an active practitioner in Rhode Island. Mr. Henry P. Johnston's book, 'Yale and Her Honor Roll in the American Revolution,' gives the records of twenty-three graduates who served as surgeons or surgeons' mates in this war, and of six other physicians who were officers in the army.

The first bestowal of the degree of Doctor of Medicine in America was by Yale College in 1723, when Dr. Daniel Turner, a well-known London physician and voluminous medical writer received the honorary degree. The first American medical degree in course was given by the College of Philadelphia, now the University of Pennsylvania, in 1768. The first graduate of Yale College to receive a medical degree in

course was John Augustus Graham of the class of 1768, who was graduated bachelor of medicine from Columbia in 1772, and the first to be admitted to the doctorate of medicine in course was Winthrop Saltonstall of the class of 1793, M.D. Columbia, 1796.

There are certain directions in which Yale graduates during the eighteenth century especially contributed to the improvement of medical conditions in this country, an improvement everywhere slow and well marked only after the Revolution.

The Yale physicians of the eighteenth century, with a few not very important exceptions, which I have mentioned in a note,* were trained at home and were thrown in unusual degree upon the results of their own experience. While in the main their practice is not known to have differed from that which prevailed at the time, there is evidence of some local peculiarities. There developed early in Connecticut that special interest in the indigenous *materia medica* which, transmitted in direct succession from Jared Eliot, through Benjamin Gale, Jared Potter and Eneas Munson, became a distinguishing characteristic of Eli Ives and William Tully, the professors of *materia medica* and therapeutics in the Yale Medical Institution in its early years. This contributed to a less violent system of treatment of diseases than was customary in those days. Even in early colonial days a mild treatment of fevers prevailed in New Haven, according to Hubbard, who in writing of this town in his History of New England recorded that "The gentle conductitious aiding of nature hath been found better than sudden and violent means of purgation or otherwise; and blood-letting, though much used in Europe for fevers, especially in the hotter countries, is found deadly in this fever, even almost without

* The notes accompanying this address are omitted from this publication.

exception." In all probability the unusual success achieved by Benjamin Gale and certain other Connecticut physicians in the inoculation and treatment of smallpox is to be attributed to the mild, cooling and open treatment which they adopted, rather than to the preliminary mercurial treatment to which they ascribed it. These tendencies, for they were only such, did not find, however, their full expression until the appearance of Nathan Smith's work on 'Typhous [typhoid] Fever' in the next century.

Connecticut physicians were pioneers in the work of organization of the medical profession, and in this work graduates of Yale were prominent. The oldest existing medical society in this country is the still active and flourishing Litchfield County Medical Society founded in 1765 and preceded only by two short-lived voluntary organizations, one in Boston and the other in New York.

The first organized effort on the part of the profession to secure effective legal regulation of medical practice in the colonies was in 1763 when physicians of Norwich, Conn., petitioned the General Court for an act of incorporation, which was, however, not granted. The name of Elisha Tracy of the class of 1738 appears among the signers of this interesting memorial. This first unsuccessful attempt was the beginning of a series of efforts which, largely through the initiative of the Medical Society of New Haven County, organized in 1784, resulted in the incorporation of the Connecticut Medical Society in 1792. In the meantime State medical societies had been formed in New Jersey (organized in 1766, incorporated in 1790), Massachusetts (1781), Delaware (1789) and New Hampshire (1791).

The charter of the Connecticut Medical Society is, in most respects, an admirable instrument, and, as regards the organiza-

tion of State medical societies, historically almost as interesting as the famous Connecticut constitution of 1639. It embodies in a simple and practical fashion democratic and federative principles of organization and government resembling those adopted by the Commonwealth, and remains to this day a model for similar societies in other States. Of those concerned in the establishment of this Society graduates of Yale were the most active and influential, and they compose over one-third of the charter members. The first president was Dr. Leverett Hubbard (Y., 1744), and upon his death Dr. Eneas Munson (Y., 1753), was chosen his successor and held the office for seven years.

The most noteworthy contribution to medical literature before the Revolution by a graduate of Yale was Benjamin Gale's (Y., 1733) 'Historical memoirs relating to the practice of inoculation for the smallpox, in the British-American provinces, particularly in New England,' published in 1765 in the *Philosophical Transactions* of London. This creditable and historically interesting paper attracted attention both here and abroad, chiefly on account of its advocacy of the mercurial treatment before inoculation. It may here be mentioned that one of the most valuable of the Yale bicentennial publications, the 'Literary Diary' of President Ezra Stiles, edited by Professor Dexter, contains some interesting historical matter upon this subject of mercurial inoculation, as indeed it does relating to a number of other subjects of medical interest.

After the war of independence we find in American medical writings greater productivity and originality than before, attributable largely to the increased medical and surgical experience gained during the war, and to the higher degree of self-reliance, engendered by the political conditions.

The first original separate medical work in this country after the close of the Revolutionary war was the volume published in New Haven in 1788, entitled, 'Cases and Observations by the Medical Society of New Haven County in the State of Connecticut.' This publication, which contains twenty-six papers reporting cases of disease and autopsies, is an event of importance in American medical bibliography, not so much on account of the intrinsic value of the communications, although several are interesting, but because, in evidence of the newly-awakened medical life of the young republic, there is collected here for the first time a series of independent, original observations and studies by different American physicians. Nothing of the kind had appeared before in this country. One-third of the contributors to this volume are graduates of Yale.

Nine years later, in 1797, was started the first American medical journal, *The Medical Repository*, published in New York, and its projector was the talented and scholarly Elihu Hubbard Smith of the class of 1786, with whom were associated Dr. Samuel L. Mitchell and Dr. Edward Miller. Dr. Smith, the father of American medical journalism, died much lamented the following year. Although so young, he was physician to the New York Hospital, the editor of several works, and a contributor to literary periodicals as well as to his own journal, in which his scholarly papers on the plague of Athens and the plague of Syracuse can still be read with pleasure and profit. The establishment of *The Medical Repository*, which was continued until 1824, was of great service in promulgating medical knowledge and stimulating medical thought and writing in this country at the close of the eighteenth and in the early years of the nineteenth centuries.

The graduate of Yale, however, whose published contributions in the eighteenth

century are of the greatest permanent value to medicine was not a physician, but was that useful and versatile man, Noah Webster, of the class of 1778. Noah Webster is the first epidemiologist which this country has produced. In 1796 he published 'A collection of papers on the subject of bilious fevers, prevalent in the United States for a few years past,' and in 1799 appeared in two volumes a work, well known to all students of epidemiology, entitled, 'A brief history of epidemic and pestilential diseases,' which is of unusual interest, and on account of its records and observations of epidemic diseases in this country has an enduring value. There are scattered papers by him on various medical subjects, and one of these buried in *The Medical Repository* (Second Hexade, Vol. II.) should be rescued from forgetfulness. In this critique of Erasmus Darwin's theory of fever Noah Webster gives a well-reasoned, clear and definite presentation of that modern theory, associated with Traube's name, which explains febrile elevation of temperature by the retention of heat within the body.

NINETEENTH CENTURY.

With the turning of the century Yale College, under the guidance of the first President Dwight, passed not only in name but also in spirit from the eighteenth to the nineteenth century. It was transformed from a local to a national institution, and it entered upon a new era of expansion in which seeds were planted destined in the natural course of development to grow into the spreading tree of a university. The first fruit of this new university idea was the establishment of the Medical Department, some account of which will now engage our attention.

The need at that time of a medical school in this place is apparent from the fact that only eight or nine graduates of the

College before the foundation of the medical department in 1810 had received a medical degree in course, although a much larger number had spent a year in study at a medical school.

A part of the plan proposed in 1777 by a committee of the General Assembly to enlarge Yale College, provided a board of civilians was added to the corporation, included the establishment of professorships of medicine and of law. In the same year Dr. Stiles, before his entrance upon the duties of the presidency to which he had been elected, 'drafted a plan of an university, particularly describing the law and medical lectures,' to be laid before the committee of the General Assembly. These negotiations were at the time unsuccessful, and when at last in 1792 the closer union between the State and College was effected, these early proposals had dropped out of sight.

In two respects the circumstances attending the establishment of the Yale medical department are of peculiar interest. The initiative came from within the College and not from without, and the form of union between the College and the Connecticut Medical Society is something unique in the history of medical schools.

The idea of founding a medical department connected with the College unquestionably originated with President Dwight and was a part of his plan for extending the scope and usefulness of the institution. This broad-minded man was, as is well known, much interested in natural science, and he considered in his writings several matters of medical interest. One of the letters in his 'Travels in New England and New York' contains an argument, really remarkable in the light of our present knowledge, in support of his conclusion that malaria is caused by minute living organisms.

It is clear from several passages in the autobiographical reminiscences published

in Professor Fisher's 'Life of Benjamin Silliman' that at the time of Professor Silliman's appointment to the chair of chemistry and natural history in 1802 a medical department was definitely contemplated, and that his appointment was regarded as an important step toward that end. The plan had from this time the hearty sympathy and active support of Professor Silliman. 'Expecting,' as he says, 'from the first to be ultimately connected with a medical school in Yale College,' he attended both in Philadelphia and in Edinburgh, where he had gone mainly for chemical study, courses of lectures upon anatomy, materia medica, botany and theory and practice of medicine, coming under the influence of such famous medical teachers as Wistar and Barton in the former city, and James Gregory and John Barclay in the latter.

For centuries the medical departments of universities were the home of all that there was of chemistry and of other branches of natural and physical science, and it is significant that the medical department of this University came into being at the time when Benjamin Silliman had made New Haven the most important center for scientific work and influence in this country. It can hardly be an accidental coincidence that among the graduates of Yale College in the early years of Professor Silliman's teaching are found the names of such men as William Tully, Alexander H. Stevens, who represented medicine at the one hundred and fiftieth anniversary of this University; Jonathan Knight, Edward Delafield, John Wagner, Samuel H. Dickson and George McClellan, who became physicians and surgeons of national and international fame.

In 1806 the corporation of the College passed a resolution for establishing a medical professorship, and the Rev. Dr. Nathan Strong, of Hartford, who introduced the

resolution, and Professor Silliman were appointed a committee to examine and report, and to devise means for effecting the object.

It is to be emphasized that the Medical Department is the direct offspring of Yale College, and was not started, as nearly every other medical school in this country has been, by a group of outside physicians who have subsequently sought connection with a college. Even if there were no other claims, this origin should entitle the Yale Medical School for all time to the fostering care and support of its parent.

In order to understand the occasion for the negotiations which now ensued between the corporation of the College and the Connecticut Medical Society, it is to be borne in mind that this Society was possessed, through its charter of 1792, of unusual prerogatives which gave it control of medical education in this State. It was not only an examining and licensing body, which was proper, but also a degree-conferring body, which was decidedly improper and a usurpation of a function which should belong only to a college or university. From the beginning the Society had actively exercised all of these functions, and had furthermore made several regulations, which it was empowered to do, regarding medical education.

It was evidently necessary for the College to come to some sort of understanding with the Medical Society, and to induce it, if possible, to relinquish some of its chartered privileges.

It is not necessary here to enter into the details of these negotiations between the College corporation and the Medical Society, which extended over three years, especially as these have been fully set forth in a readily accessible paper by Dr. E. K. Hunt, a generous benefactor of the Medical School. Suffice it to say that concessions were made on both sides, and that, largely through the

efforts of President Dwight and Professor Silliman, representing the College, and of Dr. Eli Ives, representing the Medical Society, a satisfactory and amicable arrangement was reached, apparently without a great deal of friction, and was embodied in 'Articles of Union,' which constitute the act creating 'The Medical Institution of Yale College,' passed by the General Assembly in 1810 at the October session.

This act fixed the number of professors at four ('to include a complete circle of medical science'), the price of the ticket, and the time of examinations; provided for the establishment of a botanical garden, and of collections in anatomy and in *materia medica*; for a joint committee of an equal number of persons from the Medical Society and the corporation to nominate professors to be chosen by the corporation, and also for a like joint examining board, in which the president of the Society had the casting vote in case of a tie; repealed the right of the Society to grant honorary degrees in medicine, which could thereafter be conferred by the president of the College upon recommendation of the Society; provided that each county could send, upon recommendation of the Society, a gratuitous student, and fixed the term of medical study for college graduates at two years, and for others at three years, attendance upon a single course of lectures being requisite for the license, and upon two courses for the doctorate.

It is evident from this summary that the Connecticut Medical Society shared to a considerable degree with the College the control of the Medical Institution. I do not suppose that the College would have entered into this agreement with the Medical Society, had not the circumstances been such as I have mentioned. Nevertheless this union between the College and the State Medical Society had at that time distinct advantages, the most important of

which was the securing of the active interest of the physicians of the State in the new institution. In general the circumstances connected with the foundation and conduct of most medical schools in this country have not been calculated to secure the interest and sympathy of the great body of the medical profession.

No more competent testimony to the benefits derived from the union which existed here could be desired than that of Dr. Jonathan Knight, who says, in his introductory lecture in 1853: "The result of this arrangement has been eminently happy; all unpleasant feeling was at once and forever allayed; the members of the Society became interested in the School; we have at all times had the benefit of their council and support, and it gives me pleasure to state that no instance of disagreement has ever arisen among the members of the board, or between the School and State Society; on the contrary, each has regarded the other as a fellow laborer in the endeavor to promote and advance the interest of medical science."

The relations continued harmonious throughout the remaining period of existence of the agreement between the Society and the Medical School, but with changed conditions the union ceased to be useful and in some ways had become embarrassing, so that in 1884, by mutual consent, it was annulled, and the entire control of the School, the official name of which had meantime been changed by the new charter of 1879 to that of 'The Medical Department of Yale College,' passed into the hands of the University.

The charter of 1810, by its limitation of the number of professors and of the period of undergraduate medical study and its regulation of other matters better left to the discretion of the College, was an extremely inelastic instrument, and it is not surprising that repeated legislative changes

were found necessary. There have been not less than four distinct charters of incorporation of the Medical School, and in addition five or six amendatory acts. The present charter, which seems to be free from the defects of its predecessors, was enacted in 1879.

At the time of its incorporation in 1810 the Medical Institution of Yale College was the sixth medical school in the United States, the others being the medical department of the University of Pennsylvania, founded in 1765, the College of Physicians and Surgeons in New York, founded in 1807, but a descendant of the medical department of Columbia University, established in 1768, and the medical departments of Harvard (1783), of Dartmouth (1797), and of the University of Maryland (1807).

A commodious stone building on Grove Street, erected by Mr. James Hillhouse, was obtained for the use of the Medical School, and in 1814 this with an adjacent plot of ground was purchased by the aid of a generous donation by the State of twenty thousand dollars, obtained largely through the efforts of Dr. Nathan Smith. This building, which is now South Sheffield Hall, was the location of the Medical School until its removal in 1859 to its present site on York Street.

The members of the first faculty of the Medical School, appointed in 1812, were, in the order of arrangement of their names in the College catalogue, Eneas Munson, professor of materia medica and botany; Nathan Smith, professor of the theory and practice of physic, surgery and obstetrics; Eli Ives, adjunct professor of materia medica and botany; Benjamin Silliman, professor of chemistry and pharmacy, and Jonathan Knight, professor of anatomy.

Dr. Munson, to whom I have already referred, was an octogenarian at the time of his appointment, which was, as was intended, only an ornamental one, Dr. Ives, the adjunct professor, his pupil and friend,

performing the active duties of his chair. The remaining members of this faculty made a group of medical teachers who could challenge comparison with any similar group in this country. Of Benjamin Silliman it is not necessary for me to speak further, as his most important work lay outside of the immediate field of medicine, and will be considered by another speaker.

Dr. Nathan Smith, when he came to New Haven from Dartmouth, was already a star of the first magnitude in the medical firmament. Starting a poor boy in a small village in Vermont, he managed by his own efforts to obtain a good general education and then at the Harvard Medical School and in Great Britain a medical education of a character then almost unknown in New England. He was the originator of the Dartmouth Medical School in 1797, the most distinguished member of the first medical faculty of Yale, and in 1820 the organizer of the Medical Department of Bowdoin College. He did much of his most important work in New Haven, where he remained until his death in 1829.

Nathan Smith shed undying glory upon the Yale Medical School. Famous in his day and generation, he is still more famous to-day, for he was far ahead of his times, and his reputation, unlike that of so many medical worthies of the past, has steadily increased as the medical profession has slowly caught up with him. We now see that he did more for the general advancement of medical and surgical practice than any of his predecessors or contemporaries in this country. He was a man of high intellectual and moral qualities, of great originality and untiring energy, an accurate and keen observer, unfettered by traditions and theories, fearless, and above all blessed with an uncommon fund of plain common sense.

Nathan Smith's essay on typhus fever, published in 1824, is like a fresh breeze from

the sea amid the dreary and stifling writings of most of his contemporaries. The disease which he here describes is typhoid fever, and never before had the symptoms been so clearly and accurately pictured. He recognized that this fever is due to a specific cause and is self-limited. It took courage in those days for a physician to write, "During the whole course of my practice I have never been satisfied that I have cut short a single case of typhus, which I knew to be such," and again, "It does not follow of course that this disease in all cases requires remedies, or that a patient should necessarily take medicine because he has the disease." To him the *lancet* was not the '*magnum donum Dei*' that it was to Benjamin Rush, and he did more to do away with its indiscriminate use than any single man. The treatment which he advocated—cold water, milk, and avoidance of all violent remedies—is practically the same as that now employed, but it was many a day before physicians came to accept Dr. Smith's revolutionary views.

To the surgeon Nathan Smith's paper on the pathology and treatment of necrosis has in course of time become as much of a classic as the essay on typhus fever is to the physician. Here we find the same admirable description of symptoms, and the introduction of methods of treatment which anticipated modern surgery. This is not the occasion, even did time permit, to describe Dr. Smith's achievements in surgery. It must suffice to say that he was the first to perform a number of important surgical operations, and that in this branch, not less than in medicine, he was an innovator and reformer.

Although none of Dr. Smith's colleagues can be placed in the same rank with him as contributors to medical knowledge, they were men of excellent attainments and became distinguished teachers.

Dr. Eli Ives was connected with the

Medical School until his death in 1861, having succeeded to the professorship of theory and practice of physic upon the death of Dr. Smith in 1829, and becoming emeritus in 1853. He was a highly respected physician of large practice in this city. He was widely known as a botanist, and was credited with the most extensive knowledge of the indigenous materia medica of any man of his day, a taste for which he had acquired from his preceptor, Dr. Munson. His mind was richly stored with facts, and all were impressed with the value of his teachings.

Dr. Jonathan Knight, who was only twenty-three when appointed professor, became one of the most influential men in the medical profession of this country, having been twice president of the American Medical Association. He was transferred to the chair of surgery upon the death of Dr. Hubbard in 1838. Of dignified personal appearance and manner, with well-balanced mental powers, and fine literary culture, Dr. Knight has probably never had his superior in any medical school in this country as a finished lecturer. He was an active teacher in the Medical School for fifty-one years, dying only a few months before Professor Silliman, the latest survivor of the first medical faculty.

With this able and devoted group of teachers and a class of thirty-three students the Medical School began its work in November, 1813. To follow in detail its history from that day to this would far exceed the limits of this address. I regret that I can do no more than make mention of some of the professors who have passed to the majority: Thomas Hubbard, of necessity an inadequate successor of Dr. Nathan Smith in the chair of surgery, a plain, self-taught man, of whom Dr. Knight says that he filled his position to the time of his death in 1838 'with great and increasing reputation to himself and benefit to the institu-

tion'; William Tully, a really remarkable man, of whom I had hoped to say much more, erudite, original, an experimentalist, unrivaled in his knowledge of the materia medica, an extensive contributor to medical literature; Charles Hooker, of good scientific training, who had the great merit of introducing the newer medicine with its methods of physical examination into New Haven, a writer of valuable papers on auscultation and percussion and on physiological subjects; Henry Bronson, scholarly, devoted to antiquarian research, contributor of important papers on medical history and biography; Worthington Hooker, interested in medical education and the improvement of professional organization, a facile writer, widely known as a useful popularizer of natural science; Moses Clark White, for thirty-three years professor of pathology, who taught as early as 1860 the use of the microscope in medicine in this School; Leonard Jacob Sanford, a faithful teacher of anatomy for nearly a quarter of a century, devoted to the interests of the Medical School; James Kingsley Thacher, endowed with unusual intellectual powers and capacity for original scientific investigation, eminent as a comparative anatomist, abreast of modern physiology and clinical medicine, whose early removal by death was an irreparable loss to this Medical School and to medical and biological science.

While I refrain in general from mention of the names of those who are still living and are the faithful and able successors of these distinguished men, I cannot in this connection pass over the name of Dr. Charles Augustus Lindsley, a member of the medical faculty for thirty-seven years and its executive officer for twenty-three years, a devoted teacher and eminent sanitarian.

The period of greatest prosperity of the Medical School, until quite recent years, was the first two decades of its existence, in which the average annual attendance of

students was between 70 and 80. The annual attendance then fell to an average of between 30 and 40 for the four decades from 1850 to 1890. Since 1895 it has for the first time exceeded 100. Up to 1894 the largest class was that of 1822, which numbered 92, the largest number of graduates in any year up to 1897 being 36 in 1829. Of the 1,221 graduates of the medical department up to and including 1900, 27.6 per cent. were also college graduates, and of these three-fourths were graduates of Yale College or the Sheffield Scientific School. The highest ratio of college graduates (40.6 per cent.) was in the decade 1881 to 1890, when the total number of graduates was smallest.

It is pleasant to recall that the medical department, established through the efforts of the first President Dwight, entered upon a second era of prosperity in the administration of the second President Dwight, who in his annual reports has forcibly presented the needs and the possibilities of this first offspring of the College.

The standards of the Yale Medical School have always been kept high in comparison with those prevailing at the time, and at certain periods the School has taken the lead in movements to improve medical education, which from about the end of the third to the middle of the eighth decades of the past century was in a woeful plight in America.

At the beginning the course of medical lectures here extended through six months, a longer period than obtained at the time in any other medical school in this country.

The first organized effort to raise the standard of requirements for medical education in the United States was made by a Convention of Delegates from Medical Societies and Medical Schools which met in Northampton, Massachusetts, in 1827. The Yale Medical School faithfully conformed to the recommendations of this convention, and went to the trouble of securing in 1829

from the Legislature an amendment of its charter whereby the period of medical study was increased to four years for all who were not college graduates, and to three for graduates, and knowledge of Latin and of natural philosophy was required for matriculation. The Medical College soon found itself standing almost alone, 'faithful among the faithless,' and, in order to preserve its own existence, it was compelled after three years to return to the old order as regards the length of the period of medical study, although it retained the preliminary requirements, which, however, afterwards became inoperative, as they were so far above the demands of other colleges.

The inadequacy of the system of didactic lectures for the training of medical students was nowhere in this country earlier recognized than here. In 1855 the course was supplemented by daily recitations, and, as their advantages were realized, they received in the following years greater and greater emphasis, until they in combination with laboratory practice became, at least as early as 1867, a distinctive, and certainly a valuable feature of the school.

In 1879 the Yale medical department placed itself in the front rank, as regards its standards, with only a few companions at that time, by introducing a stated matriculation examination and a three years' graded course, lengthened in 1896 to four years. Clinical instruction and the recitation and laboratory plan of teaching, which had been early adopted, continued to be the basis of the course. The thoroughness of the training is attested by the unusual success of the graduates of the Yale medical department in competitive examinations for positions in the army and in hospitals, and in State Board examinations for license to practice.

With the laboratory building erected in 1893, and the clinical building now in process of construction, the teaching re-

sources of the medical department have been greatly increased, and there is every indication that it has entered on a new era of success and usefulness, but it cannot reach the height of its endeavor or of the position properly belonging to an important department of this great University without a large increase of its present meager endowment.

Of the total number of physicians who have received their liberal education at Yale College and the Sheffield Scientific School, less than one-fifth are graduates of the Yale medical department, and it is pertinent to inquire how their alma mater has fitted them for their subsequent professional studies. For the great majority and until comparatively recent years this collegiate training was furnished by the old-fashioned classical course, and there can be no question but that this, combined with other influences of college life, gave an excellent discipline of mind and character, but with no peculiar adaptation to the study of medicine.

The advance of medical science and art during the last half century has given ever-increasing prominence to the value to the student of medicine of a good practical knowledge of chemistry, physics and general biology. It is to the great credit of this University that this need was first clearly recognized and supplied in this country by the Sheffield Scientific School, which in 1870 offered well-planned courses in these branches of science, announced as intended especially for the preliminary training of prospective medical students. With the establishment of the Laboratory of Physiological Chemistry four years later the distinctive pre-medical biological course was fully organized, and since 1889 this has been open also to students in the academical department.

No more convincing testimony to the importance of this new departure in collegiate

education is needed than the mere mention of the names of some of those who were graduated from the Scientific School in the ten years following the establishment of this course and who have acquired distinction in medicine or in sciences akin to medicine. Fortunately I can not illustrate my argument here by the selection of names from those who have passed away, and I trust that it will not be considered invidious if I cite names so familiar to physicians and biologists as those of Prudden, T. H. Russell, Hun, W. B. Platt, Chittenden, Yamagawa, Curtis, Sedgwick, Gilman Thompson, E. B. Wilson, Mitsukuri, H. E. Smith, E. A. Andrews, Ely. Not only has the laboratory of physiological chemistry under the direction of Professor Chittenden been of great service in the preparation of students for the study of medicine, but its contributions to a science of great medical and biological importance are unequaled in number and value in this country and have given it rank with the best laboratories of its kind in the world.

There have been all told not far from 2,300 graduates of Yale in all its departments (including the medical), who have become physicians, not counting twice the names of those graduated from more than one department. Of the graduates in arts (1702-1897) about 1,100 (9 to 10 per cent.) have entered the medical profession, the percentage being about the same for the eighteenth and the nineteenth centuries, but varying considerably in different years and decades, as appears from data which I have inserted in a note.* Especially significant is the fact that from the classes of 1822, 1824, 1825, 1826, and 1828, when the medical department was at the height of its early prosperity, the number of graduates in arts who became physicians was 80 per cent. above the general percentage

* The notes accompanying this address are omitted from this publication.

for the nineteenth century, and that over 41 per cent. of these received their medical degree from the Yale Medical School, as against 24 per cent. in general for the period since the opening of the medical department. Of the graduates of the Scientific School (1852-1897) at least 193 (9.1 per cent.) were later graduated in medicine, 22.3 per cent. of these receiving their degree from the Yale medical department.

It is of course out of the question to attempt to give here even the most summary account of the more than two thousand Yale physicians of the nineteenth century. Among those no longer living are the names of such famous men as Alexander H. Stevens, Samuel H. Dickson, George McClellan, Nathan R. Smith, William Power, Alfred Stillé, Samuel St. John, William H. Van Buren, Edmund R. Peaslee, J. Lewis Smith, Daniel G. Brinton, William T. Lusk and many others deserving of mention did time permit. The graduates of Yale in the medical profession have contributed their full share to the making of the medical history of this country. Over one hundred became professors in medical colleges, especially noteworthy being the number and distinction of those who have been and who are connected with the medical schools in New York City. At least thirty have been presidents of their State medical societies.

In all these two hundred years of her existence men have gone forth from Yale who have adorned the profession of medicine. Among them have been great teachers, leaders who have advanced medical knowledge, improved medical and surgical practice, and raised the standards of professional life and of medical education, men who have served their country in a professional capacity in peace and in war, and many more who have led the useful lives of general practitioners, honored in their homes and by their colleagues, and con-

tributing to the welfare of the communities where they have lived.

In centuries past the greatest renown of many universities lay in their medical faculties. There have been later times when the conditions of medicine and of medical education made it less fit to enter into the life and ideals of a university. It is not so to-day. Medicine has now become one of the great departments of biological science with problems and aims worthy of the highest endeavor of any university, surely none the less worthy because they are associated with human interests of the highest importance.

The union of medical school and university should be of mutual benefit. Medicine needs the influences of a university for its highest development, and the usefulness and fame of a university are greatly increased by a strong medical department. There is to-day no direction of scientific research more productive in results of benefit to mankind and in the increase of useful knowledge than that upon which medicine in these later years has entered, and there can be no nobler work for a university than the promotion of these studies.

But medical teaching and research can no longer be successfully carried on with the meager appliances of the past. They require large endowments, many well-equipped and properly-supported laboratories, and a body of well-paid teachers thoroughly trained in their special departments. With an ampler supply of such opportunities as these there is every reason to believe that the Yale medical department would take that important position in the great forward movement of modern medicine to which its origin, its honorable history and the fame of this ancient University entitle it. May the next Jubilee find medicine holding this high position in Yale University!

WILLIAM HENRY WELCH.

VARIETAL MUTATION IN THE TOMATO.

THE following remarks refer to the origination by mutation* of a strongly marked and distinct variety of tomato from seed of an old and well-known variety, under ordinary cultivation in an isolated garden plot; and to the subsequent duplication of that case of mutation upon the same ground and under the same conditions of cultivation, but in plants produced from other seed of that old variety, which was grown in a different and distant region. The mutation in these two cases is remarkable in that it was uniformly manifested in every plant of each of the two crops in which it occurred; that it produced plants which were widely different from the parent plants; that the second case was an exact repetition of the first, and that it occurred in both cases under circumstances that preclude the probability that it was the result of cross-fertilization.

My observations in these cases were made in connection with amateur gardening upon my house-lot in Washington, a statement of the results of which follows in narrative form. I chose the Acme variety of tomato for cultivation because of its long-known excellence, and the cases referred to occurred unexpectedly in the variety thus chosen. In the spring of 1898 I purchased a dozen young plants which had been produced from seed by a gardener in the vicinity of Washington, and transplanted them in my garden plot. As the plants matured and fruited they showed all the recognized varietal characteristics of Acme, a description of which is herewith given for the purpose of comparing it with other varieties presently to be mentioned. The plants were large and diffuse, the color of the foliage being a medium shade of green;

haulms slender, somewhat numerous, some of them reaching a length of more than six feet; the petiole-midrib long and slender; leaflets moderately narrow, distant, petiolulate and only slightly rugose; fruit depressed-globular in shape, with an occasional tendency to become transversely oval, uniformly ripened, fleshy and well flavored; and in ripening the change from the chlorophyl-green to crimson, passing through more or less of yellow.

I selected seeds from one each of the earliest and most characteristic fruits of several vigorous plants of this crop of 1898, and made a mixed packet of them. These seeds I planted in 1899, expecting to produce true Acme plants, because of my care in selecting and preserving the seeds, because of the comparative stability of that variety, and because no other tomato plants were grown with them, or in their neighborhood, from which cross-fertilization might have occurred. To my surprise, however, all the plants which grew from these seeds were distinctly different from the parent plants of the year before, both as to habitus and as to fruit, and all were uniform in their new characteristics. They were sturdy and compact plants with foliage of a deeper green than that of the parent plants; haulms few and strong, the more vigorous reaching a length of about four and a half feet, or an average of about two-thirds the length of the parent plants; petiole-midrib short and strong; leaflets moderately broad, not distant, sessile or nearly so, and strongly rugose; fruit similar to that of the parent plant in size, shape and consistence, but more delicate in color, which changes from the chlorophyl-green to cherry-red or light crimson through a neutral or flesh color, a yellow tint seldom appearing. It is also singularly free from the pronounced tomato flavor of the common kinds. The seeds which I saved from this new variety were accidentally destroyed

* In this article I use the term 'mutation' in the phylogenetic sense that has been given to it by Professor Hugo de Vries in his exhaustive work, 'Die Mutationstheorie,' Leipzig, 1901.

and I supposed the variety was therefore lost; but two years later I recovered it upon the same ground and under the same conditions of isolation and cultivation, but from a new source as to seed.

In the spring of 1900 I bought from a Philadelphia company of seed-growers a packet of their 'selected Acme Tomato' seed, grown and gathered on a Pennsylvania farm in 1899. From a part of these seeds I grew thirty plants to maturity, every one of which was true to the Acme variety as described in the second paragraph of this article. In this case also there was no probable source of cross-fertilization, and I carefully saved a mixed packet of seed selected from typical fruits of several of the best plants, as I did in the former case. These seeds I planted in my garden plot in 1901, not doubting that they would produce true Acme plants, notwithstanding my former experience. On the contrary, however, all the plants grown from those seeds were not only quite different from the parent Acme plants, but they were in all respects, both as to habitus and as to fruit, like those which grew upon the same ground in 1899, which are described in the third paragraph of this article, and which variety I believed was lost at the end of that year. That is, in 1900 and 1901 I exactly repeated my experience of 1898 and 1899, the second experience having been with seed from an entirely new source, as already stated. The new variety belongs to a group of varieties of which the two known to gardeners as the 'Potato-leaf Honor Bright' of Livingston and the 'Dwarf Champion' of Ferry, respectively, may be taken as types. It is quite a different group in several respects from that to which the Acme belongs. For convenience of reference I will designate this new variety as the 'Washington.'

When, in the spring of 1901, I planted the seed of the Acme plants, which I had

grown in 1900, I at the same time planted the remainder of the Pennsylvania packet of Acme seed, carefully keeping separate both the seed and the resulting plants. The second portion of the Pennsylvania seeds produced true Acme plants, as did those of the first portion in 1900, and, although they grew vigorously, their fruit was more than two weeks later in ripening than was that of the Washington variety, thus adding another element of difference between the two varieties. This second planting was fortunate because it gave excellent opportunity to compare the two varieties with each other in all stages of their growth. As the plants of both varieties matured their differences of habitus became very conspicuous; indeed, it was readily observable with the appearance of the first leaves of the plantlets.

While all varieties of cultivated plants which are reproduced from seed are notably unstable in their varietal characteristics, some varieties, of even the same species, are more unstable than others. This varietal instability of cultivated plants is manifested in both mutation proper and atavic reversion. The first is regenerative, and divergently progressive, especially in respect of results desired by the horticulturist, and the second, degenerative and convergently retrogressive. The tendency to mutation proper in cultivated plants is generally manifested in connection with selective cross-fertilization, but in view of my experience herein recorded, and of that of other persons in other cases, it cannot be doubted that it often occurs spontaneously in plants that have been fertilized only by pollen from those of their own variety. The tendency toward degenerative change in cultivated plants is apparently an inevitable result of promiscuous cross-fertilization, and is toward the primitive, uncultivated condition of the species. I, of course, assume that the Washington variety of tomato

herein described originated by spontaneous, saltatory mutation, without cross-fertilization, and that this form of mutation differs only in degree, not in kind, from the saltatory origin of new species which has been elaborately described and demonstrated by Professor de Vries in his work already referred to.

This manner of origination of the Washington variety of tomato is assumed for the following reasons: (1) No probable source of cross-fertilization was discovered by careful investigation; (2) all the new plants were identical with one another in their varietal character; and (3) the mutation in question was exactly repeated in a succeeding crop under like conditions of isolation and cultivation. If my Acme plants had received adventitious fertilization by pollen from any other than flowers of their conate crop-associates, the cross-fertilization would doubtless have been incomplete as to the whole crop and various as to the kinds of hybrids produced. Even if it were credible that the first case of complete mutation of my whole crop might have been the result of cross-fertilization from some unknown source, it would still be too much to believe that exactly the same result could have been produced a second time in succeeding years by such adventitious means.

Saltatory mutation may be said to have both a predisposing and an exciting cause, the former being always present, at least latently, and the latter acting only under the stimulation of changed conditions; but I do not propose to discuss the nature of either of them. While the exciting cause of saltatory mutation in plants very often acts in connection with the process of cross-fertilization, it sometimes, as has been shown, acts independently of it. In such cases as that which is here recorded one naturally seeks the exciting cause in some peculiarity of the physical conditions under which the plants grew. I by no means as-

sume that the exciting cause of the mutation which produced the Washington variety of tomato will be found in the physical conditions of my garden and its vicinity, but the following mention is made of those conditions, that they may be considered in any inquiry that may be made concerning it. My ground is in a northern suburb of Washington and, before the Civil War, it was part of a worn-out farm of stiff clayey soil. It is somewhat dry, but was watered freely with Potomac river water, especially during the hot summer months. It was fertilized with stable manure, lawn-mowings (used also as mulching) and crude sodium nitrate, the last about half an ounce to the plant, applied in weak solution near the roots. Besides the evident obscurity of the exciting cause of the case of mutation in question, when considered with, as well as aside from, reference to these conditions, it should also be mentioned that no similar case has been reported from other gardens around Washington in which tomatoes are grown, although practically the same conditions prevail in many of them that exist in mine.

That the mutation which produced my new Washington variety was not atavic, or retrograde, in character is shown by the horticulturally improved characteristics of the fruit, and by the fact that the entire habitus of the plant is unlike that of the parent Acme, and also unlike that of the plants from which the Acme was originally produced. In both fruit and habitus the new variety is also very unlike those common tomato plants and fruit to which all improved varieties sooner or later convergently revert under promiscuous cross-fertilization and careless cultivation. Although the Acme is one of the least unstable of the very many varieties of tomato which gardeners have recognized, its deterioration by atavic reversion is very common and is readily observable in the markets of Wash-

ington, where gardeners have brought the fruit during more than twenty years; but few of them have kept it pure. One may there trace the reversion through various grades from the typical to almost worthless kinds.

In view of all the facts that have here been stated, there seems to be no room for doubt as to the spontaneous, saltatory and phylogenetic character of the mutation which produced the Washington variety of tomato. Whether it will show the usual degree of varietal stability in future seed propagation, and whether any similar mutation will occur in other varieties of tomato under conditions similar to those of my garden, remain to be demonstrated.

CHARLES A. WHITE.

SMITHSONIAN INSTITUTION,
October 3, 1901.

SCIENTIFIC BOOKS.

A Treatise on Zoology. Edited by E. RAY LANKESTER. Part III. The Echinoderma, by F. A. BATHER, assisted by J. W. GREGORY and E. S. GOODRICH. London, A. and C. Black. 1900. Pp. vii + 344.

The student of zoology, if he wishes an elementary text-book, finds as great difficulty in making his selection as he does in buying a new bicycle or typewriter. Apparently the more advanced student will not be thus hampered by any embarrassment of riches, for it is doubtful whether any other work aims as high and attains as much as the volume under review.

The average worker who has added somewhat to his primary zoological training finds it a dreary and often fruitless performance to extract the new facts of science or the present state of knowledge on any particular topic from the almost endless collection of 'elementary' text-books, no matter how valuable they may be in fulfilling their true function. It is almost equally tiresome to sift out the same information from the great mass of technical papers on particular things. The present volume supplies in a large degree this deficiency for the Echinoderma, and is a most welcome addition

to general zoological literature. The entire series is planned to include ten parts, of which this is the third. Each of the larger groups of animals is to be described by a separate author after a definite model, in order to secure uniformity in both scope and method.

The general systematic survey of the phylum Echinoderma, with its seven classes, is quite full and comprehensive and includes the main facts of ontogeny, phylogeny, anatomy and classification. The orders and families are all clearly defined and most of the prominent genera are reviewed or mentioned. One of the striking features of this volume is the fulness with which the fossil forms are treated, thus according them their true value in any general treatise on echinoderm morphogeny. Instead of the starfishes and sea-urchins constituting the entire program, or 'whole show,' as they do in the minds of the average student and in half the text-books, here they form but the last two of the seven classes recognized, and the length of their discussion is in proper proportion. It is sincerely to be hoped that similar true values will be given among other classes, whether extinct or not.

The phylum Echinoderma comprises two divisions or grades, the Pelmatozoa and the Eleutherozoa. In the first are the classes Cystidea, Blastoidea, Crinoidea and Edrioasteroidea. In the second grade are the Holothuroidea, Stelleroidea and Echinoidea. This arrangement shows the unequal value of the classes and does not express their phylogenetic relations. The latter probably would be more truly represented, according to Bather, by placing a primitive class, Amphoroidea, at the base and deducing from it several lines of descent, namely, Edrioasteroidea, Anomalocystida, Aporita, Rhombifera and Diploporita. From the Edrioasteroid line, it is supposed, there sprang first Holothurians, then Stelleroidea, then Echinoidea. The Blastoids are included in the Diploporite line, and from them as a fresh development with a new lease of life arose the important class Crinoidea, whose discussion occupies, as is wholly proper, nearly one-third of the present volume.

The class Stelleroidea comprises the Asteroidea and Ophiuroidea, generally considered as quite distinct. Some recent genera, how-

ever, and many of the fossil forms, show that no clear line of separation can be drawn, though the names are still retained for simple convenience.

The usual primary subdivisions of the Echinoidea into two subclasses, the Palæechinoidea and Euechinoidea, have been abandoned and the older divisions, Regularia and Irregularia, adopted. The primitive ancestral Echinoid is unknown, though it is evident that the first forms were small sac-like bodies, with the mouth and anus at opposite poles and the muscular body supported by a series of angular plates, of which five pairs were perforated by pores. The thickening of the plates and the consequent loss of flexibility is believed to explain the reduction in the number of vertical rows taking place in the passage from paleozoic to neozoic genera.

C. E. BEECHER.

Studien über die Narcose, Zugleich ein Beitrag zur allgemeinen Pharmakologie. By E. OVERTON. Jena, Gustav Fisher. 1901. Pp. 195.

The chief object of these studies is the presentation of a new theory of narcosis which was put forward simultaneously but independently by Overton and H. Meyer. The essential point of the theory is that narcotics are such substances which are more or less soluble in the lipoids of the nerve cells, chiefly cholesterin and lecithin. However, as all substances reach the nerve cells only after being taken up by the blood and the lymph, they have in the first place to be soluble in the chief medium of these fluids—*i. e.*, water. The question, therefore, whether and in what degree a substance is a narcotic—*i. e.*, whether and in what degree it is able to enter into the nerve cell—depends upon whether and how much this substance is more soluble in fats than in water; in other words, the narcotic capacity of a substance depends upon the coefficient of its solubility in organic solvents divided by its solubility in water.

The book consists of two parts. The first part deals in an interesting and instructive way with the general aspect of the subject of narcosis. At the start the author shows that the distinction made by Claude Bernard, Dastre and other French writers, between anæsthetics

and narcotics cannot be maintained. Neither does the practical separation of the inhalation anæsthetics from the other narcotics have a scientific basis. There is, however, according to the author, a distinct difference between indifferent narcotics and narcotics of a basic character. The latter vary in their effects upon animals as well as plants from species to species; while the indifferent narcotics affect all vertebrates and some invertebrates in the same degree, provided the concentration of the narcotic within the blood of the animal is taken as a basis for the unit, and not the quantity of the narcotic used up in the production of the narcosis of the animal. The writer discusses the various steps which a narcotic has to pass through from its administration to the animal to its arrival in the body cells, and the different modes of penetration of the several layers of the cell, according to the compound employed as a narcotic. He then describes in detail the methods employed by Paul Bert, as well as those employed by himself, to obtain a constant concentration within the plasma of the blood of the volatile as well as of the non-volatile narcotics.

The author reviews the different theories of anæsthesia: hyperæmia, anæmia, Claude Bernard's semi-coagulation of the protoplasm, Dubois's theory of partial dehydration of the protoplasm. He quotes further Richet's rule that a compound is the stronger an anæsthetic the less soluble it is in water; and after reviewing our present knowledge of the presence of cholesterin and lecithin in the nerve tissues, he mentions that already as early as 1847 Bibra and Harless have suggested that there might be a connection between anæsthesia and the capacity of the anæsthetics to dissolve fats; and that L. Hermann has further suggested that cholesterin and lecithin of the ganglion cells might present the point of attack of the anæsthetics.

Turning to his own above-mentioned theory Overton states that he studied the solubility of the narcotics in olive oil, on account of the difficulty of obtaining sufficient quantities of lecithin, and describes in detail the physical and physiological methods employed by him for determining the division-coefficient (Thei-

lungs coefficient) $\frac{\text{oil}}{\text{water}}$ of the many indifferent and basic anæsthetics. His studies led him to the conclusion that the narcotic power of a compound depends in the first place upon its division-coefficient between the aqueous medium and the cholesterin-lecithin solvents of the organism, provided the absolute solubility of the compound in the cholesterin-lecithin solvent is not below a certain minimum.

In the second part detailed descriptions and tables are given of the numerous experiments made on a great many compounds, establishing in each one its division-coefficient and its narcotic power. The compounds comprise indifferent and basic narcotics, also antiseptics and antipyretics which possess more or less anæsthetic powers as secondary effects. The author draws from his numerous experiments the conclusion that the longer and the less branched the carbon chains of a compound are, the stronger is its narcotic power, and that the substitution of a hydrogen atom by a hydroxyl group diminishes, and the substitution by an alkyl group increases, the narcotic power of a compound. Overton thinks that the indifferent narcotics interfere probably in a physical way with the cholesterin and lecithin of the cells, while the basic narcotics interfere also with the protoplasm of the cell, hence the greater clinging of the latter group of narcotics to the cells and their deleterious effects.

Overton's book is a very valuable contribution to biology and pharmacology; it opens new fields and new methods of research and will prove to be a fruitful stimulus to student and investigator.

S. J. MELTZER.

NEW YORK.

Les matières colorantes naturelles. By V. THOMAS (Chef des travaux de chimie appliquée à la Faculté des Sciences de Paris). Une publication de l'Encyclopédie Scientifique des Aide-Mémoire. Publiée par Gauthier-Villars, Paris, sous la direction de M. Léauté (Membre de l'Institut). Pp. 180.

It is probable that no department of chemistry, during the past thirty years, has experienced a more marvelous development and

elaboration than that relating to the artificial dyestuffs. At the present time these synthetic dyes are numbered by the thousand, and millions of dollars are invested in their commercial production. Two of the largest chemical factories of the world are devoted to this industry, one employing over 200 trained chemists, the other over 160, practically all of them Ph.D. men from the universities. The relation between the structure of these dyestuffs and their tinctorial value has been definitely established for most classes of artificial colors, and the literature of the subject is vast in extent.

The result of this tremendous activity in the field of artificial colors has been that the natural colors have been correspondingly neglected, and it is only within quite recent years that attention has again been directed to these substances, many of which have been familiar since ancient times. These scattered researches upon the tinctorial constituents of plants used in dyeing have been collected, digested, and the results presented in a condensed form by the author. The work is ably and carefully done, the chapter upon the Flavone Colors being especially praiseworthy.

In this volume the author treats only those natural coloring matters which are commonly regarded as derivatives of benzophenone, xanthone or flavone, thus including the majority of the natural yellow dyes.

Each chapter opens with general statements concerning that particular group of colors, its history, development, etc. This is followed by a detailed description of the individual colors, giving history, preparation, properties, tinctorial value, etc., the reactions and syntheses by which the constitutional formula has been elucidated being clearly and concisely explained. References to original articles are numerous, and in some cases (*e. g.*, syntheses in the flavone group) quite extensive.

The separate chapters deal with the following colors:

I. Derivatives of benzophenone.—Maclurin and derivatives, catechin and derivatives, kinoin.

II. Derivatives of xanthone.—Indian yellow, euxanthone, gentisin and gentisein, datiscetin, paradatiscetin.

III. Derivatives of flavone (phenylpheno- γ -pyrone).—Chrysin, tectochrysin, apigenin, acacetin, luteolin, quercetin, rhamnetin, isorhamnetin, rhamnazin, fisetin and derivatives, morin, myricetin, k ampferid, galangin, loto-flavine.

The volume concludes with an alphabetical table of the coloring matters and their derivatives, giving the name of the compound, its melting point, and the reference to the page of the text where the same may be found described in detail, thus constituting an excellent index.

The book presents an able review of a field which is frequently unjustly slighted in the larger text-books. It can be heartily commended to those interested in this branch of organic chemistry.

MARSTON TAYLOR BOGERT.

Pflanzenphysiologie. Ein Handbuch der Lehre vom Stoffwechsel und Kraftwechsel in der Pflanze. Von DR. W. PFEFFER. II. Kraftwechsel. Zweite vollig umgearbeitete Auflage. Leipzig, Wm. Engelmann. 1901. Pp. 353.

The first volume of this comprehensive work appeared in 1897 and was reviewed by the writer of this note in *SCIENCE* (7: 318. 1898). The recent part deals with the general action of growth, and the influence of various factors upon it, the inherent causes of specific form, variation and heredity, rhythm and resistance.

The commendation given the first volume of this splendid work seems equally well deserved by the second. The citations of literature are quite inclusive up to 1900, and many of the more important papers appearing since that time are given, although not much time could have been given to a consideration of their contents.

It is to be said that the author has not had so much critical editorial work before him in the preparation of the present part as in the first volume, since the greater number of principles discussed are in the form in which they have been accepted for a decade. Much of the material rests exactly as it was left by Pfeffer's lengthy papers of a few years since upon transformations of energy, and in other sections the subject matter has remained almost undisturbed since the first edition of the book.

Some of the phases of the activity of the plant discussed do not appear to have been carried to the extent that might be reasonably expected from a work of this character. Thus in dealing with the influence of light upon plants, the author has not followed to a logical conclusion the discussions foreshadowed in the preface.

The influence of water content upon growth and form, correlation, reproduction and regeneration comes in for a well-conceived treatment, and the pages devoted to these topics are valuable additions to literature.

The first volume has already been translated by Dr. Ewart in a manner adding much to its scientific and practical value, and it is to be hoped that he will be as speedy and attentive in editing the present volume. An unusually large number of typographical errors will doubtless be reduced to a minimum in the process.

The fulness of discussions, exactness and pertinence of citations, together with the grasp of the subject and breadth of view of the author, make this book very easily the greatest work yet produced on plant physiology, and in the historical development of the subject it will prove to be as valuable as the notable volume of Sachs.

D. T. MACDOUGAL.

SCIENTIFIC JOURNALS AND ARTICLES.

THE October (closing) number of Volume 2 of the *Transactions of the American Mathematical Society* contains the following papers: 'Geometry of a Simultaneous System of Two Linear Homogeneous Differential Equations of the Second Order,' by E. J. Wilczynski; 'Theory of Linear Groups in an Arbitrary Field,' by L. E. Dickson; 'On Certain Aggregates of Determinant Minors,' by W. H. Metzler; 'Ueber die Anwendung der Cauchy'schen Multiplikationsregel auf bedingt convergente order divergente Reihen,' by A. Pringsheim; 'Ueber den Goursat'schen Beweis des Cauchy'schen Integralsatzes,' by A. Pringsheim; 'New Proof of a Theorem of Osgood's in the Calculus of Variations,' by O. Bolza; 'On Certain Pairs of Transcendental Functions whose Roots Separate each other,' by M. B ocher; 'On the System of a Binary Cubic and a Quadratic and the

Reduction of Hyperelliptic Integrals of Genus Two to Elliptic Integrals by a Transformation of the Fourth Order,' by J. H. McDonald; 'On the Theory of Improper Definite Integrals,' by E. H. Moore; 'On the Convergence and Character of a Certain Form of Continual Fraction,' by E. B. Van Vleck; Notes and Errata, Volumes 1 and 2.

The October number (Volume 8, No. 1) of the *Bulletin of the American Mathematical Society* contains the following articles: 'The Eighth Summer Meeting of the American Mathematical Society,' by F. N. Cole; 'The Ithaca Colloquium,' by Edward Kasner; 'Upon the Non-Isomorphism of two Simple Groups of Order $8\frac{1}{2}$,' by Ida M. Schottenfels; 'Concerning Surfaces whose First and Second Fundamental Forms are the Second and First Fundamental Forms respectively of another Surface,' by Alexander Pell; 'Notes,' and 'New Publications.' The November number of the *Bulletin* contains: 'On Wronskians of Functions of a Real Variable,' by Maxime Bôcher; 'The Configurations of the 27 Lines on a Cubic Surface and the 28 Bitangents to a Quartic Curve,' by L. E. Dickson; 'The Fiftieth Annual Meeting of the American Association for the Advancement of Science,' by G. A. Miller; 'Riemann-Weber: Partial Differential Equations of Mathematical Physics,' by J. S. Ames; 'Notes,' and 'New Publications.'

SOCIETIES AND ACADEMIES.

AMERICAN PHYSICAL SOCIETY.

THE fall meeting of the American Physical Society was held at Columbia University on Saturday, October 26, President Michelson presiding. The first paper, by F. L. Tufts, described experiments on the effects of stationary sound waves on unignited gas jets. The disturbances caused in such jets by sound waves were made visible by means of the 'Schlieren Methode,' the source of illumination being the spark of an induction coil. The jet was found to assume a vibrating sinuous form, with increased amplitude at greater distances from the orifice. The results could be explained upon the assumption that the initial velocity of the gas, upon issuing from the orifice, is the re-

sultant of its own proper velocity and that due to the vibration of the sound wave. Photographs of unignited jets when disturbed in this way were shown. A second paper by Mr. Tufts dealt with experiments with the ordinary organ pipe. The Schlieren method was applied in this case to show the vibrations of the blast of air blown against the tongue of the pipe, and photographs were shown which gave excellent confirmation of the usual theory of the action of such pipes.

A note on the use of the Arons' mercury lamp as a source of illumination in certain color experiments was presented by Ernest Merritt. The light from the mercury arc is chiefly due to three lines in its spectrum, lying respectively in the violet, the green and the yellow. These lines are sufficiently near to the three primary colors to make the light of the lamp seem not greatly different from white; but when the lamp is used to illuminate colored objects the absence of the red is rendered evident. Red objects, for example, usually appear black when seen by this light. When a selection is made from colored worsteds, such as are used in the ordinary test for color-blindness, the selections are much the same as those made by a red-blind individual.

After the noon recess the Physical Society joined with the Mathematical Society during the reading of a paper by M. Hadamard on the 'Theory of Elastic Plates.' In the afternoon session a note was presented by Wm. Hallock on 'Measurements of Subterranean Temperatures,' in which were given the results of the most recent work on this subject. An instrument for the measurement of entropy was described by A. G. Webster. This 'entropy meter' had not been actually constructed, nor did the speaker think that it would make a very practical apparatus. It showed a possible method, however, by which entropy changes might be automatically registered and measured. Mr. Webster also reported the results of experiments upon the audibility of sound over grass and water. It was found that under similar conditions of quietness, etc., a given sound could be heard almost exactly four times as far over water as over grass. The assumption that water is a perfect reflector, while grass

is a 'black body' toward sound waves, is not sufficient to explain this difference.

ERNEST MERRITT.

BIOLOGICAL SOCIETY OF WASHINGTON.

THE 342d meeting was held on Saturday evening, November 2.

Mr. H. J. Webber exhibited specimens of the pineapple suffering from the disease termed 'root bind.' This was caused by planting improperly trimmed cuttings, which caused the roots as they developed to wind tightly around the stalk, causing defective nutrition and finally death.

Charles Louis Pollard gave some 'Notes on a Trip to Mount Mitchell,' made during the present spring for the purpose of obtaining botanical specimens and of studying incidentally the distribution of certain species of violets.

H. J. Webber described 'A Cow Pea Resistant to Root Knot Worm,' stating that in examining an extensive series of cow peas and other plants this one variety had been found entirely free from the parasites, although growing immediately between two varieties that were badly affected. The root knot worm, a small nematode, not only affected cow peas, but very many plants, doing serious damage, and the finding of the cow pea led to the hope that other plants might be found equally resistant, while by planting the pea as an alternating crop it would be possible to lessen the numbers of the worms.

Frederick V. Coville gave an 'Exhibition of Specimens of Alaskan Willows,' including examples of all species from that region. For descriptive purposes the speaker grouped these willows in three divisions, the tree, bush and procumbent forms, exhibiting a series of slides showing the floral divisions of Alaska and illustrating the habitat of the various groups. The different species were described in some detail as to their range, abundance or rarity, date of discovery and economic value when the species was of sufficient size.

M. A. Carleton spoke of the 'Characteristics and Distribution of Xerophytic Wheats,' illustrating his remarks with lantern slides of the Russian wheat region. The speaker said that wheats were grouped in eight divisions: (1) Common; (2) Club or square head; (3) Poulard;

(4) Durum or macaroni; (5) Polish; (6) Spelt; (7) Emmer; (8) Eiuikorn.

What might be called xerophytic or drought-resistant wheats belong to several of these groups, but the most important ones belong in the durum or macaroni wheat group. This is the group, therefore, which was chiefly discussed. These wheats differ from the ordinary wheats as now known in this country by having rather large flattened heads with large chaff and very large yellowish white grains which are extremely hard and vitreous in fracture, and often rather transparent. They always have beards, which are usually very long. In some varieties the heads and beards are black. These wheats are very resistant to drought, being able to grow where the rainfall is as low as ten inches per annum. They also resist the leaf rust very greatly, but are more or less subject to stem rust when it occurs in very great abundance. They are also seldom injured by bunt, smut or other diseases. Naturally they are adapted to semi-arid or arid regions, and at present are growing mainly in east and south Russia, Algeria, Argentina, parts of India and in various portions of the Orient and Mediterranean region. In this country they are especially adapted to our semi-arid plains from North Dakota to Texas.

The investigations of this department on the basis of soil and climate have led us to believe that those wheats will yield about one-third more to the acre in our semi-arid regions than other wheats, and what is more important, produce a constant yearly crop in large portions of that region where other wheat cannot be grown at all. Numerous practical tests have since proved this prediction to be justified. At the same time these wheats are the very best adapted for making macaroni, and there is now a great demand for them from this country, the people in Europe having learned of what good quality they are. Wherever they have been tried for the purpose, they also are considered to make excellent bread. In the establishment of these durum wheats we have a striking example of the beneficial results that may follow purely scientific investigations.

T. W. STANTON,

Secretary.

THE TORREY BOTANICAL CLUB.

AT the meeting of the Club on October 8 the scientific program consisted of informal reports of summer's work, including reports from Dr. Rydberg, of his visit to Sweden and Norway; from Mr. Murrill, of his attendance on the Botanical Congress at Geneva; from Mrs. Harris, of work among the lichens in the Adirondacks; and from Mrs. Britton, of work among the mosses there and in the Catskills, with advance notes reporting Dr. Britton's collection in the West Indies. Dr. Underwood spoke of his collecting in Porto Rico, examining thoroughly the eastern part of the island during five weeks spent there. He collected over 1,000 numbers of dried plants and sent back a large number of cacti now growing in the Botanical Garden. He was afterward in the Berkshire Hills for two weeks, then attended the A. A. S. meeting at Denver, Colorado, and spent some time in botanical work throughout many parts of that State, collecting about 600 numbers of the fall flora, particularly about Ouray and Pikes Peak.

The secretary reported extension of range of *Aster curvescens* by his discovery of its growth in quantity in the southern Berkshire Hills.

Dr. MacDougal reported his work in Montana where he aided in maintaining a summer laboratory for four weeks at Big Fork, at the north end of Flathead L., and entertained Dr. H. C. Cowles and twenty students of the University of Chicago. Dr. MacDougal then joined a collecting party exploring a part of northern Montana not known to have been before visited by a botanist, except as Canby gave it a flying trip in 1884. Dr. MacDougal collected about 900 flowering plants. Some days of every week the work was among snow and ice, with alpine flora, lakes a mile long of snow-water, chiefly without outlet and without life, as they freeze solidly to the bottom. He exhibited a panoramic view of the mountains seen across Flathead L., with numerous photographs showing the technique of collecting and camp equipment.

Dr. M. A. Howe reported on his eleven weeks' collecting trip for marine algæ in Nova Scotia and Newfoundland. He made about ten principal stays of a week each, at Yarmouth, Digby, Grand Pré; at Pictou, a station for

Fucus serratus, and where he obtained it in quantity; at Cape Breton; on the south end of Newfoundland, the richest locality in the larger kelps. There and along the south and east coast of Newfoundland is almost treeless, as is generally reputed, but firewood and lumber are obtainable 20 miles inland, and the west shore is forested with spruce, fir and tamarack, with yellow and white birch. Journeying east through the practically uninhabited interior, a thin coniferous forest was met, especially all around the numerous lakes. Where fires had been through it, for 20 or 30 miles, all was a flaming purple of fire-weed (*Epilobium*).

Dr. Howe mentioned the current names for the three native berries eaten so commonly there, *squashberry* for *Viburnum pauciflorum*; *baked apple berry* for *Rubus chamæmorus*; and *partridge berry* for *Vaccinium vitis-idaea*, called Swedish cranberry in parts of the U. S. where imported from Scandinavia. Dr. Howe remained four weeks in Newfoundland, and was afterward at Halifax Harbor, N. S., where Harvey, author of the *Nereis*, had made important collections.

Dr. R. M. Harper reported collecting again in Georgia, with about 500 numbers, visiting many new localities, traveling about 1,400 miles by rail, and doing much work on plant-distribution. He spoke particularly of the remarkable flora of the sandhills in Bulloch Co., resembling the 'scrub' flora in Florida. Photographs of these and other parts visited were shown. Along shady banks of the Chattahoochee River, some 50 miles from Columbus, he found some southern species, reaching their northern limit. In the Pine Mountains, southernmost eastern extension of the Appalachians, he found on the northern slopes an interesting mixture of Southern and Northern species. The southern slopes are covered with the long-leaved pine, with the flora characteristic of the pine barrens of the southern coastal plain. Among the interesting plants collected by Mr. Harper were *Elliottia* and, at Thomasville, Ga., *Nymphæa orbiculata*.

Brief remarks followed regarding fall blossoming and foliation in New York City, and Dr. Underwood exhibited a fresh specimen of *Botrychium dissectum*. It was noted by Mrs. Britton

and others that the maples, lindens and button-woods in Union Square, Washington Square and Madison Square are now covered with fresh leaves as in May, owing to defoliation by caterpillars; that the catalpas, honey locusts and poplars were but little eaten, and are not, therefore, covered with fresh leaves, but were injured by an early drought, and have sent out new shoots to replace those lost; these new shoots are now covered with fresh young leaves. The English elms in Washington Square were little eaten and have no new leaves. Horse-chestnuts have new shoots and some have new blossoms. Cherry trees have also been in bloom again. The magnolias and tulip trees of Bronx Park have blossomed and fruited twice this year.

EDWARD S. BURGESS,
Secretary.

THE SCIENCE CLUB OF THE UNIVERSITY OF
WISCONSIN.

The first meeting of the Science Club of the University of Wisconsin for the present college year was held on Thursday evening, October 31. The newly elected officers of the Club are: President, Professor W. W. Daniells; Vice-President, Professor Wm. H. Hobbs, Secretary and Treasurer, Professor L. S. Smith.

Two papers of both scientific and economic interest were presented, the first by Dr. C. K. Leith, on the 'Mesabi Iron Range of Minnesota,' and the second by Professor C. R. Van Hise, on 'The World's Past, Present and Future Supply of Ores.'

Dr. Leith's paper was based on a monographic report on the Mesabi iron-bearing district of Minnesota which he is preparing for the U. S. Geological Survey. He sketched the marvelous development of the range from the time of its discovery ten years ago to its present position as the greatest iron range in the world. The range exhibits Archean, Lower Huronian and Upper Huronian rocks in typical development, and with relations so clear as to make the Mesabi almost a type district for these three pre-Cambrian series. The iron ores are confined to the 'iron formation,' which forms the middle horizon of the nearly flat-lying Upper Huronian series. The iron formation consists of ferruginous cherts, ferruginous

slates and iron ore, all of which give evidence of having resulted from the alteration of a rock made up of green ferrous silicate granules. The granules contain fifty per cent. silica and thirty per cent. ferrous iron, with little or no potash. They were called glauconite by Spurr, but their study by the U. S. Geological Survey shows them not to be glauconite of organic origin, but a ferrous silicate deposited on the sea-bottom through chemical reactions. The iron ores have resulted from the alteration of this type of rock through the agency of underground waters. The ores are now found where the action of these waters has been vigorous. These places are the southward-pitching troughs of the gently folded iron formation, and in the parts of the troughs lying along the middle slopes. The bottoms of the troughs are mainly slaty layers within the iron formation itself.

The iron-ore deposits of the Mesabi are similar to those of other ranges of Lake Superior in having resulted from the alteration of some earlier rock, in having been concentrated by underground water, and in occurring in troughs with impervious basements. However, in the Mesabi the rock from which the iron ores resulted is the green ferrous silicate, while in the other districts it is iron carbonate. In the Mesabi the pitching troughs containing the iron-ore deposits have very gentle dips and great horizontal dimensions, while the pitching troughs in the other ranges are narrow and sharp, and have great vertical dimensions. Finally, and possibly in some way connected with these features, in the Mesabi district the ores are exceedingly soft and friable, while the old range ores are fairly hard.

Dr. Leith illustrated the various methods of mining the Mesabi ores, the most striking of which is loading by steam shovels directly on to cars. He described also the great mines of the district, several of which are shipping over 1,000,000 tons of ore a year.

The amount of ore in sight on the Mesabi is roughly estimated at 500,000,000 tons, or about twice as much as there is in sight on all the rest of the Lake Superior ranges together. It is also far in excess of all the ore now known in other parts of the United States. The development of the Mesabi range has lowered the

price of ore for the American steel manufacturers; and this fact alone, regardless of any superiority in methods, would give them the advantage in foreign markets. In Europe at the present time the situation as to the iron ore supply, as to the demand for same, and as to prices, is not greatly dissimilar to what it might have been in the United States had no Mesabi range been discovered to ease the demand for old range ores and to lower prices. A great basal factor, then, in the superiority of the United States in the iron and steel trade is the Mesabi iron range. The United States Steel Corporation controls from 70 to 80 per cent. of this raw material, and hence its future influence on the iron and steel trade of the world may be conjectured.

Professor Van Hise followed with a brief general discussion of the world's past, present, and future supplies of ores. He called attention to the tremendous revolution in mining ores of all kinds which has occurred in the past century, and ventured the opinion that in the past fifty years more ore has been mined in the world than in all its previous history.

The above papers were discussed by Professor J. Morgan Clements. Professor Clements also summarized the relation of the work which the U. S. Geol. Survey has been doing in the Lake Superior region, as well as in other mining districts of the United States, to an intelligent exploration for ore deposits and the scientific development of the same when they are found.

A resolution of sympathy in memory of the late Professor Nelson O. Whitney, of the Engineering Faculty of the University of Wisconsin, presented by Professors J. B. Johnson, F. E. Turneure, and Louis Kahlenberg, was adopted by the Club. L. S. SMITH.

THE SCIENTIFIC ASSOCIATION OF THE UNIVERSITY OF MISSOURI.

THE Association has elected the following officers for the ensuing year: President, Professor W. G. Brown; Vice President, Professor C. F. Marbut; Secretary, Dr. Charles Thom; Treasurer, Professor C. A. Ellwood; Chairman of Executive Committee, Dr. C. M. Jackson. At a meeting October 14, Professor H. B. Shaw displayed a series of lantern slides illustrating the

important features of the largest and most successful electrical plants in the United States. At its regular meeting on the last Monday night of each month a paper is presented embodying some original work done by the author. At its supplementary meeting held usually on the second Monday night, a popular presentation of some scientific subject offers each department an opportunity to present matters of general interest from any source.

CHAS. THOM,
Secretary.

UNIVERSITY OF MISSOURI.

THE ACADEMY OF SCIENCE OF ST. LOUIS.

At the meeting of the Academy of Science of St. Louis on the evening of November 18, twenty-four persons present, the following subjects were presented:

Mr. F. C. Baker, some interesting molluscan monstrosities.

Dr. Stuart Weller, Kinderhook faunal studies. III. The faunas of beds No. 3 to No. 7 at Burlington, Ia.

Professor William Trelease read an untechnical address on the progress made in botany during the nineteenth century.

One person was elected to membership in the academy.

WILLIAM TRELEASE,
Recording Secretary.

DISCUSSION AND CORRESPONDENCE.

THE PYTHON IN PENNSYLVANIA.

TO THE EDITOR OF SCIENCE: On August 9, a python, probably *Python natalensis*, was found in the grass on Presque Isle, Pa., by three young men from Erie who, as they supposed, killed it and took it to the city. However, it revived and was exhibited in the window of the Tribune bicycle store. On August 29 I measured and weighed it. The length was about seven feet four inches, greatest girth eleven and one-half inches; weight, seventeen pounds. That evening it pushed away the wire netting from one corner of its cage and escaped. It probably took up its residence under a building in the rear of the store, but had not been seen when last I heard, October 14. Reports of the liberation of large snakes in the vicinity of

Presque Isle I investigated, but they proved to be unfounded. Who can tell how this African snake found its way to the shore of Lake Erie and how long it had found subsistence there?

E. L. MOSELEY.

SANDUSKY, OHIO,

Oct. 27, 1901.

SHORTER ARTICLES.

THE UNEXPLAINED SOUTHERLY DEVIATION OF FALLING BODIES.

THE formula published by Mr. Roever, of Washington University (SCIENCE, July 12, 1901, p. 70), giving the southerly deviation of falling bodies due to the earth's rotation, is of special interest, because it marks a fresh attack upon a problem which in my 'History of Physics,' p. 75, I call an unsolved problem. The difficulty lies in a wide discrepancy between the theoretical and the observed results. The latter are over 1,000 times greater than the former.

1. *Experiments.*—When Robert Hooke undertook to verify experimentally Newton's prediction of an easterly deviation of falling bodies, due to the earth's rotation, he reported also a small southerly displacement.*

When in 1791 G. B. Guglielmini again undertook to verify Newton's prediction by a series of experiments from a tower at Bologna, a southerly deviation was again observed. He found H ('height' or distance fallen through) = 241 Paris feet (78.3 m.), E. D. ('easterly deviation') = 8.375 lines (18.894 mm.), S. D. ('southerly deviation') = 5.272 lines (11.894 mm.).†

In 1802 J. F. Benzenberg experimented from the St. Michael's tower in Hamburg. H = 235 feet (76.3 m.); E. D. = 3.99 lines (9.00 mm.); S. D. = 1.5 lines (3.4 mm.).‡

* See Ball, 'An Essay on Newton's Principia,' pp. 146, 149, 150.

† See Gilbert's *Annalen*, Vol. XI., p. 172; Vol. XII., 1803, p. 372; Vol. XIV., p. 222. Rosenberger, in his 'Geschichte der Physik,' Vol. III., p. 96, refers to Guglielmini's book, 'De diurno terrae motu, experimentis physico-mathematicis confirmato,' Bologna, 1792, but as early as 1803 the book is spoken of as being very rare.

‡ Gilbert's *Ann.*, Vol. XIV., p. 222. Rosenberger refers to Benzenberg's book, 'Versuche über die Gesetze des Falles,' Hamburg, 1804.

In 1804 Benzenberg experimented in a shaft of a coal mine at Schlebusch. H. = 260 ft. (84.4 m.). An E. D. was noticeable, but on selecting from the total number those experiments which, in his judgment, were made under the most favorable conditions, there seemed to be no indication of a S. D.*

In 1831 F. Reich experimented in a mine-shaft at Freiberg. H. = 158.5407 m., E. D. = 28.396 mm., S. D. = 4.374 mm. These results are deduced from six series of experiments. Altogether 106 balls were dropped. Reich's are the most carefully conducted experiments on the subject which have been made. Yet they differ much among themselves, though not as much as those of Benzenberg.†

In 1848 W. W. Rundell published experiments made in the shaft of a Cornish mine.‡ Balls were dropped through a distance of one-fourth of a mile and a S. D. of 10 to 20 inches (25 to 51 cm.) was noticed. From the account of the experiments it is difficult to convince oneself that sufficient precautions were taken against disturbances from air-currents.

All observers experimented with metallic balls. Are these observed southerly displacements due wholly to experimental error? Though we may incline to that opinion, we cannot deny the force of Benzenberg's remark: 'Sonderbar bleibt doch diese Tendenz der Fehler nach Süden.'

2. *Theory.*—Mr. Roever is not the first to derive a formula for S. D., due to the attraction of the rotating earth. This was done in 1803 by Gauss § and by Laplace.||

Neglecting the resistance of the air, Gauss obtained

$$\begin{aligned} \text{E. D.} &= y = \frac{1}{3} \cos \phi \, g \, \text{int}^2, \\ \text{S. D.} &= x = \frac{1}{3} \cos \phi \, \sin \phi \, g \, n^2 t^4, \end{aligned}$$

where u is the angular velocity of the earth, ϕ the latitude. Applying this to Benzenberg's

* Gilbert's *Ann.*, Vol. XVIII., p. 381.

† See Poggendorff's *Ann.*, Vol. XXIX., 1833, p. 494. Rosenberger refers to Reich's book, 'Fallversuche über die Umdrehung der Erde,' Freiberg, 1832.

‡ Robertson's *Mechanic's Magazine*, London, Vol. XLVIII., p. 485.

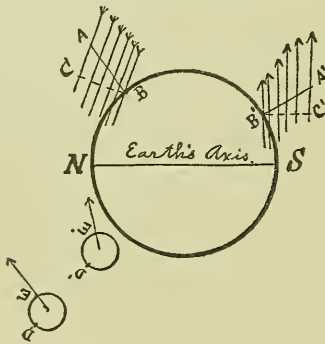
§ Gauss, 'Werke,' Vol. V., 1877, p. 495.

|| *Bull. d. sciences par la Soc. Philomath.*, Plairial an 11 (1803).

data, Gauss took $\frac{1}{2} g t^2 = 235$, $\phi = 53^\circ 33'$, $t = 4$ seconds, $nt = \frac{360}{3} \frac{6}{5}$ spatial minutes, and $1' = \frac{1}{3438}$ radians. Gauss found E. D. = 3.91 lines, the experimental value being 3.99. The formula gives S. D. = .00046 lines, the experimental value being 1.5 lines.

The resistance of the air was found by both Gauss and Laplace to make no appreciable difference in the S. D. Several writers deduced formulæ which seemed to give a much larger S. D. than those of Gauss and Laplace, but in every case some error in the reasoning has been detected.* The deductions of Gauss and Laplace have, thus far, stood the test of criticism.

Other than gravitational agents were considered by Oersted and Sir John Herschel.† They suggested that the 'electric currents * * * known to be circulating around the earth in the direction of the parallels of latitude' induce currents in a falling metallic body and cause deflection to the south. But they became doubtful of this explanation by the remarks of Grove, who said that "inasmuch as a falling body was



* See Gauss's criticism on Olbers, Gauss' 'Werke' Vol. V., p. 495; reference to Guglielmini's speculations in Gilbert's Ann., Vol. XII., p. 372; M. Petit's article in *Comptes Rendus*, Vol. XXXIII., p. 193, 1851, and M. Dupré's criticism of that article in Vol. XXXIV., p. 102, 1852, as well as Rosenberger's criticism of Dupré, in *Gesch. d. Physik*, Vol. III., p. 436; W. C. Redfield in *Am. Journal of Science*, Vol. III., p. 283, 1847, and the correction on p. 451 of same volume; the theoretical part, contributed by Professor Cowie, in W. W. Rundell's article, *Mechanic's Magazine*, Vol. XLVIII., p. 488.

† *Am. Journal of Science*, Vol. III., 1847, p. 139; *Report British Assoc.*, 1846, Misc. Communicat., p. 2.

moving between electrical currents, placed both north and south of its line of fall, in his opinion the effect of the one would counterbalance that of the other, so as together to produce no effect."

I myself have been considering the effect of a metallic ball falling through the varying magnetic field of the earth. Electric currents will be generated in the ball. Resolve the motion of the ball in the northern hemisphere into two components, one component, *AC*, parallel to the lines of force, the other, *CB*, perpendicular to them. The motion along *AC* produces no current in the ball. That along *CB* generates a current in a plane normal to the earth's magnetic lines of force. By Lenz's law, there is a resistance to and diminution of the motion producing the current. Hence, in all regions north of the magnetic equator there results a northerly deviation. Similar reasoning shows that south of the magnetic equator a falling metallic body experiences a southerly deviation.

Moreover, if the dip is greater in the lower levels of the atmosphere, then it will be seen from the two positions of the ball in our figure, that there is a relative motion of rotation between the ball and the earth's lines of magnetic force. The ball has in the northern hemisphere an *apparent* rotation about an axis pointing east and west, in a direction counter-clockwise when seen by an observer looking westward. Hence by Lenz's law the ball will experience a *real* rotation in a clockwise direction about the same axis. The interaction between the rotating ball and the air will cause the ball in the northern hemisphere to drift southward.

I have been unable to secure accurate data for the determination of the magnitude of the two effects, but, taking the largest rate of variation in the magnetic intensity and the dip, along a vertical line, given by Humboldt,* both effects are found much too small to cause a deviation measurable in an experiment.

It is evident that the problem of the southerly displacement of falling bodies needs reinvestigation, experimentally, and perhaps also theoretically. The Washington Monument, in

* *Cosmos*, Vol. V., pp. 97, 115, London, 1872.

our national capital, might be a good place for experimentation.

FLORIAN CAJORI.

COLORADO COLLEGE,
COLORADO SPRINGS.

ASTIGMATIC IMAGES OF THE BOTTOM OF A POOL
OF WATER.

IF light radiate from a point below the surface of water, it can pass out through the surface only within a circle forming the base of a right cone whose semi-angle is the critical angle.

Consider such rays lying in a vertical plane passing through the radiant point. The rays which have passed out into the air, if produced below the surface, are tangent to a virtual caustic. This caustic is a portion of the evolute of an ellipse, one cusp of which is in a vertical through the radiant point, and at a depth $\frac{d}{n}$, where d is the depth of the radiant

point, and n is the index of refraction. The branches of the caustic are tangent to the surface in the circle determining the critical angle. Successive sets of consecutive rays having an increasing angle of incidence do not intersect at a common point, but they intersect at consecutive points on the caustic. If the vertical plane be rotated slightly in azimuth, the rays from the same radiant point will intersect in the caustic in its new position. This caustic from the same radiant point will always lie on a surface of revolution, formed by revolving the caustic in any vertical plane about the vertical line through the radiant point.

If the radiant point be viewed by an eye placed at a fixed point, the pupil of the eye may be conceived divided into vertical zonal elements. Rays from the radiant point in these various elements will intersect in a definite area upon the surface of revolution. The point would, therefore, appear as a hazy patch upon the caustic surface. The text-books all represent the apparent position of a coin seen through a water surface, as being lifted up and towards the eye of the observer, upon the caustic surface.

It is, however, evident that if the rays diverging from the radiant point in all azimuths, and at a fixed angle of incidence, be produced backwards after passing out into the air, they

will all intersect in a common point upon the vertical line through the radiant point. If, therefore, the pupil of the eye be divided into horizontal zonal elements, all the rays entering the eye will have a virtual intersection on this vertical line. The focus of the upper zonal elements of the eye will be slightly below those of the lower. Nevertheless, the intersection of all rays entering the eye from the radiant point will be upon a line, instead of being spread out over an area as in the other case. The fact is that a plumb line deeply piercing still water appears straight throughout. The image upon the vertical line is much more distinct than that formed upon the caustic surface. The latter image imparts a haziness to the appearance of the body viewed, but the apparent position is determined by lines which intersect in a common point, rather than by those which do not.

With this view of the matter the writer in May, 1881, presented to the Academy of Science of St. Louis a discussion of the apparent form of the flat bottom of a pool as seen through the surface.* The appearance was found to be represented by a conchoid, which was related in a simple way to the conchoid of Nicomedes. The equations of both curves were deduced, and several other cases were discussed.

In a recent number of *Annalen der Physik*,† Mattheissen has deduced the equations of these two conchoids and has pointed out that the surface produced an astigmatic effect. He likewise deduces the equation for the nebulous image due to intersection upon the caustic. The minimum of this surface and that of the conchoid are coincident and tangent to each other, and they have the water surface as a common asymptote.

FRANCIS E. NIPHER.

NOTES ON INORGANIC CHEMISTRY.

THE earliest determinations of the density of sulfur vapor were by Dumas and Mitscherlich, and gave figures which pointed to the molecule S_6 , and this has passed current until quite recent times. In 1860 Deville and Troost found

* *Trans. Acad. of Sc. of St. Louis*, Vol. IV., No. 2, p. 325.

† No. 10, 1901, S. 347.

that above 860° the sulfur molecule consists of two atoms, S_2 . More recently by boiling point and freezing point methods the molecule of sulfur in solution has been found to contain eight atoms, S_8 , and it has been inferred that the same molecule exists in sulfur vapor just above its boiling point. In the *Berichte* of the German Chemical Society, Biltz goes over the whole ground, especially examining the density of the vapor under diminished pressure at the boiling point. The greatest density he could obtain corresponded to the molecule S_7 , but this was not found to be a constant point. The conclusion he draws is that two molecules only of sulfur exist, one S_8 and the other S_2 , and that at the boiling point the molecule with eight atoms begins to decompose into molecules of two atoms. This decomposition is progressive, until at 850° it is complete, the gas at this temperature consisting wholly of the molecules S_2 .

A PATENT has recently been taken out by the Clayton Aniline Company, limited, of Manchester, for the continuous concentration of sulfuric acid, which involves the use of cast-iron vessels in the place of platinum. The dilute acid is allowed to flow in a continuous stream on to the surface of a large mass of hot concentrated acid contained in a large cast-iron pan. The concentrated acid must be of a strength not less than ninety to ninety-three per cent. From the bottom of the pan the concentrated acid is drawn off at such a rate as to keep the level of the acid in the pan constant. The great advantages claimed for the process are the simplicity and the cheapness of the plant, and it has already been shown that for most uses the acid concentrated in iron pans is satisfactory.

ABOUT a year ago an article appeared in the *Comptes Rendus* by Gautier, in which the position was taken that arsenic in minute quantities is a normal constituent of the human body. By a new and very delicate method the author found and determined quantitatively arsenic in numerous organs of the body, notably in the pancreas, brain, thymus gland and skin. Since, after digestion of the pancreas with pepsin, the arsenic remained in the nuclein residue, the existence of an arsenic-nuclein was assumed.

In the last number of the *Zeitschrift für Physiologische Chemie* there is a paper by Hödlmoser, combating Gautier in every point. In eighteen cases the pancreas and liver were examined by Gautier's method, and in fifteen other cases the same organs were examined by a method, pronounced by the author even more delicate, and in no case was any trace of arsenic found. Numerous other experiments were carried out, carefully following the work of Gautier, but always with negative results. No explanation is offered of the great discrepancy between the author's results and those of Gautier, but one is promised.

THE subject of the toxic action of boric acid is brought up anew by a description in the *Therapeutic Gazette*, by Dr. J. F. Rinehart, of two cases, occurring in his practice, of poisoning by boric acid. Each was after the administration of the acid in five-grain doses every four hours. The symptoms of poisoning appeared after several days and consisted chiefly of an erythematous eruption over the body, accompanied by extreme weakness. The patients recovered slowly on ceasing to administer the drug. The conclusion drawn by Dr. Rinehart is that "any use of boric acid as a preservative of foods should be prohibited by law, as the poisonous effect of any quantity sufficient to preserve food would appear to be proven." This conclusion would, however, seem to be somewhat overdrawn, as it is hardly probable that any such quantities of the acid as were administered in the above cases would ever be ingested from foods in which it was used as a preservative. The chief danger to be apprehended from the indiscriminate use of boric acid in foods, as was recently noticed in this column, is in the case of young children, where they are fed on milk preserved by borax. Here danger may well be apprehended. In any case food preserved by boric acid should be distinctly so labeled.

J. L. H.

CURRENT NOTES ON PHYSIOGRAPHY.

THE RIVER SYSTEM OF CONNECTICUT.

THE discovery of numerous parallel faults arranged in several systems in the small Triassic area of the Pomperaug valley in western Connecticut, and the coincidence of many

streams with lines parallel to one or another of these fault systems has led Hobbs to infer a very general dependence of stream courses on fault lines or on faulted troughs ('The River System of Connecticut,' *Journ. Geol.*, IX., 1901, 469-485). He notes that the modern school of physiographers attach 'little importance to geological structure planes as a factor in determining the position and the orientation of water courses'; and if it is joint and fault planes that are meant by 'structure planes' this comment is probably deserved as far as explicit mention of such controls is concerned. Nevertheless, the value of faulting in initiating surface inequalities, and hence in determining the course of consequent streams at the time of faulting, as well as in producing planes of structural weakness, and hence in determining the later development of subsequent streams, has not been altogether overlooked. But it is under the interaction of many controls that modern physiography finds explanation for river courses, and it is the want of consideration of other controls than faults that leaves Hobbs' paper unconvincing.

The author extends the systems of fault lines from the small Pomperaug basin all over Connecticut, preserving them rigidly straight and parallel throughout. He then compares these lines with the stream courses as shown on the topographic map of the State, and where a fair coincidence is found he concludes that there is a relation of cause and effect, thus explaining 'the definite orientation of water courses.' There are serious difficulties in the way of accepting this conclusion.

It is inherently improbable that the Pomperaug fault lines possess an extension all over the State in systems so rigid as are here postulated. Some one of the infinite varieties of curvature is much more probable than the highly specialized case of straight paths. Strict parallelism is also improbable as compared to the many possible patterns of more or less distinct divergence. The possibility of accidental coincidence between eight systems of lines, seven of which run between S. 48° W. and S. 44° E., and the river courses of a region whose slope is southerly and whose structural features (independent of faults) frequently have a similar

trend, is not given sufficient consideration. Moreover, the branchwork pattern of the Connecticut valleys has little resemblance to the network pattern of valleys that have been worn along ancient fault lines in a well-faulted area: the Stockholm district of Sweden, for example. This typical district shows a most characteristic oblique reticulation in the arrangement of its valleys, such as would be expected in a maturely dissected upland, obliquely criss-crossed by many fault lines; and it has numerous isolated lozenge-shaped uplands occupying the meshes in the network of fault-line depressions. In Connecticut the valleys have not a reticulated pattern, and the uplands as a rule are not lozenge-shaped, but give forth spurs between ramifying valleys. Well defined as is the fault-line network in the Stockholm district, its lines are neither straight nor in groups of parallels; they exhibit just such irregularities of curvature and divergence as might be expected in a geological instead of in a geometrical design.

While faulted troughs (*Graben*) might have guided many Connecticut streams for a time after the Triassic deformation, it is highly improbable that such courses could persist during the deep denudation that the region as a whole has since suffered, in the course of which many streams would presumably desert their original courses in the process of adjustment to new-found structures. While the brecciated belts of fault planes might during the denudation of the region frequently gain the patronage of subsequent streams, all other belts of weak structures would be active competitors for such patronage; yet no account is taken of such competition, although it must have been common. The northward course of the Farmington, for example, follows the weak beds of the lower Trias, and is oblique to the known faults of its district. Many of the existing streams in the lowlands have courses consequent upon the form of the glacial drift; such is the case with the Quinnipiac below Meriden; and if some of these streams have now cut down here and there to bed rock, it is only by the chance of superposition that the rock is found, as in the Connecticut above Hartford. The possibility that the lower courses of the Connecticut and Housatonic have gained their southeast trends

by superposition from a now vanished cover of Cretaceous strata is rejected because fault planes 'would, in the opinion of the writer, afford the simpler explanation.' But while simplicity is a strong recommendation in artificial mechanism, it cannot be logically employed as a means of choice between two theories of river development; if that were so, no rival could be found for the Gordian method of locating the Susquehanna and other Appalachian rivers by antecedence. Fault breccias, where they occur, may certainly exert much influence on the development of river courses in Connecticut; but until their occurrence in the central and eastern part of the State is proved by something more trustworthy than the graphic extension of systematic lines from the western part, this explanation of stream orientation may be regarded as standing in an interrogative rather than in a demonstrative attitude.

LAKE WINNIPEG.

LAKE WINNIPEG, 260 miles long, with an area of nearly 10,000 square miles or a little less than that of Lake Erie, is a member of the series of lakes that occupies an inner lowland of the ancient coastal plain, marginal to the great Laurentian highland of eastern Canada. Reports by Dowling and Tyrrell give a number of physiographic details concerning the Winnipeg basin ('Report on the Geology of the West Shores and Islands of Lake Winnipeg,' Geol. Surv. Canada, XI., 1901, F. 'Report on the east shore of Lake Winnipeg. . . .' Ibid, G.). The lake is 710 feet above sea level, with a general depth of from 40 to 60 feet. Its eastern border is relatively straight, although minutely irregular in the smaller view. The rock floor here is of Archean gneisses and granites, with a few schists, all reduced to a surface of small relief, over which post-glacial lacustrine clays have been spread to an altitude of 150 feet over the lake. The clay plain is forested, but if cleared and drained it may become 'rich agricultural land.' Further eastward, the generally even but minutely rugged Archean rises above the clays, first in isolated knobs, then in larger patches, finally occupying all the surface; it is severely glaciated, bearing little drift, but with many small lakes

in its hollows. The east shore of the lake is frequently bordered by low clay cliffs; but rocks appear in low points and islands, beyond which there are many shoals. The west shore of the lake is very irregular, a frayed outline of Cambro-Silurian strata; cross-bedded sandstones below, and even-bedded limestones (Trenton) above. These rocks frequently form bluffs, back from which the country is generally level, but rising slightly further westward. Over this upland is a mantle of boulder clay, showing faint lines of stratification as if deposited in a body of water. The boulder clay frequently assumes the form of drumlins, and many of these are noted along the lake shore and on islands, where they are cut back into cliffs, while curved beaches are strung along between them, as on the southeastern coast of Lake Ontario.

The outline of the western shore strongly suggests an effective glacial erosion, by which the Trenton border has been shaped, somewhat as has been described by Chamberlin for similar outcrops in southern Wisconsin. The similarity of Winnipeg and its fellows to Onega and Ladoga of northern Russia has often been remarked, and seems to be increased as new details are gathered.

A PIEDMONT LAKE IN BAVARIA.

WÜRM or Starnberger Lake, 15 miles southwest of Munich, is one of several water-bodies piedmont to the Alps on the upland of southern Bavaria. It has recently been monographed by W. Ule ('Der Würmsee (Starnbergersee) in Oberbayern, eine limnologische Studie.' *Wiss. Veröffentl. Ver. f. Erdkunde, Leipzig*, V., 1901, 211 p., 15 figs., 5 pl., atlas of 8 sheets). The lake has an area of 57.1 sq. kil.; an altitude of 584 met., and a maximum depth of 123 met. It lies in the Deckenschotter, or oldest glacial gravels, occupying part of a valley that was primarily the result of stream erosion between the first and second glacial epochs; but the valley has been much modified by deposits of drift from branches of the Isar glacier during the second and third glacial advances. Glacial erosion is given small value in this distal portion of the glaciated area. A slight deformation, producing a depression along the mountain base,

is thought to have had some small share in aiding the formation of a lake basin here as elsewhere along the piedmont belt; but the evidence of this is in chief part borrowed from the district of Lake Zurich, and that evidence has been somewhat discredited, as far as lake-making is concerned, in recent years. A chapter is given to the systematic relations of the lake; the element of time, or stage of development, is given too small a share in the proposed classification. Neither the interglacial valley in the Deckenschotter nor the later glacial advances are described in terms of youth, maturity or old age. Temperature, color, transparency, waves, currents, changes of level, and composition are all duly considered. The monograph as a whole is very clearly written; its chapters are closed with concise summaries, and it has current page headings and an excellent index; advantages that do not always accompany scientific publications.

W. M. DAVIS.

THERMODYNAMICS OF THE GAS-ENGINE.

The second report of the Gas-Engine Committee of the Institution of Mechanical Engineers of Great Britain was presented on the 18th of October by Professor Burstall, of Birmingham University, and the results of experiments, preparations for which were described in the first report (*Proceedings*, 1898) were given. They involve some important details of a novel character and throw some light upon previously obscure points in the theory of that now important prime mover.

Illuminating gas was employed having a mean heating value of about 4.8 calories per liter. A new form of igniting apparatus permitted the ignition of even very weak charges with completeness and certainty, the current being obtained from four cells of the storage battery, with a low voltage and a comparatively heavy current, insuring a 'short and thick' spark.

Varying compression was adopted to determine the effect of such variation upon the efficiency of the motor, and, with each compression, varying mixtures of air and gas, changing about one per cent. at each new series of tests, supplied data for ascertaining the relative values of these mixtures.

For the first time, so far as the writer is aware, the theory of the gas-engine as here applied was constructed with the assumption of a variation of specific heats with temperature, following M.M. Mallard and Le Chatelier. The following are Professor Burstall's formulas:

$$K_v = a + sT; \quad K_p = b + sT;$$

$$K_p - K_v = \text{const.} = b - a = R.$$

$$H_v = (w_1 + w_2) \int_{T_1}^{T_2} (a + sT) \delta T;$$

$$= (w_1 + w_2) [a(T_2 - T_1) + s/2 \cdot (T_2^2 - T_1^2)].$$

$$H_p = (w_1 + w_2) \int_{T_2}^{T_3} (b + sT) \delta T;$$

$$= (w_1 + w_2) [b(T_3 - T_2) + s/2 \cdot (T_3^2 - T_2^2)];$$

where H_v and H_p are the quantities of heat added during the periods of constant volume and constant pressure, respectively; w_1 and w_2 are the weight of air and gas, and the weight of residual products from the previous stroke in the clearance spaces.

The equation of the adiabatic also differs from that for constant values of specific heats, thus:

$$\delta q = K_v \left(\frac{dT}{dv} \right) \delta v + K_p \left(\frac{dT}{dp} \right) \delta p;$$

$$dT/dp = v/R; \quad dT/dv = p/R;$$

$$\delta q = K_v v/R \cdot \delta p + K_p p/R \cdot \delta v = 0.$$

$$(a + sT)v \delta p + (b + sT)p \delta v = 0.$$

$$(b - a) \log_e v + a \log_e (pv) + spv/R = \text{const.}$$

$$p^a v^b e^{\frac{pv}{R}} = \text{constant.}$$

The correspondence of the actual expansion lines of the indicator diagram with the adiabatic for variable specific heats was found much closer than for the usual assumption of constant values with varying temperatures. In the computations of the heat-balance the usual method would give results about fifteen per cent. lower than with variable specific heats.

The entropy equation becomes, in the latter case,

$$\phi = a \log_e \frac{T}{T_0} + R \log_e \frac{V}{V_0} + S(T - T_0);$$

where V and V_0 are the volumes at temperatures T and T_0 , respectively.

In determining the temperatures, the Callendar platinum instrument was employed; but a peculiar and ingenious special construction was adopted to secure safety of the instrument against injury by the action of the charge. Among other interesting determinations made with this thermometer, were the temperatures of the charge at various distances from the cylinder-wall. It was found that the charge was distinctly hotter at the core than adjacent to the metallic surface of the cylinder, the difference ranging from one to two hundred degrees centigrade.

The gas used required 5.49 volumes of air for combustion and produced 0.5672 volumes of CO and 1.257 volumes of steam. After combustion the volume is, total dry, 4,996. The weights were, gas, per meter, 0.6; air, 1.29. Heating values were 553 B. T. U. per cubic foot, 4,850 cal. per cubic meter.

The engine was six inches by twelve and ran at about 200 revolutions per minute and at from 90 to 100 per cent. of its rated power; usually at about 95. The compression in Series I. ranged up to from 200° C. to 300° C., and the index of the compression-curve, $pv^n = C$, from 1.28 to 1.445; its maximum being found at 311° C.; but the irregularities of the figure are too great to reveal any law. Probably 1.33 may be taken as the figure for approximate computations. The expansion-curve value of $n = 1.4$, as an average, or very nearly that, ranging from 1.328 to 1.501. The mechanical efficiency was from 68 to 80 per cent., averaging about 75.

In the final series of trials, with compression ranging from 327° C. to 452° C. as maxima, the index of the expansion-curve was about 1.3, varying from 1.2 with an exhaust temperature of 637° C. to 1.344 with a temperature of exhaust of 862° C. The compression-curve was less variable; the index averaged very nearly 1.35. The mechanical efficiency varied from 0.64 to 0.83, and the thermal efficiency from 18.1 to 22.7 per cent.

The employment of compression produced, on the whole, an increasing total efficiency with increasing terminal pressure, though reducing mechanical while augmenting thermodynamic efficiency. From 13 to 16 per cent.

of the heat-supply appeared as useful work outside the machine. The gas used ranged from an average of 24.6 cu. ft. per I.H.P. per hour to 19.7, and from 34.9 per B.H.P. to 28.5. The jacket carried away about 30 per cent. of the heat developed, the exhaust about 45 per cent. and radiation about 3. The heat-balance for the most efficient case was

$$\begin{array}{rcccccc} \text{I.H.P.} & \text{Jack.} & \text{Exh.} & \text{Rad.} & \text{Loss.} & \text{Total.} \\ 23.1 & + 30 & + 42.6 & + 3 & + 1.3 & = 100. \end{array}$$

R. H. THURSTON.

THE NEW STAR IN PERSEUS.

PROFESSOR W. W. CAMPBELL, director of the Lick Observatory has issued the following bulletin:

A discovery of extraordinary interest to astronomers has just been made by Professor Perrine in reference to the new star in the constellation Perseus. This star appeared suddenly and unexpectedly last February, having been discovered by Anderson in Edinburgh. In some four days its brightness increased from invisibility in ordinary telescopes until it became the brightest star in the northern sky. All available astronomical resources throughout the world were immediately devoted to the investigation of this remarkable object.

Many interesting facts concerning it have been brought to light. To mention only a few, its brightness diminished irregularly from that of the most prominent star in the northern sky in February until in June it was on the limit of visibility for trained and sensitive eyesights, where it has since remained. The star's atmosphere was violently disturbed, as shown by a study of its spectrum in the spring months and since June, at least, the spectroscope has shown that it is now a nebula, though retaining to the eye and in the telescope the point-like form of an ordinary star. The disturbance that gave rise to the new star was sufficiently violent to convert it from a dark invisible body into a gaseous nebula.

In August Professor Max Wolf, of Heidelberg, Germany, secured a four-hour exposure photograph of the region of the sky containing the new star. His negative showed the existence of some extremely faint nebulous patches

about five minutes of arc south of the star, but with no evidence of any relationship between the nebulous clouds and the star.

On September 20 Ritchey at the Yerkes Observatory photographed the same region with a more efficient instrument and found that the nebulous cloud was very nearly circular, some ten minutes of arc in diameter, but of varying intensity in its different parts with the new star situated near the middle of the nebulosity.

A recent photograph, secured by Professor Perrine with the Crossley reflector, recorded the principal features of the nebulous cloud. He compared his photograph with the Yerkes photograph of the same object and made the interesting discovery that the brightest portion of the nebula, at least, and perhaps the whole nebula, had moved to the southeast more than one minute of arc in the past six weeks.

This observation is in every respect unique. Motion on this enormous scale or one fiftieth part of this scale has never been observed for any celestial body outside the solar system, and it is morally certain that the observed phenomenon is closely related to the violent disturbances which gave birth to the new star. It is perhaps as wonderful and important as any fact yet determined in connection with new stars.

THE U. S. NAVAL OBSERVATORY.

IN his annual report to the President, Hon. John D. Long, Secretary of the Navy, indorses the recommendation of the board of visitors to the Naval Observatory, that a civilian astronomer be placed at the head of that institution. Mr. Long says:

"Attention is called to the first and very important report of the board of visitors to the Naval Observatory. I earnestly commend its recommendations to careful consideration. This board was created by act of Congress in March last. I believe its visitations will be found valuable in making the observatory efficient and in rank with the best institutions of the land. It appears that no other observatory in the world has the expenditure of so much money, but also that its results are not commensurate with those of some other observatories the expenditures of which are less. Its

head should of course be the best astronomer, who has proper administrative qualifications, that can be found in the country. It is especially desirable that he should have continuity of tenure, and the observatory has undoubtedly suffered from frequent changes in its superintendents.

"While the average term of service of superintendents at Greenwich has been twenty-eight years and at Harvard fifteen, at the Naval Observatory it has been only a little over three. I urgently recommend that the legislation of the last Congress to the effect 'that the superintendent of the Naval Observatory shall be, until further legislation by Congress, a line officer of the navy of a rank not below that of captain,' be repealed, and that on the contrary it be enacted that there shall be no limitation upon the field from which the superintendent is to be selected. As well might the above-quoted statute have provided that the Commissioner of Fish and Fisheries should be selected from the line of the Marine Corps, or the Director of the Geological Survey from the line of the army.

"There is no vital relation between the navy and the observatory. It may happen that some naval officer is preeminently qualified for such a place, in which case he would be appointed to it, but the country is entitled to have unlimited range of selection. The present limitation, which shuts out the whole body of civilian astronomers and even any astronomer in the navy who does not happen to be in the line, or, if in the line, below the rank of captain, is peculiar. Only a very small proportion of naval officers are not below the rank of captain, and as most of them are required for naval services—a requirement which is now increasing—the list from which selection can be made is a noticeably small one. It is evident, too, from the wording of the above quotation from the statute, that Congress in passing it had in mind further legislation in this respect."

SCIENTIFIC NOTES AND NEWS.

THE Council of the American Association for the Advancement of Science will meet at the Quadrangle Club, adjoining the grounds of the University of Chicago, on the afternoon of Wednesday, January 1. Section H, Anthro-

pology, of the Association will also meet at Chicago during convocation week.

DR. L. O. HOWARD, chief of the Division of Entomology of the U. S. Department of Agriculture and permanent secretary of the American Association for the Advancement of Science, will give the annual lecture at the Chicago meeting of the American Society of Naturalists.

THE American Academy of Arts and Sciences has given Professor R. W. Wood, of the Johns Hopkins University, an appropriation of \$350 from the Rumford fund to aid in the continuation of his researches on the anomalous dispersion of sodium vapor. An account of the results obtained thus far will appear shortly in the *Proceedings of the Royal Society of London*.

PROFESSOR FERDINAND FREIHERR VON RICHTHOFEN, who holds the chair of geography at Berlin, has received from the German Emperor the gold medal for science for his services in supplying the German expedition to China with valuable maps.

DR. SETH LOW has resigned the presidency of the American Geographical Society, New York. He was elected to this office a year ago to succeed the late Judge Charles P. Daly.

THE regents of the State University of Iowa have granted Professor C. C. Nutting, the head of the department of zoology, leave of absence for three months, in order to enable him to join the United States Fish Commission steamer *Albatross* on its cruise to the waters of the Hawaiian Islands. Professor Nutting will have charge of the work on marine invertebrates.

MR. STEWART CULIN made a trip during the summer, on behalf of the Hon. John Wanamaker, in the interests of the Archeological Museum of the University of Pennsylvania, visiting Louisiana, New Mexico, Arizona and California. He secured some 6,000 archeological and ethnological specimens, chiefly from the southwest.

MR. YELJI NAKAJIMA, chief engineer of the city of Tokyo, and professor in the Imperial University, with Mr. Rintaro Naoki, and Mr. Shikajiro Hattori, engineers of Tokyo, are at present in the United States studying engineer-

ing works, especially those concerned with water supply.

CAPTAIN WILLIAM CROZIER has been appointed chief of ordnance in the army with the rank of brigadier-general. Captain Crozier was formerly instructor in mathematics at West Point, and was appointed recently professor of natural and experimental philosophy to succeed General Michie, but declined the position.

ASSISTANT-SURGEON JOHN F. ANDERSON, of the United States Marine-hospital Service, has been detailed by President Roosevelt to go to Liverpool to investigate the recent outbreak there of the bubonic plague.

CAPTAIN E. L. MUNSON, assistant-surgeon U. S. A., has recently been appointed assistant professor of military hygiene in the Army Medical School in Washington, D. C.

MR. IRA A. COLLINS, recently a teacher at Ridgewood, N. J., has gone to the Philippine Islands for three years to teach for the United States Government. He will endeavor to introduce visual instruction in the schools, using lantern slides in teaching the history and geography of the United States to the natives. Mr. Collins, being also able to make plaster life masks and photographs, hopes to send some such anthropometric data to the museums of this country.

DR. WALTER HOUGH has recently returned from a five months' exploring trip in northeastern Arizona, bringing a large collection of archeological and ethnological material for the National Museum. Fifty-four or more sites were examined, and in 18 of these excavations were made, comprising the ruins lying east of Holbrook, Arizona, in the Petrified Forest Reserve; ruins on the north border of the Apache Reserve, and ruins in the Jedido Valley, Hopi Reserve.

DURING the past summer, Mr. Frank M. Chapman, the associate curator of the departments of mammalogy and ornithology, of the American Museum of Natural History, New York City, made an extended trip in the western British possessions. In Manitoba he secured material for groups of cormorants, Wilson's phalarope and the yellow-headed blackbird.

In the Selkirk Mountains he secured the specimens needed for a group of the American dipper or water-ousel.

WE trust that the announcement of the death of Dr. Arthur König, professor of physics in Berlin, published in the *New York Evening Post* and other journals, is incorrect. It seems probable that there is confusion, owing to the recent death of Dr. R. König, of Paris.

MR. THOMAS MEEHAN, the well-known horticulturist and botanist, died in Germantown on November 19. He was born in England in 1826 and came to this country at an early age. Dr. Meehan was botanist of the Pennsylvania State Board of Agriculture, vice-president and one of the curators in charge of the herbarium of the Philadelphia Academy of Natural Sciences, editor of *Meehan's Monthly*, was a fellow of the American Association for the Advancement of Science and a member of numerous other scientific societies. He was the author of valuable papers in botany and horticulture.

DR. WILLIAM FISHER NORRIS, professor of ophthalmology in the University of Pennsylvania, died in Philadelphia on November 18. He was born in that city in 1839, and graduated from the academic and medical departments of the University of Pennsylvania. Dr. Norris was well known for his researches and publications on diseases of the eye. In conjunction with Dr. C. A. Oliver he edited the standard 'System of Diseases of the Eye,' and was the author of a 'Text-book of Ophthalmology.'

DR. ALBERT LEARY GIBON, medical director of the United States Navy, retired with the rank of commodore, died from apoplexy in New York on November 17. Born in Philadelphia sixty-nine years ago, he received his education there and at Princeton College. He was made professor of chemistry and toxicology in the Philadelphia College of Medicine and Surgery in 1853, but resigned to enter the navy in 1855. He had been president of the American Academy of Medicine, of the American Public Health Association and of the Association of Military Surgeons, and was the author of contributions to naval hygiene and public health.

THE American Physiological Society will hold its fourteenth annual meeting in Chicago, on Monday and Tuesday, December 30 and 31, 1901. The sessions will be held at the Physiological Laboratory of the University of Chicago. The headquarters of the Society will be at the Hotel del Prado, 59th Street and Washington Avenue, near the University. Information regarding other local arrangements and railway rates will be furnished later. Members of the Society will please inform the Secretary at their earliest convenience whether they intend to be present and what communications they desire to make. Those who will require apparatus or other necessities for the making of demonstrations may communicate with Professor Jacques Loeb, University of Chicago.

THE steamer *Gauss*, bearing the German Antarctic Expedition, which sailed from Kiel August 11, has arrived at Cape Town.

THE New York Zoological Park has received large accessions of animals from Maine and from Hamburg. They include buffaloes, elks, bears, baboons and other animals. The gelada baboons are said to be the only specimens in captivity.

THE American Museum of Natural History, New York City, has acquired an important collection of mammals and birds from the State of Vera Cruz, Mexico, which contains good series of specimens of several species not before represented in the museum collection. The Museum has also received from the Duke of Loubat a valuable collection of mammals chiefly from the State of Jalisco, which adds much valuable material. A third collection of mammals and birds has been received from Venezuela, collected by Mr. Klages; and a final instalment of birds and mammals of the H. H. Smith collection from the Santa Marta district of Colombia has also come to hand.

THE New York *Independent* publishes an article on the Nobel Foundation by the secretary of the Swedish Nobel Committee, Dr. C. L. Lange, according to which the first distribution of the five prizes will take place on December 10, of the present year, and the amount of each prize will be about \$40,000. The amount that has been deducted from the income for local

uses is said to be one quarter of the whole amount or about \$65,000 a year.

The Journal of the American Medical Association understands that one of the wealthy families of Chicago is arranging to endow, in a most liberal manner, an institution for the study and scientific investigation of infectious diseases. The details and particulars have not yet been made public, but it is reported that it will be second in importance only to that of the gift by Mr. Rockefeller.

The Publishers' Weekly gives some information in regard to the export and import of books and other printed matter for the first nine months of the present year. The value of the imports is \$2,868,489, and of the exports \$2,592,268. As compared with the same period of last year, the imports have increased about \$360,000, and the exports about \$270,000.

UNIVERSITY AND EDUCATIONAL NEWS.

As a gift of a graduate, whose name is withheld, a new building will be erected at Harvard University at a cost of nearly \$100,000. The building will contain an auditorium having a seating capacity of about 1,000.

DR. GEORGE WOODWARD has made a gift of \$20,000 for the establishment of a Woodward Fellowship in Physiological Chemistry at the University of Pennsylvania.

RECENT contributions to the Oberlin College endowment fund are: C. B. and E. A. Shield, of Chicago, \$10,000; Merritt Starr, of Chicago, \$2,500; Dr. L. C. Warner, of New York, \$3,000 from a fund now held in trust by him.

MRS. L. J. WOOD, of Jamaica Plain, Mass., has given \$1,000 to the Physical Laboratory of the Johns Hopkins University for new apparatus.

It is reported in the daily papers that a recent decision of the United States District Court of the State of Michigan greatly increases the value of the estate of William Lampson, bequeathed to Yale University. By this decision the University comes into possession of land supposed to contain large quantities of copper.

THE building at the University of Michigan devoted to physics and chemistry is being remodeled, and the alterations are now well advanced.

THE list of graduate students in Cornell University for the current year is published. It includes the names of 163 candidates for advanced degrees; of these 96 are for Ph.D., 40 for A.M., 13 for M.M.E., 11 for M.S. in Agriculture, 2 for D.Sc., and 1 for M.C.E. There are 185 graduate students in regular university courses and 15 who are not candidates for any degree. Mr. J. W. Prince (C.M.) holds the Sibley Fellowship in M.E. and Mr. L. D. Crain (Perdue) the university fellowship in the same subject. Of the 15 candidates for no degree, 2 are in M.E. Of the 185 graduates, mainly A.B.'s in the regular courses, 60 are in M.E., 68 in medicine and the remainder in various courses.

THE department of botany, of the Iowa State University, conducted its first summer school of botany at Lake Okoboji during the summer. The session continued from July 27 to August 20, and proved very successful. The summer-school laboratory was located by Professor Macbride near Okoboji post office, a central point with respect to the most diversified botanical region in the State. The work was in charge of Assistant Professor B. Shimek, and consisted chiefly of field excursions and the subsequent elaboration and laboratory investigation of the material so secured.

It is announced that Professor Robert Craik, M.D., LL.D., dean of the faculty of medicine and Strathcona professor of hygiene and public health at McGill University, will resign his position and receive a seat on the Board of Governors. Dr. Craik has been connected with McGill for over half a century.

At the University of Toronto, Dr. Howard Barnes has been appointed assistant professor of physics.

At the University of Michigan, Messrs. A. M. Clover, R. F. Sanford and N. F. Harriman have been appointed instructors in the chemical laboratory, and Instructor G. O. Higley has returned from a year's leave of absence in Zurich.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

EDITORIAL COMMITTEE: S. NEWCOMB, Mathematics; R. S. WOODWARD, Mechanics; E. C. PICKERING, Astronomy; T. C. MENDENHALL, Physics; R. H. THURSTON, Engineering; IRA REMSEN, Chemistry; CHARLES D. WALCOTT, Geology; W. M. DAVIS, Physiography; HENRY F. OSBORN, Paleontology; W. K. BROOKS, C. HART MERRIAM, Zoology; S. H. SCUDDER, Entomology; C. E. BESSEY, N. L. BRITTON, Botany; C. S. MINOT, Embryology, Histology; H. P. BOWDITCH, Physiology; J. S. BILLINGS, Hygiene; WILLIAM H. WELCH, Pathology; J. McKEEN CATTELL, Psychology; J. W. POWELL, Anthropology.

FRIDAY, DECEMBER 6, 1901.

HENRY AUGUSTUS ROWLAND.*

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IN reviewing the scientific work of Professor Rowland one is most impressed by its originality. In quantity, as measured by printed page or catalogue of titles, it has been exceeded by many of his contemporaries; in quality it is equaled by that of only a very, very small group. The entire collection of his important papers does not exceed thirty or forty in number and his unimportant papers were few. When, at the unprecedentedly early age of thirty-three years, he was elected to membership in the National Academy of Sciences, the list of his published contributions to science did not contain over a dozen titles, but any one of not less than a half dozen of these, including what may properly be called his very first original investigation, was of such quality as to fully entitle him to the distinction then conferred.

Fortunately for him, and for science as well, he lived during a period of almost unparalleled intellectual activity, and his work was done during the last quarter of that century to which we shall long turn with admiration and wonder. During these twenty-five years the number of industrious cultivators of his own favorite field increased enormously, due in large measure to the

* Address by Dr. T. C. Mendenhall at the Memorial Meeting at the Johns Hopkins University on October 16.

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.

stimulating effect of his own enthusiasm, and while there was only here and there one possessed of the *divine afflatus* of true genius, there were many ready to labor most assiduously in fostering the growth, development and final fruition of germs which genius stopped only to plant. A proper estimate of the magnitude and extent of Rowland's work would require, therefore, a careful examination, analytical and historical, of the entire mass of contributions to physical science during the past twenty-five years, many of his own being fundamental in character and far-reaching in their influence upon the trend of thought, in theory and in practice. But it was quality, not quantity, that he himself most esteemed in any performance; it was quality that always commanded his admiration or excited him to keenest criticism; no one recognized more quickly than he a real gem, however minute or fragmentary it might be, and by quality rather than by quantity we prefer to judge his work to-day, as he would himself have chosen.

Rowland's first contribution to the literature of science took the form of a letter to *The Scientific American*, written in the early autumn of 1865, when he was not yet seventeen years old. Much to his surprise, this letter was printed, for he says of it, 'I wrote it as a kind of joke and did not expect them to publish it.' Neither its humor nor its sense, in which it was not lacking, seems to have been appreciated by the editor, for by the admission of certain typographical errors he practically destroyed both. The embryo physicist got nothing but a little quiet amusement out of this, but in a letter of that day he declares his intention of some time writing a sensible article for the journal that so unexpectedly printed what he meant to be otherwise. This resolution he seems not to have forgotten, for nearly six years later there appeared in its columns what was, as far as is known, his

second printed paper and his first serious public discussion of a scientific question.

It was a keen criticism of an invention which necessarily involved the idea of perpetual motion, in direct conflict with the great law of the conservation of energy which Rowland had already grasped. It was, as might be expected, thoroughly well done and received not a little complimentary notice in other journals. This was in 1871, the year following that in which he was graduated as a civil engineer from the Rensselaer Polytechnic Institute, and the article was written while in the field at work on a preliminary railroad survey. A year later, having returned to the Institute as instructor in physics, he published in the *Journal of the Franklin Institute* an article entitled, 'Illustrations of Resonances and Actions of a Similar Nature,' in which he described and discussed various examples of resonance or 'sympathetic' vibration. This paper, in a way, marks his admission to the ranks of professional students of science and may be properly considered as his first formal contribution to scientific literature; his last was an exhaustive article on spectroscopy, a subject of which he, above all others, was master, prepared for a new edition of the *Encyclopædia Britannica*, not yet published.

Early in 1873 the *American Journal of Science* printed a brief note by Rowland on the spectrum of the Aurora, sent in response to a kindly and always appreciated letter from Professor George F. Barker, one of the editors of that journal. It is interesting as marking the beginning of his optical work. For a year, or perhaps for several years, previous to this time, however, he had been busily engaged on what proved to be, in its influence upon his future career, the most important work of his life. To climb the ladder of reputation and success by simple, easy steps might have contented Rowland, but it would have been quite out of har-

mony with his bold spirit, his extraordinary power of analysis and his quick recognition of the relation of things. By the aid of apparatus entirely of his own construction and by methods of his own devising, he had made an investigation, both theoretical and experimental, of the magnetic permeability and the maximum magnetization of iron, steel and nickel, a subject in which he had been interested in his boyhood.

On June 9, 1873, in a letter to his sister, he says: "I have just sent off the results of my experiments to the publisher and expect considerable from it; not, however, filthy lucre, but good, substantial reputation." What he did get from it, at first, was only disappointment and discouragement. It was more than once rejected because it was not understood and finally he ventured to send it to Clerk Maxwell, in England, by whose keen insight and profound knowledge of the subject it was instantly recognized and appraised at its full value. Regretting that the temporary suspension of meetings made it impossible for him to present the paper at once to the Royal Society, Maxwell said he would do the next best thing, which was to send it to the *Philosophical Magazine* for immediate publication, and in that journal it appeared in August, 1873, Maxwell himself having corrected the proofs to avoid delay. The importance of the paper was promptly recognized by European physicists, and abroad, if not at home, Rowland at once took high rank as an investigator.

In this research he unquestionably anticipated all others in the discovery and announcement of the beautifully simple law of the magnetic circuit, the magnetic analogue of Ohm's law, and thus laid the foundation for the accurate measurement and study of magnetic permeability, the importance of which, both in theory and in practice during recent years, it is difficult to

overestimate. It has always seemed to me that when consideration is given to his age, his training, and the conditions under which his work was done, this early paper gives a better measure of Rowland's genius than almost any performance of his riper years. During the next year or two he continued to work along the same lines in Troy, publishing not many, but occasional, additions to and developments of his first magnetic research. There was also a paper in which he discussed Kohlrausch's determination of the absolute value of the Siemens unit of electrical resistance, foreshadowing the important part which he was to play in later years in the final establishment of standards for electrical measurement.

In 1875, having been appointed to the professorship of physics in Johns Hopkins University, the faculty of which was just then being organized, he visited Europe, spending the better part of a year in the various centers of scientific activity, including several months at Berlin in the laboratory of the greatest continental physicist of his time, von Helmholtz. While there he made a very important investigation of the magnetic effect of moving electrostatic charges, a question of first rank in theoretical interest and significance. His manner of planning and executing this research made a marked impression upon the distinguished director of the laboratory in which it was done and, indeed, upon all who had any relations with Rowland during its progress. He found what von Helmholtz himself had sought for in vain, and when the investigation was finished in a time which seemed incredibly short to his more deliberate and painstaking associates, the director not only paid it the compliment of an immediate presentation to the Berlin Academy, but voluntarily met all expenses connected with its execution.

The publication of this research added much to Rowland's rapidly growing reputation, and because of that fact, as well as on account of its intrinsic value, it is important to note that his conclusions have been held in question, with varying degrees of confidence, from the day of their announcement to the present. The experiment is one of great difficulty and the effect to be looked for is very small, and therefore likely to be lost among unrecognized instrumental and observational errors. It was characteristic of Rowland's genius that with comparatively crude apparatus he got at the truth of the thing in the very start. Others who have attempted to repeat his work have not been uniformly successful, some of them obtaining a wholly negative result, even when using apparatus apparently more complete and effective than that first employed by Rowland.

Such was the experience of Lecher in 1884, but in 1888 Roentgen confirmed Rowland's experiments, detecting the existence of the alleged effect. The result seeming to be in doubt, Rowland himself, assisted by Hutchinson, in 1889, took it up again, using essentially his original method, but employing more elaborate and sensitive apparatus. They not only confirmed the early experiments, but were able to show that the results were in tolerably close agreement with computed values. The repetition of the experiment by Himstedt in the same year resulted in the same way, but in 1897 the genuineness of the phenomenon was again called in question by a series of experiments made at the suggestion of Lippman, who had proposed a study of the reciprocal of the Rowland effect, according to which variations of a magnetic field should produce a movement of an electrostatically charged body. This investigation, carried out by Crémieu, gave an absolutely negative result, and because the method was entirely different from that employed by Row-

land and, therefore, unlikely to be subject to the same systematic errors, it naturally had much weight with those who doubted his original conclusions.

Realizing the necessity for additional evidence in corroboration of his views, in the fall of the year 1900 the problem was again attacked in his own laboratory, and he had the satisfaction, only a short time before his death, of seeing a complete confirmation of the results he had announced a quarter of a century earlier, concerning which, however, there had never been the slightest doubt in his own mind. It is a further satisfaction to his friends to know that a very recent investigation at the Jefferson Physical Laboratory of Harvard University, in which Rowland's methods were modified so as to meet effectively the objections made by his critics, has resulted in a complete verification of his conclusions.

On his return from Europe, in 1876, his time was much occupied with the beginning of the active duties of his professorship, and especially in putting in order the equipment of the laboratory over which he was to preside, much of which he had ordered while in Europe. In its arrangement great (many of his friends thought undue) prominence was given to the workshop, its machinery, tools, and especially the men who were to be employed in it. He planned wisely, however, for he meant to see to it that much, perhaps most, of the work under his direction should be in the nature of original investigation, for the successful execution of which a well manned and equipped workshop is worth more than a storehouse of apparatus already designed and used by others.

He shortly found leisure, however, to plan an elaborate research upon the mechanical equivalent of heat, and to design and supervise the construction of the necessary apparatus for a determination of the numerical value of this most important

physical constant, which he determined should be exhaustive in character and, for some time to come at least, definitive. While this work lacked the elements of originality and boldness of inception by which many of his principal researches are characterized, it was none the less important. While doing over again what others had done before him, he meant to do it, and did do it, on a scale and in a way not before attempted. It was one of the *great* constants of nature, and, besides, the experiment was one surrounded by difficulties so many and so great that few possessed the courage to undertake it with the deliberate expectation of greatly excelling anything before accomplished. These things made it attractive to Rowland.

The overthrow of the materialistic theory of heat, accompanied as it was by the experimental proof of its real nature, namely, that it is essentially molecular energy, laid the foundation for one of those two great generalizations in science which will ever constitute the glory of the nineteenth century. The mechanical equivalent of heat, the number of units of work necessary to raise one pound of water one degree in temperature, has, with much reason, been called the Golden Number of that century. Its determination was begun by an American, Count Rumford, and finished by Rowland, nearly a hundred years later. In principle the method of Rowland was essentially that of Rumford. The first determination was, as we now know, in error by nearly 40 per cent.; the last is probably accurate within a small fraction of 1 per cent. Rumford began the work in the ordnance foundry of the Elector of Bavaria at Munich, converting mechanical energy into heat by means of a blunt boring tool in a cannon surrounded by a definite quantity of water, the rise in temperature of which could be measured. Rowland finished it in an establishment founded for

and dedicated to the increase and diffusion of knowledge, aided by all the resources and refinements in measurement which a hundred years of exact science had made possible.

As the mechanical theory of heat was the germ out of which grew the principle of the conservation of energy, an exact determination of the relation of work and heat was necessary to a rigorous proof of that principle, and Joule, of Manchester, to whom belongs more of the credit for this proof than to any other one man or, perhaps, to all others put together, experimented on the mechanical equivalent of heat for more than forty years. He employed various methods, finally recurring to the early method of heating water by friction, improving on Rumford's device by creating friction in the water itself. Joule's last experiments were made in 1878, and most of Rowland's work was done in the year following. It excelled that of Joule, not only in the magnitude of the quantities to be observed, but especially in the greater attention given to the matter of thermometry. In common with Joule and other previous investigators, he made use of mercury thermometers, but this was only for convenience, and they were constantly compared with an air thermometer, the results being finally reduced to the absolute scale. By experimenting with water at different initial temperatures he obtained slightly different values for the mechanical equivalent of heat, thus establishing beyond question the variability of the specific heat of water. Indeed, so carefully and accurately was the experiment worked out that he was able to draw the variation curve and to show the existence of a minimum value at 30 degrees C.

This elaborate and painstaking research, which is now classical, was everywhere awarded high praise. It was published in full by the American Academy of Arts and

Sciences by the aid of a fund originally established by Count Rumford, and in 1881 it was crowned as a prize essay by the Venetian Institute. Its conclusions have stood the test of twenty years of comparison and criticism.

In the meantime, Rowland's interest had been drawn, largely, perhaps, through his association with his then colleague, Professor Hastings, towards the study of light. He was an early and able exponent of Maxwell's magnetic theory, and he published important theoretical discussions of electromagnetic action. Recognizing the paramount importance of the spectrum as a key to the solution of problems in ether physics, he set about improving the methods by which it was produced and studied, and was thus led into what will probably always be regarded as his highest scientific achievement.

At that time the almost universally prevailing method of studying the spectrum was by means of a prism or a train of prisms. But the prismatic spectrum is abnormal, depending for its character largely upon the material made use of. The normal spectrum as produced by a grating of fine wires or a close ruling of fine lines on a plane reflecting or transparent surface had been known for nearly a hundred years, and the colors produced by scratches on polished surfaces were noted by Robert Boyle, more than two hundred years ago. Thomas Young had correctly explained the phenomenon according to the undulatory theory of light, and gratings of fine wire and, later, of rulings on glass, were used by Fraunhofer, who made the first great study of the dark lines of the solar spectrum. Imperfect as these gratings were, Fraunhofer succeeded in making with them some remarkably good measures of the length of light-waves, and it was everywhere admitted that for the most precise spectrum measurements they were indispensable. In their

construction, however, there were certain mechanical difficulties which seemed for a time to be insuperable. There was no special trouble in ruling lines as close together as need be; indeed, Nobert, who was long the most successful maker of ruled gratings, had succeeded in putting as many as a hundred thousand in the space of a single inch. The real difficulty was in the lack of uniformity of spacing, and on uniformity depended the perfection and purity of the spectrum produced. Nobert jealously guarded his machine and method of ruling gratings as a trade secret, a precaution hardly worth taking, for before many years the best gratings in the world were made in the United States.

More than thirty years ago an amateur astronomer, in New York City, a lawyer by profession, Lewis M. Rutherford, became interested in the subject and built a ruling engine of his own design. In this machine the motion of the plate on which the lines were ruled was produced at first by a somewhat complicated set of levers, for which a carefully made screw was afterwards substituted. Aided by the skill and patience of his mechanic, Chapman, Rutherford continued to improve the construction of his machine until he was able to produce gratings on glass and on speculum metal far superior to any made in Europe. The best of them, however, were still faulty in respect to uniformity of spacing, and it was impossible to cover a space exceeding two or three square inches in a satisfactory manner. When Rowland took up the problem, he saw, as, indeed, others had seen before him, that the dominating element of a ruling machine was the screw by means of which the plate or cutting tool was moved along. The ruled grating would repeat all of the irregularities of this screw, and would be good or bad just as these were few or many. The problem was, then, to make a screw which would be practically

free from periodic and other errors, and upon this problem a vast amount of thought and experiment had already been expended.

Rowland's solution of it was characteristic of his genius; there were no easy advances through a series of experiments in which success and failure mingled in varying proportions; 'fire and fall back' was an order which he neither gave nor obeyed, capture by storm being more to his mind. He was by nature a mechanic of the highest type, and he was not long in devising a method for removing the irregularities of a screw, which astonished everybody by its simplicity and by the all but absolute perfection of its results. Indeed, the very first screw made by this process ranks today as the most perfect in the world. But such an engine as this might only be worked up to its highest efficiency under the most favorable physical conditions, and in its installation and use the most careful attention was given to the elimination of errors due to variation of temperature, earth tremors and other disturbances. Not content, however, with perfecting the machinery by which gratings were ruled, Rowland proceeded to improve the form of the grating itself, making the capital discovery of the concave grating, by means of which a large part of the complex and otherwise troublesome optical accessories to the diffraction spectroscopy might be dispensed with. Calling to his aid the wonderful skill of Brashear in making and polishing plane and concave surfaces, as well as the ingenuity and patience of Schneider, for so many years his intelligent and loyal assistant at the lathe and work-bench, he began the manufacture and distribution, all too slowly for the anxious demands of the scientific world, of those beautifully simple instruments of precision which have contributed so much to the advance of physical science during the past twenty years.

While willing and anxious to give the

widest possible distribution to these gratings, thus giving everywhere a new impetus to optical research, Rowland meant that the principal spoils of the victory should be his, and to this end he constructed a diffraction spectrometer of extraordinary dimensions and began his classical researches on the solar spectrum. Finding photography to be the best means of reproducing the delicate spectral lines shown by the concave grating, he became at once an ardent student and, shortly, a master of that art. The outcome of this was that wonderful 'Photographic Map of the Normal Solar Spectrum,' prepared by the use of concave gratings six inches in diameter and twenty-one and a half feet radius, which is recognized as a standard everywhere in the world. As a natural supplement to this he directed an elaborate investigation of absolute wave-lengths, undertaking to give, finally, the wave-length of not only every line of the solar spectrum, but also of the bright lines of the principal elements, and a large part of this monumental task is already completed, mostly by Rowland's pupils and in his laboratory.

Time will not allow further expositions of the important consequences of his invention of the ruling engine and the concave grating. Indeed, the limitations to which I must submit compel the omission of even brief mention of many interesting and valuable investigations relating to other subjects begun and finished during these years of activity in optical research, many of them by Rowland himself and many of them by his pupils, working out his suggestions and constantly stimulated by his enthusiasm. A list of titles of papers emanating from the Physical Laboratory of the Johns Hopkins University during this period would show somewhat of the great intellectual fertility which its director inspired, and would show, especially, his continued interest in magnetism and electricity, leading to his

important investigations relating to electric units and to his appointment as one of the United States delegates at important international conventions for the better determination and definition of these units. In 1883 a committee appointed by the Electrical Congress of 1881, of which Rowland was a member, adopted 106 centimeters as the length of the mercury column equivalent to the absolute ohm, but this was done against his protest, for his own measurements showed that this was too small by about three-tenths of one per cent. His judgment was confirmed by the Chamber of Delegates of the International Congress of 1893, of which Rowland was himself president, and by which definitive values were given to a system of international units.

Rowland's interest in applied science cannot be passed over, for it was constantly showing itself, often, perhaps, unbidden, an unconscious bursting forth of that strong engineering instinct which was born in him, to which he often referred in familiar discourse and which would unquestionably have brought him great success and distinction had he allowed it to direct the course of his life. Although everywhere looked upon as one of the foremost exponents of pure science, his ability as an engineer received frequent recognition in his appointment as expert and counsel in some of the most important engineering operations in the latter part of the century. He was an inventor, and might easily have taken first rank as such had he chosen to devote himself to that sort of work. During the last few years of his life he was much occupied with the study of alternating electric currents and their application to a system of rapid telegraphy of his own invention. A year ago his system received the award of a grand prix at the Paris Exposition, and only a few weeks after his death the daily papers published cablegrams

from Berlin announcing its complete success as tested between Berlin and Hamburg, and also the intention of the German Postal Department to make extensive use of it.

But behind Rowland, the profound scholar and original investigator, the engineer, mechanic and inventor, was Rowland the man, and any estimate of his influence in promoting the interests of physical science during the last quarter of the nineteenth century would be quite inadequate if not made from that point of view. Born at Honesdale, Pennsylvania, on November 27, 1848, he had the misfortune, at the age of eleven years, to lose his father by death. This loss was made good, as far as it is possible to do so, by the loving care of mother and sisters during the years of his boyhood and youthful manhood. From his father he inherited his love for scientific study, which from the very first seems to have dominated all his aspirations, directing and controlling most of his thoughts. His father, grandfather and great-grandfather were all clergymen and graduates of Yale College. His father, who is described as one 'interested in chemistry and natural philosophy, a lover of nature and a successful trout-fisherman,' had felt, in his early youth, some of the desires and ambitions that afterward determined the career of his distinguished son, but yielding, no doubt, to the influence of family tradition and desire, he followed the lead of his ancestors.

It is not unlikely, and it would not have been unreasonable, that similar hopes were entertained in regard to the future of young Henry, and his preparatory-school work was arranged with this in view. Before being sent away from home, however, he had quite given himself up to chemical experiments, glass-blowing and other similar occupations, and the members of his family were often summoned by the enthusiastic boy to listen to lectures which were fully

illustrated by experiments, not always free from prospective danger. His spare change was invested in copper wire and the like, and his first five-dollar bill brought him, to his infinite delight, a small galvanic battery. The sheets of the *New York Observer*, a treasured family newspaper, he converted into a huge hot-air balloon, which, to the astonishment of his family and friends, made a brilliant ascent and flight, coming to rest, at last, and in flames, on the roof of a neighboring house, and resulting in the calling out of the entire fire department of the town. When urged by his boy friends to hide himself from the rather threatening consequences of his first experiment in aeronautics, he courageously marched himself to the place where his balloon had fallen, saying, 'No! I will go and see what damage I have done.'

When a little more than sixteen years old, in the spring of 1865, he was sent to Phillips Academy at Andover, to be fitted for entering the academic course at Yale. His time there was given entirely to the study of Latin and Greek, and he was in every way out of harmony with his environment. He seems to have quickly and thoroughly appreciated this fact, and his very first letter from Andover is a cry for relief. '*Oh, take me home!*' is the boyish scrawl covering the last page of that letter, on another of which he says, 'It is simply horrible; I can never get on here.' It was not that he could not learn Latin and Greek if he was so minded, but that he had long ago become wholly absorbed in the love of nature and in the study of nature's laws, and the whole situation was to his ambitious spirit most artificial and irksome. Time did not soften his feelings or lessen his desire to escape from such uncongenial surroundings, and, at his own request, Dr. Farrand, principal of the academy at New Jersey, to which city the family had recently removed, was consulted as to what ought to

be done. Fortunately for everybody, his advice was that the boy ought to be allowed to follow his bent, and, at his own suggestion, he was sent, in the autumn of that year, to the Rensselaer Polytechnic Institute at Troy, where he remained five years, and from which he was graduated as a civil engineer in 1870.

It is unnecessary to say that this change was joyfully welcomed by young Rowland. At Andover the only opportunity that had offered for the exercise of his skill as a mechanic was in the construction of a somewhat complicated device by means of which he outwitted some of his schoolmates in an early attempt to haze him, and in this he took no little pride. At Troy he gave loose rein to his ardent desires, and his career in science may almost be said to begin with his entrance upon his work there and before he was seventeen years old.

He made immediate use of the opportunities afforded in Troy and its neighborhood for the examination of machinery and manufacturing processes, and one of his earliest letters to his friends contained a clear and detailed description of the operation of making railroad iron, the rolls, shears, saws and other special machines being represented in uncommonly well executed pen drawings. One can easily see in this letter a full confirmation of a statement that he occasionally made later in life, namely, that he had never seen a machine, however complicated it might be, whose working he could not at once comprehend. In another letter, written within a few weeks of his arrival in Troy, he shows in a remarkable way his power of going to the root of things which even at that early age was sufficiently in evidence to mark him for future distinction as a natural philosopher. On the river he saw two boats equipped with steam pumps, engaged in trying to raise a half-sunken canal boat by pumping the water out of it.

He described engines, pumps, etc., in much detail, and adds, "But there was one thing that I did not like about it; they had the end of their discharge pipe about ten feet above the water, so that they had to overcome a pressure of about five pounds to the square inch to raise the water so high, and yet they let it go after they got it there, whereas if they had attached a pipe to the end of the discharge pipe and let it hang down into the water, the pressure of water on that pipe would just have balanced the five pounds to the square inch in the other, so that they could have used larger pumps with the same engines and thus have got more water out in a given time."

The facilities for learning physics, in his day, at the Rensselaer Polytechnic Institute were none of the best, a fact which is made the subject of keen criticism in his home correspondence, but he made the most of whatever was available and created opportunity where it was lacking. The use of a turning-lathe and a few tools being allowed, he spent all of his leisure in designing and constructing physical apparatus of various kinds with which he experimented continually. All of his spare money goes into this and he is always wishing he had more. While he pays without grumbling his share of the expense of a class supper, he cannot help declaring that 'it is an *awful* price for one night's pleasure; why, it would buy another galvanic battery.' During these early years his pastime was the study of magnetism and electricity, and his lack of money for the purchase of insulated wire for electromagnetic apparatus led him to the invention of a method of winding naked copper wire, which was later patented by some one else and made much of. Within six months of his entering the Institute he had made a delicate balance, a galvanometer and an electrometer, besides a small induction coil and several minor pieces. A few weeks later he announces the finishing

of a Ruhmkorff coil of considerable power, a source of much delight to him and to his friends.

In December, 1866, he began the construction of a small but elaborately designed steam engine which ran perfectly when completed and furnished power for his experiments. A year later he is full of enthusiasm over an investigation which he wishes to undertake to explain the production of electricity when water comes in contact with red-hot iron, which he attributes to the decomposition of a part of the water. Along with all this and much more he maintains a good standing in his regular work in the Institute, in some of which he is naturally the leader. He occasionally writes: 'I am head of my class in mathematics,' or 'I lead the class in natural philosophy,' but official records show that he was now and then 'conditioned' in subjects in which he had no special interest. As early as 1868, before his twentieth birthday, he decided that he must devote his life to science. While not doubting his ability 'to make an excellent engineer,' as he declares, he decides against engineering, saying: "You know that from a child I have been extremely fond of experiment; this liking, instead of decreasing, has gradually grown upon me until it has become a part of my nature, and it would be folly for me to attempt to give it up; and I don't see any reason why I should wish it unless it be avarice, for I never expect to be a rich man. I intend to devote myself hereafter to *science*. If she gives me wealth I will receive it as coming from a friend, but if not, I will not murmur."

He realized that his opportunity for the pursuit of science was in becoming a teacher, but no opening in this direction presenting itself, he spent the first year after graduation in the field as a civil engineer. This was followed by a not very inspiring experience as instructor in natural science in

a western college, where he acquired, however, experience and useful discipline.

In the spring of 1872 he returned to Troy as instructor in physics, on a salary the amount of which he made conditional on the purchase by the Institute of a certain number of hundreds of dollars' worth of physical apparatus. If they failed in this, as afterward happened, his pay was to be greater, and he strictly held them to the contract. His three years at Troy as instructor and assistant professor were busy, fruitful years. In addition to his regular work he did an enormous amount of study, purchasing for that purpose the most recent and most advanced books on mathematics and physics. He built his electro-dynamometer and carried out his first great research. As already stated, this quickly brought him reputation in Europe and, what he prized quite as highly, the personal friendship of Maxwell, whose ardent admirer and champion he remained to the end of his life. In April, 1875, he wrote, "It will not be very long before my reputation reaches this country," and he hoped that this would bring him opportunity to devote more of his time and energy to original research.

This opportunity for which he so much longed was nearer at hand than he imagined. Among the members of the Visiting Board at the West Point Military Academy in June, 1875, was one to whom had come the splendid conception of what was to be at once a revelation and a revolution in methods of higher education. In selecting the first faculty for an institution of learning which, within a single decade, was to set the pace for real university work in America, and whose influence was to be felt in every school and college of the land before the end of the first quarter of a century, Dr. Gilman was guided by an instinct which more than all else insured the success of the new enter-

prise. A few words about Rowland from Professor Michie, of the Military Academy, led to his being called to West Point by telegraph, and on the banks of the Hudson these two walked and talked, 'he telling me,' Dr. Gilman has said, 'his dreams for science, and I telling him my dreams for higher education.' Rowland, with characteristic frankness, writes of this interview, 'Professor Gilman was very much pleased with me,' which, indeed, was the simple truth. The engagement was quickly made. Rowland was sent to Europe to study laboratories and purchase apparatus, and the rest is history, already told and everywhere known.

Rowland's personality was in many respects remarkable. Tall, erect and lithe in figure, fond of athletic sports, there was upon his face a certain look of severity which was, in a way, an index of the exacting standard he set for himself and others. It did not conceal, however, what was, after all, his most striking characteristic, namely, a perfectly frank, open and simple straightforwardness in thought, in speech and in action. His love of truth held him in supreme control, and, like Galileo, he had no patience with those who try to make things appear otherwise than as they actually are. His criticisms of the work of others were keen and merciless, and sometimes there remained a sting of which he himself had not the slightest suspicion. 'I would not have done it for the world,' he once said to me after being told that his pitiless criticism of a scientific paper had wounded the feelings of its author. As a matter of fact, he was warm-hearted and generous, and his occasionally seeming otherwise was due to the complete separation, in his own mind, of the product and the personality of the author. He possessed that rare power, habit in his case, of seeing himself, not as others see him, but as he saw others. He looked at himself and his own work exactly

as if he had been another person, and this gave rise to a frankness of expression regarding his own performance which sometimes impressed strangers unpleasantly, but which, to his friends, was one of his most charming qualities.

Much of his success as an investigator was due to a firm confidence in his own powers, and in the unerring course of the logic of science which inspired him to cling tenaciously to an idea when once he had given it a place in his mind. At a meeting of the National Academy of Sciences in the early days of our knowledge of electric generators he read a paper relating to the fundamental principles of the dynamo. A gentleman who had had large experience with the practical working of dynamos listened to the paper, and at the end said to the academy that unfortunately practice directly contradicted Professor Rowland's theory, to which instantly replied Rowland, 'So much the worse for the practice,' which, indeed, turned out to be the case.

Like all men of real genius, he had phenomenal capacity for concentration of thought and effort. Of this, one who was long and intimately associated with him remarks, "I can remember cases when he appeared as if drugged from mere inability to recall his mind from the pursuit of all-absorbing problems, and he had a triumphant joy in intellectual achievement such as we would look for in other men only from the gratification of an elemental passion." So completely consumed was he by fires of his own kindling that he often failed to give due attention to the work of others, and some of his public utterances give evidence of this curious neglect of the historic side of his subject.

As a teacher his position was quite unique. Unfit for the ordinary routine work of the class room, he taught, as more men ought to teach, by example rather than by precept. Says one of his most eminent

pupils, "Even of the more advanced students, only those who were able to brook severe and searching criticism reaped the full benefit of being under him, but he contributed that which in a university is above all teaching of routine, the spectacle of scientific work thoroughly done and the example of a lofty ideal."

Returning home about twenty years ago, after an expatriation of several years, and wishing to put myself in touch with the development of methods of instruction in physics, and especially in the equipment of physical laboratories, I visited Rowland very soon after, as it happened, the making of his first successful negative of the solar spectrum. That he was completely absorbed in his success was quite evident, but he also seemed anxious to give me such information as I sought. I questioned him as to the number of men who were to work in his laboratory, and although the college year had already begun he appeared to be unable to give even an approximate answer. 'And what will you do with them?' I said. 'Do with them?' he replied, raising the still dripping negative so as to get a better light through its delicate tracings, 'Do with them?—*I shall neglect them.*' The whole situation was intensely characteristic, revealing him as one to whom the work of a drill-master was impossible, but ready to lead those who would be led and could follow. To be neglected by Rowland was often, indeed, more stimulating and inspiring than the closest personal supervision of men lacking his genius and magnetic fervor.

In the fulness of his powers, recognized as America's greatest physicist, and one of a very small group of the world's most eminent, he died on April 16, 1901, from a disease, the relentless progress of which he had realized for several years and opposed with a splendid but quiet courage.

It was Rowland's good fortune to receive

recognition during his life in the bestowal of degrees by higher institutions of learning; in election to membership in nearly all scientific societies worthy of note in Europe and America; in being made the recipient of medals of honor awarded by these societies, and in the generously expressed words of his distinguished contemporaries. It will be many years, however, before full measure can be had of his influence in promoting the interests of physical science, for with his own brilliant career, sufficient of itself to excite our profound admiration, must be considered that of a host of other younger men who lighted their torches at his flame and who will reflect honor upon him whose loss they now mourn, by passing on something of his unquenchable enthusiasm, something of his high regard for pure intellectuality, something of his love of truth and his sweetness of character and disposition.

T. C. MENDENHALL.

*REPORT OF THE BOARD OF VISITORS TO
THE NAVAL OBSERVATORY FOR
THE YEAR 1901.*

IN pursuance to a call issued by the Secretary of the Navy, a meeting of the Board of Visitors to the Naval Observatory was held in Washington, beginning April 9, 1901. The Board was organized by the selection of Charles A. Young as chairman and Ormond Stone as secretary. Another meeting was held in Washington, beginning October 29, 1901. At both of these meetings, and afterwards by correspondence, as careful an examination as time permitted was made, directly and by committee, of the condition and needs of the Observatory, and of such other matters as are referred to in the law creating the Board. In this examination the Board was greatly aided by conferences with the Secretary of the Navy, the Superintendent and staff of the Naval Observatory, officers of the Civil Service

Commission, and others, all of whom have given the Board their most cheerful assistance. As a result of the deliberations of the Board the following recommendations are respectfully offered for consideration:

ASTRONOMICAL DIRECTOR.

It is recommended that no astronomical director be appointed at present, as a dual headship has been found to work unsatisfactorily, and under the existing law the appointment of an astronomer as sole director of the Observatory—which the Board considers the proper solution of the question—is impracticable.

METHOD OF FILLING VACANCIES.

Vacancies should not be filled among assistant astronomers nor among professors of mathematics in the Navy without examination for each vacancy occurring. For example, the results of a given examination should not be used for filling a subsequent vacancy, except in so far as such results may properly form a part of a new independent examination. No distinction should be made between employees of the Observatory and other applicants. Employees should, however, of course, be at liberty to present evidence of experience or capacity as shown by their work at the Observatory in the same manner as other candidates present similar evidence as shown by their work elsewhere. The responsibilities of the positions of assistant astronomer and professor of mathematics are distinctly different from those of a computer, although much of the required experience may properly be gained in connection with the latter position and be credited in the examinations for the higher positions. At the same time it is important that the positions of computer should be filled by persons whose prime interest is in practical and theoretical astronomy and whose ambition it will be to occupy higher positions in the Observatory. As far as is

consistent with the routine needs of the institution, the duties of the computers should be so arranged as to encourage them to prepare for advancement within the Observatory itself. The positions of piece-work and of regular computers are essentially of the same nature, and promotion from one of these grades to the other may very properly be made, but always on the basis of merit rather than length of service. In no case should appointments be made to the Observatory merely by transfer from other bureaus or offices in the service, nor should appointments ever be made even temporarily without competitive examination.

ASSISTANT ASTRONOMERS.

In accordance with the principles herein stated, instead of recommending the name of a person to fill the vacancy now existing among the assistant astronomers at the Naval Observatory, we recommend that an examination be held with the assistance of the Civil Service Commission, in accordance with an announcement, a copy of which accompanies this report as Exhibit A, the examiners to be the members of the Board of Visitors for the time being. In order to carry this out, it is requested that Departmental Order No. 14 be so modified that employees of the Naval Observatory may have the same right to apply as other persons.

ADMINISTRATION OF THE OBSERVATORY.

We desire to call attention to the fact that the enactment which created the Board of Visitors provides that "the Superintendent of the Naval Observatory shall be, until further legislation by Congress, a line officer of the Navy of a rank not below that of captain," thus implying that a change in the law is in contemplation. As every other prominent observatory is under the direction of an astronomer, we wish to record our deliberate and unanimous judgment that the law should be changed so as

to provide that the official head of the Observatory—perhaps styled simply 'the director'—should be an eminent astronomer appointed by the President, by and with the advice and consent of the Senate, holding this place by a tenure at least as permanent as that of the superintendent of the Coast Survey, or the head of the Geological Survey, and not merely by a detail of two or three years' duration. Only in this way can there be a continuous and effective policy of administration which will insure astronomical work of a high order. In rank, salary, privilege and prestige he should be superior to any other official on the ground.

The limitation in the selection of assistants should also be removed, and the assistant once appointed should be secure against detachment or removal except by the action, for cause, of the director.

The institution should be related to the Navy Department, if continued under its control, in some such way as the Royal Observatory at Greenwich is related to the British Admiralty. It should be put under the control of the Secretary directly, and not through a bureau as at present.

SCOPE AND PLAN OF WORK.

The relation of the United States Naval Observatory to astronomy is unlike that of any other observatory in the country. A private observatory is usually devoted to a special line of work selected by its director, or by the head of one of its departments. This work is then carried on in the manner and in the special directions chosen by the officer in charge. The Naval Observatory, on the other hand, is maintained at the expense of all the people of the United States, and its work should not be entirely determined by the wishes and interests of any one individual; a principal use should be to supply the wants of astronomy by undertaking researches which have been

neglected elsewhere, either because they are too expensive or for other reasons. It is believed that the policy of undertaking neglected work, and doing what is most needed and not what is most attractive, would commend itself to Congress, to astronomers and to the people.

The Naval Observatory should cooperate with the other observatories of the country, use its influence to prevent needless duplication of work, and supply important deficiencies in work done elsewhere.

Great care should be taken in preparing a permanent scheme of work in the preparation of which the opinions of experts in each department should be carefully considered.

Important changes in such a plan should be made only after careful consideration, and should in general relate to details of observation, reduction and form of publication, rather than to objects or classes of investigation. The officers required to carry out this work should be selected for special fitness or experience, as well as for general astronomical knowledge, and a change in duty should be seldom made and then only for important reasons. If any observer has by years of experience attained great skill with a meridian circle, to place him in charge of an equatorial would be much like making a sailing master of an engineer, however skilled he may be. Great care should be taken in the assignment of duties to different members of the observing staff in order to secure a satisfactory distribution of force among the instruments and to avoid undue concentration or the reverse. At the same time the special aptitudes of individuals should be kept in mind, and their interest enlisted by giving them as far as possible independence of responsibility.

The following provisional plan is suggested for criticism and amendment:

The meridian circle is necessarily one of

the most important instruments in a government observatory. Daily observations should be made, whenever possible, of the sun and moon, and of sufficient number of standard stars to determine accurately the error of the standard clock and the constants of the instrument. The major planets should be observed on a certain number of nights every year to correct their ephemerides, but not often enough to curtail seriously the other work of the instrument. A system of standard stars should be selected by cooperation with the various national almanacs and observatories, and a certain number of observations of each of these stars should, if possible, be secured each year. In planning the observations, the determination of their absolute and not merely their relative positions should be taken into consideration. In preparing a list of standard stars it is suggested that instead of attempting to observe all stars brighter than a given magnitude, it might be better to take only those of about the same magnitude and spectrum, in order to eliminate errors due to magnitude and color, and to choose those nearly equally spaced in the sky, adding such polar and equatorial stars as will culminate at nearly equal intervals and will not interfere with one another. It would also be necessary to include all the very bright stars as a basis for daylight observations. As examples of special researches that might have been taken up under such a system may be mentioned the comparison stars for Victoria and Sappho proposed by Dr. Gill in 1889, and the comparison stars selected by the Astrophotographic Conference of 1900 for observations of Eros.

The altazimuth instrument should perhaps also be used for observing the moon when off the meridian, and for determining the time when clouds render it impossible to observe on the meridian. The observation of zenith stars should be continued

with the prime vertical instrument and vertical circle. These observations, which appear to be of a high degree of excellence, have now lasted eight years, and should be maintained for at least eleven years longer, or through a complete metonic cycle, to furnish a good determination of the constant of nutation. An additional computer is much needed for the reduction of this work.

The determination and distribution of accurate time will always be an important function of a government observatory, and requires a careful administration. Not only is the exact time required for rating the chronometers of the Navy, but at present time signals are distributed by telegraph from the Naval Observatory throughout the country. The value of accurate time to the people generally is so great that no reasonable effort should be spared to reduce the inevitable errors from every source as much as possible. Formerly large sums were expended by railroads, cities, factories and makers of clocks and watches in the purchase of time signals, furnished by various observatories. To many observatories this was an important source of income.

In 1883 the astronomers of the country, recognizing the great value of a system of uniform standard time, used all their influence toward securing its adoption, notwithstanding the obvious danger to their private interests—since under such a system it would be possible for a single institution to furnish time to the whole country. In fact, in 1891 the Naval Observatory assumed the task. While the time as now distributed from the Observatory is sufficiently accurate for most business purposes, since a nonaccumulating error of a few seconds is of little importance in that view, it appears, however, that at considerable distances from Washington the errors are often considerably greater than

under the old system, when the time was communicated from a standard clock not very far away, the errors being often large enough to interfere with the utility of the signals for chronometer rating and scientific purposes. The difficulty lies largely in the methods by which the time is transmitted by the telegraph, but more in the slightly irregular rate of the standard clock through long intervals of cloudy weather during which star observations cannot be obtained.

It would seem that by cooperation with other observatories a considerable improvement might be made, by arranging matters so that every night, or at least on nights during which the weather is bad at Washington, these observatories should each send a time signal to the Naval Observatory, indicating also the interval since the last observation.

It is difficult to see any way in which the efficiency of the Navy is increased by means of the 26-inch equatorial telescope. If left idle, however, it would be a subject for severe criticism, owing to the large sums of money already expended upon it. Its work should, therefore, be planned wholly in the interests of astronomy. The same principle should be adopted as with the other instruments. Researches should be undertaken which have been neglected at other observatories, duplication of work should be carefully avoided, and no investigation should be undertaken that can be done equally well with smaller instruments. The following examples of the species of work to be undertaken may be mentioned: A list of double stars which are too difficult to be observed with small instruments, and of which no recent accurate measures have been made, should be prepared with the advice of specialists in this department, and measured with the greatest accuracy; binaries and suspected binaries should, of course, receive special attention; neglected

asteroids and variables should similarly be followed; the observations of the satellites should be continued with this instrument, especially those of Saturn and Uranus, which are likely to be neglected at European observatories for the next few years owing to their southern declinations.

Lost asteroids, and perhaps others, can best be found and followed by photography. The spectroscopic approach and recession of the stars is at the present time under investigation with so many very large telescopes that this work may be left to them. The number of known spectroscopic binaries, however, is so great that it may be necessary hereafter to follow them carefully to determine the laws governing their motions. The work of the 12-inch equatorial should supplement that of the 26-inch.

In general the plan of work should be altered but rarely, and then only when changes seem imperative. Special attention should be given to work neglected elsewhere, and every effort made to render our knowledge of astronomy as complete as possible.

AMERICAN EPHEMERIS AND NAUTICAL ALMANAC.

Among the most important scientific publications of the Government of the United States are those issued by the Office of the American Ephemeris and Nautical Almanac. The first and best known is the Almanac issued every year, which gives name to the office. Four European countries—Great Britain, Germany, France and Spain—make similar publications, and a great saving might be effected by carrying still further the plan of cooperation already in part adopted. To avoid errors certain elements are computed independently three times, but if this is done for all five of the almanacs evidently much work is wasted. So far as possible the same quantities should be published in all of the

almanacs, and computed independently as many times as may be deemed necessary. Ninety-six pages are devoted to that important and laborious problem, the exact path of the moon. Here an independent computation seems needless when we consider that the only American observatory at which the position is regularly determined is at Washington. The occasional observations made at other places have, in general, but little permanent value, and for observations of the moon at sea far less accurate positions are needed. In fact, 72 additional pages are devoted to lunar distances. In order that the saving suggested may be accomplished without delaying the publication of the Almanac, arrangements should be made with the foreign almanac offices to complete their computations at least a year longer in advance than is done at present.

A second most important consideration is that changes should be made only after a most careful examination and consultation with astronomers for whose benefit the Almanac is printed, and with the approval of the Board of Visitors. Changes not only cause great inconvenience, but often render it necessary to employ some other almanac when reducing the observations extending over a long period of years. The changes suggested below are so extensive that they should be made only if approved by American astronomers in general.

Washington mean time is not used even at Washington, and its use in the Almanac seems superfluous. Greenwich mean time, as modified in standard time, is in universal use in the United States, and is already used in a large part of the Almanac. Central time, which differs from Greenwich time by exactly six hours, might be conveniently used to simplify the interpolation for the transits of the moon and planets.

The phase angle, i , should be given for

the outer planets as well as for Mercury and Venus.

The ephemerides of the satellites are often insufficient for even the identification of these bodies. This is particularly the case with Hyperion and Iapetus. For the latter even the apparent ellipse is not given. It will probably not be necessary to return to the bulky tables of the satellites of Jupiter, published yearly in the Almanac before 1882. It would be convenient to have the correction to the ephemeris given when it is known—for instance, the ephemeris of Mimas for this year (1901) is in error by about four hours. Accordingly it is invisible on account of the ring at the predicted times of elongation.

The published positions of observatories should be changed only after careful consultation with the directors. If a system of longitude like that of the Coast Survey is adopted, it should be so stated in the description. The statement that 'the latest available data have been used' is too indefinite.

A great saving in expense might be effected by the adoption of some of the changes mentioned above. This would permit the insertion of valuable data now omitted. For instance, the list of star places might be greatly extended, ephemerides for physical observations of the moon and planets might be inserted, and approximate ephemerides of Eros and of some of the more interesting asteroids, such as Hungaria, Tercidina, Sirona and Polyhymnia.

It is recommended that these and similar changes be proposed to astronomers, and that they be invited to suggest others, as was done by Professor Newcomb when taking charge of the office.

A series of papers of very great scientific value, entitled 'Astronomical Papers prepared for the use of the American Ephemeris and Nautical Almanac,' has been

issued by this office during the last twenty years. The 'Contribution to Celestial Mechanics,' made while the office was under the direction of Professor Newcomb, was a notable one, and a continuation of the papers mentioned is greatly to be desired. A continued investigation of the motion of the moon is especially recommended.

INSTRUMENTS.

The Board at its meeting in April appointed a committee which made as careful an inspection of the instruments of the Observatory as was possible during the time at its disposal. On the whole, the 26-inch equatorial is in good condition. It is recommended that this instrument be supplied with a micrometer at least equal in quality to that constructed for the large equatorial of the Pulkowa Observatory. Also a good field illumination should be provided, as well as a symmetrical illumination for the wires.

Since the visit of the committee in April a number of improvements have been made on the 12-inch equatorial; a bright field illumination is still needed. An investigation of the object glass, which gives poor stellar images, is now in progress by Mr. King, the officer in charge. This examination will show whether the glass is merely out of adjustment or should be refigured.

Extensive repairs are needed for the 9-inch transit circle, and especial attention is invited to Exhibit B, which gives a list of the most important improvements referred to.

A number of changes have been made in the 6-inch transit circle; these and others still needed are referred to in Exhibit C. For both transit circles collimators should be provided having object glasses of larger apertures, and also better means should be provided for obtaining the necessary meteorological data.

The prime vertical transit should be pro-

vided with a long focus lens and an azimuth mark. The house containing the altazimuth is too small. The present building should be replaced by one of such size that collimators may be placed inside of the dome, and, as in the case of the prime vertical, a long focus lens and an azimuth mark should be provided.

For use with the meridian and prime vertical instruments three new chronographs are needed.

Special attention is called to the importance of a careful study of each instrument of the Observatory and a prompt publication of the results of such investigations.

LIBRARY.

The Library contains 18,025 bound volumes and 3,891 pamphlets. It is devoted to astronomy and mathematics, and the allied sciences, and is particularly rich in complete sets of the publications of observations, academies, and learned societies of Europe, many of which are rare as well as modern treatises and reports of investigations. It is admirably arranged and is in excellent order. The assistant librarian in charge has made considerable progress in the preparation of a comprehensive card catalogue, which will render the material on the shelves much more available.

The appropriation of \$750, which is now provided for the Library, is not sufficient for its needs. About \$350 of this is required to keep up the scientific journals and the works, such as yearbooks, which appear periodically. The remainder of the appropriation is not sufficient to provide the new books, engravings, photographs, and fixtures required, and to fill up gaps in the Library when special opportunity offers. It is recommended that the appropriation be increased to \$1,000.

ADDITIONAL REQUIREMENTS.

In the opinion of the Board, there is urgently needed—

1. A repair shop for the instrument maker.
2. Residences for those who are regularly engaged in late night observations.

EXPENDITURES.

The expenditures for the Naval Observatory are presented in Exhibit D.

From the manner in which the appropriations have been made, it is not easy for the Board of Visitors to determine what portion of the expenditures pertains properly to astronomical work, what portion to naval work, and what portion to the improvement and care of the grounds as a park.

Respectfully submitted.

CHAS. A. YOUNG,
CHAS. F. CHANDLER,
ASAPH HALL, JR.,
E. C. PICKERING,
ORMOND STONE,
WILLIAM R. HARPER.

THE ASSOCIATION OF AMERICAN AGRICULTURAL COLLEGES AND EXPERIMENT STATIONS.

THE fifteenth annual convention of the Association of American Agricultural Colleges and Experiment Stations was held at Washington, D. C., November 12 to '14. President A. W. Harris, of the University of Maine, presided at the general sessions and delivered the president's annual address. This address set forth clearly the more important things for which the land-grant colleges stand and summarized the results of their work. The land grant act of 1862 was considered important not only as providing for agricultural education, but as the first sufficient recognition of study and investigation as the basis of the best success in the arts and industries. It also proclaimed the duty of the national government to promote industrial education, and in its results demonstrated the effectiveness

of governmental cooperation. The most important of the direct results of this act to agriculture was the experiment station. "If the agricultural college did nothing more than to establish, maintain, and officer the experiment station, it would be justified many times over." The establishment of the agricultural colleges also caused the strengthening and broadening of industrial education along all lines and has culminated in a great system of technical education. "It is also a great result of the land-grant college to have asserted and established the doctrine that education in all its forms, from the lowest to the highest, is a State function in which the State has the fullest rights and for which it must bear the responsibility, sharing the privilege and responsibility with private corporations only as it thinks best." The speaker considered state aid and control in higher education as necessary to the best national development, and especially so because in this way the results of higher education become the property of all the people. The address concluded with an eloquent tribute to the memory and worth of Justin S. Morrill.

The report of the Executive Committee presented by its chairman, President H. H. Goodell, of the Massachusetts Agricultural College, called the attention of the Association to the fact that the bill for the establishment of schools or departments of mining and metallurgy in connection with the land-grant colleges passed the Senate, but failed to be called up in the House of Representatives during the last session of Congress. The introduction of a similar bill into Congress early in its next session was recommended.

The report of the Committee on Revision of the Constitution called forth a vigorous discussion. The Association refused to change its name. Among the important amendments adopted were those providing that the election of officers shall be by bal-

lot upon nominations made on the floor of the convention, and that the program of the annual conventions of the Association shall hereafter be made up and distributed sixty days before the meeting of the convention; and "the subjects provided for consideration by a section at any convention of the Association shall concentrate the deliberations of the section upon not more than two main lines of discussion, which lines shall so far as possible be related. Not more than one-third of the working time of any annual convention of the Association shall be assigned to miscellaneous business."

The Committee on Graduate Study at Washington reported that no progress had been made since the last convention in securing a Government bureau in Washington for the administration of graduate work. The Association directed the committee to continue its efforts in this direction and, in the meantime, to secure if practicable the same opportunities for study and research in other departments of the government as are at present afforded graduate students in the Department of Agriculture. A resolution was also adopted by the Association recording its appreciation of the action of the government in making available the facilities for research and advanced work in the Department of Agriculture, and expressing a desire that these facilities may be still further extended and that a national university devoted exclusively to advanced study and graduate and research work be established.

The sixth report of progress was submitted by the Committee on Methods of Teaching Agriculture. Attention was called to the publication by the Department of Agriculture of the syllabi of courses in agro-techny, rural engineering and rural economics prepared by the committee last year. In surveying the progress of agricultural education in this country during re-

cent years the committee "found abundant evidence that the attitude of this Association and the work of this committee as its representative have already borne good fruit in stimulating and aiding the movement for the specialization of agricultural instruction in our colleges, the strengthening of agricultural faculties, and the bettering of the material equipment for agricultural education." The committee announced its intention to prepare and publish during the coming year a report on the courses in agronomy in our agricultural colleges and the facilities for instruction in this subject.

The Committee on Cooperative Work between the Stations and the Department of Agriculture made the following recommendations as supplementary to those embodied in the report submitted at the last convention: "(1) 'When cooperation is desired by the station it is deemed advisable that the proposal for such cooperation be made to the department by the director of the experiment station; where on the other hand the department desires the cooperation of the station, it is deemed advisable that the proposal be made in the first instance to the director rather than to members of the staff. (2) While it is well understood that no financial obligations can be undertaken beyond the end of the fiscal year, yet it should be recognized that any arrangement for joint experimentation which requires some years to complete creates a moral obligation upon both parties to carry the work to a conclusion. (3) Where a line of investigation has been in progress in any State under the auspices of either institution it is, as a rule, unwise for the other party to undertake independently the same line of investigation at least until after full consultation upon the subject.'"

The committee was continued with the addition of Professor B. T. Galloway of the Department of Agriculture.

The report of the Committee on Indexing Agricultural Literature called attention to the fact that progress in this direction could not be made by the Department of Agriculture until its library was provided with funds for this purpose. A paper on 'Agricultural College Libraries,' prepared and presented by Miss Josephine A. Clark, librarian of the Department of Agriculture, and a member of this committee, completed the report. This paper emphasized the great importance of libraries as aids to the work of investigation and instruction and pointed out the necessity of systematic arrangement and complete cataloguing of agricultural libraries. Arrangements in progress by the library of the Department for assisting agricultural colleges in classifying and cataloguing their libraries were explained.

The report of the bibliographer, A. C. True, noted the work of a bibliographical character being done by the Department of Agriculture, and enumerated with explanatory notes forty-four general and partial bibliographies in lines relating to agriculture issued during the past year.

The general plan of the graduate summer school of agriculture, as proposed by the Ohio State University at the last convention and approved by the Executive Committee, was explained by President W. O. Thompson of the University. It was stated that sufficient encouragement had been received from the leaders of agricultural education and research to warrant a decision to hold the first session of the school at the Ohio State University at Columbus, Ohio, during the summer of 1902. It was announced that Secretary Wilson had cordially approved the plan for this school, and that, acting under his advice, Doctor A. C. True, director of the Office of Experiment Stations, had consented to act as dean of the school. The Ohio State University makes itself responsible for the general management of the first session of

the school, but if it proves a success it is proposed to make it a cooperative enterprise, to be managed by a committee of control appointed by the Association. Future sessions may be held at institutions in different parts of the country. This plan for the school was endorsed by the Association and a prospectus of the first session will soon be issued.

The Association voted in favor of exhibits illustrating the progress of instruction and research in agriculture and the mechanic arts, at the St. Louis Exposition in 1903, and committees on these exhibits were appointed.

The resolution introduced by Professor W. A. Henry, of Wisconsin, was adopted by the Association, urging upon Congress "the necessity and wisdom of providing a building for the accommodation of the Department of Agriculture which in magnitude shall be sufficient to provide for its future, as well as present, needs, and which will properly represent in its architecture the enormous importance of agriculture in this country, and which will constitute a worthy addition to the government buildings of the capital of the United States."

In the section on college work a paper on the relation of agricultural colleges to the proposed national university, by President W. O. Thompson, of the Ohio State University, was presented in which the writer affirmed that in his judgment "the relation of the agricultural colleges to a national university should be that of sympathetic cooperation and enthusiastic support, as against all other measures whether proposed as substitutes or stepping-stones." This paper called forth a lively discussion in which it appeared that there was a general sentiment in the section in favor of securing some agency under government control for making the laboratories, museums, libraries, and other educational facilities in Washington available to advanced students.

W. M. Liggett, Dean of the College of Agriculture of the University of Minnesota, read a paper on the value of short courses, in which he described the different courses in agriculture given in Minnesota, and stated that he considered the short courses valuable adjuncts to the longer courses.

Honorable J. H. Brigham, Assistant Secretary of Agriculture, spoke of the short courses as a means not only of giving valuable instruction to farmers, but also of bringing about more cordial relations between the agricultural colleges and farmers. In his judgment "the best way to secure the support of farmers is to let them come to the college even for a short time and see that you are trying to do good."

In the section on agriculture and chemistry considerable time was given to a consideration of the question to what extent the Department of Agriculture and the experiment stations may profitably cooperate in the study of grass and forage plant problems and the lines of work which are likely to yield the most important results. Professor B. T. Galloway, chief of the Bureau of Plant Industry, gave a brief history of the cooperative forage plant work of the Department and the stations. He expressed his opinion that the success of the movement depended on grouping the stations with reference to the problems to be solved in different sections of the country, and devising a working plan for each group. The following lines of work were suggested: (1) The introduction of crops from foreign countries, (2) growing and disseminating introduced crops after they have become in a measure established, (3) dissemination of native crops of local value, (4) breeding crops for certain conditions, (5) increasing production by improved cultural methods. Professor R. H. Forbes, director of the Arizona Experimental Station, described the grass and forage crop conditions of that Territory, and gave an account of the co-

operative investigations carried on there. These investigations have for their object the improvement of the ranges through the exclusion of live stock, the sowing and harrowing in of seeds of native plants, the introduction of new forage plants suited to the arid region, and the construction of small embankments for holding the storm water. As conducted for two years on a reserve of 350 acres they have given promising results. Professor F. Lamson-Scribner, agrostologist of the Department of Agriculture, gave an account of the cooperative work under his direction, which includes arrangements with seventeen experiment stations.

The problems of irrigation in humid regions and the investigations in progress in this line were described and discussed by Professor Elwood Mead, of the Office of Experiment Stations; Professor E. B. Voorhees, director of the New Jersey Experiment Stations; F. H. Newell, of the U. S. Geological Survey and Professor H. J. Waters, director of the Missouri Experiment Station.

Papers on plant breeding were presented by Professor W. J. Stillman, of the Washington Agricultural Experiment Station, and Professor W. M. Hays, of the Minnesota Experiment Station. There was also a paper on the artificial plant food requirements of different soils and the methods employed in fertilizer experiments, by Doctor B. W. Kilgore, director of the North Carolina Experiment Station.

In the report of the section on horticulture and botany the marked strengthening of advanced courses in these subjects in colleges was pointed out. The demand for especially qualified men in horticulture was stated to be greater than the supply. There has recently been rapid progress in bacterial and physiological investigations and special studies on the selection and breeding of plants. At the meeting of the

section there was an earnest discussion of the relations of instruction and research in horticulture in the agricultural colleges, called forth by a paper by Professor E. S. Goff, of the University of Wisconsin. The question of cooperation between the farmer and the experiment station, and the best methods of such cooperation, were also much discussed on the basis of the paper by J. Craig, of the New York Cornell Experiment Station. Other papers were also read in this section on observations concerning the first and second generations of plants, by Professor B. D. Halsted, of the New Jersey Agricultural Experiment Stations; on the effect of light and heat on the germination of Kentucky blue grass, and on the quality of some commercial samples of grass and clover seed, by E. Brown of the Bureau of Plant Industry.

Professor L. C. Corbett, of this Bureau, described the experimental farm of the Department of Agriculture which is being established on a part of the Arlington estate near Washington. It is intended to plant on this farm extensive collections of varieties of fruits in order to have authentically named specimens for comparative studies; cultural experiments with fruits and crops, and phenological investigations are also to be undertaken there. Mr. F. D. Gardner, of the Office of Experiment Stations, who is in charge of the newly established experiment station at Porto Rico, made an interesting exhibition of fruits which he had brought from that island; and H. J. Webber, of the Bureau of Plant Industry, exhibited specimens of cowpeas which are believed to be resistant to the attacks of nematodes.

In this connection it may be well to state that a newly organized society of official horticultural inspectors for the United States and Canada held its sessions in Washington, November 11 to 13. Representatives from fifteen States were present.

Professor S. A. Forbes, of the University of Illinois, presided. With regard to the limits of time within which nurseries may be inspected, it was found impossible to determine upon any definite period for all States, since the local conditions, requirements of State law, and other demands of State inspectors rendered uniformity in this matter impossible. In a discussion of the nursery pests which are to be regarded as dangerous enough to influence the granting of a certificate those mentioned by different inspectors as of chief importance included the crown gall, peach yellows, pear blight, San Jose scale, woolly aphid and sinuate pear borer. In a discussion of the question of the best insecticide for orchards infested with San Jose scale, the fact was brought out that the results of experiments with kerosene, crude petroleum and mechanical combinations of both these substances with water were not uniform in different States. Resolutions were passed to the effect that the time of inspection should be left to the discretion of the inspector of each State; that the certificate should not extend beyond the time of the beginning of the breeding period of the San Jose scale for the next year; that one form of certificate should be issued as a rule, which should be so worded that the stock could be sold after objectionable stock had been treated, as suggested by the inspector; and that in States which required inspection of nursery stock the expenses of inspection should be borne by the State.

The report of the section on entomology presented by Professor M. V. Slingerland, of the Cornell University Experiment Station, reviewed the progress of entomology during the past year, especially as regards instruction, investigation and inspection. At the meeting of the section the following papers were read: 'A Year's Experience with Crude Petroleum in New Jersey,' by Professor J. B. Smith, of the New Jersey

Experiment Stations; 'Some of the most Important Insects in Massachusetts,' by Professor H. T. Fernald, of the Massachusetts Hatch Experiment Station; 'The Time of Emergence and Oviposition of the Spring Brood of the Hessian Fly,' by H. Garman, of the Kentucky Experiment Station; 'Life History of the Sugar Cane Borer in Louisiana,' by Professor H. A. Morgan, of the Louisiana Experiment Stations; 'Florida Observations and Experimental Work,' by H. A. Gossard, of the Experiment Station of Florida; 'Apple Aphids,' by E. D. Sanderson; 'A Folding Fumigator,' by F. A. Sirrine, of the New York State Experiment Station.

The report of the section on mechanic arts was presented by Professor H. W. Tyler, of the Boston School of Technology. This gave at some length the progress of instruction in mechanic arts during the year.

A reception tendered to the Association by the Secretary of Agriculture and Miss Wilson was numerously attended by the delegates and their ladies, and was thoroughly enjoyed by all who participated in it.

The following officers of the Association for the ensuing year were elected:

President, W. M. Liggett, of the College of Agriculture of the University of Minnesota; Vice-Presidents, W. O. Thompson, of the Ohio State University; H. J. Waters, of the University of Missouri; J. H. Washburn, of the Rhode Island College of Agriculture and Mechanic Arts; J. H. Worst, of the North Dakota Agricultural College; and J. C. Hardy, of the Mississippi Agricultural and Mechanical College; Secretary-Treasurer, E. B. Voorhees, of the New Jersey Experiment Stations; Bibliographer, A. C. True, of the Department of Agriculture; Executive Committee, G. W. Atherton, of the Pennsylvania State College; H. H. Goodell, of the Massachusetts Agricultural College; Alexis Cope, of the Univer-

sity of Ohio, and H. C. White, of the Georgia State College of Agriculture and Mechanic Arts.

Officers of sections: College Work, J. L. Snyder, of the Michigan Agricultural College, chairman; W. E. Stone, of Purdue University, Indiana, secretary; Agriculture and Chemistry, H. J. Waters, of the University of Missouri, chairman; C. G. Hopkins, of the University of Illinois, secretary; Horticulture and Botany, J. Craig, of the New York Cornell University, chairman; A. Nelson, of the University of Wyoming, secretary; Entomology, F. M. Webster, of the Ohio Experiment Station, chairman; H. E. Summers, of Iowa State College, secretary; Mechanic Arts, H. W. Tyler, of Massachusetts Institute of Technology, chairman; F. A. Anderson, of the Kentucky Agricultural and Mechanical College, Secretary.

A. C. TRUE.

MARCEL NENCKI.

By the death, on October 14, of Professor Marcel Nencki, director of the Laboratory of Physiological Chemistry in the Institute of Experimental Medicine at St. Petersburg, physiological chemistry has lost one of its most active workers. Professor Nencki was born in Poland, January 15, 1847. After completing his medical studies at Berlin, he went to Berne in 1872, as assistant in the Pathological Institute of the Swiss University. At the same time he became Privatdocent in physiological chemistry; and his appointment to a chair in that subject, in 1877, was among the earliest recognitions which the science received as an independent field of study. In 1891 Professor Nencki went to St. Petersburg to take charge of one of the laboratories in the newly founded Institute, being succeeded at Berne by the late Professor Drechsel.

Of Professor Nencki's extensive contributions to organic chemistry, physiological chemistry and bacteriology, it will suffice

here to recall his investigations on the chemistry of putrefaction and on the chemical processes which take place in the intestine; his studies on the behavior of aromatic bodies in the animal organism; his thorough researches on the pigments of the blood and on animal pigments in general; the investigation of the formation of ammonia and urea in mammals; and his last published paper (with N. Sieber) on the chemical composition of enzymes. In 1897, on the twenty-fifth anniversary of the beginning of his scientific activity, there appeared a volume entitled 'Sommaire des travaux accomplis par M. le professeur M. Nencki et ses élèves dans ses laboratoires à Berne et à St. Petersburg.' 1869-1896. In recent years he has collaborated with Professor Andreasch in editing Maly's 'Jahresbericht über die Fortschritte der Thierchemie.' Although interrupted thus early, the work of a lifetime earnestly devoted to the pursuit of scientific truth has left many records of permanent value.

L. B. M.

SCIENTIFIC LITERATURE.

Studien über den Körperbau der Anneliden, V.

By EDUARD MEYER. Translated from the original Russian. In Mittheilungen aus der Zoologischen Station zu Neapel, XIV., 3, 4, 1901. Pp. 338, 6 double plates.

Of the many attempts that have been made to explain the historical origin of the mesoblast and cœlome in higher animals, none is of greater interest than that of Professor Eduard Meyer, of the University of Kasan, whose views find their latest and fullest development in the present masterly paper, the product of many years of painstaking research by an uncommonly clear-sighted observer. All students of embryology are familiar with Hatschek's pregnant suggestion, made in 1877, that the mesoblastic pole-cells, characteristic of annelidan and molluscan development, were originally germ-cells, and that the cœlome of the annelids shows essentially the same relations as the gonad-cavities of the platodes. Accepting this sugges-

tion, R. S. Bergh, in 1885, maintained that the segmented cœlome of annelids is homologous with the cavities of the gonad-follicles of platodes and nemertines, and that the primitive function of the peritoneal epithelium of annelids was that of a germinal epithelium. The same conclusion was independently reached by Meyer and developed by him in 1890, as a sequel to his embryological studies on *Psygmobranchus*, into a general theory, of which the essential points are that the mesoblast-bands (developed from the pole-cells) of annelids are homologous, as a whole, with the paired gonads of the platodes; that by a change of function many of the primitive germ-cells gave rise to somatic mesoblastic elements; that by this process a 'secondary mesoblast' arose; and that lastly, by a partial process of substitution, the secondary mesoblast, in a greater or less degree, took the place of the primary mesoblast of the platode, which, however, still appears in the ontogeny as the 'larval mesenchyme' and some other structures. These last assumptions were not mere guesses, but were based on careful observations which showed that in at least one larval annelid (*Psygmobranchus*) there are two entirely distinct sources of mesoblast, namely, a 'primary mesenchyme' derived from the ectoblast, and a 'secondary mesoblast' derived from the pole-cells, and forming the 'mesoblast bands' in the ordinary sense. The former gives rise to the larval muscles, some of which are only temporary or provisional structures (including the protrochal ring-muscle), and to some of the adult muscles, including those of the gut, of the dissepiments, and the circular muscles of the body-wall. The latter gives rise to the peritoneal epithelium, the gonads, and the longitudinal muscles of the adult. These results were supported by the independent observations of Bergh and Vejdovsky, showing that in leeches and earthworms also the circular muscles are of wholly different origin from the longitudinal ones, the latter alone arising from the mesoblast pole-cells.

In the present paper Meyer reenforces his position by a great number of new observations on many different annelids, of which the most thoroughly studied were *Polygordius* and *Lopadorhynchus*. Although both these forms had

already become classical objects through the earlier work of Hatschek, Fraipont, Kleinenberg and others, Meyer brings forward an almost bewildering profusion of new results for both, which sustain and extend his earlier conclusions on *Psygmobranchus*. In both forms primary and secondary mesoblasts are wholly distinct in origin and in fate; in both, the mesoblast bands (secondary mesoblast) give rise only to the peritoneal epithelium, the gonads and the definitive longitudinal muscles of the body-wall; in both there are several regions in which mesoblast (primary mesenchyme) is independently derived from the ectoblast. From the primary mesenchyme are derived not only the provisional larval musculature, but also an important part of the definitive musculature, namely, that of the gut, of the parapodia and cephalic appendages, of the dissepiments, and the circular and diagonal muscles (when present) of the body-wall. Meyer thus shows that although a part of the larval musculature (for instance, the prototrochal ring-muscle) is undoubtedly of a provisional character, yet a much larger part of it is retained in the adult than has hitherto been supposed. This part is assumed to have been derived from the platode parenchyma, which has, as it were, been carried over into the annelid organization. Among many interesting special points may be mentioned the discovery of a *paratrochal* ring-nerve; and the demonstration, both in *Polygordius* and in *Lopadorhynchus*, of numerous true neuromuscular foundations—*i. e.*, areas in which nerve-cells and primary muscle-cells are proliferated from common ectoblast areas, but it is also shown with perfect clearness that Kleinenberg was in error in maintaining the origin of the secondary mesoblast-bands and the ventral nerve-cords from such a common neuromuscular foundation. Interesting detailed studies are given of the larval nervous system; Kleinenberg is shown to have been in error in deriving the germ-cells directly from the ectoblast; and the existence of Hatschek's famous nephridial 'Längscanäle' is again denied.

Fortified by these new facts, Meyer reasserts and further extends his original hypothesis, giving a thorough and critical review of the

literature and putting forward many ingenious suggestions regarding the possible phylogeny of the coelome, blood-vessels and musculature, the origin of metamerism, and other deep-lying morphological problems. Phylogenetic speculations on embryological data are getting out of fashion, and some of Meyer's conclusions will doubtless meet with little sympathy on the part of those whose interest in the historical problems of morphology has suffered a temporary attack of paralysis through devotion to more 'modern' questions. Even the sceptical reader, however, who will take the trouble to examine Meyer's work with care, will not be able to deny that the theoretical views are everywhere held closely in touch with admirably thorough and extended observation, and constitute no mere inflated speculative system, but a natural working hypothesis growing directly out of the facts.

In the present paper Meyer considers only the larval development; and his results form a most important supplement to that of students of cell-lineage, who have not, in general, carried their work to a sufficiently late period to determine the real relation of the germ-layers to the adult body. It may be pointed out, however, that the comparative study of cell-lineage in platodes, annelids and mollusks has steadily added weight to Meyer's original contention of a double origin of the 'mesoblast,' for it has shown that in the two higher groups a 'larval mesenchyme' is often formed from cells of the ectoblastic quartets, which are quite distinct from the pole-cells of the secondary mesoblast, the latter (with the apparent exception of *Capitella*) being always derived from a cell of the fourth quartet (otherwise entoblastic). The cell-ancestry of the larval mesenchyme thus agrees in a general way, though with interesting modifications of detail, with that of the mesenchyme (mesoblast) of polyclades, which inevitably and independently suggests the same view as that of Meyer, though from a quite different point of view.* Meyer's observations render it in the highest degree probable that, as the writer has suggested, mesen-

chyme may arise from any of the three ectoblastic quartets; for (not to mention the so-called 'head-kidneys' of *Nereis*), such origin has already been observed in the second and third, and if the cell-lineage of *Polygordius* and *Lopadorhynchus* is of the same type as in other annelids, as can hardly be doubted, the umbrellar neuro-muscular foundations in these forms must be derivatives of the first quartet.

The gonad theory of the coelome, which Meyer has done so much to advance, has made a deep impression on morphology, as may be seen, for instance, by reference to the admirable review of the theories of the coelome by Ray Lankester in the second volume of his 'Treatise on Zoology,' which appeared last year; and it has made serious inroads on the widely accepted enterocœle theory. Whether the two views can be reconciled is not to be determined without further research; for some of the most important observations on which Rabl, Lankester and others have relied in attempting to trace the transition from the pole-cell type to the enterocœle type (*e. g.*, pole-cells in *Amphioxus*, gut-pouches in *Paludina*) have been shown to be erroneous. Meyer believes the enterocœle type to be secondary; Lankester accepts the reverse view. Others have suggested the possibility that the two types have been distinct from the beginning, and this has for years been held open in the writer's advanced lectures on zoology and embryology as a possible basis for a division of the 'triblastic' animals into two parallel but independent series that diverged further down than the platodes—a division which, though entirely provisional, and as yet without adequate basis, nevertheless brings into order a surprisingly large number of facts otherwise difficult to reconcile. This is a question for the future, and may be left with Lankester's significant remark, that "When the cell-lineage of mesenchyme and its tissue-products has been cleared up we may be able finally to put aside the hasty criticisms and phantastic assertions of those who have grown impatient over the slow and difficult task of cellular embryology."

EDMUND B. WILSON.

* Cf. Wilson, 'Considerations on Cell-lineage and Ancestral Reminiscence,' in *Annals N. Y. Academy of Sciences*, XI., 1, 1898.

Publications of the University of Pennsylvania, Astronomical Series. Volume I., Part III.

The work before us is Part III., of the publi-

cations begun by the University of Pennsylvania for the new Flower Observatory, which was formally inaugurated with a public address by Professor Simon Newcomb in November, 1897. The Flower Observatory is widely known among astronomers as a new institution managed on a solid conservative basis, by a gifted and devoted staff of untiring workers. Though it has been in operation but a few years, it has already taken its place among the leading observatories of the country. It is distinguished by the care and accuracy of all its work rather than by the quantity of material turned out; and for that reason it has from the start taken rank with the best of modern observatories. The care and painstaking accuracy which characterized Professor C. L. Doolittle's work at the Sayre Observatory in Bethlehem, Pa., was at once recognizable in the spirit of the new institution under his direction at Philadelphia; and the results are now becoming apparent in the first volume of the 'Publications.'

Part II. of this volume appeared more than a year ago, and dealt in a characteristically thorough manner with the variations of latitude observed at Philadelphia, and with several determinations of the constant of aberration incidentally made in connection with the latitude work. This constant came out somewhat larger than the value which had generally been used by astronomers. The value found by Struve and Peters at Poulkova was $20''.44$, and for many years this was accepted as standard; but recent investigations by several authorities tend to increase the figure to about $20''.55$, which is the value found by Professor Asaph Hall, Jr., at the Detroit Observatory of the University of Michigan. Professor C. L. Doolittle's several determinations confirm this larger value; and on account of the care and precautions exercised in the work, there is little doubt in the minds of conservative astronomers that this new figure is much nearer the truth than that adopted in the nautical almanacs.

Part III. of Volume I. of the New Publications is devoted to the measures of 900 double and multiple stars made with the 18-inch Brashear refractor of the Flower Observatory, by Professor Eric Doolittle, son of the director

of the Observatory. This part consists of 146 large quarto pages of closely set matter, all beautifully and conveniently arranged. There is no defect in the conception or execution of the work, and it is not too much to say that this publication may be taken as a model for astronomers generally.

A concise introduction of eight pages deals with the constants of the equatorial, and with the micrometer employed in the measures. The latter is an ordinary filar micrometer, with the Burnham illumination. Its simplicity enabled the observer to center his whole attention on the work, and the result is a handsome volume of measures on 900 double and multiple stars, all made within the past four years. The stars are chosen mostly from the lists of Burnham, with occasional selections from the Struves and Dewbowski, and such modern observers as Hough and See. They represent in all cases objects requiring measurements. Though no special search was made for new double stars, a list of 22 such objects found in the prosecution of the regular work is given on page 8; all of them being close or interesting pairs which should receive the attention of future observers. The 900 stars measured are arranged in order of right ascension, with places referred to the epoch 1880.0. Their magnitudes and the several designations used by astronomers are clearly and accurately given in each case. The measures are nicely reduced and annual means are formed, according to the classic models of the Struves, Dewbowski and Burnham. The notes accompanying the measures are brief and to the point; no important matter is overlooked, and yet nothing superfluous is ever added. The total number of complete observations is about 3,700, representing something like 44,000 settings of the micrometer.

It should be pointed out that all these observations were taken and reduced by Professor Eric Doolittle alone, in addition to his teaching duties at the University, where he conducts advanced courses of instruction in celestial mechanics. In conclusion it may be noticed that publications dealing with the measurement of double stars are not merely of contemporary interest, but increase in value with time. Thus the work of the Herschels, the Struves and

Dewbowski are immensely more valuable now than when they were made many years ago, by reason of changes in the sidereal heavens which have since intervened; and all precise work such as that now being done at the Flower Observatory is assured of a lasting and honorable place in the history of science. Scientific research prosecuted for its own sake is among the most noble of intellectual pursuits, and the University of Pennsylvania is much to be congratulated on the distinguished place it is acquiring in the astronomical world.

T. J. J. SEE.

WASHINGTON, D. C.

A History of the Precious Metals from the Earliest Times to the Present Day. By ALEX. DEL MAR. Second edition, revised. New York, Cambridge Encyclopedia Co. 1902. 8vo. Illustrated. Pp. xxii + 480, 1-9.

The first edition of this remarkable work was published at London in 1880 and has long since been exhausted; meanwhile the author, in his profession of mining engineer, has visited many remote sources of the precious metals and has secured at first hand new material which has caused the volume to be entirely rewritten. This history is prepared by a profound student, from the point of view of the antiquarian, the archeologist and of the metallurgist, as well as the political economist, and deals with the exploration of the entire surface of the globe for gold and silver from the earliest record of mankind to the present day; copper, tin and the other heavy metals are only incidentally treated. The author is particularly well qualified for this vast undertaking, having already published several serious studies on money, its history, its science and its bearing on the progress of civilization, and having held positions of authority under the United States government, Director of the United States Bureau of Statistics, Mining Commissioner, and member of the International Congresses which met at Turin and at St. Petersburg. He is now engaged on 'The Romance of the Precious Metals' and 'The Politics of Money,' both of which are well advanced.

Mr. Del Mar maintains that the principal motive which has led to the dominion of the earth

by civilized races is the desire for the precious metals, rather than geographical research or military conquest; that the occurrence of gold has invited commerce, and the latter has been followed by invasion and eventually permanent occupation. With these facts in mind he portrays the stupendous power exerted by the quest for the precious metals from the beginnings of history in India, Persia, Egypt, Greece, Italy, Spain and the Western Hemisphere. He depicts very vividly the painful ways in which each gold-producing country has been mercilessly plundered by more powerful neighbors, saying that 'mining is slow work compared with plundering.' He also shows elsewhere that mining is generally more expensive than plundering, except where forced labor and slavery is employed. And to illustrate the latter point he claims that 'since the discovery of America the European world has acquired 19,500 and odd millions of dollars, of which 1,000 millions were obtained by conquest, 9,500 millions by slavery and 9,000 millions chiefly by free mining labor.'

Recognizing these sources of the precious metals he is decidedly opposed to the dictum of certain philosophers that the value of gold is its 'cost of production,' and says this formula does not take into account the 'millions of human lives, the rivers of human tears, the oceans of human blood, the immeasurable amount of human anguish.'

This aspect of the case is set forth in powerfully written chapters on the plunder of America (by the Spaniards), of Africa (from the Roman Emperors to South African War), of Asia (by the Romans, Portuguese and the British), and of China in all ages; chapters showing great historical research and learning. The author's arraignment of Spain is particularly interesting at this epoch: "Besides despoiling aboriginal America of her gold and silver, Spain accomplished nothing in the New World except extermination and destruction. She swept away half as many human lives as all Europe contained at the period of the discovery of America. She destroyed every memorial of the Aztec and Peruvian civilizations. She disfigured the entire face of Central and South America. And she planted nothing

in the place of what she destroyed save a race laden with disadvantages and a few mission churches crumbling to decay. The spoil she obtained amounted altogether to some seven thousand millions of dollars." And all this cost the conquerors practically nothing in comparison. And here again the author remarks, "the value of these precious metals is *not* due to the cost of production, but to their usefulness and their quality, to the relation of supply to demand."

It is gratifying to note that Christian civilization now adopts different methods and "the acquisition of the precious metals by means of conquest is virtually over."

The volume is so crowded with facts, as well as with the results of thought and argument, that no ordinary book review can do the author justice; in the words of those who reviewed the first (incomplete) edition, it 'abounds with vivid description and practical knowledge; it is replete with information, and evinces much care and study; it is able and exhaustive; of the highest scientific value, yet readable as a novel.'

In the chapter on 'Production, Consumption and Stocks of Metal' the author does not conceal his poor opinion of the 'defective and misleading statistics of the Mint Bureau,' supported in its methods by Congress, and reflecting 'the narrow views of the Mint Director.' Valuable features are the chronological summaries, the bibliography (with press marks of the British Museum Library) and the index. The volume is clearly printed on good paper, probably in England, as we observe the words 'honour,' 'labour' and 'negros,' instead of the more familiar 'negroes.' There are two illustrations, a mining scene in California and a portrait of General Nelson A. Miles, who is casually mentioned in the text.

The volume is of the highest value.

HENRY CARRINGTON BOLTON.

SOCIETIES AND ACADEMIES.

CALENDAR.

The American Association for the Advancement of Science. A meeting of the council will be held at the Quadrangle Club, University of Chicago, on the afternoon of January 1. Sec-

tion H (Anthropology) will meet at the Field Columbian Museum, Chicago, on December 31 and January 1. The next regular meeting of the Association will be held at Pittsburgh, Pa., from June 28 to July 3. A winter meeting is planned to be held at Washington, during the convocation week of 1902-3.

The American Society of Naturalists will hold its annual meeting at the University of Chicago on December 31 and January 1. In conjunction with it will meet the Naturalists of the Central States and several affiliated societies, including The American Morphological Society, The American Physiological Society, December 30 and 31, The American Psychological Association and the Western Philosophical Association, December 31 and January 1 and 2.

PHILOSOPHICAL SOCIETY OF WASHINGTON.

THE 538th meeting was held October 12, 1901.

An obituary notice of Mr. C. A. Schott, for many years chief of the computing division of the Coast and Geodetic Survey, was read by Superintendent O. H. Tittmann; and Mr. R. A. Fessenden presented, through Mr. Winston, a paper on 'Progress in Practical and Theoretical Electricity' giving a rapid sketch of the condition of all the great branches of electricity.

The 539th meeting was held October 26, 1901.

Mr. Marcus Baker described 'A Dictionary of Alaskan Names,' now in press, to be published by the U. S. Geological Survey, pointing out its characteristics and the principles on which it is made. It will contain about 6,500 adopted names, 3,000 obsolete names and cross-references and 60 pages devoted to a catalogue of authorities with brief accounts of the explorers. Dr. Dall spoke appreciatively of the work.

Mr. C. H. Hinton, of the Nautical Almanac Office, then read by invitation a paper on 'A Fourth Dimension in Space demanded by Electrical Phenomena.' The paper cannot be summarized, but may be characterized as an attempt to apply to 4-space some principles of quaternions developed for 3-space.

The 540th regular meeting was held November 9, 1901, Vice-President Adler in the chair.

Mr. Hinton continued the presentation of his

views begun at the last meeting on an explanation of electrical phenomena by a fourth dimension in space.

Dr. G. M. Sternberg, Surgeon-general of the Army, reported on 'Health Conditions in the Philippines.' He finds that the health of the troops has been constantly improving; small-pox is practically stamped out; typhoid and malarial fevers and heat strokes are almost unknown. Dysentery is one of the most serious troubles; so at most barracks distilled or sterilized water is supplied. In the discussion that followed Dr. Dall called attention to the absence of malaria in Alaska, although mosquitoes of several species are very abundant.

Dr. Adler reported on the progress of the 'International Catalogue of Scientific Literature.' After conferences for several years, definite plans were settled on during the past summer. Owing to the failure of Congress to take action, the United States was not officially represented, but Mr. Herbert Putnam, Librarian of Congress, was in London and had some share in the negotiations. The plan adopted requires each country to index and classify the literature published within its borders pertaining to 17 branches of science, beginning with 1901; the Smithsonian Institution has temporarily undertaken this work for the United States. The material is then to be arranged and published by the Royal Society in 17 volumes annually; these will be sold separately. About 320 sets have been subscribed for, for 5 years, at £1 per volume; 65 sets are to come to the United States. The speaker described some of the difficulties met with in formulating the plans, gave various details regarding the work, and exhibited the schemes of minute classification to be followed by the indexers.

CHARLES K. WEAD,
Secretary.

BIOLOGICAL SOCIETY OF WASHINGTON.

THE 343d meeting was held on Saturday evening, November 16.

C. P. Hartley exhibited some malformed ears of corn, stating that their interest lay in the fact that they had been grown from seed taken from an ear similarly abnormal, the malformation having been reproduced.

H. E. Van Deman showed a specimen of the ripe fruit of the guava from Florida, and made some remarks on the extent to which this fruit was now being cultivated.

L. O. Howard announced that he had received a letter from Mr. C. L. Marlatt, announcing the discovery of the long-sought original habitat of the San José scale insect; this was found to be in China, in the region to the south of the Great Wall. The scale insect was preyed upon by a species of ladybird beetle, living examples of which were now on their way to the United States.

H. G. Dyar presented some 'Notes on Mosquito Larvæ,' being a summary of investigations made during the past summer and including the following species: *Anopheles crucians*, *punctipennis*, *maculipennis*; *Culex sollicitans*, *territans*, *pungens*, *confinis*, *canadensis*, *sylvestris*; *Stegomyia fasciata*; *Aedes smithii*; *Uranotænia sapphirina*; and *Psorophora ciliata*. The habits and habitats of these various larvæ were described, and it was pointed out that there was great diversity in the latter. Some species preferred clear water, others infested turbid pools, and still others were found in brackish water. The speaker showed drawings of the different larvæ and drew attention to their peculiarities and their distinctive specific characters. It was noted that a species of fresh-water hydroid was seen to feed on mosquito larvæ, while on the other hand one species of larvæ fed on bacteria and another fed on other larvæ.

C. B. Simpson gave some 'Observations on Jack Rabbits,' telling of their rapid increase in parts of the west and describing their runways among the sage brush and the manner in which they were hunted by their great enemies the coyotes.

Vernon Bailey described 'The Little Deer of the Chisos Mountains, Texas,' stating that the same species, *Odocoileus couesi*, was also found in Mexico, Arizona and New Mexico, so that their occurrence in this locality was an extension of their known range. Owing to the distance of the Chisos Mountains from the railroad and the unfitness of the country for grazing purposes, the deer were still to be found there in considerable numbers. The speaker said that an adult buck would weigh only one hun-

dred pounds, and a doe much less, and pointed out the differences between the color of the summer coats of this and the large white-tailed deer of Texas, *Odocoileus texensis*.

Barton W. Evermann spoke of 'Birds in the Dry Season,' stating that few realized how important to birds was a supply of water, nor the influence of drouth on the distribution of birds. During an unusually dry summer the California quails did not breed, but kept together in flocks as they did during the fall. The speaker gave a list of eighteen species of birds that were seen to resort to a single leaking water spigot and described the manner in which various species drank. In conclusion it was suggested that during dry seasons, or in arid regions, drinking places should be provided for the benefit of the birds.

F. A. LUCAS.

DISCUSSION AND CORRESPONDENCE.

METEOROLOGICAL OBSERVATIONS WITH KITES AT SEA.

TO THE EDITOR OF SCIENCE: On page 412 of SCIENCE I stated that meteorological observations were about to be attempted with kites flown from a transatlantic steamer. With the aid of my assistant, Mr. Sweetland, and through the courtesy of Captain McAuley, this was accomplished on board the Dominion steamship *Commonwealth*, which left Boston for Liverpool on August 28. During most of the voyage we were within an area of high barometric pressure that was drifting slowly southeastward and out of which light winds blew. Although these were insufficient to raise the kites, the ship's speed of 16 knots created a corresponding wind from an easterly direction that sufficed to lift the kites on five of the eight days occupied by the voyage to Queenstown. On one of the three unfavorable days, a following wind became too light on the ship for kite-flying, and on the two other days a fresh head wind, augmented by the forward motion of the ship, was so strong as to endanger the kites, but, had it been possible to alter the course of the vessel, a favorable resultant wind might have been produced every day. The maximum height attained was only about 2,000 feet, but with larger kites and longer wire this could have been greatly ex-

ceeded. Automatic records were obtained of barometric pressure, air temperature, relative humidity and wind velocity, which did not differ markedly from records obtained in somewhat analogous weather conditions over the land. The most striking feature was the rapid decrease of the temperature with increasing height in all but one of the flights. The fall of temperature was fastest in the first 300 feet, where it exceeded the adiabatic rate of 1° Fahrenheit in 183 feet, but in the last-mentioned flight the temperature rose 6° in 660 feet, and during the afternoon remained so much warmer than at sea-level. The relative humidity varied inversely with the temperature, the direction of the wind shifted aloft toward the right hand when facing it, and its velocity generally diminished with altitude. These are probably the first meteorological observations at a considerable height in mid-Atlantic, and have a special importance because they indicate that at sea high-level observations may be obtained with kites in all weather conditions, only excepting severe gales, provided the steamer from which the kites are flown can be so manœvered as to bring the wind to a suitable velocity.

As the basis of an appeal for the exploration of the atmosphere at sea, the records described were exhibited to the Geographical Section of the British Association at its Glasgow meeting, and the appointment of a committee, with a grant of money to undertake observations with kites in Great Britain, together with the interest manifested there and on the continent of Europe, encourages the hope that my project will be realized. The equipping of the English Antarctic vessel *Discovery* with meteorological kites, as mentioned on page 779 of SCIENCE, and a similar installation on the German Antarctic ship *Gauss*, are unlikely, for various reasons, to have yielded much data on their voyages across the equator. Although the United States has taken no part in this international undertaking, an opportunity is now offered, without material expense, danger or hardship, to cooperate in a study of the general atmospheric circulation, which is one of the objects of polar exploration. Indeed, for a naval vessel not actually engaged otherwise, the sounding of the atmosphere in the tropics, whereby the relation of the upper air

currents to the winds useful for navigation may be ascertained, would seem to be as legitimate a task as sounding the depths of the oceans and determining the currents and temperatures prevailing there. But if our Navy Department will not authorize this, a private expedition should be organized to investigate the questions mentioned in my letter to SCIENCE on 'A New Field for Kites in Meteorology.' Since then, Professor Hildebrandson, of Upsala, who is an eminent authority on the circulation of the atmosphere, writes me that a meteorologist on a steamship provided with kites, and also with small balloons to ascertain the drift of the upper winds when there are no clouds, by making atmospheric soundings between the area of high barometric pressure in the North Atlantic and the constant southeast trades south of the equator, and in this way investigating the temperature and flow of the so-called anti-trades, could solve in three months one of the most important problems in meteorology. If any of your readers will furnish the steamer required, I stand ready to carry out these investigations.

A. LAWRENCE ROTCH.

BLUE HILL METEOROLOGICAL OBSERVATORY, HYDE PARK, MASS.,
November 18, 1901.

PERMANENT SKIN DECORATION.

IF Mr. H. Newell Wardle* had referred to Mr. H. Ling Roth's great compilation, 'The Natives of Sarawak and British North Borneo,' he would have found the Bornean process of tattooing described and the implements figured. From actual experience I can assure Mr. Wardle that in Sarawak, at all events, the pattern is gently printed on the skin from a wooden block and the pigment is driven into the skin by means of an ordinary tattooing needle which is hit by a slender iron rod. This is the typical Tahitian 'tatu.' Examples of the apparatus employed will be found in the splendid Furness-Hose collection in the Free Museum of Science and Art in Philadelphia.

A. C. HADDON.

LIFTING HOT STONES.

TO THE EDITOR OF SCIENCE: In the late number of *Nature* Professor S. P. Langley calls

* SCIENCE, Vol. XIV., p. 776.

attention to an old Tahitian priest who walked in bare feet over the heated stones of a pit prepared for cooking. Mr. Andrew Lang calls attention also to the fact that this was a ceremonial performance, preparatory to the cooking.

The United States National Museum is in receipt of a letter from Lieutenant Campbell E. Babcock, U. S. A., stationed at Vancouver Barracks, Washington State, enclosing a communication from Chief Peter Wildsho, of the Cœur d'Alene Indians in Idaho. Peter in his simple way is telling how fifty years ago his ancestors cooked their food in basket pots by means of hot stones. At the close of the description is the following in Peter's own words: "An amazing little story is connected with this basket for cooking food with hot stones. The medicine-man was considered a very powerful being by his tribe. He could take away the life of a man at his word or cure a sick or dying person. His power depended on the wild beasts that are fierce and powerful, and he carried constantly around his body some parts of the animal, such as a piece of the tail." This man to show his power stripped himself and painted his body. While he was singing and dancing, accompanied by all the Indians, he went to the basket containing cold water and sang, and, while all were watching him in awe, he slowly took the red-hot stones in both hands and dropped them into the basket of cold water. The water was heated and not a blister or burn was to be seen on his hands.

O. T. MASON.

THE HITTORF JUBILEE.

THE Academy of Sciences at Berlin has issued the following terse summary of the life-work of the venerable Hittorf:

HERRN JOHANN FRIEDRICH HITTORF zum Fünfsigjährigen Doctorjubiläum am XXI. October MDCCCLXXXVI.*

HOCHGEEHRTER HERR COLLEGE!

Indem die Königliche Akademie der Wissenschaften Ihnen zu der Jubelfeier Ihrer Promotion herzliche Glückwünsche sendet, erinnert sie sich dankbar des hervorragenden Antheils Ihrer Arbeit an dem Fortschreiten Ihrer Wissenschaften, der Physik und der

* Usually known as Wilhelm Hittorf.

physikalischen Chemie, in den verflossenen fünfzig Jahren.

In Ihrer scharfsinnigen Untersuchung des Selen und des Phosphors wiesen Sie den Zusammenhang der Allotropie mit der von dem Körper aufgenommenen Wärmemenge nach. Sie stellten die physikalischen Eigenschaften der Substanz in den verschiedenen Zuständen, insbesondere bezüglich der Dampfspannung fest und fanden merkwürdige Beziehungen der Allotropie zu dem elektrischen Leitvermögen.

Die Hauptarbeit Ihrer früheren Forschung aber war auf die Elektrolyse der Lösungen gerichtet. Es ist schwer zu sagen, ob die Bewunderung, zu welcher diese Arbeiten zwingen, mehr der Exactheit und Ausdauer bei der Bestimmung der Ionenwanderung entspringt, einer der mühsamsten, jemals angestellten experimentellen Forschungen, deren Resultate durch spätere Arbeiten nur bestätigt und kaum erweitert worden sind, oder aber der Folgerichtigkeit und Stetigkeit Ihrer Anschauungen über die elektrolitischen Vorgänge. Durch Sie allein sind wir an die richtigen Vorstellungen gewöhnt worden, welchen Sie gegen den Widerspruch selbst hervorragender Physiker Geltung verschaffen mussten, und von denen Sie später die Freude erlebt haben, dass sie das Fundament für einen grossen Theil der neueren physikalischen Chemie geworden sind.

Von ähnlicher grundlegender Bedeutung war die andere grosse Arbeit Ihres Lebens, die Erforschung der Vorgänge bei der elektrischen Entladung in Gasen. Schon in der ersten Entwicklungszeit der Spectralanalyse hatten Sie sich mit PLÜCKER an der verdienstvollen Classification der Spectra betheiligt. Ihre späteren grossen Arbeiten umfassten die Gasentladung in der Hauptsache nach allen Seiten ihrer Gesetze.

Sie waren der Erste, welcher einen der merkwürdigsten Vorgänge in der Natur dessen Fruchtbarkeit für die Wissenschaft und in der letzten Zeit auch für das Leben noch nicht bis zum Ende abgesehen werden kann, die Kathoden-Entladung im luftverdünnten Raume, in seiner vollen Entwicklung zur Anschauung brachte. Sie zuerst stellten das Vacuum in der hierzu nothwendigen und später nicht übertroffenen Vollkommenheit her und beobachteten und beschrieben die Ausbreitung und die vielseitigen Wirkungen der Kathodenstrahlen in musterhafter Weise. Zugleich gelang es Ihnen, diese Vorgänge der elektrischen Messung zugänglich zu machen und nach der Seite der Stromvertheilung wie des Leitungswiderstandes zu verfolgen. Dabei ergab sich, dass die Elektrizitätsleitung der Gase ganz anderen Gesetzen folgt, als diejenige in Metallen oder Elektrolyten. Grosse Dienste leisteten bei dieser Forschung Ihre, für die damalige Zeit im grössten Stile aus-

geführten Stromerzeuger, mittels deren Sie die intermittirende Entladung durch eine solche ersetzen, deren continuirliche Beschaffenheit, entgegen der verbreiteten Meinung, durch sinnreiche Hilfsmittel von Ihnen nachgewiesen wurde. Auch an den neueren Aufschlüssen über die Natur des Leuchtens im allgemeinen haben Sie bei diesen Gelegenheiten einen verdienstvollen Antheil genommen.

Ihre Arbeit, hochgeehrter Herr College, bildet ein classisches Beispiel für die Erfolge, welche durch die Concentration der Forschung erreichbar sind. Die Wissenschaft wird Ihnen für alle Zeiten zu tiefem Dank verpflichtet sein.

DIE KÖNIGLICH PREUSSISCHE
AKADEMIE DER WISSENSCHAFTEN.

The committee having the matter in charge purpose additionally to celebrate the fiftieth anniversary of Hittorf's doctorate by presenting him with a bust or a similar testimonial of their appreciation.

CARL BARUS.

SHORTER ARTICLES.

FUSARIUM EQUINUM (NOV. SPEC.).

AN epidemic skin disease among horses has appeared on the Umatilla Indian Reservation, Pendleton, Oregon. There are upwards of six thousand horses on the reservation, and of these more than sixty per cent. are said to be affected. The disease manifests itself through severe itching and loss of hair over almost the entire body. The animals remain around the rubbing posts all day, and a number of them die from starvation.

An examination of samples of the skin forwarded to the Pathological Division of the Bureau of Animal Industry demonstrated the presence of *Sarcoptes equi*. These parasites, however, were not present in sufficient numbers to account for the almost complete alopecia, and a careful examination of some samples, almost denuded of hair, failed to show their presence.

Microscopic examination of sections of the skin, stained with borax blue, or after Gram, showed the presence of large half-moon, spindle- or sickle-shaped bodies, deeply stained, in the hair sacs and sebaceous glands.

By pulling out one or more of the remaining hairs, clipping off the root with sterile scissors,

and shaking these roots up in melted agar and plating there develops, at 37° C., in the course of a few days, from one to five circular colonies of a fungus which grows rapidly and assumes a salmon-pink color. Cover-glass preparations made from these colonies contain numerous sickle-shaped segmented spores, characteristic of *Fusarium*.

There are, according to Dr. Erwin F. Smith, about twenty-five known varieties of this fungus. Some are strict saprophytes, others are parasitic on grains and plants, and others are pathogenic to plants. No *Fusarium* has, however, been known to be pathogenic to animals. I would, therefore, pending the present investigation, which will require some time, propose the name *Fusarium equinum* nov. spec.

VICTOR A. NÖVGAARD.

WASHINGTON, D. C.,

Nov. 14, 1901.

RHIZOCTONIA AND THE POTATO.

ATTENTION has been called recently to the parasitic nature of *Rhizoctonia* on various plants in the United States by Dr. B. M. Dugger and Professor F. C. Stewart. Observations at the Colorado Experiment Station on the relation of this fungus to the potato have brought out some interesting facts. During the spring months sclerotia develop freely on tubers and young sprouts in sacks and bins. A few affected tubers in a sack or bin of clean tubers, under favorable conditions, will spread the disease and in a short time render the entire lot worthless for seed. Affected tubers used for seed transmit the disease to the young plants, and these in turn to the following crop of tubers. Under proper conditions the fungus attacks all parts of the potato plant and in all stages of growth, but it is most destructive to the softer tissues. The weaker plants are often killed before they reach the surface of the ground. Those which are able to withstand its earlier attacks are apt to suffer more or less injury from it later in the season.

Little potatoes are produced by the fungus injuring the tuber stems in such a manner as to prevent free transportation of plant food between the main stem and tubers, or by completely cutting off the tuber stem while the

tubers are small. When the tuber stem receives an injury sufficient to check the free transportation of plant food, the food accumulates above the injury and soon excites the buds on the tuber stem above this point into growth. These buds develop into tubers. The fungus may continue its work and in time kill back the tuber stem, or it may cut off this stem above the newly formed tubers. If the tuber stem is attacked just as it grows out of the main stem adventitious buds may push out on the main stem around the injured point. These usually develop into short-stemmed or stemless tubers, forming bunches of small tubers. If the roots are badly injured the food supply is reduced and the plant puts out weak tuber stems. These stems are easily cut off by the fungus and the plant usually sets few or no tubers. The food which it is able to take up is used mostly in top development. The leaves become thicker, have a tendency to crinkle and take on a yellowish tinge. When the roots are less severely injured but the free transportation of food to the subterranean stems is interfered with, excessive top development is produced, and the axillary buds may develop aerial potatoes.

Aerial potatoes may be produced artificially: (1) By ringing the stem; (2) by tying a line firmly around the growing stem; and (3) by removing the subterranean tubers as soon as formed.

Sclerotia are often found on the surface of the larger tubers. Apparently these sclerotia do no injury, but experiments show conclusively that scabbing and browning of tubers may be produced by this fungus.

The corrosive sublimate treatment is promising as a preventive of this disease.

F. M. ROLFS.

FORT COLLINS, COLO., Nov. 11, '01.

THE WORK OF THE 'ALBATROSS.'

STUDENTS of marine zoology will welcome the appearance of the brochure just issued by the U. S. Fish Commission, compiled by C. H. Townsend, and entitled, 'Dredging and Other Records of the Steamer *Albatross*, with Bibliography Relative to the Work of the Vessel.' This useful paper contains in condensed form

the records of the work of the *Albatross* for eighteen years, for this vessel has never been out of commission since she was turned over to the Fish Commission, all necessary repairs having been made during intervals between the various cruises. The Bering Sea controversy and the war with Spain interrupted the regular work of the vessel for several years, but with these exceptions she has been almost continuously engaged in investigating fisheries and fishing grounds, in deep-sea sounding and dredging, and in other branches of hydrographic work.

The dredging and trawling records run from 1883 to 1900 and include data of 1,786 hauls of the dredge and trawl, from depths of less than 100 fathoms down to the maximum of 4,173 fathoms, the deepest water in which a dredge has been used. Three charts, bearing the serial numbers of stations, show the extensive area covered by these operations.

The record of hydrographic soundings shows the date, latitude and longitude, depth and character of bottom, in 4,032 soundings, but as the figures have been used in various charts no map of these is given.

Then follow records of the surface and intermediate tow nets, miscellaneous records and records of serial temperatures. All these will not only aid in identifying the large collections placed in the hands of specialists or deposited in museums, but make intelligible many references contained in papers on the *Albatross* collections in which localities are referred to by the station number only.

The chronological bibliography relative to the work of the *Albatross* between 1884 and 1901 comprises 233 titles, and a list is appended of 63 papers now in course of preparation. Finally we are given a list of something like 2,000 new species, largely of deep-sea fishes and crustaceans, which have been described from specimens obtained by the *Albatross* and which give some idea of the amount of material secured. Those who are familiar with the magnificent volumes of the *Challenger* report may be surprised to learn that the zoological material on which they are based is in every way much less than that procured by the *Albatross*, but the *Challenger* material has had the advan-

tage of being systematically worked up and published in consecutive volumes, and in a manner to show it to the best advantage. The *Albatross* has probably obtained a hundred deep-sea fishes where the *Challenger* obtained one, a statement that may be illustrated by saying that a single haul of her trawl brought up many more specimens of *Macrurus* than were secured by the *Challenger* in her entire cruise. In a way this wealth of material has been truly an embarrassment of riches, for its accumulation, and particularly its care, have occupied the time of those who might otherwise have been engaged in its study; nevertheless, we can but hope that the scientific work of the *Albatross* may proceed in the future as it has in the past.

F. A. L.

RICHMOND MAYO-SMITH.

THE Council of Columbia University adopted the following resolution on the death of Professor Mayo-Smith:

The members of the University Council have learned with profound regret and unfeigned sorrow of the sudden death of their long-time friend and colleague, Professor Richmond Mayo-Smith, the chief of the Department of Political Economy in this University.

During his zealous, devoted and successful service of twenty-four years in this institution, he founded the department over which he has presided and developed it to so high a point of excellence that it has few equals in this country or in the world. He was, moreover, the chief promoter, if not the founder, of the science of statistics in this country. His published works upon this most difficult subject have brought exact and orderly knowledge into a domain where, before, uncertainty and confusion prevailed, and have earned for him honor and gratitude from the scientific world.

His activity went, however, beyond the limits of his own department. As a member of the University Council from the date of its establishment to the moment of his death, and of several of its most important committees, he contributed largely and ably to the formation of the policies of the University as a whole, and to the present organization of this complex institution.

To all this must be added the influence of his personality. His thorough scholarship and his great modesty, his unwavering truthfulness and sound judgment, with his genuine deference for the opinions of others, his dignity of character and kindness of heart, and his manliness united with his gentleness, all conspired to make him a great intellectual and moral force, a noble example of high thinking and of simple life, throughout all branches of the University and wherever he was known.

Speaking for themselves and for the bodies which they represent, the members of the Council desire to enter on the records of the Council this minute, expressing their appreciation of the great merit of their colleague and their sense of the great loss which they individually, and the University as a whole, have sustained in the death of Professor Richmond Mayo-Smith.

SCIENTIFIC NOTES AND NEWS.

SECTION H (Anthropology) of the American Association for the Advancement of Science will hold its winter meeting at the Field Columbian Museum, Chicago, on Tuesday and Wednesday, December 31 and January 1, 1901-2. Members of the section who wish to present papers will please inform the Secretary, Mr. George Grant MacCurdy, Yale University, New Haven, Conn. Hotel del Prado, Midway Plaisance, will be the headquarters of the Section.

THE completion of fifty years since M. Berthelot began the teaching of chemistry at the Collège de France was celebrated on November 24. Addresses were made by scientific and public men, and a gold medallion was presented by President Loubet.

ARRANGEMENTS have been made to present the eminent French surgeon, M. Odilon-Marc Lannelongue, with a gold medal in celebration of his scientific jubilee.

THE Royal Society's medals will this year be awarded as follows: The Copley Medal to Professor J. Willard Gibbs, Yale University, For. Mem. R.S., for his contributions to mathematical physics; a Royal Medal to Professor William Edward Ayton, F.R.S., for his contributions to electrical science; a Royal Medal to Dr. William Thomas Blanford, F.R.S., for

his work in connection with the geographical distribution of animals; the Davy Medal to Professor George Downing Liveing, F.R.S., for his contributions to spectroscopy; and the Sylvester Medal to Professor Henri Poincaré, For. Mem. R.S., for his contributions to mathematical science.

IN celebration of the hundred and fifteenth anniversary of its foundation, the Göttingen Academy of Sciences has made the following elections: Honorary members: Professors Abbe (Jena) and Neumayer (Hamburg); non-resident members: W. Waldeyer (Berlin), Gaston Darboux (Paris), W. Zittel (Munich) and J. Wislicenus (Leipzig); corresponding members: Aurelius Voss (Würzburg), Hugo Seeliger (Munich), Max Planck (Berlin), Karl Runge (Hanover), Arthur Schuster (Manchester), Swante Arrhenius (Stockholm), Giovanni Ciamician (Bologna), Emil Fischer (Berlin), Wilhelm Ostwald (Leipzig), Walther Spring (Liège), Hermann Minkowski (Zurich), Charles Barrois (Lille), Lazarus Fletcher (London), Michel Levy (Paris), Victor Uhlig (Vienna), Friedrich v. Recklinghausen (Strassburg), Karl Chun (Leipzig), Giov. Batt. Grassi (Rome), Herbert Ludwig (Bonn), Edmond Perrier (Paris).

DR. SMITH ELY JELLIFFE has been appointed visiting neurologist to the New York Hospital, the position having been made vacant by the resignation of Dr. Frederick Peterson, recently appointed Commissioner in Lunacy.

DR. TARLETON H. BEAN has been recommended by the Fish and Fisheries Committee of the St. Louis Exposition as chief of that department.

THE lectureship in connection with the California Philosophical Union for the current year has been offered to, and accepted by, Professor R. M. Wenley, of the University of Michigan.

DR. CHARLES HERTY, adjunct professor in chemistry at the University of Georgia, has resigned in order to accept a position in the United States Department of Agriculture.

DR. NICHOLAS SENN, professor of surgery in the Rush Medical College of the University of Chicago, has returned home from a tour of the world, which included a trip across Siberia, *via* the new Russian railroad.

MR. JOSEPH W. T. DUVEL, who is holding for the third time the Ferry Fellowship in botany at the University of Michigan, spent the summer and fall in Europe, inspecting the several botanical experiment stations. He is again carrying on research work on the conditions affecting the germination of seeds, in the botanical laboratory of the University of Michigan.

DR. WILLIAM R. HARPER, president of the University of Chicago, has accepted the directorship of the educational congresses to be held in connection with the World's Fair in St. Louis.

MR. JOHN HYDE has resigned the editorship-in-chief of the *National Geographic Magazine*, which he has held since 1895, with a view to devoting so much of his time as is not occupied with his exacting duties as statistician of the U. S. Department of Agriculture to work in a much-neglected branch of economic science.

DR. REMLINGER, director of the Antirabic Institute at Constantinople, has been appointed chief of the Imperial Bacteriological Institute, replacing Professor Nicolle. Dr. Remlinger will continue also to hold his former post.

MR. ALFRED L. JONES, the originator of the School of Tropical Medicine at Liverpool, has been made a Knight Commander of the Order of St. Michael and St. George.

MR. WILLIAM MARCONI left London on November 25, for Newfoundland, where he will select sites for the erection of stations for his system of wireless telegraphy.

THE Berlin Academy of Sciences has made an appropriation of 3,000 Marks to Dr. Blanco for a continuation of his geological investigations, and of 1,500 Marks to Professor Boveri for investigations on the fertilization and early development of the egg.

WE regret to announce the death of the eminent magnetist, Professor Max Eschenhagen, at the age of 43 years. He has been in charge of the Royal Prussian Magnetic Observatory since its establishment in 1899, and he took a very active part in the planning of the magnetic work of the German Antarctic expedition and in arranging the international work to be carried out simultaneously over the entire globe during the period of the expeditions. His contributions to terrestrial magnetism are numer-

ous, his skill exhibiting itself especially in the improvement of magnetic instruments and in the designing of new ones. His light, convenient, portable magnetographs will be extensively used in the international work.

THE death is announced at the age of 59 years of Mr. A. H. Smee, author of valuable contributions to chemistry and physiology. He was the principal medical adviser of the Gresham Life Assurance Society, and his statistical reports on rates of mortality are standard authorities.

THE archeological field work, conducted in central New Brunswick during the past summer by Mr. Samuel W. Kain, yielded good results, but owing to Mr. Kain's ill health the report will not be published for some time.

THE Imperial Academy of Sciences of Vienna has received, according to *Nature*, intelligence of the botanical expedition in Brazil, from its chief, Professor R. von Waldheim, down to September 10, from São Paulo. The rivers Rio Branco, Rio Mambu and Rio Aguapiby, flowing through an almost unexplored country, had been navigated in canoes; and large consignments have already been sent to Vienna in the form of living plants and roots, herbarium specimens, preparations in spirit, woods, fruits and economic products.

REUTER'S AGENCY reports from St. Petersburg that uneasiness is no longer felt regarding the fate of the scientific expedition under Lieutenant Kozloff, which was reported some time ago to have been massacred by a band of Tibetans, as news has been received stating that the expedition left Si-ning-fu, which is near Lake Kokonor, on September 12, for Fushar. The expedition was escorted by Chinese soldiers, and further news has been received from the Russian Consul at Chuguchak, who had been informed by local authorities that the party had passed through Jan-lan and Datum.

THE Royal Geographical Society of Antwerp announces an exposition to be opened in that city in May next. The object is to popularize geographical sciences, to make those countries recently opened to commercial activity better known, and to contribute to the development of the mercantile marine and of maritime enter-

prises. There will be a section devoted to ancient and modern maps and globes, surveying instruments, etc., which will comprise also meteorological and ocean-sounding apparatus. The committee proposes to assemble important ethnographical collections, in view of the interest taken in them by the public in regard to trans-oceanic enterprises. The participation of the Kongo Free State will largely contribute to the success of this section. Besides the colonial section, there will be a department devoted to everything relating to the progress of navigation. Models of ships and of great maritime works, improvements in the art of navigation, and trophies of voyages of exploration will be exhibited. It is desired to give to the exhibition an international character.

THE subject for the Speniaroff prize of the International Geological Congress for 1893 is a critical review of methods of classifying minerals. Two copies of the paper must be sent before the next congress to the secretary of the last congress, M. Charles Barrois, 62 Boulevard, Saint-Michel, Paris. The value of the prize is about \$225.

THE November meeting of the Faculty Science Club of Wellesley College was addressed by Professor Cummings of the department of botany, to whom the lichens of the Harriman Alaskan Expedition were sent for identification. She showed on the map the region covered by this and former collecting parties, and stated that among the thousand specimens put into her hands three new species had been found and 76 not before known in Alaska.

The Botanical Gazette states that the herbarium of Theodor von Heldreich, professor of botany and director of the Botanic Gardens, Athens, is for sale. It contains approximately 20,000 species, and richly represents the floras of Greece, Asia Minor and Egypt. It contains also hundreds of types and authentic specimens of new species, described by Heldreich in the works of Bossier.

BY the will of the late Mrs. Charles E. Balch, of Manchester, N. H., the Manchester Institute of Arts and Sciences of that city is a beneficiary to the extent of \$50,000, in securities and real estate to the value of about \$30,000. The will provides that the bequest is to be ap-

plied to the purposes of the Fine Arts section of the Institute.

A COLLECTION of butterflies, containing over 5,000 specimens, has been given to the Art Gallery of the Plainfield, N. J., Public Library by Mr. Alexander Gilbert.

THE National Educational Association will hold its next annual meeting in Indianapolis, beginning on July 7.

THE twenty-second annual exhibition of the New York Microscopical Society will be held on the evening of December 6, at the rooms of the Society in the Mott Memorial Building, 64 Madison Avenue. The exhibition will be open to the public, but cards of admission will be necessary. These will be sent to those who apply by letter to Dr. George W. Kosmak, 23 East Ninety-third Street.

THE Imperial Leopold Caroline Academy of Sciences at Halle will celebrate the one hundred and fiftieth anniversary of its foundation on January 1, 1902.

As the result of a meeting held at Frankfort, under the presidency of Professor Edinger and addressed by Professor Hagen, it was decided to establish in that city a branch of the German Anthropological Society.

It has been previously announced in these columns that the *Botanische Centralblatt* has become the property of the Association Internationale des Botanistes. Arrangements for its transfer to the Association have been completed, and it will be published at Leyden beginning January 1, 1902, under the direction of an editor-in-chief appointed by the Association. Arrangements have been made for the appointment of a board of special editors in England, America and France, and reviews will henceforth be published in English, French and German. Beginning with the first of January, 1902, the *Centralblatt* will be sent gratis to all members of the Association. The annual fee for members is 25 shillings. The number of representatives on the general committee of the Association to which any country is entitled depends on the number of members living in that country. The names of previous subscribers to the *Centralblatt* are of course known to the editors in cases where the subscriptions were taken in the

subscribers' own names, but where copies were ordered through book sellers or other agents the subscribers' names or even the countries in which they reside are not known. In order, therefore, that the editors may be enabled to know the exact number of members residing in this country and thus ascertain the number of representatives on the committee to which we are proportionally entitled, all desiring to join the Association who have not already registered as members should send their names at once to the Secretary, Dr. J. P. Lotsy, care of E. J. Brill, Leyden, Holland. Any person may join the Association, and institutions, such as colleges, libraries, etc., are eligible to membership and can, by joining the Association, receive the *Centralblatt* on the same terms as private individuals. The subscription price of the *Centralblatt* to non-members of the Association is 28 shillings.

THE United States Coast and Geodetic Survey will have on January 1, 1902, four magnetic observatories cooperating in the international magnetic work to begin on that date and to continue during the period of antarctic exploration, viz: one at Cheltenham, Md., near Washington, D. C., another at Baldwin near Lawrence, Kansas, a third at Sitka, Alaska, and a fourth near Honolulu, Hawaiian Islands.

THE Göttingen Academy of Sciences has decided to establish and maintain at its own expense, during the period of the special international magnetic work, a magnetic observatory near Apia, in the Samoan Islands. The observatory will be equipped for observations in terrestrial magnetism, atmospheric electricity, meteorology and seismology. This observatory will be nearly magnetically south of the Honolulu observatory and about the same distance south of the magnetic equator as the latter is north of it. The two observatories will likewise use practically the same instruments and methods, so that interesting and valuable contributions may be expected from them. Mr. A. Nippoldt, of the Potsdam Observatory, will be in charge of the Samoan Observatory.

UNIVERSITY AND EDUCATIONAL NEWS.

MR. F. A. SAMPSON, of Sedalia, Mo., has presented to the University of Missouri his library

of Missouriiana, a collection which is valued at \$25,000, and Professor Litton, formerly of Washington University, St. Louis, who died recently, bequeathed to the University a valuable collection of scientific apparatus and books.

THE sum of \$1,200 has been pledged with which to purchase books for an alcove in chemistry at Cornell College, Mount Vernon, Iowa.

It is stated in the New York *Evening Post* that it has been decided by the alumnae of Wellesley College to use certain funds in hand for an oil portrait of Helen A. Shafer, professor of mathematics in the college from 1877 to 1888, and president from 1888 to 1894, and for the purchase of books, models and other permanent equipment for the department of pure mathematics; and, in addition, to establish a fund of \$2,000 to be turned over to the trustees and invested by them as the Shafer Memorial Fund, the interest to be expended for the benefit of the above department.

THE trustees of Clark University, at Worcester, Mass., have voted to establish a collegiate department in accordance with the will of the late Jonas Clark. E. Harlow Russell, principal of the State Normal School at Worcester, has been selected for president of the department, which is to come into operation in October, 1902.

MR. REGINALD GORDON, instructor in physics in Columbia University, has resigned to enter a mercantile business. His place will be taken by H. C. Parker, now a tutor in physics, and Mr. Parker's tutorship will be filled by G. B. Pegram, now an assistant.

MR. H. O. JONES, Clare College, Cambridge, has been appointed Jacksonian demonstrator in chemistry in place of the late Mr. W. T. N. Spivey.

MR. H. S. DAVIS, graduate student in zoology at Harvard University, has been appointed instructor in vertebrate zoology at the Washington Agricultural Experiment Station, Pullman, Washington.

PROFESSOR PAUL KAUFMANN has resigned the chair of pathology in the University of Missouri.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

EDITORIAL COMMITTEE : S. NEWCOMB, Mathematics ; R. S. WOODWARD, Mechanics ; E. C. PICKERING Astronomy ; T. C. MENDENHALL, Physics ; R. H. THURSTON, Engineering ; IRA REMSEN, Chemistry ; CHARLES D. WALCOTT, Geology ; W. M. DAVIS, Physiography ; HENRY F. OSBORN, Paleontology ; W. K. BROOKS, C. HART MERRIAM, Zoology ; S. H. SCUDDER, Entomology ; C. E. BESSEY, N. L. BRITTON, Botany ; C. S. MINOT, Embryology, Histology ; H. P. BOWDITCH, Physiology ; J. S. BILLINGS, Hygiene ; WILLIAM H. WELCH, Pathology ; J. MCKEEN CATTELL, Psychology ; J. W. POWELL, Anthropology.

FRIDAY, DECEMBER 13, 1901.

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THE MEETING OF THE AMERICAN SOCIETY OF NATURALISTS IN CHICAGO DURING CONVOCATION WEEK.

For the first time in its history the American Society of Naturalists, together with various affiliated societies, will hold its annual meeting in Chicago as guests of the University of Chicago during the week beginning December 30. A cordial invitation has been extended to the several societies by the Naturalists of the Interior and there is every reason to anticipate a large and successful meeting. It is greatly to be desired that naturalists in the east shall make a special effort to attend this meeting, as it is not likely that meetings of the American Society of Naturalists will often be held at a point so distant from the coast.

The American Society of Naturalists of late years has become chiefly a nucleus around which various affiliated societies of a more or less technical character are gathered, and the functions of the parent society have been reduced, to put the matter epigrammatically, to a discussion and a dinner. Those who have watched its progress most carefully believe that this evolution has been natural and logical. The time has clearly gone by when specialists

can be expected to listen with patience or with profit to the technical discussions of other specialists. But at the same time, as all biologists, at least, must recognize, differentiation with its inherent drawbacks must be corrected by some sort of careful cooperation of dissimilars, and it would appear that here, as in the bodies of living organisms coordination, though perhaps less conspicuous than the work of the specialized parts, is even more important.

The 'discussion,' which has become one of the two important features of the work of the Naturalists, has in the past generally proved useful and interesting. The subject chosen for this year is in no wise inferior to those of earlier years, namely, 'The Relation of the American Society of Naturalists to other Scientific Societies,' and it is likely that the whole subject of convocation week, winter meetings *versus* summer meetings, the proper function of the American Association for the Advancement of Science, and similar subjects of vital importance to the organization of American science in the future, will be thoroughly threshed out.

Hardly less important than the discussion is the 'dinner,' at which all members of all the affiliated societies should have an opportunity of becoming acquainted. It is greatly to be hoped that the *ménu* this year will be made simple and short and the service prompt, in order to allow time afterwards for making acquaintances, 'talking shop,' comparing notes, and the like. By fortunate custom all ordinary after-dinner speaking has been done away with, and in its stead with the sole accom-

paniment of coffee and cigars the president's address is given. This perhaps should be accounted the third feature of importance of the meeting of the Naturalists, and it ought to be distinctly understood that the president's address should not deal with technicalities within his own specialty but with some large subject of general interest or importance, if possible, to all naturalists and men of science. We are glad to observe that the address of the President for the current year seems likely to be of this character, the topic announced being the 'Modern Subjection of Science and Education to Propaganda.'

There is a strong feeling on the part of many men of science in America that summer scientific meetings ought to be given up, or at all events subordinated to a great winter meeting. It is argued that it is too much to expect of anyone who is comfortably resting or working in the mountains or by the sea that he shall expose himself to the fatigues and depression of tropical railroading, and the sometimes blistering heat of cities, in order to read or listen to scientific papers. A wise adaptation to the environment—when we cannot modify it—is a fundamental law of life, and it is urged with much force that the rapid growth in favor of winter meetings is simply a natural and inevitable adaptation of this kind to the environment. As our readers know, a large majority of the leading American universities and colleges have, at the instance of the American Association for the Advancement of Science, decided to set aside for the meetings of scientific and learned societies the week in which the first of January

falls. The meetings at Chicago of the Council of the American Association for the Advancement of Science and of the American Society of Naturalists and affiliated societies consequently mark the establishment of convocation week. This fact alone should make the approaching meeting one of unusual importance, and we desire once more to urge upon all naturalists who can possibly do so, and especially those in the east, the duty as well as the privilege of attending the Chicago meeting.

*EXTRACTS FROM PRESIDENT ROOSEVELT'S
MESSAGE TO THE CONGRESS.*

A SECRETARY OF COMMERCE AND
INDUSTRIES.

THERE should be created a cabinet officer, to be known as secretary of commerce and industries, as provided in the bill introduced at the last session of the Congress. It should be his province to deal with commerce in its broadest sense, including among many other things whatever concerns labor and all matters affecting the great business corporations and our merchant marine. The course proposed is one phase of what should be a comprehensive and far-reaching scheme of constructive statesmanship for the purpose of broadening our markets, securing our business interests on a safe basis, and making firm our new position in the international industrial world; while scrupulously safeguarding the rights of wage-worker and capitalist, of investor and private citizen, so as to secure equity as between man and man in this republic.

THE PACIFIC CABLE.

I call your attention most earnestly to the crying need of the cable to Hawaii and the Philippines, to be continued from the Philippines to points in Asia. We should

not defer a day longer than necessary the construction of such a cable. It is demanded not merely for commercial but for political and military considerations. Either the Congress should immediately provide for the construction of a Government cable, or else an arrangement should be made by which like advantages to those accruing from a Government cable may be secured to the Government by contract with a private cable company.

THE ISTHMIAN CANAL TREATY.

No single great material work which remains to be undertaken on this continent is of such consequence to the American people as the building of a canal across the Isthmus connecting North and South America. Its importance to the nation is by no means limited merely to its material effects upon our business prosperity; and yet with a view to these effects alone it would be to the last degree important for us immediately to begin it. While its beneficial effects would perhaps be most marked upon the Pacific coast and the Gulf and south Atlantic States, it would also greatly benefit other sections. It is emphatically a work which it is for the interest of the entire country to begin and complete as soon as possible; it is one of those great works which only a great nation can undertake with prospects of success, and which, when done, are not only permanent assets in the nation's material interests, but standing monuments to its constructive ability.

THE SMITHSONIAN INSTITUTION.

The advancement of the highest interests of national science and learning and the custody of objects of art and of the valuable results of scientific expeditions conducted by the United States have been committed to the Smithsonian Institution. In furtherance of its declared purpose—for the 'increase and diffusion of knowledge

among men'—the Congress has from time to time given it other important functions. Such trusts have been executed by the institution with notable fidelity. There should be no halt in the work of the institution, in accordance with the plans which its secretary has presented, for the preservation of the vanishing races of great North American animals in the National Zoological Park. The urgent needs of the National Museum are recommended to the favorable consideration of the Congress.

THE LIBRARY OF CONGRESS.

Perhaps the most characteristic educational movement of the past fifty years is that which has created the modern public library and developed it into broad and active service. There are now over five thousand public libraries in the United States, the product of this period. In addition to accumulating material, they are also striving, by organization, by improvement in method and by cooperation, to give greater efficiency to the material they hold, to make it more widely useful, and by avoidance of unnecessary duplication in process to reduce the cost of its administration. In these efforts they naturally look for assistance to the Federal Library, which, though still the Library of Congress, and so entitled, is the one national library of the United States. Already the largest single collection of books on the Western Hemisphere, and certain to increase more rapidly than any other through purchase, exchange and the operation of the copyright law, this library has a unique opportunity to render to the libraries of this country—to American scholarship—service of the highest importance. It is housed in a building which is the largest and most magnificent yet erected for library uses. Resources are now being provided which will develop the collection properly, equip it with apparatus and ser-

vice necessary to its effective use, render its bibliographic work widely available, and enable it to become not merely a center of research, but the chief factor in great cooperative efforts for the diffusion of knowledge and the advancement of learning.

A PERMANENT CENSUS BUREAU.

For the sake of good administration, sound economy and the advancement of science, the Census Office as now constituted should be made a permanent Government bureau. This would insure better, cheaper and more satisfactory work, in the interest not only of our business, but of statistic, economic and social science.

THE DEPARTMENT OF AGRICULTURE, FORESTRY AND IRRIGATION.

The Department of Agriculture during the past fifteen years has steadily broadened its work on economic lines, and has accomplished results of real value in upbuilding domestic and foreign trade. It has gone into new fields until it is now in touch with all sections of our country and with two of the island groups that have lately come under our jurisdiction, whose people must look to agriculture as a livelihood. It is searching the world for grains, grasses, fruits and vegetables specially fitted for introduction into localities in the several states and territories where they may add materially to our resources. By scientific attention to soil survey and possible new crops, to breeding of new varieties of plants, to experimental shipments, to animal industry and applied chemistry, very practical aid has been given our farming and stock-growing interests. The products of the farm have taken an unprecedented place in our export trade during the year that has just closed.

Public opinion throughout the United States has moved steadily toward a just appreciation of the value of forests, whether

planted or of natural growth. The great part played by them in the creation and maintenance of the national wealth is now more fully realized than ever before. Wise forest protection does not mean the withdrawal of forest resources, whether of wood, water or grass, from contributing their full share to the welfare of the people, but, on the contrary, gives the assurance of larger and more certain supplies. The fundamental idea of forestry is the perpetuation of forests by use. Forest protection is not an end of itself; it is a means to increase and sustain the resources of our country and the industries which depend upon them. The preservation of our forests is an imperative business necessity. We have come to see clearly that whatever destroys the forest, except to make way for agriculture, threatens our well-being.

The practical usefulness of the national forest reserves to the mining, grazing, irrigation and other interests of the regions in which the reserves lie has led to a widespread demand by the people of the West for their protection and extension. The forest reserves will inevitably be of still greater use in the future than in the past. Additions should be made to them whenever practicable, and their usefulness should be increased by a thoroughly businesslike management. At present the protection of the forest reserves rests with the General Land Office, the mapping and description of their timber with the United State Geological Survey, and the preparation of plans for their conservative use with the Bureau of Forestry, which is also charged with the general advancement of practical forestry in the United States. These various functions should be united in the Bureau of Forestry, to which they properly belong. The present diffusion of responsibility is bad from every standpoint. It prevents that effective cooperation between the Government and the men who utilize the resources

of the reserves without which the interests of both must suffer. The scientific bureaus generally should be put under the Department of Agriculture. The President should have by law the power of transferring lands for use as forest reserves to the Department of Agriculture. He already has such power in the case of lands needed by the Departments of War and the Navy.

The wise administration of the forest reserves will be not less helpful to the interests which depend on water than to those which depend on wood and grass. The water supply itself depends upon the forest. In the arid region it is water, not land, which measures production. The western half of the United States would sustain a population greater than that of the whole country to-day if the waters that now run to waste were saved and used for irrigation. The forest and water problems are perhaps the most vital internal questions of the United States.

Certain of the forest reserves should also be made preserves for the wild forest creatures. All the reserves should be better protected from fires. Many of them need special protection because of the great injury done by live stock, above all by sheep. The increase in deer, elk and other animals in the Yellowstone Park shows what may be expected when other mountain forests are properly protected by law and properly guarded. Some of these areas have been so denuded of surface vegetation by overgrazing that the ground breeding birds, including grouse and quail, and many mammals, including deer, have been exterminated or driven away. At the same time the water-storing capacity of the surface has been decreased or destroyed, thus promoting floods in times of rain and diminishing the flow of streams between rains.

In cases where natural conditions have been restored for a few years, vegetation

has again carpeted the ground, birds and deer are coming back, and hundreds of persons, especially from the immediate neighborhood, come each summer to enjoy the privilege of camping. Some at least of the forest reserves should afford perpetual protection to the native fauna and flora, safe havens of refuge to our rapidly diminishing wild animals of the larger kinds, and free camping grounds for the ever-increasing numbers of men and women who have learned to find rest, health and recreation in the splendid forests and flower-clad meadows of our mountains. The forest reserves should be set apart forever for the use and benefit of our people as a whole, and not sacrificed to the short-sighted greed of a few.

The forests are natural reservoirs. By restraining the streams in flood and replenishing them in drought they make possible the use of waters otherwise wasted. They prevent the soil from washing, and so protect the storage reservoirs from filling up with silt. Forest conservation is therefore an essential condition of water conservation. The forests alone cannot, however, fully regulate and conserve the waters of the arid region. Great storage works are necessary to equalize the flow of streams and to save the flood waters. Their construction has been conclusively shown to be an undertaking too vast for private effort. Nor can it be best accomplished by the individual states acting alone. Far-reaching interstate problems are involved; and the resources of single states would often be inadequate. It is properly a national function, at least in some of its features. It is as right for the National Government to make the streams and rivers of the arid region useful by engineering works for water storage as to make useful the rivers and harbors of the humid region by engineering works of another kind. The storing of the floods in

reservoirs at the headwaters of our rivers is but an enlargement of our present policy of river control, under which levees are built on the lower reaches of the same streams.

The Government should construct and maintain these reservoirs, as it does other public works. Where their purpose is to regulate the flow of streams, the water should be turned freely into the channels in the dry season to take the same course under the same laws as the natural flow. The reclamation of the unsettled arid public lands presents a different problem. Here it is not enough to regulate the flow of streams. The object of the government is to dispose of the land to settlers who will build homes upon it. To accomplish this object water must be brought within their reach. The pioneer settlers on the arid public domain chose their homes along streams from which they could divert the water to reclaim their holdings. Such opportunities are practically gone. There remain, however, vast areas of public land which can be made available for homestead settlement, but only by reservoirs and main-line canals impracticable for private enterprise. These irrigation works should be built by the National Government. The lands reclaimed by them should be reserved by the Government for actual settlers, and the cost of construction should so far as possible be repaid by the land reclaimed. The distribution of the water, the division of the streams among irrigators, should be left to the settlers themselves in conformity with state laws and without interference with those laws or with vested rights. The policy of the National Government should be to aid irrigation in the several states and territories in such manner as will enable the people in the local communities to help themselves, and as will stimulate needed reforms in the state laws and regulations governing irrigation.

The reclamation and settlement of the arid lands will enrich every portion of our country, just as the settlement of the Ohio and Mississippi valleys brought prosperity to the Atlantic States. The increased demand for manufactured articles will stimulate industrial production, while wider home markets and the trade of Asia will consume the larger food supplies and effectually prevent western competition with eastern agriculture. Indeed, the products of irrigation will be consumed chiefly in upbuilding local centers of mining and other industries, which would otherwise not come into existence at all. Our people as a whole will profit, for successful home-making is but another name for the upbuilding of the nation.

The necessary foundation has already been laid for the inauguration of the policy just described. It would be unwise to begin by doing too much, for a great deal will doubtless be learned, both as to what can and what cannot be safely attempted by the early efforts, which must of necessity be partly experimental in character. At the very beginning the Government should make clear, beyond shadow of doubt, its intention to pursue this policy on lines of the broadest public interest. No reservoir or canal should ever be built to satisfy selfish personal or local interests; but only in accordance with the advice of trained experts, after long investigation has shown the locality where all the conditions combine to make the work most needed and fraught with the greatest usefulness to the community as a whole. There should be no extravagance, and the believers in the need of irrigation will most benefit their cause by seeing to it that it is free from the least taint of excessive or reckless expenditure of the public moneys.

Whatever the nation does for the extension of irrigation should harmonize with, and tend to improve, the condition of those

now living on irrigated land. We are not at the starting point of this development. Over two hundred millions of private capital has already been expended in the construction of irrigation works, and many million acres of arid land reclaimed. A high degree of enterprise and ability has been shown in the work itself; but as much cannot be said in reference to the laws relating thereto. The security and value of the homes created depend largely on the stability of titles to water; but the majority of these rest on the uncertain foundation of court decisions rendered in ordinary suits at law. With a few creditable exceptions, the arid states have failed to provide for the certain and just division of streams in times of scarcity. Lax and uncertain laws have made it possible to establish rights to water in excess of actual uses or necessities, and many streams have already passed into private ownership, or a control equivalent to ownership.

Whoever controls a stream practically controls the land it renders productive, and the doctrine of private ownership of water apart from land cannot prevail without causing enduring wrong. The recognition of such ownership, which has been permitted to grow up in the arid regions, should give way to a more enlightened and larger recognition of the rights of the public in the control and disposal of the public water supplies. Laws founded upon conditions obtaining in humid regions, where water is too abundant to justify hoarding it, have no proper application in a dry country. In the arid states the only right to water which should be recognized is that of use. In irrigation this right should attach to the land reclaimed and be inseparable therefrom. Granting perpetual water rights to others than users, without compensation to the public, is open to all the objections which apply to giving away perpetual franchises to the public

utilities of cities. A few of the Western states have already recognized this, and have incorporated in their constitution the doctrine of perpetual state ownership of water.

The benefits which have followed the unaided development of the past justify the nation's aid and cooperation in the more difficult and important work yet to be accomplished. Laws so vitally affecting homes as those which control the water supply will only be effective when they have the sanction of the irrigators; reforms can only be final and satisfactory when they come through the enlightenment of the people most concerned. The larger development which national aid insures should, however, awaken in every arid state the determination to make its irrigation system equal in justice and effectiveness that of any country in the civilized world. Nothing could be more unwise than for isolated communities to continue to learn everything experimentally, instead of profiting by what is already known elsewhere. We are dealing with a new and momentous question, in the pregnant years while institutions are forming, and what we do will affect not only the present, but future generations.

Our aim should be not simply to reclaim the largest area of land and provide homes for the largest number of people, but to create for this new industry the best possible social and industrial conditions; and this requires that we not only understand the existing situation, but avail ourselves of the best experience of the time in the solution of its problems. A careful study should be made, both by the nation and the States, of the irrigation laws and conditions here and abroad. Ultimately it will probably be necessary for the nation to cooperate with the several arid states in proportion as these states by their legislation and administration show themselves fit to receive it.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

SECTION I, SOCIAL AND ECONOMIC SCIENCE.

OFFICERS for the Denver meeting were: *Vice-President*, John Hyde; *Secretary*, Raymond A. Pearson; *Member of Council*, E. T. Peters; *Sectional Committee*, C. M. Woodward, H. T. Newcomb, John Hyde, R. A. Pearson, Marcus Benjamin, F. R. Rutter and L. F. Schmeckebier; *Member of the General Committee*, F. H. Hitchcock.

Nine meetings were held and at each a full program was presented. Unusual interest in some papers was shown by the discussions. The average attendance was probably the largest in the history of the Section. The majority of papers treated of subjects which are of special interest in the West—one entire day, including an evening session, being given to the consideration of the economic and social aspects of irrigation.

The vice-presidential address of Professor C. M. Woodward, 'The Change of Front in Education,' was published in full in a recent number of SCIENCE. Other papers were as follows:

'Scientific Men of Colorado': DR. MARCUS BENJAMIN, Washington, D. C.

This paper had for its purpose the presentation to the Section of the records of various scientific men of Colorado, and consisted chiefly of summaries of the excellent work done by the graduates of the Scientific Department of Columbia University, formerly known as the School of Mines, towards the development of the mineral resources of Colorado, as well as of the improved methods in metallurgical science invented by them. The sketches were some twenty in number and included the careers of such men as M. W. Iles, M. C. Ihlseny, W. B. Devereux, H. V. Furman and Richard Pearce. Brief mention was also made of such scientists as the late Senator N. P. Hill, who was referred to as the only chemist ever elected to the United States

Senate ; Regis Chauvenet (a son of W. M. Chauvenet, who was president of the Association in 1870), president of the Colorado School of Mines, and others who have taken a conspicuous part in the development of scientific thought in Colorado. The paper closed with a brief appeal for the preservation in a suitable building of the remains of the former inhabitants of Colorado and the Southwest.

'Dangers from Inaccuracy in Presentation of Transportation Problems': JAMES H. BLODGETT, A.M. Division of Statistics, Department of Agriculture, Washington, D. C.

Projects for transportation of water, both for personal use and for irrigation of crops, are necessary on a scale requiring municipal or corporate association of effort. In transportation of food and other commodities the railroad and the steamship form the present culmination of carriers. Water-works for cities, or for agriculture, canal and ship enterprises call for government aid. Railroads once largely aided by public appropriations depend mainly on sales of bonds and stocks to investors. In some propositions to the public, error is combined with truth to a dangerous extent. Two groups of erroneous statements are now particularly prominent, even in school books, in regard to interior waterways: One relates to a presumed project for a ship canal between the Black and the Baltic seas, officially disclaimed by Russia; another as to interior waterways between Boston and Galveston, really no more than three feet deep in the shallowest part, and between the mouths of the St. Lawrence and the Mississippi, no more than six feet deep for long distances, with short narrow locks. The Chicago Drainage Canal has as yet no commercial relations. The limit of urban population is liable to be determined by the water supply. The extent of cultivation upon Western plains is already limited by

the availability of water. It is a question whether taxation does not tend to increase faster than average incomes or than market values of property. Municipal repudiation ought to be unknown. Many municipalities have reached the legal limits of taxation and of indebtedness, but under popular demand constitutions have been amended and new municipal organizations have been superimposed to place additional taxes on the property. In Illinois, for example, most of the following series of taxes may represent separate authorities levying independently.

(a) National, (b) state, (c) county, (d) township, (e) school district, (f) city, incorporated town, village, in addition to school tax, (g) township high-school district, (h) drainage district, (i) sanitary district, (k) townships or road districts, for hard roads.

Most of these separate agencies can incur debt not to exceed five per cent. of the valuation, making possible a very large aggregate obligation resting upon the taxable property. Township high-schools, drainage districts, sanitary districts, hard-road districts, are not numerous, but they are possible in any part of the State under general laws.

'The Census of Cuba': VICTOR H. OLMSTED, Assistant Director of the Census of Cuba.

The prospective establishment of an independent government in Cuba made information necessary concerning the numbers and distribution, the education, the racial divisions, etc., of its population. The American authorities, after deliberate consultation with eminent Cubans, decided upon a census of the island. The knowledge already had of the temperament of the people, and of the probable obstacles to speedy work, indicated that conditions in Cuba were unfavorable to census-taking on a scale so comprehensive as that of the United

States; hence only the more important data concerning population, education and agriculture were collected. The work was intrusted chiefly to Cubans. The prevailing idea was that the census was to be of Cubans, by Cubans and for Cubans, and that its successful accomplishment would indicate their capacity for the subsequent establishment and maintenance of civil government. This decision was enthusiastically received by Cuban press and public. President McKinley's proclamation, August 17, 1899, declaring the census a preliminary step towards the establishment of self-government, completed the obliteration of all suspicion of American motives theretofore prevalent throughout the island. The Assistant Director, who was placed in full charge of the census, reached Havana August 20, 1899, established a temporary office, and began dividing the island into districts, a task difficult and arduous, owing to a lack of accurate geographical data. By September 15 the island had been divided into 1,315 enumeration districts—afterwards increased to 1,607. Large numbers of educated Cubans, then out of employment, furnished an excellent field from which to select enumerators.

In cases of doubtful literacy, persons were required to read and write in the presence of the enumerator, and, as to illiteracy statistics, the Cuban census is probably the most accurate on record. The enumeration was fully completed by the time required, November 30, 1899. Delay in a few remote districts alone prevented a much earlier completion. The complete results are published in Spanish and English separately. The volume of 800 pages contains information not elsewhere obtainable concerning Cuba and the Cubans.

'Mechanical Tabulation of the Statistics of Agriculture in the Twelfth Census of the United States': H. T. NEWCOMB, Editor *Railway World*, formerly Expert Chief of the

Division of Agriculture in the Office of the Twelfth Census.

The public demanded of the twelfth census a more extended, elaborate and detailed investigation of American agriculture than had been undertaken by any of its predecessors. Previous censuses had collected the basic facts necessary to answer the inquiries of the public, but had never been able to undertake the complicated and extensive tabulation necessary fully to develop the information that they might have been made to supply. An investigation and tests prescribed by law finally led to the adoption of the Hollerith electrical tabulating machinery. This is controlled by cards to which the facts from the schedules returned by the enumerators are transcribed by means of perforations. Two kinds of cards were used: one providing for a description of single farms, and the other for the acreage, production and value of each of the separate crops raised on each farm. The facts indicated on these cards are all stated quantitatively and the perforations were made by machines somewhat similar in their manner of operation to a typewriter. About 115,000,000 crop cards and nearly 6,000,000 farm cards were necessary, and the former were punched at the rate of about 2,000, the latter at the rate of about 1,000, per day's work. These cards were fed into the tabulating machines, which consisted each of from three to ten connected adding machines impelled by electrical currents transmitted through the perforations. Several counting devices impelled in the same way were also added to the machines for different phases of the work; at one time as many as nineteen. In running cards through the machines an average of over 10,000 per day has been attained in the later months. The Division of Agriculture employs twelve of these tabulating machines for the farm cards and eighty-six for the crop cards.

The great advantage of the Hollerith tabulating machinery, aside from its precision, lies in the possibility of making a single transcription of data and but one handling of schedules serves for the most complicated tabulations and for those in which the same facts are classified and aggregated according to many different and conflicting elements. It also has the merit of simplifying the work of a large office and reducing the greater portion of it to the grade of factory work.

'The Single Tax': HON. JAMES CROSBY, Denver.

To the thoughtful mind the political outlook at the opening of the new century is profoundly interesting. The nineteenth century was a wonderful century, but in one sphere of human development it was a disappointment. With all our boasted progress, we have not made better citizens or a more contented people. Industrial slavery must be abolished before the social organism can be restored to health, and the single-tax philosophy contains the proper remedy. Single-taxers maintain that the reason the wages of labor do not increase as material progress advances is because rent, or the price paid for the use of land, is continually increasing. The land upon which Chicago now stands was not worth an old shoe one hundred years ago. To-day millions could not buy it. The land upon which Denver is built was valueless fifty years ago. To-day it is worth millions, and as the city grows, wages will not increase, but we all know that the value of land will. By collecting this ever-increasing rent and using it for the benefit of all the people we abolish land monopoly and solve the problem of the persistence of poverty amid an advancing civilization. This single tax is not a tax upon land, but upon land values, an entirely different matter. We are frequently told that the single tax would bear with great severity

upon the poor farmer. This criticism would be just if we proposed to tax land, but it is not true if land values are taxed. For while most of the land is in the country, most of the land values are in the city. Under the single tax system the farmer would pay very little tax. Land values are easily collected. Land cannot run away, nor can it be hid when the assessor appears. Everywhere, in all times, monopoly of the land upon which all must live and from which all wealth is produced, is the basis of social and political disorders. The single-tax system, if adopted, will destroy industrial slavery and will usher in a period of peace and prosperity for all.

'The Road Problem': JAMES W. ABBOTT, Special Agent U. S. Office of Public Road Inquiries for the Mountain Division, Denver.

The renaissance of road building began during the first half of the eighteenth century. Metcalf in England, and, contemporary with him, Tresaguet in France, were the pioneers in this movement, and were followed later by Telford and Macadam, whose methods, with slight modifications, are still used. It is a singular coincidence that correct road-building practices were evolved just before the beginning of the railway era. In the United States the first attempt at better roads was made by toll-road companies; later came the National 'Cumberland Road,' which was the beginning of an excellent system of government military roads constructed at public expense. While in Europe the railway and highway systems expanded together, in the United States the railway displaced the highway in public attention; and, with the beginning of the railway era, national appropriations for road building were discontinued. Then followed a very remarkable period of conquest of the wilderness, during which the highway question received almost no attention. The

period of awakening on this important subject began a few years ago, and probably received its first strong impulse from the League of American Wheelmen. Many states have appropriated money to aid in building state highways: New Jersey, New York, Rhode Island, Vermont, Maryland, California and many other states now have highway commissions. Wherever state funds are appropriated, the laws require the counties to share in the expense. The most striking feature of the reports of the highway commissioners is the demand for state highways, notwithstanding the requirement for contribution by the counties. The controlling reason for this demand appears to be the fact, now universally recognized, that the building of these improved State highways has vastly enhanced the values of contiguous and neighboring property. The United States Department of Agriculture, through its office of Public Road Inquiries, took up this matter a few years ago, and has been engaged in disseminating among the people information upon road conditions in Europe and America and in teaching improved methods.

'Farm Ownership and Tenancy in Delaware. A Study of Farm Tenancy': LE GRAND POWERS, Chief Statistician for Agriculture, U. S. Census.

The growth of farm tenancy, which has been noted in many States of our nation during the last thirty years, is a part of a social movement profoundly affecting the status of many families in the United States. It was the appreciation of this fact that led the government, by the tenth and subsequent censuses, to collect statistics relating to the subject. According to the twelfth census of the United States, there were in the state of Delaware, June 1, 1900, 9,687 farms. The number has steadily increased since 1850. In that year there were 6,063; in 1860, 6,568; in 1870, 7,615; in 1880, 8,749; in 1890, 9,381.

Of the farms of 1900, 4,876, or 50.4 per cent., were operated by tenants; 4,680, or 48.3 per cent., by individuals who owned the whole or a part of the land they tilled; and 131, or 1.3 per cent., were cultivated for their owners by salaried managers or overseers. A large number of the last-mentioned class were farms connected with public institutions, or the property of corporations, and most of the others were holdings of wealthy individuals and were operated as much for the pleasure as for the profit of the owners. During the last twenty years there has been a steady decrease in the number of farms operated by their owners, accompanied by a more marked increase of those operated by tenants. This actual and relative increase in the number of farm tenants has taken place under circumstances which have operated to assist a large number of families in rising from wage service to farm tenancy or ownership. None of the facts presented indicate the existence of a movement in Delaware toward the concentration of the ownership of farm property or its transfer to the hands of a fixed class of non-resident landlords. They lead to the conclusion that the titles to rented farms in Delaware are vested in a large number of persons, the majority of whom have, at some time in their lives, operated the farms now owned by them. This conclusion is warranted by the results of the investigation of the twelfth census concerning the ownership of rented farms. The ownership of rented farms is held under conditions that insure to capable and industrious wage-earners or tenants greater opportunities of becoming farm owners than ever existed in this country before 1850, or than is presented at this time in any other nation on the globe.

'What Next? Is it Socialism?' WALTER S. LOGAN, New York.

The present is industrial chaos. Where organization comes out of the chaos it is

warfare. On the one side are the employers of labor, on the other side the laborers; on the one side the people who receive dividends, on the other the people who receive wages. What is being fought over is the proceeds of labor. We have built up our economic civilization on the principle that the relation between one man and another should be dependent upon voluntary agreement between them. But now it has come to be a relation not between man and man, but a relation between class and class. The community founds itself upon the relationship. More men are now employed by single corporations than were working for wages in the whole United States a hundred years ago. Such is the present situation. It is admitted on all sides that it is intolerable. Socialism is defined to be the ownership and operation by the State of all cooperative industries within its jurisdiction—the industrial condition wherein the State is the only employer of labor and the only wage payer.

The advocates of socialism in picturing its blessings, assume that it is practicable—an assumption that has not been subjected to the test of trial. But great modern combinations have come upon the scene—so great and so extended that they approach in the complexity of their activities and the magnitude of their undertakings the functions of government itself. A paid servant only is watching other paid servants, and the eye of the master is almost as remote from the hand of the servant as it would be if the state itself were master. The success of the modern industrial combinations would seem to indicate that the state might succeed pretty well in operating its own industries. If socialism as a practical proposition is thinkable to-day, it is because these combinations have made it so. For good or for evil, they will leave us as a legacy the assurance that industrial operations approaching in extent the

operations of government itself can be successfully inaugurated and profitably carried on. As to the ultimate result, I have no opinion whatever to express. As to the immediate result, however, I have a very decided opinion. I believe we shall have, in the immediate future, not state socialism, but a more socialistic state. I agree that socialism must come if it is the only way to secure industrial peace and protect the masses of the people, but it is far from having been demonstrated yet that it is the only way to do this. I am not prepared to say that we have found another and better way, but I have confidence enough in our race's destiny to believe that we shall.

'Economic Work of the United States Geological Survey': L. F. SCHMECKEBIER, PH.D., United States Geological Survey, Washington, D. C.

The economic work of the United States Geological Survey consists of work in economic and mining geology, investigations relating to water supply and irrigation, the survey of forest reserves, the preparation of a topographical map of the United States, and the gathering of statistics relating to the mineral production of the country. In the field of mining geology the Survey works upon the general principle that it should endeavor to accomplish for the mining industry as a whole what the individual engineer or mine owner could not succeed in doing by his unaided exertions; in short the Survey undertakes to furnish the prospector and mining engineer with an accurate basis upon which their work may be founded. The hydrographic work falls into three general classes: (1) Work of a strictly engineering character, having to do with the measurement of surface streams and the conservation of water supply through the storage of flood water; (2) examination of the underground structure and the permeability of the water-bearing rocks; and (3) general reconnaissances for the pur-

pose of obtaining information as to the method of utilizing water supply for power, irrigation and domestic purposes. In the survey of the forest reserves every factor bearing upon the character and growth of the forest has been studied. The following points have been especially emphasized: The character of the soil; the forest litter; the depth of humus; the character and density of the underbrush and young growth; the range in size of trees of the principal species; the total height, clear trunk and apparent age and soundness; the effect of fires on reproduction; the proportion of dead standing timber; the character of the cutting; the means of transportation; the local demand for lumber; the effect of sheep pasturage; the use of water for irrigation and milling; and the extent and distribution of land more valuable for agriculture than for timber. The Survey is engaged in the preparation of a topographic map of the United States, which in addition to being a necessity for all other investigations undertaken in the field, has in itself a great economic value in all works of an engineering character. The statistics of mineral productions are compiled direct from reports made by the producers themselves.

'The Soil as a Social and Economic Factor': FRANK K. CAMERON, Ph.D. Soil Chemist, U. S. Department of Agriculture, Washington, D. C.

This paper was a presentation in general terms of the work which has been done and is being done upon soils from the point of view of the natural scientist. An outline of the work of the Bureau of Soils in the U. S. Department of Agriculture is given. The point is then made that such work can never, in itself alone, lead to the best development and management of soils, for it is in fact an economic problem, and the work of the physical scientist can only serve as a basis or point of departure

from which the economist may attack the problem. The causal relations between the character of the soil and the population it supports are brought out and the importance of the soil as a factor in the social and economic status of the community is insisted upon. A plea is made for more attention to the subject from experts in these lines.

'Woman's Suffrage in Colorado': J. E. LE ROSSIGNOL, Professor of Economics, University of Denver.

After the enactment of the Woman's Suffrage Law, in the year 1893, many women devoted themselves with enthusiasm to the theory and practice of politics, especially in the agitations concerning populism and free silver. Afterwards a number of leading women broke away from the regular political factions and formed organizations such as the Civic Federation, which took an active part in the municipal election of 1895, and in 1897 they secured the election of an independent ticket. Since then there has been a tendency for women to return to the regular party organizations. It is difficult to give an estimate of the value of woman's suffrage to Colorado, because of diversity of opinion on the subject, and because it is as yet impossible to prove either the success or the failure of the system from the point of view of social expediency. The woman vote is large. Women have not been injured by the franchise. The character of the leading women politicians is high. Women are not, as a rule, clamorous for office. Since 1894, ten women have sat as representatives in the Legislative Assembly, and three women have successively occupied the position of State Superintendent of Education. Women have also served acceptably as members of the various state boards. Women have exerted a civilizing influence upon the character of political meetings, and they have at times exerted an influence toward secur-

ing the nomination of respectable candidates. Some reforms have been accomplished, wholly or in part, through the influence of women. A considerable proportion of women voters are as yet somewhat independent of party control, forming an unknown quantity which disturbs the calculations of party managers, and whether called independence or fickleness, may be regarded as counting against rather than for political trickery and corruption. People who expected that society would be immediately regenerated through the influence of woman's suffrage have been grievously disappointed, and many of them, both men and women, consider the experiment a total failure. Such people have expected too much and are too impatient. No remarkable reforms have been accomplished, but it is safe to say that woman suffrage has done no harm, that it has done some good, and that it has been adopted by Colorado 'for better or for worse.'

'The World's Bread Supply': EDWARD T. PETERS, Division of Statistics, U. S. Department of Agriculture.

In his annual address as president of the British Association for the Advancement of Science, delivered at the Bristol meeting of that body in 1898, Sir William Crookes sounded an alarm as to the future of the world's wheat supply. He pointed out that the bread-eating populations, consisting of the people of Europe and of European settlers and their descendants in various parts of the world, are increasing in a geometrical ratio, and from the figures he presented, he reached the startling conclusion that, by 1931, the number of bread-eaters will have become so great as to require the produce of all the land in the world available for wheat-growing, unless there shall, in the meantime, have been an increase in the average production per acre, which, at the time of his address, he estimated for the world at large at 12.7 bushels per acre.

The conclusions reached by Sir William, as to the future wheat-exporting capabilities of the United States, have seemed to some writers to fall so far short of the truth as to make his conclusion in regard to the world at large seem unworthy of serious attention; but an article by Mr. John Hyde, statistician of the Department of Agriculture, published some time ago in the *North American Review*, if it does not entirely support Sir William's view, yet shows by an overwhelming array of well-considered facts and figures that the optimistic expectations of some of Sir William's critics are wildly extravagant. In considering the average capacity of the earth to support civilized populations, it is to be remembered that, with the rise in the general standard of living which was a conspicuous feature of nineteenth-century progress, bread became a smaller and smaller proportion of the total consumption of the people. Wants have greatly multiplied; and as these wants require the produce of land for their satisfaction, the average area required for the support of an individual is now much greater than it was one hundred years ago. Moreover, if the standard of living is to rise still higher, that average area must, in the absence of increased yields per acre, become greater still, and a still smaller proportion of it will be devoted to the production of bread. 'Man shall not live by bread alone' is receiving, with the advance of civilization, a more and more liberal interpretation, and this fact has a vital bearing on the capacity of the earth for supporting population. Population cannot increase beyond a certain point without arresting the improvement in the standard of living and starting a movement in the opposite direction, unless a means can be found of obtaining from the soil increasing yields. The point at which such increasing yields will become the only alternative to starvation may not be quite so near as Sir William

Crookes believes; but it is near enough to impress us with the vital importance of using to the utmost every agency by which skilled and scientific agriculture may be substituted for the loose and wasteful systems of the past, and also to emphasize the necessity of protecting the world's forests, conserving its waters and employing every other means by which the area of land available for productive purposes can be increased. Doubtless there is a limit to the number of human beings that the earth is capable of supporting in comfort, but science, skill and foresight may place that limit in a sufficiently distant future to remove all occasion for anxiety on the part of the earth's present inhabitants or their immediate posterity.

'The Interdependence of the Sciences': DR. MAX WEST, U. S. Industrial Commission, Washington.

This paper will be published in SCIENCE.

'The Present Status of Commerce in the Educational Policy and in the Administrative Organization of Modern Nations': JOHN FRANKLIN CROWELL, PH.D., Bureau of Statistics, U. S. Treasury Department.

This paper presented the results of an analysis of the courses of study of representative institutions, both in this country and abroad, in which higher commercial instruction has been given. In some respects our own schools are modeled after the institutions of continental Europe, but to a much greater extent they are the outgrowth of two tendencies in our national life—the expansion of our universities and the increasing influence of business men in public policy. A comparison of several of the more important higher schools of commerce in Europe and at home shows that there are five double groups of subjects regarded as essential to a comprehensive commercial curriculum of higher grade. These are: (1) Geography and history, (2) lan-

guages and methods, (3) science and technology, (4) economics and statistics, and (5) law and sociology. The preponderating influence of one or another of these groups is determined by the general character of the college. In some institutions the type of training offered is professedly technical, in others it is practically a commercial substitute for a liberal education. The liberal and the professional purposes are probably least dissociated in the curriculum of the Wharton School of Finance and Economy at the University of Pennsylvania, the oldest of the higher schools of commerce in this country.

The practice has prevailed of organizing a commercial curriculum of four years out of subjects hitherto taught in other departments. However necessary this may have been to meet a growing demand for special instruction of a higher commercial character, it has made the fundamental educational mistake of failing sufficiently to differentiate the field of commercial phenomena from that of industry on the one hand and finance on the other. There is accordingly much confusion, that must retard greatly the rate at which the field of commercial knowledge shall be reduced to scientific consistency. It is to the solution of the distinct problems of commerce that education must devote itself if it means to organize commercial experience for the aid of individual enterprise and of national prosperity. The scientific classification of commercial phenomena is preliminary to the solution of these inherent problems.

A truly scientific course in the study of commerce must fill four conditions:

1. The classification of the facts and methods of modern commerce.
2. The formulation and solution of commercial problems.
3. The grounding of the student in economic principles and in their ready application to commercial situations.

4. The mastery of knowledge relating to the history and development of commercial policy as embodied in the economic progress of modern nations.

This is the least that scientific thought can ask of higher commercial education.

'The Development of the Mineral Resources of Colorado': CHARLES W. COMSTOCK, Professor of Mining Engineering in the Colorado School of Mines.

The paper began with a few figures showing Colorado's position in the mineral-producing world, especially with regard to gold, silver and lead. The relative change in importance of silver and gold in the state's wealth was brought out. The figures showed that 49 per cent. of its production had been silver and 35 per cent. gold. The statistics of 1900 show 25 per cent. silver and 57 per cent. gold. The all-important point in the history of gold and silver production is the increased economy in the mining and the treatment of ores. This is indicated by the lower grade of the ore mined now as compared with earlier years. Even in Cripple Creek, the newest of the producing district, it is striking. The causes leading to these reductions are cheaper labor, cheaper fuel, lower freight rates, cleaner work and close attention to details. One of the potent factors in developing low-grade ores has been the improvement in ore-dressing machinery and methods, together with a more general dissemination of information with regard to this very important subject. The figures from one instance of actual practice show that proper mechanical preparation makes a change from a loss of \$5 per ton to a profit of \$2. The paper closed with a brief reference to the zinc problem which has been an absorbing one in Colorado for more than fifteen years.

'Protection of Communities by the Forest': GIFFORD PINCHOT, Forester, U. S. Department of Agriculture.

The relation of the forest to the community penetrates every portion of communal life on the material side. To follow it in detail would be to describe the modern community with a minuteness which has perhaps had little approach. For the general theme it is sufficient to say that the communal life of modern civilization as we know it would be impossible without the forest.

Forests protect communities especially by safeguarding the drainage systems on which they depend either for navigation or water supply, by fixing the drifting sands which have already overwhelmed so many towns and villages, by securing the prosperity of the tributary territory upon which the communal prosperity itself must hang, and finally, by providing the recreation grounds without which much of communal life must be flat, stale and unprofitable. The town or city forest is an institution of the highest beneficence which has yet only begun to appear in America. Examples are not uncommon abroad of towns free, either partly or wholly, from communal taxes by the revenues of their forests; and this is perhaps the least of the services which they render. Cheap and abundant supplies of wood come to the citizens from their forest lands, but best of all, the forest serves as a playground and breathing space whose influence penetrates to every portion of the community. Public spirit could take few directions more useful to the citizens, towns and villages of this country than to provide them with self-supporting recreation grounds of the forest type, for there is a quality of renewal inherent in play time in the forest which follows no other kind of rest from work.

'Leasing and Disposal of the Public Lands': C. E. WANTLAND, Denver.

The United States owns about half a billion acres, the net cost to date of the remaining lands being probably about \$250,000,-

000. To maintain the Land Department, an expenditure of about \$2,000,000 per annum is necessary. In the western states there are about 500,000,000 acres, about 400,000,000 million of which are used for grazing purposes by 25,000,000 cattle and sheep under conditions gradually growing worse. If leased, the revenue in ten years, in connection with the net receipts from sale of public lands, would double irrigated lands in the West now estimated at 10,000,000 acres. In the eleven western states we have only 250,000 farms, and 50 per cent. of the people live in towns and cities, while about 75,000,000 acres of public lands can still be reclaimed if the water which now runs to waste can be stored. Congress has failed to realize the great importance of the subject and very little constructive legislation has been secured. Forest reservations, the Carey Grant Act and the recent Free Homes Bill were secured after great difficulties. Public lands should be leased for short terms in limited quantities and at low rates. Owing to different conditions in the different states, leases should be issued on a county local-option basis, after careful classification of lands by commissioners and approval by stockmen. Funds should be used for reducing county taxes, for surveys and reservoir construction. The majority of stockmen are now in favor of a good lease plan, fair to all concerned. The Homestead law should be amended to enable settlers by a combination homestead and lease privilege to control enough land to make a living on, and the Government should advertise the facts about public lands for the benefit of people who want new homes. The Desert Land Law should be repealed. Forest protection and the reclamation of the arid lands will bring great prosperity to the country. The landless man of the east must be placed upon the manless land of the west.

'Irrigation': F. H. NEWELL, Hydrographer, U. S. Geological Survey.

The western half of the United States consists for the greater part of vacant land belonging to the nation and at the disposal of Congress. With this enormous area, aggregating fully one-third of the United States, it would be supposed that settlement would progress rapidly and population increase with stupendous strides. As a matter of fact, however, the past decade has not been marked by notable developments, but, on the contrary, it appears that the settled area has to a small extent actually diminished. As a rule the soil and climate are suitable for the production of large crops, were it not for the scarcity of moisture. The pioneers and their successors have taken out almost innumerable ditches and have diverted the smaller streams, demonstrating the practicability and profitable character of agriculture by the artificial application of water. In all, about ten million acres of land have been brought under cultivation by means of works built largely by farmers acting in partnership or in associations. Irrigation development when brought about in this manner has been extremely profitable. But, contrary to the experience of the farmers, large irrigation enterprises have almost invariably been financial failures. This anomalous condition, where enterprises succeed in a small way but fail financially on a large scale, merits careful consideration. There are upwards of seventy million, or even a hundred million, acres of arable land which might be reclaimed and made into homes by utilizing the waters of the large rivers or of the floods which now run to waste. The reason for the failure of the large enterprises lies for the most part in the difficulty of securing immediate settlement and of obtaining experienced farmers who can practice irrigation with success from the outset.

One of the great questions now before the people of the country is how to dispose of the crowded and surplus population around the great manufacturing centers and to render the idle laborers producers of wealth instead of helpless consumers. The public lands in the past have proved the great outlet for superfluous labor, especially at the periodical occurrence of hard times. Vast areas of fertile public lands still remain, but these cannot be utilized until the problem of supplementing the deficient water supply can be solved. This problem of water supply for the arid lands is one which must be taken up by the publicist and statesman. The engineering features are comparatively simple, but the great question to be solved is as to who is to pay for the original outlay. The public at large is undoubtedly the gainer, since by the creation of prosperous homes upon the public domain the commonwealth is strengthened, and commerce and manufacture increased. A similar question with regard to the building of light-houses and the improvement of harbors has been answered by the national government taking charge of the matter, and it is urged by many who have studied the matter thoroughly that Congress, the custodian of the public lands, must take cognizance of present conditions and not only modify the land laws to suit the conditions of the arid West, but also provide means by which large rivers may be made available and floods held so that the farmers by their own work may be able to utilize the waters, as has been done by their predecessors.

'The Scope of National Aid for Irrigation': FRED BOND, State Irrigation Engineer, Cheyenne, Wyo.

Irrigation laws are a necessary part of the statutes of every state any portion of which lies west of the 100th meridian, and they form a part of the statutes of those states. These laws are enacted for the

purpose of governing the diversion and appropriation of water and its use, and state codes and state statutes alone define water rights and provide for their determination and administration. The general government has never undertaken to exercise any authority over water used in irrigation, but has left the control of the water in the arid region entirely to the states wherein found. Whatever might have been originally undertaken with advantage by the nation does not change present conditions, and it is now too late, even were such action desirable, to undertake the enactment of laws which will come into conflict with the long-conceded rights of the states to regulate and control these matters; nor can the government determine future rights or undertake their administration without creating a conflict between those state and national authorities which have the diversion of water directly in charge. The funds for irrigation development must come from some national resource, for the states are financially unable to raise them, and no matter how willing many of them might be, they are precluded from the undertaking because the limits of taxation permitted by their respective constitutions has been reached in providing means to meet ordinary state expenses. They are, however, not only ready and willing, but entirely capable of prosecuting the work to a successful conclusion, the means being found. The funds should come from such a source as would bring about the least possible interference with present conditions, and the appropriation or setting apart of the receipts from the sale of arid lands seems most completely to fill these requirements. The volume of work undertaken in any state each year may be limited by the receipts from the sale of public lands in such state for the year previous, a plan commendable in that interests not benefited are not required to render any assistance in the work. The amount ob-

tained in this manner from any one state would not be large, but would enable a beginning to be made and at the same time give the state an opportunity to demonstrate its fitness to continue in the work of its own development under these conditions.

A part of the discussion which followed this paper is given :

F. H. Newell: The proposition presented by Mr. Bond is one which has been fully discussed by committees in Congress. The general conception is not new, but the point which he emphasizes, of the importance of state control of national funds in irrigation development, is one which, it is feared, will prove a stumbling-block to progress. Relatively few of the states would be benefited if the proceeds from the disposal of public lands in each state were devoted exclusively to works in that state. This narrowing of development is undoubtedly the outgrowth of an attempt made to cede the vacant public lands to the states to be disposed of by the legislatures. This has been shown to be contrary to the whole spirit of national administration of the public lands; these lands being held, not for the benefit of the states in which they are located, but for the making of homes by citizens. There is no apparent ground for the fear of conflict between national and state authority. There can be no question as to the importance of national development of vacant public lands, which still include nearly one-third of the United States. It is practicable for the government to erect storage reservoirs, and to divert large rivers to a point where settlers can take out the water and make for themselves homes as was done by the pioneers. The further limitation, however, which Mr. Bond seems to insist upon, that this work should be done by state officials, is one which is so opposed to all experience and precedents that it would doubtless weaken the movement in the minds of those who have studied the subject.

George H. Maxwell, Chairman of the Executive Committee of the National Irrigation Association, expressed the opinion that the paper by Mr. Bond tended to create an entirely wrong impression as to the relation of the national Government to irrigation development. No one, he said, contends or proposes that the national Government should undertake in any way to regulate the distribution of water in conflict with the laws of the state. It is proposed that the Government shall do two things: First, enlarge its policy of internal improvements to include water storage through appropriations under the river and harbor bill, the water so stored to be turned into the stream in the dry season and distributed under the state laws just as though nature had put it there. Second, build such reservoirs and irrigation works as may be necessary to bring water within reach of settlers on the public lands, reserving lands for which water is thus made available for actual settlers only, and charging the lands in proportion to benefits with the actual cost of the Government works. In carrying out this latter policy the Government occupies the relation to the states of a land owner, and will proceed just as any other land owner would do to accomplish the reclamation and settlement of his land. It is conceded in Mr. Bond's article that the national resources must provide the funds for this irrigation development. This being so, the national Government will administer their disbursement. It has steadily refused to cede the public lands to the states, because experience has shown that such a policy would result in the lands being improvidently administered or absorbed in large holdings by speculators. The same result would follow if the control of their reclamation were turned over to the states. The national Government will never appropriate money from any source for state engineers to spend to reclaim the public

domain. The sole ultimate object of the national irrigation policy is to make homes on the public domain, and when this has been done the national purpose has been accomplished. Until the home-builder is actually there, the national Government will never abdicate its functions or transfer to state politicians the administration of this great national trust.

'The Grand Canyon of the Gunnison.' Illustrated evening lecture by A. L. FELLOWS, Resident Hydrographer of U. S. Geological Survey, Denver.

Below the Black Canyon of the Gunnison, which is traversed by the D. & R. G. Railway in Western Colorado there remains still a portion of the Gunnison canyon which has been practically unknown, and a portion at least of which has never been explored until it was investigated by Mr. A. L. Fellows, resident hydrographer of the U. S. Geological Survey, and by one companion, Mr. Will Torrence, of Montrose, Colorado, in the month of August, 1901. This portion of the Gunnison Canyon is known in Hayden's survey as the Grand Canyon of the Gunnison, and although a number of efforts had been made to penetrate its secrets, these efforts have been without avail until the present attempt. This is the more extraordinary as there is no portion of Colorado that can compare with it in scenic grandeur, and the problems in geology that are presented are also of intense interest. The absolutely unexplored portion is of but a few miles in length, but there are some thirty-five miles of which very little is known. This is that portion of the canyon between the mouth of the Cimarron River at Cimarron and the mouth of Uncompahgre at Delta. The plateau which is cut by the Grand Canyon of the Gunnison is known as the Vernal Mesa, and appears to have been caused by an uplifting of the overlying strata by geological forces beneath. The sandstones

of the surrounding region were uplifted several thousand feet above the adjacent territory, but these sandstones have been eroded from the region traversed by the canyon, and the canyon itself is eroded into the metamorphic granite and through crystalline rocks to a depth at present amounting to about 2,000 feet on the average below the surrounding territory. The walls are in many cases very nearly vertical, and at times are strangely marked by gigantic veins of quartz. The flora and fauna of the canyon do not differ materially from those of other Colorado canyons, the stream being lined by spruce and cottonwood trees, and the canyon being occupied, to some extent at least, by the usual fauna of the wilder portions of Colorado. The investigation was made in the interest of a survey that is being carried on by the hydrographic division of the U. S. Geological Survey under the general direction of Mr. F. H. Newell, for the purpose of determining the feasibility of diverting the water of the Gunnison into the Uncompahgre Valley for the irrigation of its lands. The trip was made, commenced on the 12th and ended on the 21st of August, 1901. The investigation resulted in the obtaining of practically all the data desired, over a hundred excellent views of the canyon being taken, and copious memoranda made concerning the nature of the rocks and other features of interest. The trip was an excessively hard one, and was made with the lightest possible equipment, the explorers being obliged to take to the river and swim some seventy-odd times, besides scaling the sides of the cliffs times innumerable.

'The Development of Irrigation in Colorado': L. G. CARPENTER, Director of Experiment Station and Professor of Irrigation, Fort Collins, Colorado.

'The Social and Economic Aspects of Irrigation': GEORGE H. MAXWELL, Chairman

of Executive Committee of National Irrigation Association, Washington.

RAYMOND A. PEARSON,
Secretary.

AMERICAN ORNITHOLOGISTS' UNION.

THE Nineteenth Congress of the American Ornithologists' Union convened in New York City, Monday evening, November 11. The business meeting of the Fellows was held at the American Museum of Natural History, and the public sessions, commencing Tuesday, November 12, and lasting three days, were also held at the Museum.

Dr. C. Hart Merriam, of Washington, D. C., was reelected president; Charles B. Cory, of Boston, and C. F. Batchelder, of Cambridge, Mass., vice-presidents; John H. Sage, of Portland, Conn., secretary; William Dutcher, of New York City, treasurer; Frank M. Chapman, Ruthven Deane, E. W. Nelson, Witmer Stone, Drs. A. K. Fisher, Jonathan Dwight, Jr., and Thos. S. Roberts, members of the Council.

The ex-presidents of the Union, Dr. J. A. Allen and Messrs. William Brewster, D. G. Elliot and Robert Ridgway, are *ex-officio* members of the Council.

Outram Bangs, of Boston, Joseph Grinnell, of Palo Alto, Cal., Dr. T. S. Palmer and Professor F. E. L. Beal, of Washington, D. C., and Dr. Louis B. Bishop, of New Haven, Conn., were elected Fellows.

Montague Chamberlain, of Boston, was elected to corresponding membership. Fifty-five associates were elected to the new class known as members, and eighty-three new associates were elected.

By the adoption of certain amendments to the By-Laws, at the present Congress, the following classes of members are now recognized by the Union, viz., Fellows, Honorary Fellows, Corresponding Fellows, Members and Associates.

Dr. J. A. Allen, in his paper on 'The

Present Outlook for Stability in Nomenclature,' dwelt upon the American method and its gradual acceptance by foreign ornithologists as well as by workers in other branches of science.

Mr. E. W. Nelson described a collecting trip which he took through portions of Yucatan. In that country, occupied until recently by hostile Indian tribes, he discovered more than one hundred birds new to science.

Mr. Ruthven Deane exhibited books and other relics from his own library which were once the property of John James Audubon. What he had to say on 'Auduboniana,' was of historic interest.

The report of the Committee on Protection of North American Birds showed that satisfactory results had been obtained during the past year. Mr. Dutcher spoke of the great good for protection made possible by the 'Thayer Fund'—money raised through the efforts of Mr. Abbott H. Thayer. By its aid Dr. T. S. Palmer and Mr. Dutcher had been able to appear before legislative committees in many States, and new and better protective laws had been passed. Mr. Chapman referred to the present abundance of bird life on Gardiners Island, N. Y., the result of rigid protection.

Professor W. W. Cooke traced the routes of bird migration across the Gulf of Mexico, bringing out many new and interesting facts.

Excellent lantern slides from photographs of birds in life were shown by Rev. H. K. Job, and Messrs. Nelson, Chapman, Dutcher and Baily.

The New York Zoological Society invited the members of the Union to visit its park, and many availed themselves of the privilege November 15. Director Hornaday conducted the party through the grounds.

Following is a list of the papers read at the sessions.

'The Present Outlook for Stability in Nomenclature': J. A. ALLEN.

'The Plumages of the American Goldfinch (*Spinus tristis*): JONATHAN DWIGHT, JR.

'Routes of Bird Migration across the Gulf of Mexico': W. W. COOKE.

'On Methods in Museum Bird Exhibits': FRANK M. CHAPMAN.

'Ornithological Notes from Northern New Hampshire': JOHN N. CLARK.

'Some Impressions of Texas Birds': LOUIS AGASSIZ FUERTES and H. C. OBERHOLSER.

'The White-winged Crossbill in Captivity': JAMES H. HILL.

'The American and European Herring Gulls': J. A. ALLEN.

'Auduboniana': RUTHVEN DEANE.

'The Molts and Plumages of the North American Ducks (*Anatidae*): JONATHAN DWIGHT, JR.

'A Naturalist in Yucatan,' illustrated by lantern slides: E. W. NELSON.

'Photography in North Dakota Bird Colonies,' *et cetera*, illustrated by lantern slides: HERBERT K. JOB.

'A Reconnaissance in Manitoba and the Northwest,' illustrated by lantern slides: FRANK M. CHAPMAN.

'Are Humming Birds Cypseloid or Caprimulgoid?' HUBERT LYMAN CLARK.

'List of Birds of Wequetonsing, Mich.': OTTO WIDMANN.

'Notes on the Ornithological Observations of Peter Kalm': SPENCER TROTTER.

'Report of the Committee on the Protection of North American Birds': WITMER STONE.

'Results obtained under the Thayer Fund': WILLIAM DUTCHER.

'National Bird Protection—Its Opportunities and Limitations': T. S. PALMER.

'Gulls of the Maine Coast, and Miscellaneous Notes,' illustrated by lantern slides: WM. DUTCHER and WM. L. BAILY.

'Some Results of Bird Protection,' illustrated by lantern slides: FRANK M. CHAPMAN.

The next annual meeting will be held in Washington, D. C., commencing November 17, 1902.

JOHN H. SAGE,
Secretary.

JOSEPH HIRSCH.

THE biography of the late Joseph Hirsch, briefly sketched, is as follows:

Born May 22, 1836, of an old and well-known family, characterized in all its branches by taste, refinement, and ability, and with a strong proclivity toward both art and engineering, he studied at the *École Polytechnique* and became an engineer of the *Ponts et Chaussées*, standing at the head of his class in line of promotion from the first. He served in Marseilles, Algiers and Alsacia, and accepted missions in Germany and Austria. In 1861 he was engaged in the construction of the Houillères de la Sarre canal, inventing, meantime, the ingenious syphon arrangement by which its level is automatically maintained. In 1867 he was assigned to special service relative to the work of improvement of the navigation of the Saone, and presently, on his marriage with Mlle. Dreyfus-Dupont, whose distinguished relatives in this country are so well known to all engineers and army and navy men, he secured indefinite leave from the Government and devoted himself to the study and investigations which so liberally offered themselves in connection with the great iron and steel works of his father-in-law. After the close of the Franco-German war, one of these establishments, on then German territory, was sold, and Hirsch erected new and modern works at Pompey, near Fruard. In this construction he introduced every modern appliance and made it a model of its kind.

The children of this fortunate union growing up, it was decided to take up residence in Paris, and for many years, No. 1, rue de Castiglione, was a center of social,

scientific and artistic life. Meantime, his two brothers had become famous, the one as artist, the other as architect, and aided in making the new life beautiful and profitable.

In 1876 Hirsch was appointed to the chair of 'The Steam Engine,' at the *École des Ponts et Chaussées*, and, until his retirement at the age limit in 1898, he steadily added to the fame of that great institution. After those twenty-two years of service, the Inspector-General reported :

"To great scientific knowledge he added from the first extensive practical information, the fruit of personal experience, which enabled him to conduct his course as a practitioner, as well as a *savant*, and thus to give it the character most appropriate to the *École des Ponts et Chaussées*."

At his retirement he distributed a considerable sum, 10,000 fr. for ten years, in prizes for students '*les plus méritants et le moins fortunés*.' He 'gave much but with discretion; he took the trouble to give usefully.' Riches, in his view, created an indebtedness to his country and his people which he was always willing and glad to discharge.

Hirsch added to his work at the *Ponts et Chaussées* that of the department of Mechanics at the *Conservatoire des Arts et Métiers* (1886), and took great pleasure in directing its evening classes and teaching the crudely educated, as well as the well-prepared, pupils at the government school. In 1879 he was on the 'State Commission of Steam Engines'; in 1880 he had charge of the office of engineer-in-chief of the department of purchase and inspection of materials for the state railways. He was on the international juries of 1878, 1889 and 1900 in Paris, and in 1878 received the cross of *Chevalier de la Legion d'honneur* and, in 1900, that of *Officier*.

M. Hirsch published his course at the *Ponts et Chaussées* in the '*Encyclopédie des*

travaux publics,' and, in its first volume, on the steam engine, had the assistance of M. Debize. His reports upon the machinery exhibited at the International Expositions appeared in the volumes officially issued from the government press.

As M. Darlein says: "*Telles sont été les principales occupations et les travaux le plus notoires du savant ingénieur, du professeur accompli, du chercheur original, de l'homme de bien dans la plus haute acception de ce mot, qu'une mort subite vient d'arracher à la tendresse de sa famille et à l'affection de ses amis. * * * Adieu, camarade et ami, ou plutôt au revoir: ta mémoire nous demeurera chère et ton exemple nous restera utile.*"

An acquaintance of many years' duration permits the writer to speak with confidence in confirmation of the testimony given by his professional colleagues at the meetings of various societies after his death. In his home and in his private capacity he illustrated the noblest attributes of the gentleman and the scholar; serious yet always kindly and affectionate, giving and eliciting respect and affection, sweet reasonableness accompanying correct judgment and clear views of right and wrong, familiar yet dignified, provident yet liberal, as husband, father, friend, he was invariably and completely admirable. Professionally he was a leader. Practically experienced, technically learned, cultured and efficient, he was a reliable adviser and director in his whole wide field of special work. He was admired, respected and honored by every client, as by every colleague.

His record, official, professional and private, stands a permanent memorial to the man.

R. H. THURSTON.

SCIENTIFIC BOOKS.

Les Variations de Longueur des Glaciers dans les Régions Arctique et Boréales. By CHARLES RABOT. Archives des Sci. Phys. et Nat. Geneva, 1897, 1899 and 1900.

The literature of the variations of glaciers has been greatly enriched by the contributions of M. Rabot. He has brought together in a convenient form the observations that have been made on the northern glaciers, with references to his sources of information, so as not only to give an excellent review of what is known of these glaciers, but also to give the data for comparisons with future work. Many of the original publications which he refers to are in languages, such as Icelandic, Danish, Swedish and Norwegian, which are little known outside of the regions where they are spoken, so that his extracts and synopses bring before us important facts which could not be obtained otherwise without great difficulty. He does not confine himself to the variations of glaciers only, but also gives descriptions, measures of the motion, observations on melting, etc. Although he disclaims that his work is complete, it will be recognized that the incompleteness is not due to oversight on his part, but to paucity of exact information on the subject. One is surprised, indeed, that he has been able to collect so many facts regarding more than 250 glaciers, many in very remote regions.

M. Rabot divides glaciers into three classes: *inland ice*, such as the ice covering of Greenland with its great ice streams which reach tidewater, including smaller local ice-caps; *Alpine glaciers*, with which we are familiar in the Alps; and *composite* or *Alpine-Norwegian glaciers*, an intermediate form grading into each of the other two. Glaciers of the first class are the most common in the arctics.

In temperate regions, the variations of a glacier are easily determined by the change in the position of its end; but this is not so simple among arctic glaciers. Many of them end in fiords and the ice is continually breaking off as icebergs, so that the point where they end varies according as we observe them shortly before or after much ice has broken off. M. Rabot thinks the intensity of the calving is a better criterion of the state of the glacier; if much ice is coming off and at the same time the glacier is not materially receding, it is to be considered in growth; and *vice versa*.

M. Rabot reviews the observations of the

glaciers of Grinnell Land, Greenland, Jan Mayen's Land, Iceland, Spitzbergen, Francis-Joseph Land and Scandinavia, five of which regions he has himself visited, and brings out many interesting facts, but we can only notice the most important of his conclusions. Of the regions mentioned Iceland and Norway furnish the most detailed information for the longest time. It is well established that the glaciers of these two countries were much smaller before the eighteenth century than they are now, and that this smaller extension lasted for several centuries; that there was a great advance during the eighteenth century interrupted for a short time about 1750; that during the nineteenth century there has been a slight retreat marked by several minor variations, though the glaciers are still considerably larger than they were during and before the eighteenth century. A Norwegian document of the eighteenth century contains a general description of the Greenland glaciers which might apply to the country to-day, so we must infer that the extent of the ice did not differ very greatly then from what it is now. With the exception of this document all accurate information of the Greenland glaciers refers to the period since 1850. Observations since then are not at all concordant, but they seem to show in general a stationary condition or a slight advance. The natives are unanimous in asserting that the ice has been advancing within historic (?) times. The fewer observations in Jan Mayen's Land and Spitzbergen indicate that their glaciers have followed the same history as those of Iceland and Norway. The glaciers of Grinnell Land and Francis-Joseph Land appear to be retreating at present. Local ice caps, probably of comparatively recent origin, cover the islands which make up the latter.

M. Rabot mentions that the glaciers of south-eastern Alaska seem to have been at a maximum at the end of the eighteenth century; and it may be added that observations in Glacier Bay show that there was a long period in which the glaciers were much smaller than at present, followed by the comparatively short but strong advance which apparently culminated at the above date, and that since then there has been a general retreat; so that it seems quite probable that the Alaskan glaciers have experienced

variations synchronous with those of the Arctics.

The general conclusions are that in the Arctics the eighteenth century was a period of very marked advance of the glaciers, that this was preceded by several centuries of great retreat, and followed by a small retreat which is still in progress. Where the information is sufficient these conclusions are fully established; where it is meager they are partially confirmed or at least not contradicted.

M. Rabot points out certain resemblances and differences between the variations of the arctic glaciers and those of the Alps. Although, so far as can be made out, there seems to be a fair accord in the dates of the variations, there seems little relation between their respective intensities. The general advance of the arctic glaciers in the eighteenth century was not marked in the Alps; and the strong retreat of the second half of the eighteenth century in the Alps is but faintly shown in the Arctics. Moreover, it has not been possible to show a distinct relation between the variations of climate and the variations of the glaciers in the Arctics as has been done in the Alps.

M. Rabot has accomplished what must have been a laborious task, and deserves the thanks of all persons interested in the variations of glaciers.

HARRY FIELDING REID.

GEOLOGICAL LABORATORY,
JOHNS HOPKINS UNIVERSITY.

The Brain of Acipenser. A Contribution to the Morphology of the Vertebrate Brain. By J. B. JOHNSTON, Professor of Zoology, West Virginia University. Zool. Jahrb., Abt. f. Anatomie, Bd. XV., Jena, 1901, pp. 204, with 12 plates and 22 text-figures.

The application of the cell theory to the nervous system (for this is what the doctrine of the neurone amounts to in the upshot) has reached its consummation only within the past decade. Accordingly, the neurology of to-day, whether human or comparative, demands not merely topographic descriptions of the tracts and nuclei within the brain, but the precise relations between the two, stated anatomically in terms of cellular morphology as well as in terms of experimental pathology. This necessi-

tates the rewriting of some chapters in the standard text-books and the repetition of many classical researches upon the lower animals with 'modern neurological methods.'

Such, then, is the motive which has led Professor Johnston to attempt 'a complete study by modern methods of the brain of a lower vertebrate.' The type chosen, the sturgeon, was described in 1888 by Goronowitsch, and the present study aims to fill in the cellular details upon the basis of the topography as there laid down (with the result, we may add parenthetically, of correcting several errors both of fact and of morphological interpretation found in Goronowitsch's account). Standard histological methods—among which judicious staining with Delafield's hæmatoxylin is still unrivaled for lower brains—were, accordingly, supplemented by the use of methylene blue in various forms and by chrome silver impregnation. The author's results with the latter method are especially brilliant. He has succeeded in getting whole brains impregnated and cut into unbroken series of sections, so that the courses of the more important tracts could be controlled by the actual demonstration of the paths of individual fibers through them.

Of the 12 plates accompanying the paper, one is a chart showing all the more important fiber tracts in the brain of this fish elucidated by an ingenious color scheme, the reflex arc being represented as consisting of a chain of several links which are indicated by colors of the spectrum, sensory roots blue and motor roots red, with the connecting tracts in series between. The other plates (all photographic reproductions from untouched negatives) include seven views of the entire brain, 56 photographs of Golgi preparations, illustrating nearly all the important types of neurones in the brain, and 21 transverse sections from a series stained with Delafield's hæmatoxylin to illustrate the topography. The latter are accompanied by lettered outline drawings on transparent paper and incorporate also some results of the study of Golgi sections.

Dr. Johnston is one of the few neurologists who give evidence of an adequate appreciation of the importance of the peripheral nervous system as furnishing the key to the central, and

who accordingly have fully and sympathetically entered into the doctrine of nerve components as developed within the past decade. While he has not himself studied the peripheral nervous system of *Acipenser*, his analysis of the medulla oblongata has been made in the light of the facts of peripheral connections already known, and hence his results are of far-reaching importance to the major problems of the morphology of this confusing region. Into the details of these results we cannot now go, merely calling attention to the fact that in this connection he has made some observations of great importance to the phylogeny and organogeny of the vertebrate nervous system.

For instance, he confirms statements of previous writers that the communis, or visceral sensory, system of cranial nerves is related anatomically with centers both in the oblongata and in the spinal cord which are quite distinct from those of the tactile nerves (general cutaneous centers and dorsal horns). On the other hand, the acustico-lateral system of cranial nerves, innervating the ear and lateral line organs, is structurally very intimately related to the general cutaneous centers and dorsal horns. Johnston, in agreement with other very recent writers, finds the cerebellum directly related with the tuberculum acusticum, all the types of cells characteristic of the cerebellum being represented in the acusticum by transitional forms. From this it follows that the cerebellum and acustico-lateral nerve centers are phylogenetically derived from the dorsal horns of the spinal cord. It is important that this interesting conclusion be controlled by studies upon still more primitive vertebrates and by embryological studies upon the lower fishes, and that the succeeding steps in this evolutionary process be worked out in the types next above the ganoids. The first of these desiderata has already been met in large measure by an exhaustive study of the brain of the lamprey by similar methods, which Dr. Johnston has now in press in an American journal and by which the main theoretical conclusions of this paper are confirmed in a striking manner.

Another critical region upon which interesting conclusions are expressed is the pallium.

"There are found in *Acipenser* two sets of cells which seem to constitute the earliest representative of the cortex proper. One of these serves to connect the epistriata of the two sides by fibers through the anterior commissure. The other is found in the dorsal membranous roof of the fore-brain and probably corresponds to the dorsal or dorso-median cortex of reptiles. The transformation of a membranous pallium into a massive nervous pallium, which has recently been declared impossible, is seen in actual progress in its early stages in *Acipenser*."

In conclusion, we may add that, whether Dr. Johnston's theoretical conclusions stand or fall (and we think that for the most part they will stand), the cause of sound morphology is best promoted by just such exhaustive and painstaking researches as this one, by which a secure basis of positive fact is first laid down.

C. JUDSON HERRICK.

The Smithsonian Institution, Documents Relative to its Origin and History, 1835-1899. Compiled and edited by WILLIAM JONES RHEES. In two volumes. Vol. I., 1835-1887. Twenty-fourth Congress to Forty-ninth Congress. Washington, Government Printing Office. 1901. Pp. liii + 1044.

The Smithsonian Institution is taking praiseworthy pains to make permanent records of its origin, history and activities, so that the future historian of science in America shall be able to draw from authorized sources. Three volumes have previously appeared pertaining to the origin and history of Smithson's foundation, one bearing a title similar to that under review, one dealing with the 'Journals of the Board of Regents, Reports of Committees, Statistics,' and the third, the large, handsome work, 'History of the First Half Century,' edited by Dr. George Brown Goode and published in 1897. The volume in hand is compiled and edited by one who has been in the service of the Institution under all three secretaries, as chief clerk and now as keeper of archives, and whose familiarity with the life of the Smithsonian, together with painstaking research, has produced a valuable work.

The book is complementary to that issued in 1879, and contains in detail the history of the

relations of the Institution to Congress, as found in the volumes of the *Congressional Globe* and *Congressional Record*, the Journals of the Senate and House, and the Statutes at Large. Part I. contains the documents pertaining to the foundation, the will of James Smithson, the correspondence ensuing and statements of other bequests to the Institution; Part II. embraces legislation relative to the establishment of the Institution, 1835-1847; Part III. embraces the legislation in Congress from 1847 to 1887; and according to the table of contents of a second volume (printed in Vol. I.), that will contain details of legislation from 1887 to 1899.

These volumes will prove indispensable to those seeking full and accurate information of the Smithsonian Institution.

H. C. B.

Grds.
 A *College Text-book of Chemistry*. By IRA REMSEN. New York, Henry Holt and Co. 1901. Pp. xx + 689.

This book is intended to fill a place between the 'Inorganic Chemistry' and the elementary text-books by the same author. After an introductory chapter, in which some fundamental principles, including the laws of definite and multiple proportions, symbols, and equations, are discussed, six chapters are given to oxygen, hydrogen, water and the atomic theory. The remaining elements are considered in the following order of the families of the periodic system: Chlorine, nitrogen, carbon, lithium, glucinum, aluminium, copper, zinc, gallium, germanium, chromium, manganese, iron, platinum. Two short chapters on carbon compounds close the book. At appropriate points, topics pertaining to theoretical chemistry are taken up, such as the periodic law, mass action, dissociation, osmotic pressure, Faraday's law and atomic heats.

While President Remsen believes that 'the time has not yet come for the abandonment of the study of elements and their compounds in what some are pleased to call the old-fashioned way,' those subjects which pertain to what is commonly known as physical chemistry receive a fair degree of attention. Not only are the fundamental theories of solutions discussed in detail in two or three places, but several applications of the theory are considered in con-

nection with individual compounds. The great importance of such a reiteration of fundamental principles is, of course, clearly recognized by all successful teachers.

The laboratory study which the author intends should accompany the use of the text is indicated by a series of experiments at the close of the successive chapters. A few quantitative experiments are included. The subjects for experimental illustration are mostly well selected, but the addition of some work, demonstrating the fundamental properties of solutions is needed.

The book, as a whole, is written in that clear and fluent English which is so characteristic of the author and which has done so much to make him one of the greatest of the teachers of chemistry.

W. A. NOYES.

SCIENTIFIC JOURNALS AND ARTICLES.

The American Naturalist for November opens with an article on 'The Parasitic Origin of Macroergates among Ants,' by W. M. Wheeler, in which the writer describes the occurrence of certain monstrous workers of the genus *Pheidole* caused by the presence of a parasite of the genus *Mermis*. These macroergates are compared with phenomena observed among other species, the author concluding that the character of the adult ants is not due to the efforts of the attendant workers alone, but also to a certain amount of initiative in the larvæ. H. L. Osborn describes 'Some Points in the Anatomy of a Collection of Axolotls from Colorado, and a Specimen from North Dakota,' these points being wholly external and connected with the change of *Siredon* into *Amblystoma*. 'A Parasitic or Commensal Oligochæte in New England' is described in some detail by M. A. Willcox, and Albert C. Eycleshymer gives some interesting 'Observations on the Breeding Habits of *Ameiurus nebulosus*.' M. Louise Nichols considers 'The Spermatogenesis of *Oniscus Asellus* Lim., with especial reference to the History of the Chromatin,' and George H. T. Nuttall treats of 'The Formation of Specific Anti-Bodies in the Blood, following upon Treatment with the Sera of Different Animals,' giving the results of a series of investigations which

show that, although the bloods of various animals may be mixed, they may be detected and differentiated. The final paper, by W. J. Kent, is on 'The Colors of the Crayfish': red may be caused by exposure to sunlight or by environment, but all other colors are the result of environment and are protective in their nature.

The Osprey for September contains the 'Song Birds of the Kissimmee Valley, Florida,' by Wm. Palmer, 'A Visit to Otter Rock, Pacific Ocean,' by A. G. Prill; 'Notes on the Blue Grosbeak, *Guiraca cerulea*,' by John W. Daniel, Jr.; the tenth instalment of 'William Swainson and His Times,' by Theodore Gill; a second paper on 'The Cage Birds of Calcutta,' by Frank Finn; and the eighth and final chapter of 'The Osprey or Fishhawk: Its Characteristics and Habits,' by Theodore Gill. An editorial on 'Work and Worry for the Classicists' shows some of the numerous troubles in store for those zoologists who propose to abide by the decision of the majority, in regard to nomenclature, at the last international zoological congress.

The Plant World for October contains the second part of 'Notes on Trees of Cuba,' by Valery Havard; 'Some Interesting Cases of Plant Distribution,' by John M. Holzinger; 'The Knubble, Advice to Beginners in Botany,' by Walter Deane; and many briefer articles and notes on current literature. The supplement on the 'Families of Flowering Plants,' by Charles L. Pollard, is devoted to a continuation of the descriptions of the families of the order Sapindales.

The American Museum Journal for October should be in demand by ornithologists, for it has for supplement a twenty-four-page 'leaflet' devoted to the Bird Rock Group recently placed on exhibition. This is by Mr. Chapman, and is admirably illustrated by reproductions of the group and of the real Bird Rock whose bird life it so well represents. The *Journal* proper contains notes on the summer's work of the various field parties of the Museum, and on the recent acquisitions.

Journal of Physical Chemistry, October. 'On the First Plait in van der Waals's Free Energy

Surface for Mixtures of Two Substances,' by Ch. M. A. Hartman (Physical Laboratory, Leiden). This contains a review of the investigations referring to binary mixtures and a bibliography. 'A New Proof of the Formula $d = \frac{.02 T^2}{L}$,' by Felix Lengfeld. 'The Influence of Electrical Waves on Chemical Action,' by Felix Lengfeld and James H. Ransom. 'On the Dielectric Constants of Pure Solvents,' by Herman Schlundt. The work of Dr. Schlundt was carried out under the supervision of Professor Kahlenberg, of the University of Wisconsin, and while a number of new examples have been found which follow the Nernst-Thomson rule, that the greater the dielectric constant of a solvent the greater is its dissociating power, some striking exceptions have also been found, from which it is argued that the rule is inadequate.

SOCIETIES AND ACADEMIES.

CALENDAR.

The American Association for the Advancement of Science. A meeting of the council will be held at the Quadrangle Club, University of Chicago, on the afternoon of January 1. Section H (Anthropology) will meet at the Field Columbian Museum, Chicago (December 31 and January 1). The next regular meeting of the Association will be held at Pittsburg, Pa. (June 28 to July 3). A winter meeting is planned to be held at Washington during the convocation week of 1902-3.

The American Society of Naturalists will hold its annual meeting at the University of Chicago (December 31 and January 1). In conjunction with it will meet the Naturalists of the Central States and several affiliated societies, including The American Morphological Society (beginning on January 1; The American Physiological Society (December 30 and 31); The American Psychological Association and the Western Philosophical Association (December 31 and January 1 and 2); The Society of American Bacteriologists (December 31 and January 1), and The American Association of Anatomists (December 31 and January 1 and 2).

The American Chemical Society will meet at the University of Pennsylvania, Philadelphia (December 30 and 31).

The Society for Plant Morphology and Physiology will hold its fifth annual meeting at Columbia University, New York City (December 31 and January 1 and 2).

SECTION OF ASTRONOMY, PHYSICS AND CHEMISTRY OF THE NEW YORK ACADEMY OF SCIENCES.

THE Section met on the evening of November 4.

Dr. S. A. Mitchell gave a very interesting report of the recent Eclipse Expedition to Sumatra. Numerous lantern slides were exhibited, showing the arrangement of the apparatus at the different stations. The paper is given in full in SCIENCE.

Professor William Hallock gave a report of some recent work on underground temperatures.

Dr. L. Boroschek gave an account of some work he had undertaken in connection with Dr. Tufts on the absorption of light by some dyes of the fluorescein group. The dyes studied were fluorescein and a number of its nitro-derivatives. It was stated that Hewitt and Perkins (*Journal Chem. Soc.*, 1900, page 1324) claim that a double symmetrical tautomerism furnishes a satisfactory explanation for the fluorescence of fluorescein, and that in the case of dinitro- and tetra-nitro fluorescein this tautomerism is inhibited by a secondary tautomerism between the nitro and hydroxyl groups when in ortho position to each other. It was found that the mononitro-fluoresceins, obtained by condensing the 3-nitro- and the 4-nitro-phthalic anhydrides with resorcin, in which the nitro group is on a different benzol nucleus from the hydroxyl groups, show no fluorescence in alkaline solutions. According to the theory of Hewitt and Perkins alkaline solutions of such dyes should fluoresce. Photographs of the absorption spectra of alkaline solutions of the dyes were taken, and it was found that the substitution of nitro groups displaces the prominent absorption band of fluorescein towards the red end of the spectrum and increases the absorption in the ultra-violet. The absorption of light in the visible spectrum was studied by means of the flicker photometer.

The amount of light transmitted by equal thicknesses of solutions of different concentrations was measured for the different dyes. A relation was thus obtained between the absorption of light and the concentration of the dye. The work is still in progress. F. L. TUFTS,
Secretary.

SECTION OF ANTHROPOLOGY AND PSYCHOLOGY OF THE NEW YORK ACADEMY OF SCIENCES.

THE first sectional meeting of the season was held on October 28, Professor Farrand in the chair. The names of Robert MacDougall and J. E. Lough were proposed for membership.

Professor J. McK. Cattell made a brief report regarding psychology at the Denver meeting of the A. A. A. S.; and Professor G. G. MacCurdy, of Yale University, reported on anthropology at that meeting, and in addition described the explorations that are being carried on in the Mesa Verde of southwestern Colorado by the Colorado Cliff Dwellings Association.

Professor Franz Boas described the facilities for anthropological study in Berlin, as observed by him in a recent visit. Within the last 20 or 30 years, the anthropological equipment of Berlin has progressed enormously. The museum now contains better East Indian collections than can be found in England; and it is strong in nearly all departments, notably so in American and especially South and Central American anthropology. Fifty scientific workers are engaged on these collections, and 16 of these are at work on American subjects. Besides the museum, there are several other institutes in Berlin, such as the Anatomical Institute of Waldeyer and the Pathological Institute of Virchow, in which anthropological work is done.

The leader of German anthropology is Virchow. He disbelieves in the study of the variation of the whole body, and insists that only the study of the variation in the individual cells of the body can lead to fruitful results.

Reports of summer field work were presented by H. H. St. Clair, 2d, on his work in Wyoming and Oregon, and by William Jones, on his work in Iowa and Oklahoma. The work of Mr. Jones was carried on among the Sauks and Foxes, a people of Algonquin stock. One band of this

people is located in central Iowa, and another in Oklahoma. Both bands practice similar customs, live in much the same way, wear the same kind of dress, show similar physical types, and, with the exception of certain differences in idiom, and with the exception that the Iowa band have a slower, more deliberate pronunciation, they speak the same tongue. The Iowa band is the more conservative, and among them the law of the clans still holds. The education of the children is accomplished not by instruction but by imitation. The older boys imitate the men, and the younger boys imitate the older ones; and similarly with the girls. The life of the children is but a smaller edition of the life of the older people. R. S. WOODWORTH,

Secretary.

TORREY BOTANICAL CLUB.

At the meeting of the Club on November 12, the first paper was by F. S. Earle, on '*Asco-corticium* in North America,' correcting the current nomenclature as to this genus, details of which will shortly appear in print.

The second paper, by Dr. Britton, 'Remarks on the Flora of St. Kitts, British West Indies,' was a sketch of his recent observations there, with copious series of herbarium sheets, and of fruits and other specimens in alcohol. Scarcely any botanical work had been done on St. Kitts previous to its exploration by Dr. Britton and Mr. John F. Cowell last summer. In all they collected about 3,500 herbarium specimens, representing perhaps half of the flora. Many tree-ferns were brought which are now making good growth, and a great number of cacti which are already on exhibit in the succulent house of the New York Botanical Garden.

Dr. Britton spoke in particular of the great interest attaching to that purely tropical flora, its aspect wholly dissimilar from that of our Atlantic coast except only in the presence of the introduced Horseweed, *Leptilon*. St. Kitts is a volcanic mass, formed of a rugged central mountain rising to about 4,000 feet, dissected by radiating gorges which reach to the sea, and wholly surrounded by a fringe of arable land on the shore. Steep ravine-sides 300 feet deep were often completely covered with a prodigious growth of tree-ferns; there were four or five spe-

cies in the ravines and one or two more in the denser forests; some reached a height of 50 feet; another was chiefly prostrate. A good number of the filmy ferns were found; perhaps ten; and many *Gleichenias* at high altitudes, where ferns constitute the chief flora. No *Equiseta* were found; among the Lycopods, a species of *Psilotum* on tree-trunks, some large and handsome *Selaginellas*, and three *Lycopodiums* occur, of which one conspicuous species was known to the negroes as 'Staghorn.' The grasses number 30 or more, the largest a *Gynerium* known as Wild Cane or Dumb Cane. Guinea-grass, *Panicum maximum*, is the only source of hay. Sedges were few, for there is little standing water (except a littoral salt-marsh); only a little pond near a mountain summit at 3,500 feet, and a little lake in the bottom of the old crater of the volcano, Mt. Misery. *Sclerias* with saw-edged leaves were quite abundant and form an obstacle on mountain-trails.

Aroids are very conspicuous, and in great quantity, but only about eight species; two of *Anthurium*, climbing trees, two of *Philodendron*, one with perforated leaves; one *Dieffenbachia*; and a species known as Elephant's Ear, forming great masses, with leaves sometimes five feet long.

Only two palms were found, one, a *Bactris*, reaching 30 feet; two *Commelynas*; three or four *Tillandsias*; a *Dioscorea* with remarkable purple leaf, now growing in the propagating house; about sixteen orchids; and one gymnosperm, a *Podocarpus*, abundant high up, and known as 'wild rosemary tree.' Among higher plants the pepper peppers, the Papilionaceæ and allies, the *Euphorbia* and *Melastoma* families, are numerous. The Compositæ are numerous present, but chiefly as weeds; a handsome new purple-flowered *Eupatorium* was found on the top of Mt. Misery, forming a shrub, and eight to ten feet high. The alligator-pear, *Persea Persea*, is quite abundant. There are four species of *Ficus*, a wild cherry, a *Viola*, etc. A raspberry occurred in a mountain pasture at 2,000°. Among the more peculiar were the *Cecropia*, with white under surfaces of leaves, *Marcgravia* climbing appressed to trees to the height of 50 feet, and *Hillia*, interesting from its large lustrous white flowers.

The results of Dr. Britton and Mr. Cowell's expedition bid fair to prove of high economic importance aside from their scientific value. The expedition owed much to the kind assistance of the planters, who detailed their negroes and horses for the service of the explorers. Without such aid, it would have been difficult to penetrate the forest belt, through which trails had first to be cut.

Further remarks were added by Dr. Underwood regarding a dodder in tops of trees in Porto Rico; by Mr. J. H. Barnhart, on an epiphytic *Utricularia* among the specimens from St. Kitts exhibited; by Mr. F. S. Earle, on the few fungi collected; and by Mrs. Britton, on the other cryptogams, which numbered 81, and included a *Vittaria* prothallium.

EDWARD S. BURGESS,
Secretary.

ANTHROPOLOGICAL SOCIETY OF WASHINGTON.

THE 321st meeting of the Society was held on November 5. Professor W. H. Holmes read a paper on the 'Discovery of Human Relics and the Bones of Extinct Mammals in a Sulphur Spring, Indian Territory,' an abstract of which will be published in SCIENCE. This paper was discussed by Dr. W. J. McGee, Jos. D. McGuire, F. W. Hodge, Francis La Flesche and others.

Miss Alice C. Fletcher gave an account of 'The Inauguration of the New Department of Anthropology, University of California,' through the munificence of Mrs. Phoebe A. Hearst. For ten years Mrs. Hearst has been gathering museum material, spending fifty thousand dollars a year on its acquisition and looking forward to a time when the collections might be housed in a museum building. Last summer the project took form, resulting in the establishment of the Museum at the University of California with a handsome endowment, the details of which appeared in SCIENCE, October 18, 1901.

WALTER HOUGH.

DISCUSSION AND CORRESPONDENCE.

THE GEOGRAPHICAL DISTRIBUTION OF FISHES.

IN SCIENCE for November 1, Professor A. E. Ortmann offers some very interesting notes on

my paper (in SCIENCE, October 11) on the geographical distribution of fishes. On the points raised I may add a word.

1. There is little or nothing in the present relations of the fish fauna of Japan to that of the Mediterranean to suggest a former connection through a warmer climate to the northward. The forms common to the two regions are chiefly of Indian and rather deep water distribution. One curious anomaly occurs, the existence of a second species of the large trout, *Hucho*, in Japan, the other known species being in the Danube.

2. The views of Dr. Ortmann as to the faunas separated by the Isthmus of Suez and the Isthmus of Panama seem to agree with those expressed by me. Of course, from the standpoint of ichthyology, no one could say when either oceanic connection actually existed. That is a matter for geologists.

3. The fish fauna of the Cape of Good Hope is imperfectly known, that of the southeastern coast of Africa still less. It is certain, however, that some tropical or semitropical genera do pass this barrier at present. In other ages the Cape might conceivably have been less of a barrier through less extension or through warmer climate at its extremity. This again rests with the geologists.

4. I am willing to accept the theory of the former extension of the continent Antarctica on geological grounds, and the known distribution of *Galaxias* would be explained by it. But the case of *Galaxias* would not of itself prove such extension, and the value of zoological evidence in such cases is easily overestimated.

DAVID STARR JORDAN.

PREGLACIAL DRAINAGE IN SOUTHWESTERN OHIO.

TO THE EDITOR OF SCIENCE: In his reply (November 15) to Mr. Miller's criticism of my papers on preglacial drainage conditions in the vicinity of Cincinnati, Professor Tight should have added that every one of the smaller streams mentioned by Mr. Miller, in proof of his theory, is of *postglacial* origin and consequently has no bearing on the question.

A view up and down the Ohio from the hill-top at either Madison or Leavenworth, Indiana,

will convince any one at all familiar with such features that he is on the crest of a high watershed which has been cut through in very recent times; recent, that is, in comparison with the period of the alluvial valleys up and down the stream from his point of observation.

GERARD FOWKE.

THE SENEGAL BAOBAB TREE.

It is said by travelers that the fruit of the Senegal Baobab tree is used by the natives to curdle milk. As it is also called 'sour gourd' and cream-of-tartar tree, the curdling is probably due to an acid; and other vegetable acids are also known to be so used. But it seems that other vegetable products that are not acid will also curdle milk. In northern Mexico I was once served with a palatable dish of cooked 'cheese' that the mistress of the house told me she had herself curdled with the juice of berries, some of which she showed me. They were fruit of a *Solanum*, apparently *S. heterodoxum*. She was an intelligent woman, and spoke of that use of the berries as a common custom in Mexican families. Like other fruits of the nightshade family, they had no perceptible acid taste; and the curd which they produced had a consistence similar to that which is produced by rennet. Possibly the action upon milk of the juice of that and other non-acid fruits is similar to the action of rennet, which is thought by some investigators to be a kind of ferment.

C. A. WHITE.

Ind.
SHORTER ARTICLES.

THE LARGEST DEEP-SEA FISH.

DURING the cruise of the *Albatross* in 1888 in the Pacific Ocean, a fish nearly five feet long was hauled up in a trawl cast in water of the depth of over 1,000 fathoms. Unfortunately it was thrown overboard, but happily not before a photograph was taken of it. Mr. Townsend has ever since hoped to have another chance to secure the species, but without present hope. It became desirable to make allusion to the species at this time, and he has conferred with Dr. Gill and asked to indicate its probable affinities.

The species appears to be most nearly related to *Percophis*, and for the present it may be as-

sumed that such is the case, but it is by no means certain that it is. It is deserving of the generic name *Macrias* with reference to its length as well as bulk, and the specific name *amissus* is appropriate for it as an stray from its relatives as well as to indicate the loss of the type. It is definable as follows:

MACRIAS.

A genus of Percophoid fishes with moderately oblong head, eyes in the second fourth of the head's length, slightly projecting lower jaw, thick lips, small teeth, small jugular ventrals and anal with origin behind that of second dorsal.

MACRIAS AMISSUS.

The body is elongate and between five and six times longer than high; the head forms more than a fourth ($1:3\frac{4}{5}$) of the extreme length; the caudal about a seventh. The head is oblong conical in profile, with the forehead nearly rectilinear; the eyes are in the third eighth of the length, with the diameter equal to about an eighth of that length, and nearly midway between the preoperculum and the front of the jaw; the mouth is quite oblique and the supra-maxillary extends scarcely behind the front of the eye; the teeth appear to be cardiform; the lips thick. The dorsal rays are not sufficiently defined to count exactly, but they approximate the following formula: *DXI*—19.

The specimen was obtained at the *Albatross* dredging station 2788, off Chonos Archipelago, southern Chili, S. A. (Lat. S. $45^{\circ} 35'$, Long. W. $75^{\circ} 55'$), at the depth of 1050 fathoms; bottom green mud; bottom temperature, 36° F.; surface temperature, 58° F.; from an 11-foot beam trawl, Feb. 11, 1888. The dredge haul lasted three hours.

The fish was about five feet long, and is the largest deep-sea fish taken by the *Albatross*—probably the largest ever taken by beam trawl or dredge. Its color was grayish. It had the softness of flesh characteristic of deep-sea fishes, settling down on the deck so that its natural contour does not show in the large 8 x 10 photograph that was at once made of it.

There being no receptacle available for preserving it in alcohol, it was placed in a cask and salted. Later the cask and specimen were un-

fortunately thrown overboard with some rubbish from the ship laboratory.

The exact measurements of the specimen will be given later when the photograph is reproduced by the Fish Commission.

THEO. GILL,
C. H. TOWNSEND.

CURRENT NOTES ON METEOROLOGY.

HAIL PREVENTION BY CANNONADING.

THE hail prevention cannonading craze has gone very far in Windisch-Feistritz (Steiermark), the home of this newest undertaking for artificially controlling weather phenomena. In *Das Wetter* for October Dr. Friedrich Stengel, who has recently visited the locality, gives an enthusiastic account of the somewhat remarkable arrangements which have been made for this work. The huts containing the firing apparatus are 1 km. apart, in four long parallel rows, the rows also being 1 km. apart. There are three groups of stations, containing twelve, thirteen and fifteen stations each, respectively. Each section has a central station, under the charge of a *schliessmeister*, and each *schliessmeister* is directed by the general superintendent. Cannonading begins when a thunder-storm is within two or three kilometers. Sometimes only one of the sections fires; at other times all the stations participate. Firing continues until the sky begins to clear overhead, or, if this does not happen, until thunder and lightning cease and a general rain sets in. The central station of each section regulates the time of the beginning and ending of the firing, as well as the rapidity of the discharges.

THE DUST STORM OF MARCH, 1901, AND GLACIAL STUDIES.

In the October number of the *Meteorologische Zeitschrift*, Richter calls attention to the use that may be made of the fall of red dust which occurred over most of Europe on March 11 last. It was suggested some time ago that studies of glacial movements and phenomena might be facilitated by coloring a considerable portion of the surface of a glacier, and then noting the rapidity of movement, and the folding and fracturing of this particular colored stratum. The dust storm of last March colored the Euro-

pean glaciers on a grand scale, and thus an excellent opportunity of making critical studies of these glaciers has been provided, which could never have been brought about by artificial means.

THE CLIMATIC CONTROL OF GOVERNMENT IN THE TROPICS.

MR. W. ALLEYNE IRELAND, who is well known in this country through his writings on the settlement and government of tropical possessions, read a paper on the influence of geographical environment on political evolution before the British Association at its Glasgow meeting. In this paper the possibilities of native government within the tropics are discussed. The conclusion is reached that while the natives of the tropics are not deficient in intellectual power, their 'climatic discipline' renders them unfitted to play the part of legislators or responsible administrators, or to maintain a government sufficiently stable to admit of proper commercial development.

UNDERGROUND TEMPERATURES AT OXFORD.

THE volume containing the meteorological observations made at the Radcliffe Observatory, Oxford, from 1892 to 1899, presents some notable facts regarding soil temperatures. The observations were made with platinum resistance thermometers, placed at various depths. The thermometers on the whole were found to work much more satisfactorily than the common spirit thermometers with long stems. It appears that the annual variation in temperature is reduced to 0.1° at a depth of 45.3 ft., and to 0.01° at 66 ft. The semi-annual wave has these same limits at 21.4 and at 36 ft., respectively.

R. DEC. WARD.

BOTANICAL NOTES.

IMPORTANT PHILIPPINE WOODS.

UNDER this title Captain George P. Ahern, of the Ninth Regiment of United States Infantry, has issued a small quarto volume of 112 pages, illustrated with forty-two colored plates. The author, who is in charge of the Forestry Bureau at Manila, candidly states that it is a compilation undertaken in response to numer-

ous inquiries concerning the Philippine forests. In its preparation he has made use of the works of Blanco, Vidal, Delgado and Garcia. The translations are rather awkward, indicating a lack of botanical knowledge on the part of the translator. The plates are mainly from Blanco's 'Flora de Filipinas' and Vidal's 'Sinopsis de Familias y Generos de Plantas lenosas de Filipinas.'

More than six hundred species of trees are now enumerated for the archipelago, and it is estimated that there are from twenty to forty millions of acres of forests still standing, in which there are in many places trees one hundred and fifty feet in height. Gum, rubber, gutta percha and dye-producing trees occur in abundance, as also those producing timber, firewood, textiles, oils, tan-bark, medicines and edible fruits.

In many cases these forests are at present inaccessible on account of the lack of waterways and good roads. The methods of the natives are crude, slow and expensive. When good roads are made and better methods are introduced the islands will be able to supply a large amount of timber for construction, for which there is a great demand throughout the Orient.

RECENT ECOLOGICAL PAPERS.

THREE recent papers are noted here, the first of which is by Professor Doctor Bray of the University of Texas, on the 'Ecological Relations of the Vegetation of Western Texas,' published in the August, September and October numbers of the *Botanical Gazette*, in which the author points out the fact that the region is the meeting ground of no less than eight floral elements, and that the flora is one of xerophytic aspect. Excellent half-tone illustrations add much to the clearness of the text. The second paper is by A. J. Pieters, assistant botanist in the United States Department of Agriculture, on 'The Plants of Western Lake Erie,' in the *Bulletin* of the United States Fish Commission. Here it is shown that the vegetation may be grouped as follows: (1) Free-swimming, microscopic forms in the open lake—*i. e.*, the plankton; (2) other unattached species, mainly macroscopic, as *Lemna utricularia*, etc.; (3) attached submersed plants, as *Najas*, *Chara*, *Cladophora*, etc.; (4) attached plants with floating leaves, as

Nymphæaceæ and *Potamogeton*; (5) swamp plants. Here again excellent half-tone illustrations are used with good effect. The third paper is by Thomas H. Kearney, of the Division of Botany of the United States Department of Agriculture, on a botanical survey of that very interesting region, the Dismal Swamp of southeastern Virginia. After a discussion of such factors as climate, physiography, geology and soils, the plant covering is described at length, and the conclusion is reached that of the indigenous species (about 620) 'over five hundred are endemic in extra-tropical North America, the great majority in the country east of the Rocky Mountains.'

GOVERNMENT GRASS STUDIES.

THE Division of Agrostology was established in the United States Department of Agriculture in 1895 for the purpose of investigating the various problems relating to the grasses and forage plants of the country. After six years of existence a bulletin has been issued presenting a summary of the work accomplished, under the title of 'Field Work of the Division of Agrostology,' and prepared by Cornelius L. Shear. Maps show at a glance the territory covered by the various field workers, and no botanist can examine these without gratification that so much has been done in half a dozen years. The greatest amount of work has been done in the Gulf States from Florida to Texas, thence northward over the Great Plains and the eastern Rocky Mountain region to the international boundary. Twenty-seven different botanists have been engaged in these field studies.

In the Atlantic coast states the investigations included, in addition to the usual one of forage, the study of grasses as sand-binders, and much attention was given to this part of the subject. In the States of the Gulf coast the forage problems are more difficult of solution, the soil having been exhausted in many places, and the people having the impression that grasses for forage purposes cannot be grown here as well as in the North. The fact that between 300 and 400 species grow naturally in this region disproves the latter, and the results of experiments show

that on almost any soil some grasses may be grown with profit. On the Great Plains, although the region is so vast, the problems are less varied, since the conditions are more nearly similar throughout. Here to a great extent the problem is the preservation of the natural pastures and meadows, and their renovation where they have been injured by overpasturing or by the plow. Over a great part of this region the natural meadows should be allowed to remain, and the plow should not be permitted to disturb the well-set sod. In the Rocky Mountains the conditions are extremely varied, and the problems are accordingly more numerous. In many places the natural meadows must be preserved, while in others, as under irrigation, grasses especially suited to the new conditions must replace the scanty growth which preceded them. A new problem obtrudes itself here, viz., that of forage plants for the 'alkali soils.' The problems in the Northwest include the last mentioned (apparently solved by the growth of species of *Atriplex*), and the renovation of the natural pastures which have been overstocked. In the Southwest some interesting facts are brought to light, as that as soon as the prairie fires are stopped the mesquite tree (*Prosopis*) and the prickly pear cactus (*Opuntia*) increase very rapidly, while at the same time the extermination of the coyotes allows the rabbits and prairie dogs to increase to such a degree as to make them most serious pests. On the Pacific coast the work has included the problem of the control of shifting sands in addition to studies of pasture and meadow grasses.

In the course of these investigations much valuable material for scientific study has been obtained, and great quantities of seeds of the more important species have been secured for distribution and trial elsewhere in the country. Above forty bulletins have been issued by the division, ranging from quite popular to technically scientific. No one can look over the work done, as indicated in this bulletin, and not feel that Secretary Morton did a good thing when he established the Division of Agrostology, and that it has fully justified its existence.

CHARLES E. BESSEY.

THE UNIVERSITY OF NEBRASKA.

THE SOUTH AFRICAN MUSEUM.

THE report of the South African Museum for 1900 may be styled a record of good work performed under adverse conditions, for the war in South Africa has affected the museum in more ways than one, lessening not only the number of contributors to the collections, but the number of visitors. This falling off is the first break in a steady increase that has been going on for a considerable period. The accessions of vertebrates have been principally of birds, but one example of the young of the rare cat *Felis nigripes* was obtained in a rather curious way, it having run into the trenches at Zand River during a hot engagement.

Two of the contributors to the museum, Mr. Walter Francis and Dr. A. C. Stark, have been killed during the war; the latter was engaged in the preparation of a work on the birds of South Africa, the first volume of which had appeared. The second volume has been completed by the director, Dr. W. L. Sclater, and is now in press. Dr. L. Peringuey has sent to the printer the first part of a descriptive catalogue of the *Scarabeidæ*, and states that the manuscript of the second part is well advanced. The second volume of the *Annals* of the museum is well along and all the collections are said to be in good shape, and we hope with Sir David Gill that the time may soon come when it will be possible to increase the small appropriation made for the maintenance of this museum.

F. A. L.

SCIENTIFIC NOTES AND NEWS.

DIRECTOR W. W. CAMPBELL, of the Lick Observatory, was elected a foreign associate of the Royal Astronomical Society at the meeting of November 9.

MR. ALEXANDER AGASSIZ, accompanied by Mr. W. McM. Woodworth, has undertaken an expedition to the Maldiv Islands in the Indian Ocean, in order to study the coral formations. A steamboat for this purpose has been chartered at Ceylon.

PROFESSOR F. LAMSON SCRIBNER, chief of the Division of Agrostology of the United States Department of Agriculture, has been given charge of the Bureau of Agriculture which is to

be organized in the Philippines. Professor Lamson-Scribner will sail for the Philippines with his family on February 1.

MR. EDWIN REYNOLDS, of Milwaukee, has been elected president of the American Society of Mechanical Engineers.

DR. JOSEPH LARMOR, lecturer in mathematics in Cambridge University, has been nominated by the council as junior secretary of the Royal Society.

PROFESSOR WILLIAM B. SCOTT, Blair professor of geology at Princeton University, has returned from his visit to the Argentine Republic, where he spent six months in investigations preparatory to his work in publishing the reports of the Princeton Patagonian expeditions.

PROFESSOR E. W. MORLEY, professor of chemistry in Adelbert College, has returned from Paris, where he went to be present at the International Conference of Weights and Measures during October.

DR. MAXWELL SOMMERVILLE, professor of glyptology in the University of Pennsylvania, has returned from an expedition to the Orient. He has brought with him valuable collections, which will soon be added to the great collection which he presented to the museum several years ago.

D. I. BUSHNELL, JR., has returned from St. Louis, where he explored a number of small mounds in that part of Forest Park that is to be occupied by the Fair in 1903. A knowledge of them is thus secured before their total destruction.

AN oil portrait of Dr. Edward G. Janeway was unveiled at the anniversary meeting of the New York Academy of Medicine on November 26. An address was given by Dr. R. H. Fitz, of Harvard University, whose subject was 'Some Surgical Tendencies from a Medical Point of View.'

DR. HERMAN STRECKER, a sculptor and entomologist, died at his home at Reading, Pa., on November 30, aged sixty-five years. Dr. Strecker was the author of a work on 'Native and Exotic Butterflies and Moths,' and owned a collection, said to contain 375,000 specimens.

THE little son of Professor T. D. A. Cockerell died at East Las Vegas from diphtheria on November 25. Though only eight years old, he had made a number of little discoveries of his own. Thus he discovered the larva of *Picris occidentalis*, and raised the butterfly. He also found the first psocid recorded from New Mexico, and collected at least three new insects: a new bee of the genus *Epeolus*, described by Professor Cockerell; a new meloid beetle, now in the National Museum, not yet described; and a new grasshopper of the genus *Melanoplus*, described by Mr. Scudder, and about to be published.

SIR WILLIAM MACCORMAC, the eminent British surgeon, died on November 4, at the age of sixty-five years.

M. GUILLAUME TIBERGHEN, for fifty years professor of philosophy in Brussels University, died on November 28, aged eighty-two years.

THE death is also announced of Dr. Federico Horstman y Cantos, for forty years professor of anatomy in, and for a long time dean of the Medical Faculty of, the University of Havana.

AN examination will be held on January 21, to fill the position of assistant in the Division of Entomology, U. S. Department of Agriculture, at a salary of \$1,200 a year. The chief subject is the economic entomology of the orchard.

THE executive committee of the trustees of the Washington Memorial Institute met at Washington on December 7.

AT a meeting of the council of the Royal Society on November 7, the following resolution was passed: "That in the opinion of this council it is desirable that the secretaries should not be so re-elected as to hold office for a period exceeding ten consecutive years, this resolution not to apply to the present holders of office." A memorial supporting this resolution was signed by 130 fellows, a counter-memorial having the support of less than thirty.

THE twenty-fifth general meeting of the American Chemical Society will be held at Houston Hall, University of Pennsylvania, Philadelphia, Pa., December 30 and 31, 1901. The opening session will be called to order at 10 a. m., Monday, December 30. The visiting

chemists will be welcomed by Dr. J. Merritt Matthews, chairman of the Philadelphia Section; the provost of the University of Pennsylvania, and a representative of the City Government. President F. W. Clarke will address a few words in response. The remainder of the forenoon will be devoted to the reading and discussion of papers and general business. In the afternoon there will be visits to points of special interest under the direction of the local committee. In the evening the address of the retiring president will be delivered at the Acorn Club, 1618 Walnut Street, after which a reception will be given to the members of the Society and their ladies. On Tuesday, a session of the Society will be held in the forenoon. The afternoon will be devoted to visits and excursions, and in the evening there will be a subscription banquet. A meeting of the council will be held at such time and place as may be appointed by the president. The local committee expects to arrange a 'smoker,' if there is opportunity to do so. The committee has not been able to secure special transportation rates, but those who expect to attend may avail themselves of the regular holiday rates which prevail on some of the roads during this season.

DIRECTOR W. W. CAMPBELL, of the Lick Observatory, made public the following report on December 6: "On account of unfavorable conditions observations of the interesting nebula surrounding the new star in Perseus were not obtained for several weeks. The clear sky of last night, just preceding to-day's storm, was taken advantage of by Professor Perrine to secure a photograph of it with the Crossley reflector, exposure five and a half hours. The extraordinary motion in the nebula, discovered by him on November 10 and confirmed by Ritchie, of Yerkes Observatory, on the day following, continues unchanged for the two principal condensations. They have moved outward certainly more than half a minute of an arc in the last three weeks. The third condensation has greatly changed its form, but nevertheless its motion outward appears to continue. The strong mass of nebula nearest the star seems to remain unchanged, both in position and appearance."

A PEARSON CLUB has been organized recently by members of the faculty of the University of California for the discussion of fundamental problems of science suggested by Karl Pearson's 'Grammar of Science.' The membership of sixteen includes representatives from the departments of biology, geology, mathematics, philosophy and physics.

A DESPATCH to the London *Times* from Littleton, New Zealand, states that the National Antarctic Exploration ship *Discovery* arrived here November 29. All on board were well and in good spirits. They state that they entered the pack-ice in lat. 63.5 and long. 141 E., but pressure of time prevented a thorough investigation of the ice. Interesting collections were, however, made during the voyage. A party landed on Macquarie Island for a few hours, obtaining some live penguins, some eggs and some seals. The *Discovery* has been dry-docked for caulking, having sprung a leak, though not a serious one. When the *Discovery* continues her voyage, which will probably be in a fortnight, she will take with her a supply of meat presented by the Canterbury stock farmers.

THE Liverpool School of Tropical Medicine has sent a special expedition under Dr. Charles Balfour Stewart, to the Gold Coast and to the gold-mining districts of that colony, to conduct a series of operations there with a view to improving the conditions of health and sanitation.

THE Russian Pharmaceutical Society, Moscow, has celebrated with appropriate ceremonies the two-hundredth anniversary of the opening of the first free pharmacy in Russia.

THE courts have decided in favor of the ruling of the Treasury Department, which excluded an Irish immigrant suffering from tuberculosis.

THE egg of the great auk continues to bring a large price whenever chance brings one into the market, and the last was sold at the noted auction rooms of J. C. Stevens, London, for 240 guineas. This egg was the last of four owned by the late Baron D'Hamonville, and was peculiarly marked with inky lines and blotches. It was purchased by Mr. Massey, who some years ago paid the record price, 315

guineas, for what is thought to be the best egg of the great auk extant.

THE large tusk of an African elephant, recently noted in SCIENCE as having been purchased by the British Museum, is said to be one of the two shown by Messrs. Tiffany & Company at their rooms in New York. These tusks, whose measurements and weight were given in SCIENCE and have also been noted in Mr. Lucas's 'Animals of the Past' will probably continue to hold the record for elephant tusks.

PRESIDENT FRANCIS, of the Louisiana Purchase Exposition Co., states that the "Washington University site will be enclosed within the limits of the fair grounds, and all the new buildings will be used for the purposes of the exposition. The university grounds comprise about 110 acres, and upon them have been erected during the past two years educational buildings which have cost approximately \$1,000,000. None of these buildings is yet completed, but all now in course of construction will be finished within the next six months. The exposition company will give liberal compensation to the University for the use of its grounds and buildings, but the entire consideration for such use will be put into the erection of additional buildings, and into the embellishment of the grounds for the use of the exposition, thus affording unparalleled advantages for an educational exhibit."

At the meeting of the Zoological Society of London on November 19, Professor E. Ray Lankester, F.R.S., read a memoir on the new African mammal *Okapia johnstoni*. After an account of the history of the discovery of this remarkable animal by Sir Harry Johnston, Professor Lankester gave a description of its skull and skin, based upon the specimens forwarded to the British Museum by the discoverer, and compared its structure with that of the giraffe and the extinct member of the same family, *Helladotherium*. The nearest living ally of the Okapi was undoubtedly the giraffe. Mr. Oldfield Thomas read a paper on the five-horned giraffe obtained by Sir Harry Johnston near Mount Elgon. It was shown that, although the horns were unusually developed, the animal could not be specifically separated from the North-African giraffe, *Giraffa camelopardalis*.

This latter was believed to grade uniformly in the development of the horns and other characters into the South African form, which would therefore be only a subspecies, *G. c. capensis*. On the other hand, de Winton's *G. c. reticulata* (from Somaliland) seemed to be sharply separated, and therefore to be worthy of recognition as a distinct species, *G. reticulata*. With regard to the accessory horns, it was shown that they, or rudiments of them, existed in all male giraffes, even in the southern subspecies.

THE Davenport Academy of Sciences has arranged a course of popular scientific lectures as follows:

January 4—'The Snake Dance of the Mokis': DR. J. WALTER FEWKES, Bureau of Ethnology, Washington, D. C.

January 11—'The Degenerates of Animal Society': PROFESSOR HENRY B. WARD, The University of Nebraska.

January 18—'The Glacial Period in Iowa': PROFESSOR SAMUEL CALVIN, The State University of Iowa.

January 25—'Some Remarkable Members of an Ancient and Highly Distinguished Family': PROFESSOR THOMAS H. MACBRIDE, The State University of Iowa.

February 1—'The Aztecs of Ancient Mexico': PROFESSOR FREDERICK STARR, The University of Chicago.

— 'The Bottom of the Sea': PROFESSOR C. C. NUTTING, The State University of Iowa.

UNIVERSITY AND EDUCATIONAL NEWS.

MR. ANDREW CARNEGIE has offered to give \$10,000,000 to the United States for the purpose of establishing in Washington a national university.

MRS. JANE L. STANFORD completed the transfer to Leland Stanford Junior University, on December 9, of property, consisting of stocks, bonds and real estate, said to be worth approximately \$30,000,000.

MR. JOHN D. ROCKEFELLER has offered to give Bryn Mawr College \$230,000 for the erection of a new dormitory building and a central heating and electric light plant, conditional upon the trustees of the College being able to secure by commencement day, in June, 1902, pledges for the additional sum of \$250,000 needed for a library building. The authorities of the College are taking steps toward raising

the required sum, and President Thomas has already received pledges amounting to \$40,000.

THE University of Pennsylvania has received \$25,000 from Messrs. Keasbey and Mattison for the new medical laboratories, and \$5,000 from Mr. John F. Wentz for the engineering department.

TUFTS COLLEGE receives \$50,000 by the will Mary F. Stearns. The Tuskegee Institute, the Hampton School and Berea College are to divide \$50,000 and the residuary estate.

MR. CARNEGIE promised recently to subscribe £25,000 to the building fund of the Glasgow Technical College on condition that an equal sum was raised from other sources. At the last meeting of the council the chairman announced that he had received two anonymous donations of £25,000 and £10,000 and other sums, making a total of £44,000. The fund, including Mr. Carnegie's subscription, now amounts to nearly £170,000.

THROUGH the generosity of the Frazer family a fellowship in physics (value \$10,000) has been established in the University of Pennsylvania in honor of John Fries Frazer, former professor of natural philosophy in that institution. This fellowship as well as the Hector Tyndale Fellowship in the same subject are now open for application.

THE Thaw fellowship in astronomy at Princeton University, carrying \$500 a year and open to any graduate of not more than five years' standing from an accredited American college, becomes vacant at the close of the present academic year. Applications for it should be sent in before the first of May, addressed to the professor of astronomy.

THE dedication of Cunningham Hall and the Van Wormer Library of the University of Cincinnati will take place in the spring. The building of the Technical School is nearing completion.

THE registration at Harvard University this year and last is as follows :

	1900.	1901.
Harvard College.....	1992	1983
Lawrence Scientific School.....	507	549
Graduate School.....	341	312
Total arts and sciences.....	2840	2844

Divinity School.....	28	37
Law School.....	648	627
Medical School.....	605	506
Dental School.....	126	105
Veterinary School.....	18	...
Bussey Institution.....	33	32
Total professional schools.....	1457	1308
Total University.....	4288	4142

There is thus an increase of 42 students in the Lawrence Scientific School, but a decrease in the other departments, except the Divinity School. The decrease in the Medical School is explained by the fact that this year the bachelor's degree or its equivalent is required for entrance. To the above figures should be added, in order to represent the entire university influence, the following :

	1900.	1901.
Summer schools.....	987	982
Radcliffe College (regular).....	323	334
Radcliffe College (special).....	126	116
Total teachers.....	496	487
Administrative officers.....	97	97
Total University influence.....	6317	6158

To the academic staff of the University of Cincinnati have been added :

C. W. Marx, C.E. (Washington Univ.), recently professor of mechanical engineering in the University of Missouri, professor of mechanical engineering and director of the Technical School.

C. H. Judd, A.B. (Wesleyan), Ph.D. (Leipzig), recently professor of experimental psychology, New York University School of Pedagogy, professor of psychology and pedagogy.

J. E. Ives, Ph.D. (Clark), instructor in physics.

J. F. Snell, A.B. (Toronto), Ph.D. (Cornell), recently assistant in the U. S. Department of Agriculture, instructor in chemistry.

L. L. Waters, A.M., Ph.D. (Columbia), instructor in chemistry.

J. M. Prather, A.B., A.M. (Harvard), Ph.D. (Chicago), recently assistant in Biological Laboratory of the University of Chicago, instructor in biology.

Wm. Osborn, A.M., instructor in biology.

D. T. Wilson, M.A. (Vanderbilt), recently instructor in astronomy in the University of Chicago, instructor in astronomy.

A. B. Griggs, B.S., C.E., instructor in civil engineering.

S. S. Bassler, lecturer on meteorology.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

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FRIDAY, DECEMBER 20, 1901.

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THE NAVAL OBSERVATORY REPORT.

No excuse is necessary for devoting the space we do to this important paper in our present number. We include with it only such portions of the reports of departments as seem to be of general interest. Among these is the very business-like report of the National Almanac Office.

Readers who have followed the discussions of the organization of the observatory which have appeared in our columns during the past year will be interested in this branch of the subject. We trust they will bear with us if we describe the spirit in which we have endeavored to carry on the discussion. We have taken as a fundamental principle that our remarks should be based on official publications and that no heed should be given either to gossip about the interior affairs of the observatory, which circulates so freely, or to supposed leaks through unofficial channels.

The case as thus presented has seemed to us too serious to admit of our indulging in carping, fault-finding or minor criticisms, even had we been disposed to do so. As presented in the report of the board of visitors for 1900 it took the following form : Our government has for more than half

a century been supporting a great national observatory for the promotion of astronomical science. During the last few years this has been done at a cost exceeding that of any other observatory, public or private, in the world. Even the great observatories of Greenwich and Paris, which the two governments have supported in friendly rivalry, do not approach ours in the matter of outlay.

The latter has, at various times during the past twenty years, been reported upon, officially and unofficially, by the highest scientific authorities in the land. Only one voice is heard in these reports. The work of our observatory, considered as a whole, does not come up to any standard of which our country can be proud. The Greenwich and Paris observatories are the pride of their respective nations; ours can inspire no such sentiment. On the cause of this failure the expressions are also unanimous. No reflection is ever heard upon the staff of the institution, which has always been and still is of the ablest. But this alone does not fulfil all the requirements of success. The best instruments and a well-arranged plan of work are also necessary. Above all, the work must be directed with that familiarity with the multifarious details of modern astronomy which our own good sense, as well as the experience and practice of all other nations, show to be necessary to success.

Secretaries of the navy have joined their voices with those of the scientific authorities in calling attention to this want, and asking that it be supplied. But Congress has never made provision for a director of the

observatory, and the work has suffered, and still suffers, in consequence.

Desirous of seeing to what extent the observatory had replied to all these criticisms, we made a careful study of its reports during the last ten years. It required no knowledge of technical astronomy to see that the most serious strictures seemed to be amply justified by them. Especially striking was the defense of the observatory in the report for 1900. A number of alleged weak points were pointed out in the report of the board of visitors, but the serious criticism was ignored, unless an implied denunciation of the whole body of astronomers of established reputation as men 'whose prejudices and animosities were mature and confirmed' could be regarded as a reply.

In our issue of January 4 last, we set forth the main points of the case against the observatory and earnestly invited their consideration by official authority. Our readers will be gratified to see that the head of the observatory has not thought them unworthy of attention. Desiring, as we do, in the interest of fairness and justice, to give the greatest publicity possible to every official defense of the scientific character of the institution, we invite attention to the following passages of the report, premising that we do not imply that this is or is intended to be the best that the author of the passages might say on the subject:

Critics who are in no way responsible for results, and who probably would not carry out their own suggestions if they were, have had a standing grievance against the observatory because it has not put its clocks underground. In point of fact very few

observatories do put their clocks underground. The notable exception is Pulkova.

I invite the attention of the Bureau to Mr. Hill's report, as evidence of the spirit in which the observatory has been (and still is) criticized by outside astronomers. Malice has dictated these criticisms, to my knowledge, for thirty years. In this instance ignorance becomes a valuable accessory.

Leniency in criticism of the quality of the work thus issued is not asked nor expected. Scientific work must stand or fall on its merits. But it would be an encouragement, little to be expected, if the scientific world of this country could appreciate or acknowledge the efforts to bring up to date work long in arrears. Appreciation from abroad is not wanting, and has been gratefully acknowledged.

The passage alluded to in the second extract is the following :

Before proceeding to report upon the observations secured with the instruments I desire to invite the attention of the superintendent to the following extract from SCIENCE for January 11, 1901, page 42 :

We find, also, that the total number of separate observations with the prime vertical transit was 164, less than one-half the number of nights in the year, while those with the altazimuth, used as a zenith telescope, numbered a little more than the days in the year. At the international geodetic stations the observers are expected to make about 16 double observations on every clear night.

Attention is also invited to this extract from the same publication, but of the date of January 4, 1901, page 4 :

There are also intimations that something is wrong with the prime vertical transit, and altogether the impression made on the reader is that, after seven years of effort to equip the observatory with the best instruments, it is doubtful whether a single one of real importance, except the great telescope, is in order for first-class work.

The writer of these editorials in SCIENCE clearly indicates that his conceptions of the amount of astronomical observing to be obtained with an instrument in the prime vertical are absurd.

This betrays a misconception so singular that we must correct it. In our strictures of want of continuity we expressly excepted the work with the prime vertical transit, which has been pursued with rare zeal and

diligence. The passage first quoted from our columns was intended only to show the difficulty that readers might feel in reconciling it with the following striking statement in the report for 1900, which was given a place of honor both there and in the report of the Bureau :

All the astronomical instruments of the observatory have been steadily and continuously in use during the year on every clear night and day.

In energetically showing that the instrument was out of use from April till June, Mr. Hill only impugns the accuracy of this statement, not the correctness of our remarks, which were mere condensations from the observatory report.

The intimations of our second extract comprised allusions to 'a systematic error whose origin still remains a mystery,' and reported efforts to locate this error found in the publications and reports of the observatory. Our 'grave doubts' may be justified by the facts now reported that three other instruments have been undergoing alterations and repairs since we wrote.

A statement has appeared in the public prints that the head of the observatory will reply to the board of visitors. If this is done SCIENCE will be glad, in the interest of fairness and justice, to bring into prominence whatever he can say in defense of his position.

*REPORT OF THE SUPERINTENDENT OF THE
NAVAL OBSERVATORY.**

THE 26-INCH EQUATORIAL TELESCOPE.

THIS instrument has been in charge of Professor T. J. J. See during the whole year. Owing to the death of Mr. George

* Condensed by omitting passages of less general interest than the rest.—EDITOR.

Anderson, who had been assistant on this instrument for twenty-six years, which occurred in November last, and to the absence after February 1 of the party sent out by the observatory to observe the eclipse of the sun in Sumatra, Professor See worked entirely alone for a part of the year. The manual labor alone in using this instrument is considerable, and I consider the showing made in Professor See's report as creditable. This instrument has been devoted to the same general line of work as in previous years, and has been maintained in good order. Professor See's report is herewith transmitted.

THE 9-INCH TRANSIT CIRCLE.

This instrument has been steadily employed on the regular sun, moon, and planet work, a revision of the *Astronomische Gesellschaft* Zones, and the Zone of Zodiacal Stars undertaken for the Paris Astronomical Conference of 1896. From long service this instrument is in need of important repairs. The pivots have become so worn as to need regrinding, and the illumination should be changed so that the reticule will be illuminated by a beam of light in the optical axis of the instrument, instead of a beam cast from one side, as at present. As soon as the alterations of the 6-inch transit circle, which are noted later, are completed, the whole staff for meridian observations will be transferred to that instrument, and the 9-inch transit circle will be put under repairs. The report of Assistant Astronomer King, in charge of the instrument at the close of the fiscal year, is transmitted herewith.

THE 6-INCH TRANSIT CIRCLE.

Since this instrument was mounted two years ago a serious defect in the form of a diurnal change in the constant of azimuth, following changes of temperature, has been a source of annoyance and embarrassment and a serious detriment to the usefulness

of the instrument. Since March last a systematic and patient investigation of this defect has been carried on by Professor Updegraff with the object of determining, and if possible, removing the cause. Successive changes have been made in the instrument and its supports as a result of this investigation, without in any way altering its form (which could not be done without entirely rebuilding it), and there is reason to believe that the success of these changes is already assured.

This instrument was built by Messrs. Warner & Swasey, of Cleveland, Ohio, from designs by Professor William Harkness, U. S. N., following closely the pattern of the latest instruments by Repsold, of Hamburg. It would be presumptuous to criticise the result of the experience of the oldest and most skilful instrument-makers in the world, and yet I can not believe that this form of instrument will ever be entirely free from uncertainty in the errors of azimuth or level, or both, for the reason that in order to assure precision in other respects a principle has been sacrificed which has been recognized as fundamental in the construction of astronomical instruments for at least two hundred years, viz., that the instrument itself should be directly supported on a substantial foundation of masonry. In this form of instrument the pivots are supported by a skeleton work of metal by which they are raised sixteen inches above the piers. Differences in the rate of expansion between the masonry of the piers and the metal support of the pivots become immediately apparent in the azimuth or level of the instrument, and some evidence of this will, I believe, be always apparent. If these errors can be reduced to something manageable under normal conditions, there will still remain the probability that abnormal conditions and sudden and excessive changes of temperature may still make them incon-

veniently apparent. In this connection I may observe that preparations have been made for a south meridian mark for both the 6-inch and 9-inch meridian circles, but no steps have been taken during the year to erect them.

THE CLOCK SYSTEM.

The effort to bring the department of meridian observations, which is the real *raison d'être* of the Observatory itself, to a state of the highest efficiency and up to the most modern standard of requirement, has included not only a thorough overhauling of both meridian instruments, but also an examination, and if possible an improvement in the clock system of the Observatory. Critics who are in no way responsible for results, and who probably would not carry out their own suggestions if they were, have had a standing grievance against the Observatory because it has not put its clocks underground. In point of fact very few observatories do put their clocks underground. The notable exception is Pulkova. It is difficult to maintain a clock underground and not ruin it by rust. The experiment was tried in the very early days of the Naval Observatory and abandoned after the valuable Kessels clock had been nearly sacrificed to the experiment. If, however, a clock can be inclosed in air-tight case from which the air has been partially exhausted, it should be entirely removed from the influences of temperature, pressure and humidity, and it should, theoretically, be as safe in a vault as above ground. This is the principle which has governed the construction of the clock vault of the Naval Observatory. The vault is dug in the basement of the clock house, which stands on the highest eminence in the Observatory grounds, a knoll of quite abrupt grades, of a gravel soil, and so situated that the natural drainage is away from the vault in all directions. The vault is

built with double walls and roof and thick concrete floor, the space between the walls being filled with nonconducting material. The air of the vault is dried by gas and proper provision is made for ventilation. The air-tight cases containing the clocks are of metal and glass, and in each is exposed in full view a rust gauge of bright steel, which is closely watched, and its condition reported to the Superintendent at frequent intervals. The Kessels clock, which is regarded as the standard, is regulated to mean time, and as it is not capable of sustaining the electrical connections necessary for chronometric connection on the clock circuit, it is compared with the sidereal sounder by coincidence of beats by the aid of a microphone. the beats of the clock being wholly inaudible to the unaided ear. So far the whole arrangement has proved on the whole satisfactory, and the rate of the Kessels clock reduced to a constant of almost 0. Some trouble has been experienced in making the clock case actually air-tight, and if the experiment (for I regard it as no more than an experiment) fails, it will be from this cause. Professor Updegraff's report is herewith transmitted.

THE 12-INCH EQUATORIAL.

This instrument has undergone extensive alterations during the year. It was remounted in April, and has been employed in charge of Assistant Astronomer Theo. I. King, since that time. This instrument is used for the benefit of visitors admitted to the Observatory at night.

THE PRIME VERTICAL TRANSIT INSTRUMENT AND 5-INCH ALTAZIMUTH.

These instruments have remained in charge of Assistant Astronomer G. A. Hill, in continuation of the observations for variation of latitude.

I invite the attention of the Bureau to Mr. Hill's report, as evidence of the spirit in which the Observatory has been (and

still is) criticised by outside astronomers. Malice has dictated these criticisms, to my knowledge, for thirty years. In this instance ignorance becomes a valuable accessory.

THE 40-FOOT PHOTO-HELIOGRAPH.

Photographs have been taken of the sun daily whenever the weather and other circumstances would permit. During the absence of the photographer, Mr. George H. Peters, on duty with the eclipse expedition, his place was supplied by Mr. E. A. Boeger, computer.

THE TOTAL SOLAR ECLIPSE OF MAY 18, 1901.

By virtue of a provision of the urgency deficiency bill of the last session of Congress, the Observatory was enabled to equip and put in the field an expedition to the island of Sumatra to observe the total eclipse of the sun of May 18, under charge of Professor A. N. Skinner, U. S. N. Professor Skinner's very interesting preliminary report of the expedition and its results is forwarded herewith. A detailed report will appear in conjunction with a report of the eclipse of May 28, 1900, in a forthcoming volume.

It may very reasonably be asked whether, in view of the meager results on account of cloudy weather on the day of the eclipse, the expense of sending an expedition to such a distance was a justifiable outlay of public money. The reply would be that a chance of failure on account of the weather was one of the conditions which attached unavoidably to the undertaking. Other expeditions were less fortunate and secured no results at all. But the real answer is that results, no matter how meager, fully justify the outlay, because such results are not to be judged by themselves, but are to be regarded as forming a part of the general sum of observations of this and other eclipses. The problems presented will be solved, not by the recorded observations of any one

person at any one time, but by the accumulation of such observations in the general account of human knowledge. From this point of view even one photograph, or a single observation of contact, would have fully justified the entire outlay. At Fort de Kock ten excellent negatives were obtained, which were acknowledged by foreign astronomers to be the best made by any party in the field, and at Solok, the Observatory's other station, contacts were observed and some photographs obtained. I am satisfied with the results.

A serious drawback to the expedition has been the withdrawal for so long a period of an important part of the Observatory's astronomical staff.

An acknowledgement is due the War Department for uniform courtesy to the expedition both on board the transports and at Manila, and to the commanding officer of the U. S. S. *General Alava* for much valuable assistance.

COMPUTATIONS AND PUBLICATIONS.

Since my last report the whole computing force of the Observatory has been assembled in one division, instead of being distributed to the various instruments as heretofore. This change has resulted in a decided economy of time and labor, and is generally in the interests of system and efficiency. All astronomical observations, by whomsoever made, are turned over to the computing division for reduction, it being understood that the author is consulted as to the methods of reduction and exercises a general supervision in cooperation with the officers at the head of the division. Professor Eichelberger has been placed in charge of this division, and in his absence with the Sumatra eclipse expedition his place was supplied by Assistant Astronomer King, up to the close of the fiscal year.

During the year the first volume of the new series of Washington Observations has

been published and distributed. The second volume is ready for the press and will be printed immediately. A third volume is nearly ready, and other volumes will follow as rapidly as the material can be prepared for the printer, and until the accumulation of unpublished work is exhausted. This breaks the long suspension of printing which has been a source of anxiety for several years. Leniency in criticism of the quality of the work thus issued is not asked nor expected. Scientific work must stand or fall on its merits. But it would be an encouragement, little to be expected, if the scientific world of this country could appreciate or acknowledge the efforts to bring up to date work long in arrears. Appreciation from abroad is not wanting, and has been gratefully acknowledged.

NAUTICAL ALMANAC OFFICE.

Professor W. S. Harshman was appointed Director of the Nautical Almanac March 28, 1901. Up to that time and since the retirement of Professor Simon Newcomb the direction had been in the hands of a professor of mathematics who held the post in addition to his regular duties at the Observatory. The Almanac demands the undivided time and attention of a competent director. This need had become imperative. Professor Harshman has had the advantage of long experience in the office in a subordinate capacity. He has systematized and regulated the office and brought the work up to date, the regular issue of the Almanac three years in advance having failed. The office is now in a high state of efficiency, and general harmony and enthusiasm prevail in its staff. The Nautical Almanac has been noted, since its foundation in 1849, for thoroughness and precision in its methods and for superior excellence in its personnel. That this quality is still dominant is shown by the high stand taken by several of its staff in the competitive ex-

aminations for professorships. The report of the Director of the Nautical Almanac is herewith transmitted.

THE BOARD OF VISITORS.

The Board of Visitors established by the naval appropriation act approved March 3, 1901, which went into effect on July 1, met in April, and since that time and prior to July 1, two duly constituted committees of the board have visited the Observatory officially. The law provides for one 'annual visitation to the Observatory at a date to be determined by the Secretary of the Navy, and * * * such other visitations, not exceeding two in number annually, by the full board or by a duly appointed committee as may be deemed needful or expedient by the majority of the board.' The board has already made the full number of visits allowed by law to any one year.

THE DEPARTMENT OF NAUTICAL INSTRUMENTS AND GENERAL STORE-KEEPER AND DEPARTMENT OF CHRONOMETERS AND TIME SERVICE.

By the detachment of Lieut. Commander Charles E. Fox in May, the last remaining officer of these departments was withdrawn, and both of these important departments left without any regularly assigned personnel whatever. The regulations for the government of the Observatory issued by the Department provide for three officers for this work. I believe this situation is unique in the public service. It is hard to make bricks without straw, but that is the situation of these departments at the present time.

As the work could not cease, a computer, previously detailed from the astronomical department has been put in charge of these departments, with one of the clerks of the Observatory in charge of the books. This arrangement is not only improper, but is prejudicial to the service and injurious to

the individual. I have in previous reports made specific recommendations looking to the establishment and maintenance of a permanent force for these departments. I renew these recommendations. The accompanying reports show the volume of business in these departments for the year.

THE PRIME VERTICAL TRANSIT AND THE
ALTAZIMUTH.

Sir: In compliance with paragraph twenty three of the regulations governing the United States Naval Observatory, I respectfully submit the following report of the operations in my department during the year ending June 30, 1901.

Before proceeding to report upon the observations secured with the instruments I desire to invite the attention of the superintendent to the following extract from SCIENCE for January 11, 1901, page 42:

"We find, also, that the total number of separate observations with the prime vertical transit was 164, less than one-half the number of nights in the year, while those with the altazimuth, used as a zenith telescope, numbered a little more than the days in the year. At the international geodetic stations the observers are expected to make about sixteen double observations on every clear night."

Attention is also invited to this extract from the same publication, but of date January 4, 1901, page 4:

"There are also intimations that something is wrong with the prime vertical transit, and altogether the impression made on the reader is that, after seven years of effort to equip the observatory with the best instruments, it is doubtful whether a single one of real importance, except the great telescope, is in order for first-class work."

The writer of these editorials in SCIENCE clearly indicates that his conceptions of the amount of astronomical observing to be ob-

tained with an instrument in the prime vertical are absurd.

Taking up the first extract, I wish to answer it. I was, by orders of the Department, as well as by yourself, detailed last spring as an observer in one of the parties sent south to observe the eclipse of the sun, and for six weeks I was detached from the instrument.

From April 15 to May 1, I was directed to give my whole time to preparing for shipment the apparatus to be used in the eclipse. From May 1 until June 1, 1900, I was at Griffin and Barnesville, Ga., engaged in preparing for the phenomena just mentioned. In addition, I observed at both places on fifteen nights, to determine their latitude and longitude.

The wisdom of the Observatory displayed in having those two fundamental positions determined is well illustrated by the misfortune that came to an observer who went to Africa. He trusted to an approximate latitude and longitude, and found at the instant of the eclipse he was entirely outside of the shadow line.

If the writer of the above extract was only superficially informed of the time necessary to secure a complete observation of a star across the prime vertical, he would not have attempted to make a comparison between the number of observations secured during the same period with the prime vertical and the zenith telescope. It will take about four hours per night to observe sixteen pairs of stars with the zenith telescope, the number usually obtained by those engaged in the variation of latitude work. In the same time it is impossible for anyone using the prime vertical to secure more than four or five, and had the writer consulted an astronomer he would have found that out.

During the past spring I observed practically all night on each in which the sky was clear, and over a tour of observing of

nine or ten hours the largest number of star observations I could possibly obtain was nine or ten.

As an additional answer to his senseless criticism, I would invite the attention of the superintendent to a comparison of the number of observations made with our instrument with that obtained by the only other astronomer who is now continuously observing with the prime vertical transit.

In 1900 I obtained in ten and one-half months observing 164 observations. The observer at Pulkova for the full year made 106. Since 1896 I have secured 1,150 observations. In the same time the prime vertical at Pulkova has yielded 755. This record will be found in Professor Albrecht's report on the variation of latitude for 1900, a copy of which is in the library.

The remarks contained in the second extract are equally absurd.

In justice to our prime vertical transit, I desire here to state that it is of a better form, it is built in a more symmetrical manner, and its mounting permits of determining the errors it may have in a more complete manner than any other now in use.

In 1898 I obtained about 125 observations of α Lyræ in the full daylight, as well as in the night. The range between the greatest and least declination for the whole year's work, including every observation made, and the good, fair, and poor seeing that obtained for each, was 1.44". If four observations are rejected, because they stand out so markedly from the others, made at a time when the seeing was very poor, and so noted in the observing book, the range is reduced to 1.04".

There is not in existence a meridian circle, vertical circle or zenith telescope that has been used to observe the same star or pair of stars, *throughout the year*, that has as small a range as that in the declination, or latitude secured with it. The

probable error of a single observation for that series, including the variation of latitude, is $\pm 0.16''$.

I have during the year made an investigation of the form of the two pivots attached to the instrument. I have examined each throughout the length of its bearing surface in the Y's, and the results, which will be printed in the volume containing the observations secured with the instrument, do not indicate that either pivot is out of parallelism with the cube, or that their departure from a true cylinder is of enough magnitude to affect an observation.

In the past year I have made 619 observations with the aid of both instruments. The reduction of the observations on the sheets, which have all been made by myself, are practically complete to the 1st of January, 1901.

Last fall I made a complete rediscussion of the prime vertical transit observations, basing the derived latitude upon the star places obtained from the New Catalogue of Fundamental Stars, prepared by Professor S. Newcomb. After it was finished the results were transmitted to Professor Albrecht, of the Central Bureau der Internationalen Erdmessung, Potsdam, Germany, to be used by him in his annual paper upon the 'Variation of Latitude.'

From that discussion the following mean yearly latitudes were obtained:

	°	'	"
1894.....	38	55	14.51
1895.....			.52
1896.....			.61
1897.....			.46
1898.....			.45
1899.....			.43
1900.....			.55
Mean.....	38	55	14.50
Reduction to the clock room.....			— .52
Latitude of Naval Observatory.....	38	55	13.98

The individual observations of all prime vertical transits up to December 31, 1899, are now ready for the printer. The intro-

duction to the volume to contain them is three-fourths completed, and will be finished in time to transmit it to the Government Printing Office by the last of July or middle of August.

The 5-inch altazimuth was used during the year principally as a zenith telescope, in connection with the prime vertical transit. I am not making zenith-telescope observations exclusively with it, but only of those stars that are observed with the prime vertical, and which permit of being observed by Talcott's method.

This observatory is the only one in this country equipped with a prime vertical transit and for that very reason the major portion of the data we are securing for the study of the variation of latitude is made with it.

GEORGE A. HILL,
Assistant Astronomer.

ANNUAL REPORT OF THE SECRETARY OF
AGRICULTURE, 1901.

THE Fifth Annual Report of the Secretary of Agriculture, Hon. James Wilson, is considerably longer than in former years, reflecting thereby the great growth and development which has attended this Department during his administration.

WEATHER BUREAU.

He announces an important extension of the forecast field of the Weather Bureau, which now includes reports from certain points in the British Isles and on the continent of Europe, from the Azores, Nassau, Bermuda and Turks' Island. The Atlantic forecasts based upon these reports now form part of the regular night forecasts issued in Washington. Three new forecast districts have been established—in Boston, New Orleans and Denmark. An extension of the forecast to farmers through the Rural Free Delivery is contemplated. Substantial improvements are reported in the De-

partment's system of wireless telegraphy, of which the Secretary states in conclusion :

While there is much experimental work yet to be done before the present system is reliable for inter-ship communication, or before any two systems can work within the same field without each rendering the other useless, such progress has been made by the Government experimenters that, with no interference by private systems, stations can be successfully operated over at least 150 miles of coast line, and they are now in operation on the North Carolina and Virginia coasts, and soon will be instituted between the Farallone Islands and the mainland and Tatoosh Island and the mainland, on the Pacific coast.

ANIMAL INDUSTRY.

A large portion of the report covers the subject of animal industry. The grand total of animals and animal products exported during the year exceeded \$250,000,000 in value. This vast foreign market is only preserved to our producers by the indefatigable efforts of the Department and the rigid inspection exercised through the Bureau of Animal Industry. This Bureau inspected for export 385,000 cattle, 228,000 sheep and 48,000 horses and mules, and nearly 1,000 vessels carrying live-stock. Imported animals were also inspected to the number of 342,000, and, where necessary, quarantined. The Secretary suggests that with the enormous interests our stock-raisers have at stake, and inspection or quarantine affording, after all, a relative, not an absolute guarantee of protection, it might be well for this country to follow the example of Great Britain and exclude live-stock from other countries entirely. The meat-inspection service involved the inspection at time of slaughter of nearly 37,000,000 animals. Of the more than 5,000,000 cattle inspected, the condemned carcasses were about one-fourth of 1 per cent. ; of the 6,500,000 sheep, one-tenth of 1 per cent. ; and of 24,000,000 hogs, one-third of 1 per cent. In the control of indigenous diseases, 1,500,000 inspections were made and over 45,000 cars disinfected in the Texas fever

service alone. In the repression of scabies in sheep nearly 8,000,000 animals were inspected and over 1,000,000 dipped under the supervision of the Department inspectors. In combating the disease known as 'black leg' the Bureau distributed over 1,500,000 doses of vaccine, the result being to reduce losses in affected herds to less than 1 per cent., where formerly it was in most cases about 10 per cent. To aid in detecting tuberculosis in cattle and glanders in horses, over 44,000 doses of tuberculin and 7,000 doses of mallein have been supplied. The Secretary points out the serious evil resulting from a system of State inspection, which, if it became general, would effectually prevent the marketing of live-stock in some sections, and would destroy much of the usefulness of the Federal inspection. He regards the present conditions as so menacing to the interests of the cattle industry in the West and Southwest, that he has requested the Attorney-General to cooperate in bringing the matter before the Supreme Court for decision as to the constitutionality of these State laws. This request has been favorably received and the assistance of the Department of Justice promised.

PLANT INDUSTRY.

The organization of the Bureau of Plant Industry is reported. It has brought together in one group investigations in plant physiology and pathology, botany, grasses and forage plants, pomology, and the experimental gardens and grounds including the experimental farm at Arlington, and the introduction of foreign seeds and plants.

Plant Physiology and Pathology.—Investigations in plant physiology and pathology have been lately devoted to the study of cotton diseases, diseases of orchard fruits, and of forest trees and construction timber. An interesting discovery to cotton-growers is reported of a cowpea resistant to the fungus that destroys the cotton roots. The

cowpea being used in rotation with cotton, the securing a resistant cowpea will be of the greatest possible value to cotton-growers. Remarkable success is reported in experiments in plant-breeding to secure samples of cotton resistant to wilt and other diseases. Numerous valuable hybrids have also been developed. One from an American upland cotton and an Egyptian variety promises to be greatly superior to either parent. The Department has been for several years trying to secure by breeding a race of oranges resistant to frost. A cross of hardy Japanese with the Florida sweet orange has resulted in the hardiest evergreen orange known, and there is promise of ultimately securing a fruit both hardy and of good quality. Considerable success has also been attained in breeding raisin grapes resistant to the disease known as 'coultre.'

Botanical Investigations.—In botanical investigations important work has been done on seeds, improvement of crops, and methods of crop production in our tropical possessions, and prevention of losses to cattle in the West from eating poisonous plants. The low germination of commercial samples of Kentucky blue-grass seed was investigated. It was found that there is a stage in harvesting this seed when heating takes place in the tops of the grass, piled in windrows, which tends to destroy the germination of the seed. This can be avoided by methods of handling the grass, but the Department is experimenting with machinery which will dry the moist seed without permitting it to heat. Comparative experiments regarding the relative value of American and European clover seed give results strongly in favor of the former, at least under conditions prevalent in this country. A remedy has been found which, when promptly administered, is effectual in the treatment of animals poisoned from larkspur and poison camas.

The agricultural conditions of our new possessions are being thoroughly studied, and special attention is being given to the production in these possessions of tropical crops, for which the United States pays out millions of dollars annually. Raising coffee in Porto Rico has been the subject of special study. Our annual importations of this valuable crop now amount to \$70,000,000. The Secretary asserts that much loss has resulted to the cattle industry in the West in recent years, owing to the injudicious management of ranges. The Department's experiments show that much could be done, under proper control, to restore the ranges to their original condition, and he recommends action by Congress, giving the President authority to secure for the experimental needs of his Department such tracts of public range lands as may be necessary.

Pomological Investigations.—The pomological investigations have been especially directed to the extension of the fruit markets abroad and to the encouragement of the domestic production of fruits hitherto largely imported. Prune-growing has been made the subject of special study; also the growing of European grapes in the South. Attention is called to the rapid increase in our exports of apples since the magnificent showing of this fruit made by this Department at the Paris Exposition.

Arlington Farm—Tea Experiments.—Progress is reported in preparing the Arlington farm to serve in conducting experiments, as an adjunct to the Department. The Secretary cordially commends the experimental work now carried on at Summer-ville, S. C., under the direct supervision of Dr. C. U. Shepherd. About 4,500 pounds of high-grade tea, which found a ready market, were produced here during the year.

Introduction of Valuable Seeds and Plants.—Great activity has characterized the intro-

duction of valuable seeds and plants from abroad, with most satisfactory results. The development of the rice industry in Louisiana and Texas since the introduction by the Department of the Japanese rice, during the past three years, has been remarkable. At the same time our imports of this product have decreased from 154,000,000 to 73,000,000 pounds. The United States imports yearly nearly \$800,000 worth of macaroni. Macaroni wheats have been introduced in the past two years very successfully into the Dakotas and also into Kansas and Nebraska. Fully 90 per cent. of the date palms introduced in recent years from Africa are now growing vigorously in Arizona and southern California. This year a collection of the choicest varieties in Egypt have been obtained. Progress is reported in the introduction of Egyptian cotton. The imports of this product now amount to about \$8,000,000 yearly.

Congressional Seed Distribution.—In regard to the Congressional seed distribution, the Secretary states that he has endeavored to meet the wishes of Congress in every way possible and to secure seeds of as high a character as can be obtained under the conditions under which the work is done. It has been arranged to send out cotton seed, tobacco seed, sorghum seed, and sugar-beet seed, and grasses and forage plants, under the direct auspices of the Department, and not through the contractor.

BUREAU OF SOILS.

The Division of Soils has recently been made a Bureau and has received increased financial resources, which enable it to extend its scientific investigations, as well as its practical operations.

Soil Survey.—An extensive review of the work of soil survey shows that the areas surveyed and mapped during the year exceeded 3,500,000 acres, making a total of nearly 6,000,000 acres surveyed during the

past two years. The field work, including preparation of reports, transportation and supplies, has cost an average of \$3.26 per square mile, or about 51 cents per hundred acres. A part of the expense has been paid by state organizations, and effective cooperation has been had with the stations. The demands for soil survey in various parts of the country continue to be received in excess of the ability of the Bureau to comply. The Secretary enumerates sundry important results in the work of the survey, but dwells especially upon what has been achieved in connection with tobacco. Especially successful have been the experiments made by the Bureau in the growing of a fine type of Sumatra leaf on certain soils in the Connecticut Valley. During the past year nearly 43 acres have been grown under the direct control of the Department experts. An interesting feature of the experiment is that the bulk of the cost, estimated at \$20,000, has been invested by the farmers themselves, and it is gratifying to record that their enterprise has been rewarded far beyond their expectations. The recommendations of the Department have also been followed in the methods of curing tobacco in Pennsylvania, with the result of effecting a saving from the ravages of the black rot, exceeding one-half million dollars. Urgent demands for assistance in the tobacco industry have reached the Department from New York, Wisconsin, Texas and Florida. Referring to the reclamation of alkali lands, to which attention has frequently been called in the reports of the soil survey, the Secretary says that he is more and more convinced that to carry the lesson home to the individual it will be necessary for the Department itself to undertake a practical demonstration of the efficiency of drainage. The necessity of a special study of climatology in connection with the soil work is pointed out. "The time has come," says the Secre-

tary, "when the work should be taken up on a scale commensurate with the extension of at least two or three crop interests. It is certain that the immediate benefit to the farmers will amply repay expenditure."

WORK OF THE BUREAU OF CHEMISTRY.

In this Bureau investigations into the composition, nutritive value and adulteration of food products have been continued. This work during the year was devoted particularly to the study of preserved meats, the composition and nutritive value of the preserved article being compared with the original, and the preservatives, if any were employed, determined. Food products imported into this country, and suspected of adulteration or of containing injurious constituents, have also been examined. The Secretary is authorized to inspect, through the Bureau of Chemistry, American food products intended for export. Unfortunately, Congress has not provided appropriations adequate to the proper execution of this law. The Secretary adds that it is important that our food products going abroad be pure and wholesome, and that we should protect our exporters against discrimination in foreign countries.

In connection with the Bureau of Forestry, the chemist is taking up the work of forest chemistry, and is studying forest trees in their relation to the soil and the products they yield. Among the chemical industries immediately dependent on forest productions are the tanning industry, manufacture of wood pulp, production of wood spirit, charcoal and other products. The sugar laboratory of the Bureau continues to study all the chemical problems relating to the production of sugar-producing plants and the manufacture of sugar. The chief part of this work is devoted to the study of sugar beets. The work that the Bureau of Chemistry is doing for other departments of the Government is considerable and con-

stantly increasing. By agreement with the Secretary of the Treasury, the chief of the Bureau has been designated as supervisor of sugar tests in the laboratories of the appraisers in the ports of New York, Philadelphia and Boston. The other departments to which the aid of the Bureau of Chemistry has been extended are the War Department, the Post-Office Department, the State Department and the Department of the Interior.

In cooperation with the Office of Public Road Inquiries, a laboratory for the study of road materials has been organized in the Bureau of Chemistry. The prime object of this laboratory is to aid road-builders in selecting the best available materials in their localities.

WORK OF THE BUREAU OF FORESTRY.

Another of the newly organized bureaus is that of Forestry. The Secretary reports that this Bureau is cooperating with the Federal Government, with several States and many private owners in handling their forest lands. Altogether, assistance has been asked for a total area of 52,000,000 acres, of which 4,000,000 are held by private owners. The work of forest management is reviewed in some detail. During the year nearly 800,000 acres under private owners were examined by representatives of the Bureau, and four detailed working plans, covering 226,000 acres, were prepared. The working plan for the Black Hills forest reserve was completed and working plans were undertaken for the Prescott and Big Horn and the Priest River reserves.

Forest investigations include the study of commercial trees and economic tree-planting, of forest fires, grazing, lumbering, forest productions, and other important lines. The region containing the proposed Appalachian forest reserve was examined in cooperation with the United States Geo-

logical Survey, and nearly 10,000,000 acres were mapped, lands classified and the forests carefully studied. The Secretary regards the creation of the proposed forest reserve as urgent in order to protect the headwaters of important streams, to maintain the already greatly impaired supply of timber and to provide a national recreation ground. Upon the request of the Secretary of the Interior, the effects of grazing and forest fires were investigated on twelve of the forest reserves.

In the study of economic tree-planting in cooperation with farmers and others in making forest plantations, 46,145 acres were examined and plans were prepared for nearly 6,000 acres, while 148,000 applications for tree-planting plans were received.

THE OFFICE OF EXPERIMENT STATIONS.

The Secretary reports, as the result of a broad inquiry made through the Office of Experiment Stations, that by far the largest part of the work of the stations has direct relation to the important agricultural interests of the communities in which they are located.

The work of the stations is becoming better understood by the farmers, and a broader, deeper foundation of scientific inquiry is being laid each year. Cooperation between this Department and the stations continues to increase, and the value of these cooperative methods to the agricultural interests are very generally acknowledged. As a result of the practical confidence so attained, Congress and the State Legislatures have shown a disposition to be liberal with this Department and with the stations. The movement for the separation of the office of director of the station from that of president of the college has advanced, and at present there are but eleven States and Territories in which the college president exercises the functions of director

of the station. At the same time, the amount of teaching required of station officers has been materially reduced.

The experiments of the station in Alaska, with headquarters at Sitka and subsidiary stations at Kenai, on Cook Inlet, and at Rampart, in the Yukon Valley, are regarded as distinctly encouraging. From all the evidence received at the Department, it seems clear that agriculture may be sufficiently established in this Territory to serve as an important aid to the mining, lumbering and fishing industries. During the year a station has been established in Hawaii. Among the first work at this station was the planting of taro, with the special object of studying the diseases seriously affecting that crop. Probably 50 per cent. of the working population in these islands depend on taro for their daily food, and, owing to these diseases and the attendant deterioration of the crop, the price of taro has increased 500 per cent. in the last decade. Some other diseases of fruits and vegetables call for study, and poultry experiments have been inaugurated with a view to increasing the supply of poultry. It is reported that live chickens sell in Honolulu at \$15 a dozen and eggs at 40 and 50 cents a dozen. Hogs bring from 10 to 17 cents a pound on the hoof, and experiments have been undertaken in the feeding of swine with various tubers and roots.

The station at Porto Rico has not yet been fully established, owing to the difficulty of securing suitable land for the purpose. In the meantime, such investigations will be undertaken as can be pursued on lands leased or loaned by persons ready to engage in cooperative work with the station director. Some preliminary investigations in coffee culture have already been arranged for.

The Secretary earnestly recommends that the annual appropriations for all these sta-

tions be increased to \$15,000, the same as the National Government contributes at present to all of the other stations in the various States and Territories.

The Philippines.—He regards it as extremely desirable that agricultural investigations should be undertaken in the Philippine Islands under the War Department and in cooperation with the Department of Agriculture. In furtherance of this work, the Secretary recommends an additional appropriation of \$15,000 for the ensuing fiscal year 'to institute agricultural investigations in the Philippines and, if feasible, to locate and maintain an agricultural experiment station there.'

Agricultural Education.—An increase in college-extension work in agriculture is noted and stress is laid on the movement for the establishment of secondary schools of agriculture and the introduction of the elements of agriculture into the rural schools, as hopeful signs of progress in agricultural education. The Secretary suggests that his Department, already giving aid to rural schools in various ways, should take a still more active part in encouraging this work. He recommends encouragement by distributing seeds and plants to establish school gardens, by furnishing schools with collections of specimens of insects, of plant diseases, and other illustrative material, and by supplying the teachers with such publications of the Department as may be useful to them.

Aid to Farmers' Institutes.—He reviews very fully the great development in the work of farmers' institutes. In 1899 over 2,000 farmers' institutes were held in this country, attended by over half a million farmers. These were held in forty-three States and Territories. The Secretary thinks that there is room for much useful work by his Department in aid of this and other movements for the education of our farmers in the improvement of our agriculture. He

has therefore asked for a special appropriation of \$5,000 to enable the Office of Experiment Stations to enlarge its work with a view to giving definite aid and encouragement to farmers' institutes in the different States.

Nutrition Studies.—The dietary studies and experiments in cooking, digestion and metabolism, have been conducted in various parts of the United States in cooperation with experiment stations, agricultural colleges and universities. The results of nutrition investigations already made should, the Secretary thinks, be practically and beneficially applied to the feeding of men wherever a considerable number of persons are to be fed on a systematic plan. He instances the hospitals for the insane in the State of New York, the annual cost of food for which is over \$1,000,000, and states that of the \$26,000,000 expended for 100,000 persons maintained in the public institutions in New York State alone, \$6,000,000 is expended for food. He urges investigations to determine the best dietary for the use of our soldiers and civil officers in tropical regions, and states that a special appropriation of \$5,000 has been asked for the study of the food supply and consumption of people living in the tropics.

IRRIGATION MATTERS.

The Secretary devotes a great deal of space to a discussion of irrigation investigations. These have been conducted through the Office of Experiment Stations, and embrace (1) studies of irrigation laws and the social and industrial institutions of irrigated agriculture; (2) investigations of the methods by which water is conserved, distributed and used.

Titles to Water.—In reference to the first subject the Secretary states that the character of the titles to water finally recognized will do more than all other influences combined to determine whether the Western

farmers ought to be tenants or proprietors. Naturally, this makes the disposal of the water resources of the West a matter of vital importance not only to the persons directly interested, but to the country at large. Every consideration which justified the general government in the control, the survey, and disposal of public lands, applies equally to the orderly and just establishment of titles to water by public authority, either state or national. He points out the confusion and trouble and almost endless litigation frequently attending the settlement of this question, and declares it to be absolutely necessary that some simple and final method of determining and protecting rights to streams should be provided. In the meantime the conditions, as they exist in arid states, are being carefully studied by the Department.

Improved Instruments.—Irrigation experts of the Departments have designed improved instruments for measuring water, by which registers are now furnished to irrigators at about one-half the cost of the foreign instruments.

Irrigation in Humid Regions.—Attention is directed to the growth of irrigation in the humid regions, and the remarkable fact is stated that in Louisiana more money has been expended on pumping-plants in the past two years than in any arid state. By irrigation, rice-growing in Louisiana and Texas has raised the price of land originally worth \$5 to \$10 per acre to \$50 and even \$100 per acre.

Legislation by Congress.—The Secretary expresses the belief that irrigation will, in the near future, become a subject for legislation by Congress, there being important reasons why it should have the attention of that body. At the same time, he says that those best informed believe that the uncertain character of water rights can only be remedied by a larger measure of public control and the making of certain classes of

irrigation structures permanently public works. These, it is urged, should not be owned by private parties, and the argument produced in favor of constructing reservoirs by act of Congress is the same which justifies setting aside forest reserves and the maintaining of a force to control them. On the other hand, the Secretary points out that an appropriation of money by Congress to construct such irrigation works will bring the country face to face with a new Government policy and will carry a larger measure of public control over the water resources of the West than has hitherto prevailed or been sanctioned by public sentiment.

Land Laws affecting Irrigation.—He reviews the influence of land laws on irrigation development, stating that laws which control the disposal of 500,000,000 acres of arid public lands must have a vital influence upon the success of irrigated agriculture. He condemns the desert-land act, stating that 640 acres is more land than a man of moderate means can cultivate under irrigation. Cutting down the entries from 640 to 320 acres is an improvement, but he believes in the entire repeal of the desert-land act and in requiring settlers or homesteaders to cultivate as well as live on their land.

The Grazing Lands.—Referring to the grazing lands, he says probably 400,000,000 acres of the public domain has no agricultural value except for pasturage. It is at present an open common, with no laws for its protection or disposal. He refers to the frequent conflicts of the farmers under irrigation with the range stockmen, and recommends, as a remedial and beneficial measure, the leasing of the grazing land in such a way as not to interfere with the homesteader. The rentals, he believes, would amount in the aggregate to a large sum, which could be appropriately applied to the reclamation of the irrigable lands.

He points out that such leasing is not an experiment, as it has been successfully tried, although in a limited way, in Colorado, Idaho, Montana, Nebraska, Utah and Wyoming. He winds up the discussion of this subject by presenting the following conclusions:

1. That private enterprise will have to be supplemented by public aid in the construction of certain classes of irrigation works if we are to secure the largest development of Western agriculture.

2. That reservoirs located in the channels of running streams should be public works.

3. That the first step toward national aid for irrigation should be the passage of enlightened codes of water laws by the States to be benefited.

4. That the land laws should be modified by repealing the desert act and by requiring cultivation as well as residence on a homestead.

5. That the non-irrigable grazing lands should be leased in small tracts so as to unite the irrigable and the pasture lands.

WORK IN ENTOMOLOGY.

Under this head the Secretary reports the successful introduction and establishment in California of the fig-fertilizing insect, with the result that it has been thoroughly established at several points, and that the Division of Entomology is now ready to supply fig insects to any grower after he has succeeded in raising to the bearing stage caprifig and Smyrna fig trees. The discovery is reported, by an expert of the Division sent to Asia for the purpose, that the San José scale is not indigenous to Japan, but that it is so in north China. It has been found in a section of that country where there have been no fruit importations, and all fruits are of native sorts. Further, in this district, it was found to have a natural enemy—a ladybird beetle,

of which the expert in question has collected many specimens and forwarded them to Washington, and steps will be taken to acclimatize this important species. This importation will doubtless prove of extreme value to fruit-growers in this country. Another valuable importation of the ladybird beetle was of one which feeds upon several distinct species of plant lice accidentally imported into this country from Europe.

BIOLOGICAL SURVEY.

The Survey is engaged in mapping the natural boundaries of the crop belts of the country. Its aim is to furnish farmers with lists of products likely to be successful, so far as climatic conditions go, in different parts of the country. During the past season the work of mapping the life zones and crop belts has been continued, particularly in Texas and California. A fiber plant, closely related to the Mexican istle or Tampico plant, is found growing in great abundance over a large part of the arid Sonoran zone. In view of the great quantity of fiber of other species of agave imported into this country (\$12,000,000 worth in 1900), the Texas species is likely to prove of great value.

In response to constant complaints, the Survey has prepared and distributed a circular of direction for the destruction of prairie-dogs, and is now conducting experiments in the Dakotas, Nebraska, Kansas and Texas, with a view to discovering remedial measures against this pest, cheap enough for general use. It has been discovered that the bullock oriole and the California least tit feed extensively on the orange and olive. In Texas, the large blackbirds, known as jackdaws, and which have been slaughtered in great numbers for the millinery trade, are particularly useful owing to their feeding habits in the rice and cabbage-growing districts. In addition to its other duties, the Survey is

charged with the general supervision of matters relating to game protection. In aid of the preservation of native birds and game it has published bulletins on the laws governing the transportation and sale of game, digests of State game laws, etc. Carrying out the provisions of the Lacey act, the Secretary acknowledges his obligations to three other executive departments, the Treasury, Interior and Justice, to several railroad and express companies, and to many State officials and individuals. Under the system of permits established for the transportation of foreign wild animals and birds, 186 permits were issued during the year, covering the entry of 350 animals and nearly 10,000 birds. Numerous violations of the laws regulating interstate commerce and game have been reported to the Department and in many instances it has been called upon to assist in prosecuting the offenders.

THE DIVISION OF STATISTICS.

The work of this Division consists largely in the preparation of reports relative to the principal products of the soil, including the extent and geographical distribution of the area of production, the condition and prospects of the crops during the growing season, and the quantity, quality and disposition of the products harvested. It has included also reports on various branches of rural economics, such as transportation, wages of farm labor, cooperation in agricultural industries, etc. An urgent demand exists for broadening the scope of the work of this Division. But this cannot be done without enlarging its appropriations. Telegraphic interchange of crop reports has been arranged for with the governments of some of the principal grain-growing countries of Europe. In furtherance of the plan to place the crop reports in the hands of the farmers as early as possible, a system of cards containing the most important

points of the statistician's monthly report has been adopted. These cards are mailed promptly after the publication of the telegraphic summary to postmasters throughout the country with the request that they be promptly displayed in their offices. The Secretary recommends the enlargement of the Division under Bureau organization.

PUBLIC ROADS.

In establishing an Office of Public Road Inquiries, the object was to promote the improvement of public roads throughout the country. Efforts were first directed to ascertain the condition of the roads, the state of public opinion in regard to their improvement, the obstacles in the way, and the best methods to be employed in securing better roads—such has been the work of this office up to the present. For spreading information and awakening interest, nothing has been found so effectual as the 'object-lesson,' or sample roads, which, during the past year, have been built in nine States under the advice and supervision of the office. In building these sample roads, machines have been loaned by manufacturers and carried free by the railroad companies, while the local community furnishes material and labor. During the year, for the better carrying out of the work of the office, the United States was divided into four divisions, the eastern, middle, western and southern, each under a special agent.

PUBLICATIONS.

In the performance of its duty to diffuse the information acquired through its several Bureaus, Divisions and Offices, the main dependency is upon the issue and distribution of publications. This work, therefore, affords a fair reflex of the intelligence and activity of the investigating branches of the Department. The Secretary deplors the fact that this condition has not been as fully recognized in the appropriations as

it should be, and the work of publication has, therefore, not kept pace with the wonderful growth and development of the Department. He deplors particularly the unavoidable suspension toward the close of the year of the work of both printing and distribution, and that no less than thirty-five worthy employees had to suffer distress by being furloughed through no fault of their own. Notwithstanding these restrictions, there were issued during the year 606 separate publications, aggregating nearly 8,000,000 copies. Nearly 3,500,000 copies were Farmers' Bulletins, of which two thirds in round numbers were distributed under Congressional orders. With the increased appropriation and the accumulated copies, this year's supply of these bulletins will, under the present law, which assigns four-fifths, instead of two-thirds, to the use of Congressmen, make the allowance of each Senator, Representative and Delegate 15,000 copies. A special building has been rented to be devoted exclusively to the storage and shipment of Farmers' Bulletins, of which not less than 7,000,000 will have to be printed this year. The amount provided, however, for material and labor in their distribution is quite inadequate and must be supplemented by a special appropriation, if the demands of Congressmen are to be met. Referring to the great demand for the Year-book and the growth of the Department, the Secretary points out the inadequacy of the quota assigned the Department. When the edition of this work was 300,000 copies, 30,000 were placed at the disposal of the Department, the same as now, notwithstanding that the edition to-day is half a million copies. The demand for the publications of the Department continues to be greatly in excess of its ability to supply. Many of these—over 24,000 copies last year—were sold by the Superintendent of Documents. This is almost three times as many as the

sales made by that officer of the publications of all other Departments of the Government. A special appropriation has been asked for to carry on more effectively the work of illustration, which the condition of the appropriations in recent years has caused to be somewhat neglected. Over 140 persons are employed, including editors, proof-readers, artists, clerks and laborers, in the work of publications, and these are greatly hampered, owing to their segregation in different buildings in crowded and inadequate quarters.

ACCESSIONS TO THE LIBRARY.

Over 4,000 books and pamphlets were added to the Library during the year. These included many books of special value in the work of the Department and a large number of scientific periodicals. Every effort is made in the Library of the Department to meet the demands occasioned by the constantly broadening fields of investigation entered upon by the Department, and to aid educational and scientific workers engaged elsewhere upon kindred work. The Department Library is regarded as the headquarters of agricultural literature, and should be able to meet demands from without as well as within the Department. The Secretary calls attention to the danger of destruction by fire of the 70,000 pamphlets and books now in the Library, owing to the character of the building at present occupied by the Department.

ACCOUNTS AND DISBURSEMENTS.

Congress appropriated \$3,303,500 for the United States Department of Agriculture for the fiscal year ended June 30, 1901, being an increase of \$558,920 over the appropriation for the preceding year. When all accounts shall have been finally settled the payments will amount to about \$3,220,000.

The regular appropriation of \$15,000 for

each of the 48 agricultural experiment stations in the several States was also made.

On June 30, 1901, the unexpended balance of the appropriations for the year 1899, amounting to \$28,899.27, were covered into the Treasury.

During the year \$6,340 was paid for rental of leased buildings in Washington. Owing to inadequate accommodations, Congress, at the last session, provided for the lease of additional buildings, and the rental for the fiscal year 1902 will exceed \$10,000.

EXPORTATION OF AGRICULTURAL PRODUCTS.

The highest record previously attained in the export of agricultural products—in 1898—was surpassed by over \$90,000,000 in the fiscal year of 1901, when a value of over \$950,000,000 was reached. Of the merchandise sent abroad during the year, 65 per cent. originated on the farm. Of foreign customers for our agricultural products, the United Kingdom stands first, taking over 50 per cent. The next most important markets are afforded by Germany, France, the Netherlands and Belgium, in the order named. The Section of Foreign Markets has begun the preparation of a most comprehensive report on the character of our agricultural importations received by the United Kingdom, from countries other than the United States. The importance of this report is evidenced by the fact that, large as were our exports to the United Kingdom, they comprised only one-third of the foreign farm produce purchased by that country. Special statistics have been compiled by the Section of Foreign Markets relative to our trade in farm products with our new insular possessions. Our agricultural exports to Cuba, Porto Rico and the Philippines during the year comprised about 53 per cent. of the domestic merchandise sent to these islands. Our imports of agricultural products from these islands exceeded our exports by just \$30,000,000.

CONCLUSION.

The report concludes with a review of the development of agriculture and commerce during the past twenty years, and of the contributions by the Department of Agriculture to the progress of events and the building up of domestic and foreign trade. The Secretary says that coincident with this growth numerous institutions have grown up in this country and abroad, devoted to the application of science to the service of agriculture, thus creating a great demand, at good salaries, for the right sort of men. Each nation is seeking to extend its productions, and is depending more and more upon the aid of science. Men combining knowledge with practical experience and ability are hard to get, and hence the Department has to face the necessity of paying much higher salaries, or of being compelled to either lose opportunities of getting the best men or to lose some of those who, under its training, have developed such qualities as make them exceptionally valuable.

He concludes by saying that he would urge upon Congress, in the strongest terms and for the best interest of the country, such liberality as will enable him to obtain and retain the best men that can be found to fill the important places at his disposal.

MEMBERSHIP OF THE AMERICAN ASSOCIATION.

THE following have completed their membership in the American Association for the Advancement of Science during the month of November:

Samuel L. Bigelow, Ph.D., Asst. Prof. Chemistry, University of Michigan, Ann Harbor, Mich.

Thos. A. Chittenden, Instr. in Mechanical Engineering, A. & M. College, W. Raleigh, N. C.

Patrick B. Delany, Electrician, Inventor, South Orange, N. J.

Wm. Fox, Asst. Prof. Physics, The College of the City of New York, New York, N. Y.

Manuel R. Gutierrez, Prof. Physics, Normal School, Calle de las Victimas, No. 1, Jalapa, Vera Cruz, Mex.

John J. Hollister, Mining Engineer, Gaviota, Santa Barbara Co., Cal.

John W. Leonard, Author-Lawyer, Wheaton, Ill.
Wm. L. Martin, Augusta, Ga.

George H. Maxwell, Chairman, Natl. Irrigation Ass'n, 1827 Phelps Place, Washington, D. C.

Charles P. Nott, Palo Alto, Cal.

C. Howard Parmly, Asst. Prof. Physics, The College of the City of New York, New York, N. Y.

Wm. B. Potter, Ch. Eng. Ry. Dept. G. E. C., Gen. Elec. Co., Schenectady, N. Y.

Ferdinand A. Schiertz, Rosario Mines Ltd., Guadalupe y Calvo, Chihuahua, Mexico.

Solon Shedd, Prof. Geology and Mining, State Agric. College, Pullman, Wash.

Dr. Edw. G. Spaulding, Instr. Philosophy, The College of the City of New York, New York, N. Y.

Dr. Edw. W. Taylor, Instr. Neuropathology, Harvard Medical School, Boston, Mass.

Jos. B. Tyrrell, Mining Engineer, 181 Metcalfe St., Ottawa, Canada.

SCIENTIFIC BOOKS.

Practical X-Ray Work. By FRANK T. EDDYMAN, B.Sc. (Lond.), F. I. C. London, Scott, Greenwood & Co.; New York, D. Van Nostrand Company. Price, \$4.00.

This little book, as the name indicates, seems to be a thoroughly practical guide for the beginner in X-ray work. As would be expected, the scientific knowledge to be gained by even a careful study of the treatise must be almost entirely empirical. The scope and purpose of such a book quite preclude treating the physics of the subject in any but a statement-of-fact way.

The work is divided logically into three parts; the first part, wisely brief, treats of the history of the development of X-ray practice; the second, of the apparatus and of its management; the third, of practical X-ray work.

It is to be noted that Mr. Eddyman is a physicist and presumably trained in the science of the subject; also that he has charge of the radiographic work in a large hospital, and so has had ample experience in the practical application of X-ray diagnosis in surgical and medical cases. Such a combination is almost necessary if one is to prepare a book of real value on this subject. The author seems to have succeeded admirably, giving only enough of the pure physics to make the application of it intelligible, and

going into the detail of manipulation with great care and thoroughness.

In Chapter II., dealing with sources of electricity, somewhat more space than is necessary seems to be given to primary batteries, since in this country at least such sources of current are seldom if ever found desirable. The use of the alternating-current supply is discouraged rather briefly (p. 42) when we consider that a motor-generator is known to be a very convenient and efficient method of deriving a low-voltage direct current from a higher-voltage alternating source.

A very important point in the design of contact breaks is emphatically presented (p. 66) and exceedingly well explained. It is very desirable that the duration of 'make' be long as compared with the time of 'break'; thus an interval is allowed long enough for the current to reach a maximum value before it is interrupted. Makers quite often pay too little attention to this, and writers frequently ignore it altogether.

The classification of breaks (p. 66) should, in the writer's opinion, include a fifth, viz., mechanical breaks. Such breaks have been used in this country with much success.

In the description of various tubes (Chap. 5), it is a cause of surprise and regret that one or two very effective American tubes are not mentioned. The automatic regulating tube invented by Sayen is used all over the United States and has been highly spoken of abroad by no less authorities than Lord Kelvin and Röntgen himself. The scope and plan of the book in general is such as to commend it to the writer as the best of the few that have yet appeared on the subject.

It should be a very valuable aid to all engaged in X-ray work who have not had much experience of their own, though, as the author clearly states, such personal experience is absolutely necessary to all who would produce reliable results.

Very little seems to be said in Mr. Eddyman's book about the use of X-ray methods in medical diagnosis, though that line has been considerably developed in this country. The results of investigators in all countries except in England seem to have been rather consistently overlooked.

ARTHUR W. GOODSPEED.

Lehrbuch der Meteorologie. Von DR. JULIUS HANN. Leipzig, Tauchnitz. 1901. Royal 8vo. Pp. xiv + 805. Pls. 8. Charts 15. Figs. 111.

That a text-book of meteorology from the hand of the leading meteorologist of the world would be a masterly presentation of the subject was a foregone conclusion. No one is better qualified than Dr. Hann to write such a book. As director of the Hohe Warte in Vienna; professor in the Universities of Vienna and of Graz; editor of the *Meteorologische Zeitschrift*; a life-long original investigator of the widest range of meteorological phenomena; an earnest student of meteorological publications in all languages, Dr. Hann has brought to his latest work a wonderfully rich experience and an amazing fund of knowledge.

The 'Lehrbuch der Meteorologie' is more than a text-book. It is rather a treatise on meteorology. It ranks as a worthy companion to the same author's 'Handbuch der Klimatologie.' The 'Lehrbuch' is not intended to be a 'popular' presentation for beginners, nor is it adapted for general reading. It is a systematic and concise review of the whole subject of meteorology, as complete as is possible within the limits of 800 pages. Nothing of any importance is omitted. Admirable brief historical summaries of the different topics are followed by references to the results of the most recent investigations. So many, so well selected, and so complete are the references, in text and footnotes, that the book is indispensable to every student of meteorology simply as a bibliography. In fact, teacher and student alike will want to have this volume always close at hand, on their desk, or on the nearest shelf of their bookcase.

Since Schmid published his classical 'Lehrbuch der Meteorologie,' in 1860, no author has attempted so complete a presentation of the subject as has been given by Dr. Hann. In its general plan the new 'Lehrbuch' is not unlike that of Schmid, allowing for the natural changes which have resulted from the advance of the science during the last forty years. Schmid's 'Lehrbuch' was a landmark in its time, and is so still, as a classic. Hann's 'Lehrbuch' now occupies, and will continue to occupy, a similar position. Schmid's book was overweighted

with tabular matter and with mathematical discussions. Dr. Hann has very wisely reduced his tabular matter to a minimum, and has devoted an appendix to the consideration of the more important physical theories which involve mathematical treatment. A few of the shorter and simpler formulæ only are included in the general text. By this arrangement the text is unencumbered, and the reading becomes easier and pleasanter. None of the modern text-books of meteorology, of which there are many, attempt to cover the field which Dr. Hann has so successfully covered. Hence no comparison of the new 'Lehrbuch' with these text-books is desirable, or even possible.

There is clearly no need to outline the contents of such a book as that now before us. Throughout, in the arrangement of the contents, the treatment of each subject, and the selection of the references, the hand of the master is clearly seen. If we were to single out one chapter which is likely to be of the most general interest to meteorologists at the present time, it would probably be that dealing with the theory of extra-tropical cyclones, a subject in the discussion of which Dr. Hann has taken a very prominent part, he being a strong advocate of the dynamic theory of the origin of these disturbances. In this country, Mr. H. H. Clayton, of Blue Hill Observatory, and Professor F. H. Bigelow, of the Weather Bureau, have made interesting contributions to this discussion. An excellent summary of the main facts in the case is given, and the position of the author is made clear by the statement (p. 586): "Es soll also hier die Ansicht vertreten werden, dass es zwar atmosphärische Störungen und damit Wirbelbildungen mannigfachen Ursprunges giebt, dass aber die Hauptursache derselben, namentlich aller grösseren und langlebigeren atmosphärischen Wirbel, in den Störungen der grossen atmosphärischen Zirkulation zu suchen sein dürfte."

Americans may well take satisfaction in noting the frequent references made by Dr. Hann to the work of Mr. H. H. Clayton and of his associates at Blue Hill Observatory, and also to that of the Weather Bureau. For a book of the size of this 'Lehrbuch' there are comparatively few illustrations in the way of charts and

weather maps. Since the publication of Bartholomew and Herbertson's new 'Atlas of Meteorology,' however, there is not much need of introducing charts into text-books of meteorology, especially when the books are of such a grade as the present one. There are four half-tone views of clouds; one of lightning; two of hail-stones, and one of a waterspout. This waterspout is the one which occurred off the southern coast of New England on August 19, 1896 (see SCIENCE, N. S., Vol. IV., 1896, p. 718). Isothermal, isanomalous, isobaric, wind and rainfall charts are included.

It is seldom that a reviewer has so pleasing a task as that involved in writing a notice of Hann's 'Lehrbuch der Meteorologie.' The book is a masterpiece.

R. DEC. WARD.

A Manual of Determinative Bacteriology. By F. D. CHESTER, Delaware College Agricultural Experiment Station. N. Y., The Macmillan Co. Price, \$2.60.

Systematic bacteriology is the *bête noir* of the bacteriologist. The amount of confusion which exists in literature regarding the description of species is hardly conceivable. The descriptions are found scattered through an extensive literature; they are sometimes verbose and extended, and at other times brief and insufficient. Anything which looks toward a simplification of this complex problem will always be received with relief by bacteriologists.

The work of Professor Chester is a somewhat modest attempt to give a little assistance in this realm of confusion. It does not pretend to be a study of systematic bacteriology, but rather, as the name indicates, of *determinative* bacteriology. The author has endeavored to collect all species of bacteria which have been sufficiently described for even moderately satisfactory determination, and to arrange these within the limits of one medium-sized book in such a way that they can easily be found. By the use of artificial analytical keys, based upon simple, but important characters, the bacteria which the author includes in his list have been classified into easily distinguishable groups.

The amount of labor which has been involved in the collection and tabulation of these numerous species, about 800 in all, is very great.

Inevitably, also, the work is very uneven. Professor Chester has been obliged to use as his data the descriptions published by the numerous bacteriologists, and inasmuch as these descriptions vary so widely in their accuracy and in the extent of the details given, there is considerable difference in the completeness of the descriptions of species listed. But this, of course, cannot be laid to the fault of the author, but rather to the incompleteness and irregularity of the original descriptions.

Two phases of this work are of especial value, and bacteriologists will owe a debt to Professor Chester for introducing them. The first is the substitution of a new, descriptive word for the long, frequently verbose descriptions which have been widely used by bacteriologists. The single word 'arborescent' is quite as descriptive as the long phrase commonly found in bacteriological descriptions. A careful study of the essential characters of colonies, gelatin growths, etc., has enabled Professor Chester to select a comparatively small number of words which are distinctively characteristic, and which can almost always be used in place of the long paraphrases. This makes it possible to reduce the length of descriptions and to give them in the form of terse sentences, with a few characteristic adjectives. The work of describing species is thus immensely simplified. The second important addition is the arrangement of analytical keys. This, in itself, is one of the most important phases of the work. By the use of these analytical keys it is quite easy to trace any unknown species of bacterium very quickly to its proper place in Professor Chester's list, and then, by further study of a few carefully drawn descriptions, to determine whether the unknown species corresponds with any of those previously described. It is hardly necessary to emphasize the immense value it will be to bacteriologists to have all the known species of bacteria systematically arranged and traceable by means of a skilfully devised key. In these two respects the work of Professor Chester will be of the utmost assistance to bacteriologists.

The author adopts Migula's classification, based upon flagella, and this inevitably makes a part of the arrangement of species uncertain.

A large majority of the descriptions of bacteria in literature contain no reference to flagella. In many cases, therefore, Professor Chester has been forced to infer the presence or absence of flagella, and to classify the organisms to a certain extent in this way by guesswork. Without attempting to criticise the value of a classification based upon flagella, one cannot but deplore the fact that the classification must be based upon characters so difficult to determine. Most bacteriologists are more interested in the physiological aspects of bacterial action than in their structure, and it will be a long time before the students of bacteria will become so familiar with microscopic methods as to be able to describe the distribution of flagella. For species described in past years, and for those described by many bacteriologists for years to come, we must expect that the distribution of flagella will be a subject not attended to with sufficient accuracy to make possible a grouping of the species according to Migula's classification. At all events, in this determinative list of Chester's many of the species are classified without any knowledge of their flagella, and their arrangement into groups, as Professor Chester has arranged them, is, in many cases, therefore, a pure matter of inference.

One other point may raise more criticism. The author has taken the liberty to give names to unnamed species. Where an author refers to a bacterium by number, Chester has given it a name. The original author will, therefore, frequently quite fail to recognize an old friend under a new name. The use of synonyms and a good index of names, however, relieve some of the difficulties arising from this wholesale use of new names.

It is, of course, inevitable that in a work of this sort there will be some omissions. Each bacteriologist who is particularly well acquainted with a certain group of bacteria will, naturally, be able to look through the treatment of Professor Chester and find many points to criticise. Each specialist will, doubtless, find some omission and be inclined to differ with the author in regard to the proper relationship of the species. This, however, is inevitable and does not at all detract from the usefulness

of the work. The work is at best a provisional one, and one which will require constant modification and perfection in future years. On the whole, the work is of a high character and must hereafter form a part of the library of every bacteriological laboratory.

H. W. CONN.

Das Wirbelthierblut in Mikrokristallographischer Hinsicht. Von DR. H. U. KOBERT, mit einem Vorworte von PROFESSOR DR. R. KOBERT. Stuttgart, Ferdinand Enke. 1901. Pp. 118, mit 26 in den Text gedruckten Abbildungen.

The reviewer does not recall any monograph since Preyer's 'Die Blutkrystalle' (1871) which presents the literature on the crystalline derivatives of the blood in the manner of this little book. In view of the medico-legal importance of the microchemical methods for the detection of blood, Dr. Kobert has given in detail numerous directions for obtaining various blood-pigment derivatives in crystalline form; many of these have originally been suggested by the well-known pharmacologist and physiological chemist, Professor R. Kobert of Rostock, to whom the author—his nephew—is largely indebted. While the monograph is intended for physicians and chemists rather than for the crystallographer, purely chemical methods of examination are only considered incidentally. Each chapter concludes with an historical summary of the literature on its subject. Among the topics treated are hemocyanin, in connection with which the reader may now consider the very recent paper by Henze (*Zeitschr. f. Physiol. Chem.*, XXXIII., 370), arterin and phlebin, to prove the independent existence of which (in distinction from oxyhæmoglobin and hæmoglobin) the author devotes considerable space; methæmoglobin and similar compounds; hæmatin and hæmin, with many (in part unpublished) data regarding the so-called Teichmann's crystals; hæmochromogen, of the crystals of which several photomicrographs are reproduced and form a useful addition to the usual textbook description; hæmatoporphyrin, melanins, serum-proteid crystals, hæmosterin and a few other crystalline derivatives.

Dr. Kobert's monograph may properly be studied in connection with Schulz's 'Die Krys-

tallisation von Eiweissstoffen' (reviewed in SCIENCE of November 1, 1901), which likewise deals with the blood proteids.

LAFAYETTE B. MENDEL.

SHEFFIELD SCIENTIFIC SCHOOL
OF YALE UNIVERSITY.

SCIENTIFIC JOURNALS AND ARTICLES.

The Popular Science Monthly for December has for its first article 'A Mechanical Solution of a Literary Problem' by T. C. Mendenhall, this being the noting of the relative frequency with which words of a given number of letters occur in the writings of various authors as compared with Shakespeare. The results were plotted in curves, and the curve derived from the plays of Marlowe was almost identical with that derived from the plays of Shakespeare. Sir Robert Giffen discusses 'The Importance of General Statistical Ideas,' showing the application of Statistics to the solution of such questions as the probable increase of population, food supply, commerce or manufactures. R. T. Glazebrook describes 'The Aims of the National Physical Laboratory of Great Britain' and under the title 'Cement for a Modern Street' S. F. Peckham treats of the progress that has been made in the manufacture of good cements. In 'The Influence of Rainfall on Commerce and Politics' H. Helm Clayton shows that there is a certain periodicity in years of abundant rainfall and consequent plentiful food supply and general prosperity. The political party which chances to be in power during these seasons of plenty assumes the credit for them which is really due to weather conditions. William L. Poteat tells of 'Lucretius and the Evolution Idea' and D. T. MacDougall briefly describes 'The Sensory Mechanism of Plants.' Finally, under the caption 'The Reception of the Origin of Species,' we have a reprint of some of the more noted reviews which appeared shortly after the publication of that work.

Bird Lore for November–December completes the third volume of this magazine, and contains the index for the past year. The number comprises 'Recognition Marks of Birds,' by Ernest Seton-Thompson; 'A Bird of the Season,' by

C. William Beebe; 'Mocking-bird Notes,' by Lucy Gould Baldwin; 'A New Device for Securing Bird's Pictures,' by Frank M. Chapman; 'Bird Life in the Klondike,' by Tappan Adney, and a poem 'On Hearing a Winter Wren Sing in Winter,' by Lynn Ten Sprague. 'Birds and Seasons' now gives place to 'How to Name the Birds,' studies of the families of Passeres, by Frank M. Chapman, the first of a series of papers on identification. In the Department for Young Observers, E. W. Sinnott tells of 'My Bird Restaurant,' while many notes and reviews and an account of the New York meeting of the American Ornithologists' Union complete a large and well-illustrated number. The frontispiece of a ptarmigan on its nest deserves particular mention as a fine example of protective coloration.

The Museums Journal of Great Britain contains a brief but suggestive article by F. W. Rudder 'On the Registration of Type Specimens by Local Scientific Societies,' showing the desirability of having published records of types in the possession of societies or individuals. E. M. Holmes contributes a paper 'On the Arranging and Indexing of Scientific Pamphlets in Museum Libraries,' a subject which has been pretty well worked out in the United States. D. P. H. discusses 'Hygiene as a Subject for Museum Illustration' and there are a large number of notes from many museums in various parts of the world.

SOCIETIES AND ACADEMIES. CALENDAR.

The American Association for the Advancement of Science. A meeting of the council will be held at the Quadrangle Club, University of Chicago, on the afternoon of January 1. Section H (Anthropology) will meet in the Field Columbian Museum, Chicago (December 31 and January 1 and 2). The next regular meeting of the Association will be held at Pittsburg, Pa. (June 28 to July 3). A winter meeting is planned to be held at Washington during the convocation week of 1902-3.

The American Society of Naturalists will hold its annual meeting at the University of Chicago (December 31 and January 1). In conjunction with it will meet the Naturalists of the Central States and several affiliated societies, including the American Morphological Society (beginning on January 1); The American Physiological Society (December 30 and 31);

The American Psychological Association and the Western Philosophical Association (December 31 and January 1 and 2); The Society of American Bacteriologists (December 31 and January 1), and The American Association of Anatomists (December 31 and January 1 and 2).

The Astronomical and Astrophysical Society of America will meet in Washington (beginning on December 30).

The Geological Society of America will meet at Rochester, N. Y. (December 31 and January 1 and 2).

The American Chemical Society will meet at the University of Pennsylvania, Philadelphia (December 30 and 31).

The Society for Plant Morphology and Physiology will hold its fifth annual meeting at Columbia University, New York City (December 31 and January 1 and 2).

WINTER MEETING OF SECTION H, ANTHRO- POLOGY, OF THE AMERICAN ASSOCIA- TION FOR THE ADVANCEMENT OF SCIENCE.

THE Secretary has received the following titles of papers for presentation at the meeting to be held in Chicago, December 31, 1901, and January 1-2, 1902:

'The Beginnings of Anthropology': W J MCGEE.

'Twenty Years of Section H': GEORGE GRANT MACCURDY.

'The Exhibit of Hopi Ceremonies in the Field Columbian Museum': GEORGE A. DORSEY.

'On Some Painted Stone Slabs from the Graves of the Ruins of Walpi': C. L. OWEN.

'Basketry Designs in Northern California': ROLAND B. DIXON.

'Pueblo Indian Settlements near El Paso, Texas': J. WALTER FEWKES.

'Field Work in Arizona, 1901': WALTER HOUGH.

'The Anthropological Work of the Hyde Expedition': ALES HRDLICKA.

'Some Observations concerning the Navaho Blanket Industry': FRANK RUSSELL.

'Certain Forms of Winged-Perforated Slate Objects': WARREN K. MOOREHEAD.

'The Variability of Anthropometric Types': FRANZ BOAS.

'A Voice Tonometer': C. E. SEASHORE.

'The Psychological Elements of Visual Space Orientation About a Horizontal Axis': ROBERT MACDOUGALL.

'The Sherman Anthropological Collection, Holyoke, Mass.': GEORGE GRANT MACCURDY.

'The Significance of the Cross': PAUL CARUS.

SECTION OF ANTHROPOLOGY AND PSYCHOLOGY
OF THE NEW YORK ACADEMY OF SCIENCES.

A MEETING was held on November 25, with Professor Farrand occupying the chair.

Professor Robert MacDougall stated some of the conclusions of an investigation into the 'Combination of Simple Rhythm Groups in Higher Syntheses, and their Equivalences.' He has found that the simplest rhythmic units are always combined into larger groups, provided only the units succeed each other with sufficient rapidity. And these larger groups may be combined into others still larger—a process to which no definite limits can be set. The simplest group of rhythmic units is the pair or dipody, which appears in every rhythmic series that admits of such grouping. The means by which this coupling of the units is accomplished in poetry are: Subordination of the accent of one unit to the accent of the other, differentiation in the intervals, introduction of mid-line and final pauses, catalexis and rhyme. In any sort of rhythm that is objectively expressed, the first unit of a dipody receives the major accent, and also occupies more time than the second unit. Even in a long rhythmic series, there is properly no mere reduplication of units, but each unit fulfils a unique function in the series, in virtue of which it is differentiated from all the other units, in emphasis and duration and also in its internal configuration.

Professor Edward L. Thorndike spoke of some general aspects of the investigation which he is at present carrying on into the correlations amongst mental abilities. He found that regular correlation, where each degree of one function involves a similar degree of the other, is by no means the rule in the case of mental abilities. The relationships are often extremely irregular. For instance a high degree of one ability may go with a high degree of another but all other grades may involve no similarity in the other. A single coefficient of correlation in such cases is of course an absurdity. Correlations seem more marked between complex than between simple abilities. A variation of the Pearson method was outlined, which is well adapted to work with mental correlations and especially with studies involving few cases.

As samples of his results, Dr. Thorndike demonstrated the absence of correlation between certain motor and mental tests, the pronounced correlation between ability to spell and ability to notice the structure of words, the pronounced correlations between school marks in different subjects and the lesser degrees of correlation in the case of objective tests in the same subjects.

Mr. J. Franklin Messenger outlined an 'Experimental Study of Number Perception.' His experiments had reference to the so-called space threshold in tactile sensations, to the fusion of touch sensations, and to the perception of number through touch. The validity of a threshold determined only by the distance apart of the two points applied to the skin was denied, because distance is only one of the elements on which the perception is based, and often not the most important element. The fusion of two tactile sensations was also denied because of such facts as the following, that two points, *one on each hand*, may be perceived as one point when the hands are close together.

The speaker offered a theory of the tactile perception of number. Number is not directly sensed by touch, but is inferred from various peculiarities of the tactile sensation, such as the geometrical arrangement of the stimulating objects, the distance apart of these objects, the contour of the surface stimulated—and also from the preceding sensation and the attitude of the subject.

R. S. WOODWORTH,
Secretary.

TORREY BOTANICAL CLUB.

AT a meeting of the Club at the College of Pharmacy on October 30, the scientific program was opened by a paper by Dr. D. T. MacDougall, entitled, 'Some Characters of Alpine Vegetation.' The paper was illustrated with numerous sheets of mountain plants from Montana, many of them with attached photographs showing the habitat. In the Missoula region where Dr. MacDougall was working this summer, the growing season for many plants was about 40 days only, but the actual light reaching the plants may have been 30 to 40 per cent. greater than at sea level, and with a larger

proportion of blue rays. These mountain tops may be among the driest places on the continent or may contain swamp pockets. There is no distinct type of Alpine vegetation as such; but Alpine plants are really xerophytes, being such plants as have adapted themselves to an insufficient water supply.

Our Alpine plants are often thought to be identical with polar plants. But the polar plant receives light continuously through a long period, though the light is of little intensity. The polar plant has an atmosphere of much greater humidity, but a much colder soil. Polar plants develop much greater thickness of leaf. Alpine plants abound in more numerous protective devices, as waxy coatings, hair, thicker stems, and modes of propagation without seeds. *Poa alpina*, for example, in many mountain regions is never known to flower.

Remarks followed regarding the viviparous state of *Poa alpina*, Dr. Rydberg observing its abundance in Greenland and Spitzbergen, and Miss Isaacs remarking on her collecting it at 7,500 feet altitude during the last summer in Switzerland.

Dr. Underwood called attention to the relative amount of sunlight in tropical and in northern regions, showing that the amount of light is much greater north of the tropics, though more oblique.

Discussion followed regarding relations of moisture. Dr. Schoeney referred to the peculiar erect and densely appressed stems assumed by a cespitose *Opuntia* about Boulder, Colorado. Dr. MacDougal spoke of the remarkable degree to which many of the *Cacti* have adapted themselves to xerophytic conditions, so that they lose water less than $\frac{1}{300}$ as readily as in ordinary plant structures in similar positions.

Dr. Rydberg referred to the permanent moisture found within ten or twelve inches of the surface in the dry sand hills of Nebraska.

The second paper was by Dr. P. A. Rydberg, 'Revisions of *Limnorchis*,' being a study now printing in the *Bulletin*, treating of the former genus *Habenaria* and of segregations accepted from it, including the new genera *Limnorchis*, the green and swamp orchids of the Eastern United States, *Piperia*, *Lysiella* and *Gymnadeniopsis*; and the revival of the genus *Blephari-*

glottis of Rahneseque. The first *Limnorchis* described was Koenig's '*Orchis hyperborea*,' often found in Iceland and Greenland, but rare in America, though sometimes occurring in the cold upper region of New York and Canada. Discussion of synonymy and illustration by numerous specimens accompanied the paper. The diagnostic characters were drawn from the spur, lip and stamens, 24 species of *Limnorchis* and 9 of *Piperia* being recognized.

Reference was made by Mr. G. H. Watson to a remarkable growth near Ellenville, New York, where two trees not only different in species, but in family had so twisted together as to become incorporated, and in response to remarks appreciating its significance, he promised further investigation and a photograph of the trees.

EDWARD S. BURGESS,
Secretary.

SCIENCE CLUB, UNIVERSITY OF WISCONSIN.

AT the November meeting of the University of Wisconsin Science Club, Professor C. S. Schlichter presented a paper on 'A New Method of Determining the Size and Velocity of Underground Streams,' and A. H. Pfund discussed 'The Dispersion and Absorption of Selenium.'

During the past summer Professor Schlichter made preliminary tests, for the Hydrographic Division of the U. S. Geological Survey, of the movement of streams percolating through sands and gravels beneath rivers like the Arkansas and Platte, which, across the semi-arid plains in western Kansas and Nebraska, entirely disappear during the months of July and August. The method devised for these tests was an electrical one which permitted rapid and extensive surveys to be made at low expense. A double row of one and one-half inch drive wells was sunk across the channel of the river. The upstream wells were charged with a strong electrolyte, which dissolved and passed downstream with the underground water. When the chemical reached the lower wells its presence was shown by the deflection of a needle, and the rate of movement was then easily calculated. The underground flowage at the places tested was found to range from 3 to 15 feet per day, and to be fairly constant, not

varying more than 10 per cent. The gradient at such places is 8 to 10 feet per mile.

Professor Schlieter's paper was discussed by Professors C. R. Van Hise, J. B. Johnson, F. W. King, F. E. Turneaure and E. A. Birge.

Mr. Pfund discussed the 'Dispersion and Absorption of Selenium.' By devising a new method for depositing films of the aniline dyes on glass and for photographing the interference fringes produced by a Michelson interferometer, the dispersion of amorphous selenium, a comparatively opaque substance, has been success-fully studied. The refractive index of selenium rises with extraordinary rapidity until at the limit of the photographic field it reaches a value of 3.13, one of the very highest known. In general, the light-absorbing power of selenium lies between that of the aniline dyes and that of the metals. With a small concave grating, it has been found that selenium absorbs light more and more strongly as the end of the ultra-violet spectrum is approached, instead of there being a region of retransmission.

C. K. LEITH.

DISCUSSION AND CORRESPONDENCE.

THE MATHEMATICAL THEORY OF THE TOP, SIMPLIFIED.

TO THE EDITOR OF SCIENCE: Professor A. G. Greenhill has been good enough to show me his terse method of treating the top integrals. As this is a subject on which Professor Greenhill speaks authoritatively, and will interest a number of your readers, in particular his many friends in Sections A and B of the American Association, I suggest that it be published in SCIENCE.

CARL BARUS.

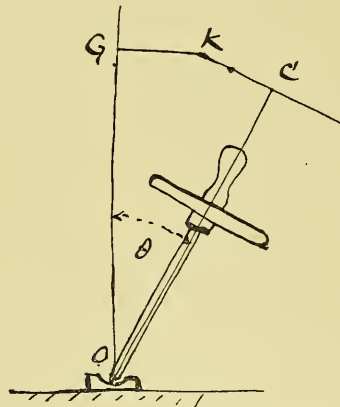
Brown University, Providence R. I.,
November 20, 1901.

Let the vector OH represent the resultant angular momentum of a symmetrical top; spinning about its point O is a small smooth fixed cup, as in the Maxwell top.

Since the axis Og of the torque of gravity is always horizontal H will describe a curve (a Poinso't herpolhode), in a fixed horizontal plane at a height OG above O , the vertical vector OG representing the constant component G of angular momentum about the vertical.

We assume that the component G' of the angular momentum of the top about its axis OC remains constant, as there is nothing to alter it, if the top is symmetrical.

FIG. 1.



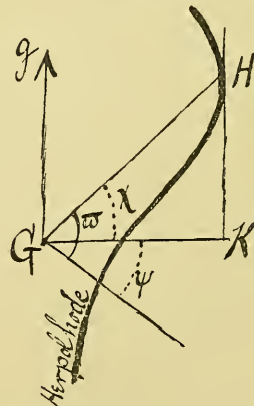
Expressed by Euler's angles θ and ψ the vector OH has the components (Figs. 1 and 2)

$$(1) \quad OC = G', \quad CK = A_1 \sin \vartheta \frac{d\psi}{dt}, \quad KH = A_1 \frac{d\vartheta}{dt},$$

A_1 denoting the moment of inertia of the top about an axis through O perpendicular to OC .

The velocity of H is equal to the torque of gravity $Wgh \sin \vartheta$, so that, denoting the polar

FIG. 2.



coordinates of H in the horizontal plane GHK by ρ and π , and resolving in the radial direction GH .

$$(2) \quad \frac{d\rho}{dt} = Wgh \sin \vartheta \cos GHK = Wgh \sin \vartheta \frac{KH}{\rho}$$

$$(3) \quad \rho \frac{d\rho}{dt} = A_1 Wgh \sin \vartheta \frac{d\vartheta}{dt},$$

and integrating,

$$(4) \quad \frac{1}{2} \rho^2 = A_1 Wgh (E - \cos \vartheta).$$

To make the equations homogeneous, put

$$(5) \quad OG = \delta, \quad OC = \delta', \quad 4A_1 Wgh = k^2,$$

so that

$$(6) \quad \rho^2 = \frac{1}{2} k^2 (E - \cos \vartheta).$$

Now denoting the perpendicular GK from G on the tangent at H by p ,

$$(7) \quad p \sin \vartheta = \delta' - \delta \cos \vartheta,$$

so that, eliminating ϑ ,

$$(8) \quad p^2 = \frac{[\delta' k^2 - \delta(Ek^2 - 2\rho^2)]^2}{k^4 - (Ek^2 - 2\rho^2)^2},$$

and this is the characteristic geometrical property of a Poinsoth herpolhode; it also defines the trace of a rolling line of curvature, the intersection of an ellipsoid and a confocal hyperboloid of two sheets, and then δ is the angle between the generating lines of the confocal hyperboloid* of one sheet through H (Darboux).

Since

$$(9) \quad KH^2 = GH^2 - GK^2,$$

$$(10) \quad A_1^2 \left(\frac{d\vartheta}{dt} \right)^2 = 2A_1 Wgh (E - \cos \vartheta) - \frac{(G' - G \cos \vartheta)^2}{\sin^2 \vartheta};$$

and putting $\cos \vartheta = z$, $\frac{Wgh}{A_1} = n^2$,

$$(11) \quad \left(\frac{dz}{dt} \right)^2 = 2n^2 Z,$$

$$(12) \quad Z = (E - z)(1 - z^2) - \frac{(G' - Gz)^2}{2A_1 Wgh} \\ = (E - z)(1 - z^2) - 2 \left(\frac{\delta' - \delta z}{k} \right)^2.$$

Denoting the roots of $Z = 0$ by z_1, z_2, z_3 , and arranging them so that

$$(13) \quad z_1 > 1 > z_2 > z > z_3 > -1,$$

then with $\frac{d\vartheta}{dt}$ positive, $\frac{dz}{dt}$ negative, as in Fig. 1,

$$(14) \quad nt = \int_z^{z_2} \frac{dz}{\sqrt{2Z}},$$

an elliptic integral of the first kind; and, by inversion, z is an elliptic function of t .

To make the reduction to Legendre's standard form, put

* Proc. London Math. Society, XXVI., XXVII.

$$(15) \quad z = z_2 \sin^2 \phi + z_3 \cos^2 \phi,$$

$$(16) \quad z - z_3 = (z_2 - z_3) \sin^2 \phi,$$

$$(17) \quad z_2 - z = (z_2 - z_3) \cos^2 \phi,$$

$$(18) \quad z_1 - z = (z_1 - z_3) \Delta^2 \phi,$$

$$(19) \quad k^2 = \frac{z_2 - z_3}{z_1 - z_3}, \quad k'^2 = \frac{z_1 - z_2}{z_1 - z_3};$$

then

$$(20) \quad nt = \sqrt{\left(\frac{2}{z_1 - z_3} \right)} \int_{\phi}^{\frac{3}{2}\pi} \frac{d\phi}{\Delta \phi} \\ = \sqrt{\left(\frac{2}{z_1 - z_3} \right)} (K - F\phi),$$

$$(21) \quad F\phi = K - mt, \quad mt = \sqrt{\left(\frac{z_1 - z_3}{2} \right)} nt.$$

Then, in Jacobi's notation,

$$(22) \quad \phi = am(K - mt),$$

and in Gudermann's notation,

$$(23) \quad z = z_2 \operatorname{Sn}^2(K - mt) + z_3 \operatorname{Cn}^2(K - mt),$$

the expression of z or $\cos \vartheta$ by elliptic functions of t .

Next, denoting the angle KGH by χ ,

$$(24) \quad \tan \chi = \frac{KH}{GK} = \frac{A_1 \sin \vartheta \frac{d\vartheta}{dt}}{GK \sin \vartheta} \\ = \frac{\sqrt{(2A_1 WghZ)}}{G' - Gz} = \frac{\sqrt{2Z}}{2 \frac{\delta' - \delta z}{k}},$$

$$(25) \quad \sin \vartheta \cos \chi = \frac{G' - Gz}{\sqrt{[2A_1 Wgh(E - z)]}},$$

$$\sin \vartheta \sin \chi = \frac{\sqrt{Z}}{\sqrt{(E - z)}}.$$

Resolving transversely to GH , or rather, taking the moment of the velocity of H round G ,

$$(26) \quad \rho^2 \frac{d\pi}{dt} = Og \cdot GK = Wgh \sin \vartheta \cdot GK \\ = Wgh (G' - G \cos \vartheta)$$

so that, from (6),

$$(27) \quad \frac{d\pi}{dt} = \frac{G' - G^2}{2A_1 (E - z)}$$

$$(28) \quad \pi = \frac{Gt}{2A_1} + \frac{G' - GE}{2A_1} \int \frac{dt}{E - z}$$

$$= \frac{\delta}{k} nt + \frac{\delta' - \delta E}{k} \int_z^{z_2} \frac{dz}{(E - z) \sqrt{2Z}},$$

involving an elliptic integral of the III. kind, and then

$$(29) \quad \psi = \pi - \chi.$$

But the component of the angular momentum round the vertical

$$(30) \quad OC \cos \vartheta + CK \sin \vartheta = G' \cos \vartheta + A_1 \sin^2 \vartheta \frac{d\psi}{dt} = G$$

so that

$$(31) \quad \frac{d\psi}{dt} = \frac{G - G' \cos \vartheta}{A_1 \sin^2 \vartheta} = \frac{G - G'z}{A_1 (1 - z^2)} = \frac{G - G'}{2A_1} \cdot \frac{1}{1 - z} + \frac{G + G'}{2A_1} \cdot \frac{1}{1 + z}$$

which gives ψ as the sum of two elliptic integrals of the III. kind, their addition into a single integral (Legendre) is shown by (23), (29).

The reduction to the Weierstrassian form is effected by putting

$$(32) \quad p\mu - e_a = s - s_a = \frac{1}{2}M^2(z - z_a),$$

where M is a homogeneity factor at our disposal ; and now

$$(33) \quad nt = \int_{s_3}^{s_2} \frac{M ds}{\sqrt{S}}, \quad S = 4(s - s_1)(s - s_2)(s - s_3),$$

$$(34) \quad p'^2 \mu = S = \frac{1}{2}M^2 Z,$$

$$(35) \quad \frac{nt}{M} = \int_{s_3}^{\infty} \frac{ds}{\sqrt{S}} - \int_{s_2}^{\infty} \frac{ds}{\sqrt{S}} = \mu - \omega_2.$$

If v, σ, Σ denote the corresponding values of μ, s, S when $z = E$,

$$(36) \quad pv - p\mu = \frac{1}{2}M^2(E - z)$$

$$(37) \quad pv - e_a = \sigma - s_a = \frac{1}{2}M^2(E - z_a)$$

$$(38) \quad ip'v = -\sqrt{(-\Sigma)} = M^2 \frac{\delta' - \delta E_1}{k}$$

$$(39) \quad z_1 > E > z_2 > z > z_3, \quad s_1 > \sigma > s_2 > s > s_3,$$

so that

$$v = \omega_1 + \psi \omega_3 ;$$

and (28) becomes

$$(40) \quad \pi = \frac{\delta}{k} nt + \frac{1}{2} \int \frac{ip'v dn}{pv - p\mu}$$

with the elliptic integral of the III. kind in the standard form of Weierstrass.

In the steady motion of the top, $\frac{d\vartheta}{dt} = 0, \frac{d\psi}{dt} = \mu$, a constant, H and K coincide, and

$$(41) \quad \rho = GK = OC \sin \vartheta - CK \sin \vartheta = G' \sin \vartheta - A_1 \mu \sin \vartheta \cos \vartheta,$$

$$(42) \quad Wgh \sin \vartheta = \rho \mu = \sin \vartheta (G'\mu - A_1 \mu^2 \cos \vartheta),$$

and dropping the factor $\sin \vartheta$,

$$(43) \quad A_1 \mu^2 \cos \vartheta - G'\mu + Wgh = 0.$$

A. G. GREENHILL.

ORDNANCE COLLEGE,
WOOLWICH, ENG.

CURRENT NOTES ON PHYSIOGRAPHY.

NEW ORDNANCE MAP OF ENGLAND.

THE 'Colored One inch Map of England,' now in process of publication, marks a great improvement on both the old and the new series of the earlier ordnance survey inch-to-a mile maps. Relief is shown by brown hachures, drawn with much accuracy of expression, and by red contours at intervals of 100 feet. Water is in blue, with blue contours in the sea for every 25 feet of depth near shore ; the chief roads are in ochre, woodland on some of the sheets is green, and culture is black. Most of the sheets represent quadrangles measuring 18 miles east and west by 12 miles north and south ; but for southern England the sheets frequently include larger areas, according to some system that is not immediately apparent. Some 130 sheets have now been published, the standard sheets costing a shilling each. While looking over them, local geographical features are brought vividly to mind. The Falmouth sheet, Cornwall, includes the typical drowned valleys of Fal and Helston rivers, open to the sea on the east side of the even uplands back of the Lizard, and of Loe river, closed on the more exposed western coast by Portleven sands, one of the few beaches of this ragged shore line. The contours along the valley sides here and on the neighboring Ivybridge and Boscastel sheets are of much smoother curvature than those that follow the coast, thus showing that the shore line in this district of resistant ancient rocks is in that immature stage of development when its irregularity of detail has become greater than it was in the initial stage. Where the coast consists of weaker Mesozoic rocks, as shown on the Exeter and Sidmouth sheets, a smoother shore line of greater retreat and more mature expression is found. A little further east, where the Bridport and Weymouth sheets join, the long sweeping curve of Chesil bank is finely displayed.

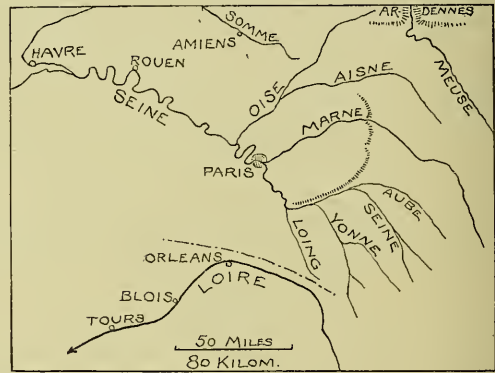
The relations of rivers to their valleys offer some interesting problems. In certain meandering valleys the rivers sweep around the valley curves in a most competent fashion, pressing against their outer banks and demanding an increased breadth of meander belt ; the Torridge in Devonshire (Chulmleigh sheet) and the

Tamar in Cornwall (Tavistock sheet) are of this kind. But it is more common to find the streams incompetent to swing steadily around the curves of their meandering valley floors; the headwaters of the Thames in the Cotswolds offer striking illustrations of this sort. The Evenlode (Oxford sheet) and the Cherwell (Chipping Norton sheet) are typical straggling streams, meandering on so much smaller a scale than their valley that they seem to wander aimlessly about its curving floor. The chief cause of the incompetence of these streams is probably to be found in their loss of volume, from having been beheaded by the (Stratford) Avon; yet some additional cause must be looked for, inasmuch as the Avon, which should be gaining in volume as its obsequent branches increase in length with the retreat of the Cotswold escarpment, is also somewhat incompetent to follow the pattern of its distinctly meandering valley (Worcester and Stratford-on-Avon sheets). No general climatic change towards less rainfall can be appealed to, for the streams cited in Cornwall and Devonshire, as well as certain others in Wales, show no signs of diminished volume by shrinking from the curvature of their valleys. The meanders of the Torridge, above mentioned, are remarkable for their large arc, and for the associated interlocking or dovetailing of the upland spurs that enter the valley meanders. The spurs that enter the meanders of the Evenlode valley appear to have been trimmed and steepened on their up-valley side, the result of the systematic down-valley migration of the river meanders before the decrease of volume took place; the distinctness with which this delicate detail of form is shown being a high tribute to the accuracy of the topographer's work.

HYDROGRAPHY OF THE PARIS BASIN.

The geological structure of the Paris basin has been minutely studied by Dollfus, who makes application of his results in a discussion of the 'Relations entre la structure géologique du bassin de Paris et son hydrographie' (*Ann. de Géogr.*, XI., 1900, 313-339, 413-435, map). The Cretaceous and Tertiary strata that occupy most of the basin have been gently undulated in late Tertiary or in post-Tertiary time; the shallow

synclines and low anticlines generally run northwest-southeast, in accordance with the trend of the more closely folded underlying Paleozoic strata, which appear in Brittany and elsewhere. The author recognizes several classes of streams: consequent, inconsequent, obsequent (the definition of this term does not agree with that given by others) and secant (traversing an anticline); subsequent streams are not explicitly noted. He then shows that many streams of the Paris basin are consequent, inasmuch as they follow synclinal troughs. The Somme is a good example of this class, although it does not drain the whole length of its syncline (p. 317). The eastern part of the syncline is occupied by the Aisne, which is led southward



by the Oise, away from what appears to have been its original westward extension to the Somme; the Oise being secant to several anticlines on its way to the Seine just below Paris. This diversion is ascribed to capture (p. 318), though the causes and proofs of capture are not clearly set forth. The diversion might possibly be consequent on a rise in the floor of the syncline between the Oise and the head of the Somme.

While many examples of consequent synclinal streams are indicated, they are usually of relatively small volume. A number of the larger streams frequently follow oblique courses, seemingly indifferent to the anticlines that lie across their way, and for this inconsequent behavior no full explanation is offered. The antecedent origin of the Meuse through the Ardennes is discarded (p. 330) on what seems insufficient evidence; its gorge is explained as the result

of retrogressive erosion by a Belgian stream, which is thought to have captured the Meuse from an assumed westward course south of the uplands, a process that seems inadmissible in view of the continuity of the Ardennes as a divide elsewhere. The numerous subsequent streams in the eastern part of the Seine system are not recognized as such; and the subsequent valley-lowlands, opened on weak strata, between the cuestas that are maintained by stronger strata, are not regarded as certainly due to differential erosion (p. 326), although no specific reasons are given to justify this scepticism. The Loire, whose former northward course from the Central plateau to the Seine is proved by the distribution of crystalline gravels, is explained as having been turned to its present westward course past the site of Orleans by one of the chief anticlines of the region; but its extension southwest past Blois and Tours seems to have been taken with little regard to the numerous anticlinal and synclinal axes mapped there.

The former northward course of the Loire, as above stated, may perhaps give explanation to the peculiar westward deflection of the Aube, upper Seine and Yonne along a subsequent valley south of the cuesta of *calcaire grossier* to the point where the Loing, a smaller stream, turns their united waters through the cuesta towards Paris. The Loing seems to represent the former course of the Loire. While that large river ran here, one of its subsequent branches might, with more or less aid from differential elevation, naturally enough have captured the Yonne, upper Seine and Aube, which then continued in their deflected course after the Loire had been turned away to the west.

HERCEGOVINA.

A students' excursion from the University of Vienna through Bosnia, Hercegovina and Dalmatia, under Penck's leadership, in the spring of 1899, led that geographer to prepare two essays on the physical features of the region visited ('Geomorphologische Studien aus der Hercegovina,' *Zeitschr. deutsch.-oesterr. Alpenvereins*, XXXI., 1900, 25-41, 'Die Eiszeit auf der Balkenhalbinsel,' *Globus*, LXXVIII., 1900, 133-136, 159-164, 173-178). Strongly folded Mesozoic limestones occupy most of the country traversed.

They have been extensively denuded and in some areas reduced to plains, while elsewhere mountains of strong relief still remain. Some of the latter possess well-defined cirques and moraines of former local glaciers. Large sink-holes abound in the highlands. Much of the upland surface exhibited bare limestone ledges, the typical Karst landscape. The lower course of the Kerka river lies across one of the plains of denudation whose surface evenly truncates the inclined limestone strata; but the plain is now elevated and trenched by the river, and in the young gorge thus formed extensive travertine deposits have produced a beautiful group of falls, back of which stretches a narrow, branching lake. In other cases, dislocation is believed to have accompanied elevation. Many streams that flowed on the surface of the lowlands before their elevation now escape to the sea from enclosed basins by underground passages, reappearing further on in great springs, and thus leaving the uplifted land forms more than usually intact. The undersigned also, as a member of Penck's party, has written a brief account of this 'Excursion in Bosnia, Hercegovina and Dalmatia' (*Bull. Geogr. Soc. Phila.*, III., 1901, 21-50).

W. M. DAVIS.

NOTES ON ENTOMOLOGY.

WITH the coming of the new century we have two new entomological journals. One, entitled *Revue Russe d'Entomologie*, is issued bimonthly by a committee of six editors, several of whom are well known to entomologists. It is a general journal, containing descriptions of new species, synopses, etc., but most of the articles are devoted to the Russian fauna. Each number contains a bibliography of current entomologic literature appertaining to the Russian fauna. The other journal is the *Zeitschrift für systematische Hymenopterologie und Dipterologie*, published by F. W. Konow, of Teschendorf, Germany. Six numbers are to appear each year. Its title indicates its intended scope, but several biologic articles have already appeared in its pages.

It has long been known that the species of *Orina*, a genus of Chrysomelid beetles, were viviparous. Recently Mr. Champion and Dr.

Chapman have investigated this matter,* confirming the previous knowledge, and discovering that one species is ovo-viviparous. They find that the eggs develop into larvæ in the ovarian tubules, and increase in size during their progress down the oviduct. This indicates that fecundation in these insects is not by the usual method; but how is as yet unknown.

Part I., 1901, of the journal of the Hungarian National Museum, *Természetrázi Füzetek*, contains world catalogues of two families of insects. One is 'Catalogus Pipunculidarum,' by C. Kertész, pp. 157-168. It brings the subject down to 1901, and includes 4 genera and 110 species. The other is a 'Catalogus Endomychidarum,' by E. Csiki. It is published as a supplement to the journal, and contains 78 genera and 585 species.

Brauer has issued another part of his 'Beiträge zur Kenntniss der *Muscaria schizometopia*.' † This deals with the synonymy of many species described by Bigot, Macquart and others that belong to genera allied to *Calliphora*. It is prefixed by a table to these genera. Nearly twenty of the species come from the United States, and many more from Mexico. Of especial value are his determinations of the Bigot material.

E. Wasmann has concluded his paper on '*Termitoxenia*,' ‡ in which he deals with the systematic position of the genus. In a previous part he thought it would go in the Stethopathidæ, but now he concludes to erect for it a new family, Termitoxenidæ, intermediate between the Eumyidæ and the Pupipara. It thus falls into Coquillett's superfamily Muscoidea.

An interesting contribution towards the life-history of an eastern mosquito has been published by Miss Nelly Evans.§ She has studied *Culex fatigans*, one of the species known to

* 'Observations on some Species of *Orina*, a Genus of Viviparous and Ovo-viviparous Beetles,' *Trans. Ent. Soc., Lond.*, 1901, pp. 1-19. 2 plates.

† *Sitzungsber. Akad. Wissensch.*, Wien, 1899 (1901), pp. 495-529.

‡ '*Termitoxenia*, ein neues, flugelloses, physogastres Dipteren-genus aus Termitennestern'; part II. *Zeitschr. f. Wissensch. Zool.*, 1901.

§ 'Some Observations on the Life-history of *Culex fatigans*, the Common Grey Mosquito of Lower Bengal,' *Proc. Asiat. Soc. Bengal*, Aug., 1901, pp. 65-67.

attack birds. Specimens were kept a month on fruit; but will not deposit eggs until they have had a meal of blood. Fertilization normally occurs after feeding, but one specimen laid eggs that had been fertilized only before feeding. Egg-boats are laid about four to six days after meal of blood; if the mosquito is again fed, it will deposit again, and some specimens laid five egg-boats. The larval stage lasts twenty days; the pupal stage four days.

Dr. F. Dahl has given an account of the habits of the ants of the Bismarck archipelago.* It is preceded by a systematic article by Professor Forel. Dahl, however, gives tables to the genera and species, both according to structure, and according to nesting habits. He compares the fauna to that of north Germany, and tabulates the species of the latter region according to nest habits. The plates illustrate two remarkable nests. One is of *Camponotus quadriceps* in the stems of a plant. The pith is partially excavated; at places the cavity is enlarged, and there are simple openings to the outside. This does not affect the plant or cause any abnormal growth. The other is a greatly enlarged stem of a plant in which there are many channels and cavities caused by *Iridomyrmex cordatus*.

Dr. G. Enderlein has written on the breathing apparatus of the Gastridæ † (more commonly known as Cæstridæ). In these larvæ, which infest various large animals, respiration is often performed under difficulties, and results in considerable modification of the breathing apparatus. These modifications, which the author describes in considerable detail, are summed up as follows:

1. Complication of the closing apparatus of the stigmata.
2. Elongation of the stigmal cleft.
3. The beginning of air reservoirs.
4. Development of the terminal tracheal structures for the reception of oxygen by the blood.

* 'Das Leben der Ameisen im Bismarck-Archipel,' *Mitt. Zool. Mus. Berlin*, II., hft. 1, pp. 1-70, 2 pls., 1901.

† 'Die Respirationorgane der Gastriden,' *Sitzungsber. Akad. Wiss.*, Wien, May, 1899 (1901), pp. 235-302, 3 pls.

Karl Verhoeff has recently added another number to his series of articles on palæarctic Myriopods.* This part deals with certain points in the morphology, classification and distribution of the Chilopoda. He makes out four pairs of mouth-parts, and five segments in the chilopod head. The systematic part treats of the genera *Bothriogaster*, *Geophilus*, *Cryptops* and *Lithobius*.

Probably no one has studied the varieties of a moth so closely as has Mr. J. A. Clark, who, in a recent article on '*Peronea cristata* Fabr. and its aberrations,' † has elucidated and named no less than sixty-two forms of this British moth. Twenty-five of these aberrations are here described for the first time.

Monographiæ Entomologiæ, No. II., is to be 'A Monograph of the Membraciæ' of the world, by G. W. Buckton. The first part has been issued, is a quarto in size, and contains fifty-six pages and eight colored plates. It is, however, far from a 'monograph'; there are descriptions of many species, but there are many other species listed but not described, and often without reference as to where they were described. One of the new species is from New York. The plates are rather crude.

Every coleopterist should be interested in Mr. H. C. Fall's recent list of Coleoptera from southern California. ‡ Apart from the fact that, next to the New Jersey list, it is the largest local list yet issued, it is of great value because of the notes on habits and variation of the species mentioned. The total number of species runs up to 2,197, included in 826 genera. The long lists of Malachiidæ and Tenebrionidæ are especially marvelous to an eastern collector. Eighty-seven new species are described, and many others indicated, but not fully studied.

Nuttall and Shipley in continuation of their investigations on the structure and habits of

*Anopheles** have given many interesting observations. The recent parts relate to the pupa and imago, and will be of particular value to those interested in the external anatomy of insects. The detailed descriptions of the emergence of the fly from the pupa and of the feeding habits of the imago are especially interesting. In the description of the thorax the authors have followed Brauer in the nomenclature of parts. They consider that the first thoracic spiracle belongs to the mesothorax and not to the prothorax, as several authors have claimed.

Major Ross has issued his 'First Progress Report of the Campaign against Mosquitoes in Sierra Leone.' † This crusade was largely in the nature of an experiment to prove that tropical towns, notorious for mosquitoes and malaria, could be largely freed from these plagues by the adoption of certain sanitary measures. It is almost needless to say that it was successful. Empty tin cans, buckets and broken bottles were gathered, pools and puddles in streets and back yards were drained, and in a few weeks mosquitoes were rarities in Freetown.

NATHAN BANKS.

THE GEOLOGICAL SOCIETY OF AMERICA.

THE fourteenth winter meeting of the Society will be held at Rochester, N. Y., beginning on Tuesday, December 31, in the Geological lecture room, Sibley Hall, University of Rochester. The meeting will be called to order at 10 o'clock a. m. by President Charles D. Walcott. The annual address of the retiring president will probably be given Tuesday evening. The Council will hold an informal session on Monday night to open and count the ballots for officers and fellows, and will meet in formal session at 9 o'clock Tuesday morning. If the weather is favorable short excursions may be planned; one to see the Niagara strata of the Genesee gorge in the northern part of the city, and another to the Pinnacle moraine in the southern edge of the city. Ward's Natural Science Establishment, which is across the street from the University, will provide a lunch

* 'Beiträge zur Kenntnis paläarktischer Myriopoden,' XVI., Aufsatz. *Nova Acta. K. Leop.-Carol. Akad. Naturf.*, LXXVII., No. 5. 1901. 3 plates.

† *Entom. Record*, 1901, pp. 227-229; 261-265; 287-293.

‡ 'List of the Coleoptera of Southern California with Notes on Habits and Distribution and Descriptions of New Species,' *Occ. Papers, Calif. Acad. Sci.*, VIII., Nov., 1901, pp. 1-282.

* 'The Structure and Biology of *Anopheles*,' *Jour. of Hygiene*, I., pp. 259-276; 431-484, 4 pls., 1901.

† Liverpool School of Tropical Medicine, Memoir 5, part 1, 1901.

for those Fellows who may wish to visit the Establishment during the noon recess. The president of the University, Dr. Rush Rhees, and the Trustees will tender a reception to the Fellows of the Society at the president's house on Thursday evening, January 2. The customary dinner will be arranged, probably for Wednesday evening.

No special reduction of railroad fare can be secured for the meeting, but during the holiday season reduced rates can usually be obtained from important railroad centers.

*PROGRAM OF AMERICAN SOCIETY OF
NATURALISTS.*

Tuesday, December 31, 1901.

8.00 P. M., Kent Theater, University of Chicago.—Address of welcome, by President W. R. Harper. Lecture by Dr. Leland O. Howard. Subject: 'International Work with Beneficial Insects.'

9.30 P. M., the President's House.—A Reception to all the Societies, by President Harper.

Wednesday, January 1, 1902.

2.00 P. M., Kent Theater.—Business meeting.

3.00 P. M., Kent Theater.—Discussion. Subject: 'The Relation of the American Society of Naturalists to other Scientific Societies.' Charles Sedgwick Minot, Harvard Medical School; C. B. Davenport, University of Chicago; W J McGee, Washington; William Trelease, Washington University, St. Louis; E. A. Birge, University of Wisconsin; J. McKeen Cattell, Columbia University.

6.45 P. M., Auditorium Hotel.—Business meeting.

7.00 P. M., Auditorium Hotel.—Annual dinner. Address of the President, Professor William T. Sedgwick, 'The Modern Subjection of Science and Education to Propaganda.'

LOCAL COMMITTEES.

Executive.—C. B. Davenport, Chairman; E. O. Jordan, Secretary; W. A. Locy, Treasurer; L. F. Barker, C. R. Barnes, John M. Coulter, John Dewey, H. H. Donaldson, G. A. Dorsey, F. R. Lillie, Jacques Loeb, E. P. Lyon, C. O. Whitman.

Reception.—H. H. Donaldson, Chairman; C. W. Andrews, Miss Helen Culver, W. R. Harper, Mrs. Martin A. Ryerson, G. C. Walker, Mrs. Coonly-Ward, C. O. Whitman.

Transportation.—Frederick J. V. Skiff, Chairman; G. A. Dorsey, F. R. Lillie, Willard A. Smith.

General.—C. M. Child, C. B. Davenport, George Dreyer, John Dewey, H. H. Donaldson, G. A. Dorsey, W. S. Hall, L. Hektoen, E. O. Jordan, F. R. Lillie, W. A. Locy, Jacques Loeb, A. P. Matthews, A. R. Reynolds, C. O. Whitman.

RAILROADS.

The New England Passenger Association, the Trunk Line, the Central and the Western Passenger Associations have granted the usual reduction (one and one third fares for the round trip) to those attending the meeting and provided with 'certificates.' The certificates, not transferable, must be obtained from the ticket agent at the starting-point (or, if the starting-point is not an important station, at the nearest station issuing certificates) to the place of meeting, at least thirty minutes before the train leaves. The going ticket may be purchased not earlier than December 26 or later than December 31. The certificate must state that the object of making the journey is to attend the meeting of the Affiliated Scientific Societies at Chicago, and they must be signed on December 31, January 1 or January 2, by Dr. L. W. Williams and by the special railway agent in attendance at the meetings on these three days.

SCIENTIFIC NOTES AND NEWS.

It is announced by cablegram from Stockholm that the Nobel prize in medicine has been awarded to Professor Behring, the prize in physics to Professor Röntgen and the prize in chemistry to Professor Vau't Hoff. The value of each of the prizes is about \$40,000. The prize for the promotion of peace has been divided between Dr. Dumant and M. Passy, and the prize in literature has been awarded to M. Prudhomme.

THE Symons gold medal of the Royal Meteorological Society has been awarded to Dr. Alexander Buchan, F.R.S.

PROFESSOR ALFRED C. HADDON, of Cambridge University, lectured before the New York Academy of Sciences and the American Ethnological Society on December 11, his subject being 'The Ethnography of British New Guinea.' Professor Haddon sailed for England on December 14.

THE Academy of Natural Sciences of Philadelphia, has nominated Professor E. G. Conklin, of the Biological Department of the University of Pennsylvania, for vice-president; and Dr. J. P. Moore, of the same department, for corresponding secretary.

SIR WILLIAM ROBERTS-AUSTEN, K.C.B., F.R.S., will deliver the tenth 'James Forrest' lecture at the Institution of Civil Engineers on April 17, 1902, the subject being 'Metallurgy in Relation to Engineering.'

DR. N. SIEBER-SCHUMOW, a woman, has been temporarily appointed to fill the place of the late Professor Nencki as head of the Department of Biological Chemistry in the Imperial Institute of Experimental Medicine, St. Petersburg.

THE Board of Overseers of Harvard College has voted that 'a joint committee of the corporation and this board be appointed to confer with Mr. Alexander Agassiz and request him to sit for a portrait to be placed in the museum as a gift from friends of his and of the university, there to remain a memorial of the great service rendered by Professor Agassiz to that department.'

AN oil painting of Professor John Johnson, LL.D., who was professor of natural science at Wesleyan University from 1837 to 1879, has been presented to the library.

As a memorial of the late Professor Dickson, there have been presented to the Glasgow University library 388 volumes of Migne's 'Pathology,' a work which Dr. Dickson long desired to acquire for the library.

A PORTRAIT of Mr. G. D. Liveing, professor of chemistry at Cambridge University, was presented to St. John's College on December 7, as a testimonial in recognition of his valuable services to science, to the university and to the town. The portrait, which is by Sir George Reid, is of three quarters length. Arrange-

ments have also been made for a bronze bust of Professor Liveing, by Miss Edith Bateson, which will be placed in the chemical laboratory during next year.

DR. CHARLES J. ESSIG, professor in the dental department of the University of Pennsylvania, has died at the age of seventy-four years. In 1878 he organized the dental department of the University of Pennsylvania, and was for many years its dean and secretary. He was the editor of 'The American Text-Book of Prosthetic Dentistry,' and the author of a well-known treatise on dental metallurgy.

MR. WILLIAM RICH HUTTON, a well-known civil engineer, died on December 11 at the age of seventy-five. He was a member of the American Society of Civil Engineers, the Institution of Civil Engineers of London and of the Société des Ingénieurs Civils de France.

MISS H. M. GOULD has given \$5,000 to New York University for the establishment of a museum of pedagogy, with the understanding that this should be applied in the first place to an exhibit of the work done for education by New York University, and that this should form an exhibit at the World's Fair at St. Louis in 1903, and afterwards become the property of the School of Pedagogy.

THE Association of American Universities will hold its annual meeting at Chicago, during the last week of February next.

AN election for officers of the Botanical Section of the Academy of Natural Sciences of Philadelphia, December 9, 1901, resulted in the choice of the following persons: *Director*, Benj. H. Smith; *Vice-Director*, Joseph Crawford; *Corresponding Secretary*, John T. Pennypacker; *Recorder*, John W. Harshberger; *Treasurer and Curator*, Stewardson Brown; *Directors*, Benj. H. Smith, Joseph Crawford, Stewardson Brown, Ida A. Keller, John T. Pennypacker.

MR. FREDERIC A. LUCAS, curator of the Division of Comparative Anatomy at the U. S. National Museum, lectured before the Woman's College of Baltimore, December 3, on 'Dinosauria.' Sir Robert Ball, of the University of Cambridge, Eng., lectured on December 6, his subject being 'Other Worlds than Ours.'

AMONG the lecturers before the Technology Club of the Massachusetts Institute are Dr. Ira Remsen, president of the Johns Hopkins University (Dec. 12); Professor George E. Hale, director of the Yerkes Observatory (Jan. 3); Professor Arthur A. Noyse (Feb. 18); Mr. William Barclay Parsons, chief engineer of the New York subway (Feb. 26); Mr. F. H. Newell, chief hydrographer, United States Geological Survey (Mar. 3).

THREE additional lectures on archeology have been arranged for December at the University of Pennsylvania. The first one will be on 'The Archeology of Michigan,' by Mr. Harlan I. Smith, of the American Museum of Natural History, New York. The second by Stewart Culin on 'Archeological Notes on the John Wanamaker Expedition of 1901.' The last lecture before the holidays will be on 'The Cliff Dwellers and their Relations,' by Dr. J. Walter Fewkes, of the United States Bureau of Ethnology, Washington, D. C.

It is announced that Boothia Felix has been chosen as the headquarters for Professor Amundsen's three-year magnetic pole expedition. Boothia Felix is a peninsula, and is the most northern part of the mainland of North America, having east, Boothia Gulf; north, Bellot Strait, and west, Franklin Channel. The magnetic pole is in this peninsula, the northern point of which is in about latitude 72 degrees north.

AN assistant is wanted for the respiration calorimeter experiments and other nutrition investigations in the chemical laboratory of Wesleyan University and for work in the collating of results of foreign inquiry and preparing reports for publication. A chemist or physiologist, or better, a physiological chemist, of university training, preferably a Ph.D. or M.D., is desired. Scholarly spirit, ability for independent research, familiarity with German, French and other chemical and physiological literature, or, at least, the capability of becoming familiar with such literature are important. A man capable of becoming a university professor or director of a scientific establishment is desired. The salary at the outset will be from \$1,000 to \$1,500, according to the qualifications, with the

chance of increase to that of an associate professorship or professorship. There may also be a second position for a man of similar abilities and academic training but with less experience and correspondingly smaller salary, very probably the equivalent of a fellowship, with opportunities for study and advancement. The work is connected with the inquiries regarding the food and nutrition of man which is being carried on under the auspices of the U. S. Government in universities, colleges and experiment stations in all parts of the country and has its headquarters at Wesleyan University. The association with a number of trained specialists, the atmosphere of research, unusual library facilities and opportunity for experimental inquiry, study and advancement make the positions very desirable for young and ambitious men. Applications for either of the above positions may be made to Professor W. O. Atwater, Wesleyan University, Middletown, Conn.

THE United States Geological Survey has in press a work entitled 'Bibliography and Catalogue of the Fossil Vertebrates of North America,' by O. P. Hay. It contains a list of about 4,100 papers which bear on the fossil vertebrates of North America and a systematic list of all the species that have been described. Furthermore, there goes with each species citations of all the works in which it has been described and discussed. An estimate shows that there are altogether about 40,000 citations. The book forms bulletin No. 179 of the Survey, and will be issued probably early in the coming year.

HENRY S. CARHART, professor of physics in the University of Michigan, and Horatio N. Chute, instructor in physics in the Ann Arbor high school, are writing a new work on physics, which will be completed in about two months. The work will be called 'High School Physics.'

THE London *Times* states that Dr. Charles Balfour Stewart has proceeded to Sierra Leone under the auspices of the Liverpool School of Tropical Medicine to study the methods successfully utilized by Dr. Logan Taylor in dealing with malaria. Dr. Balfour Stewart has had considerable experience in India, and the knowledge he there acquired proved very ser-

viceable on the recent appearance of plague in Liverpool. Now he intends to commence his attack on malaria at Cape Coast Castle, where there is great mortality among Europeans. Under Major Ross he will have the general direction of operations for improving the drainage and general sanitary conditions of Cape Coast Castle, clearing away the stagnant pools which are breeding-places for the *Anopheles* mosquito. Though Dr. Balfour Stewart has been engaged for a year by the Liverpool School of Tropical Medicine, he will, it is expected, remain on the West Coast while his help is needed to place the sanitary conditions of the colony on a satisfactory basis. He also contemplates operations in the mining districts, but will be guided by the advice of the Governor of the Gold Coast. Thus the sanitary crusade against malaria will shortly be in operation on the whole coast from the Gambia to Lagos.

MR. A. MONTEFIORE PRICE writes to the *London Times* as follows: "Now that the more serious work of the British Association is over it may perhaps interest your readers if I draw attention to some curious examples of science adapted to heraldry. I derive them from the banners and bannerets which have been hanging up in the reception room of the British Association at Glasgow during the past week. The banner, for example, of Sir William Huggins, who was president at the Cardiff meeting, 1891, shows the solar spectrum for a crest and the constellation of Orion for a coat of arms. That of Sir William Crookes presents a radiometer and three prisms, together with the quaint motto 'Ubi crux ibi lux.' Herschel was president of the meeting at Cambridge so long ago as 1845, and on his arms there appropriately appear the sun in the chief and a telescope in the base. Sir William Turner, who presided last year at Bradford, bears as a charge a wheel; Siemens blazons what is apparently a beetroot—he was interested, I believe, in sugar produced from that source, and Sir Roderick Murchison, who was president at Southampton so long ago as 1848, a pecten shell—suitably enough for so a great geologist. Sir William Flower's banner shows a coat bearing a cinquefoil and the punning motto 'Et flores et fruches.' Lord Lister (Liverpool, 1895) blazons the staff

and serpent or Æsculapius; Dawson, who presided at Birmingham in 1886, has three daws on his coat; and Sir George Airy (Ipswich, 1851), Sir Henry Roscoe (Manchester), and Sir Michael Foster (Dover) display the arms of those towns and presumably did not possess personal arms."

WE learn from the *London Times* that the business and finance committee of the general council of Edinburgh University has prepared a report on the subject of the Carnegie Trust. It says that chairs in the University founded long ago embrace nominally many subjects which, if they are to be followed beyond their elementary stages cannot profitably be now taught by one man. It may be possible for a professor to give systematic instruction over the whole subject to ordinary students, but for the purpose of higher study and research by the professor and the advanced students there is now great urgency, if not for splitting up the subject, at least for the creation of junior associate professorships to relieve the pressure and to enable more personal practical instruction to be given to the students. Any such professorships instituted by the Carnegie Trust might, therefore, with great advantage be attached to the four universities in common, subject to some new arrangement. Many benefits, besides the obvious one of economy, would accrue from the introduction of community and reciprocity as working ideas into Scottish university life. One of the foremost claims upon the trustees will be to strengthen the modern language departments in each of the universities. Traveling scholarships would be a great incentive and benefit to students. Research in medicine and science demands a large portion of the immediately available income in the hands of the Carnegie trustees. What have been required for long are special research laboratories in which higher students would in the first instance be trained in the methods and apparatus of research. Mr. Carnegie's position as a founder of libraries is a guarantee that the University libraries will receive adequate consideration at the hands of the trustees. With regard to the payment of University class fees the report says that the scheme should give a great impetus to education throughout the country. Some such

stimulus has been needed, as of late the number of university students has tended to decrease. The committee further presents an interim report on the decrease of students pending a fuller investigation which is to include the other Scottish universities and English and foreign schools. In Edinburgh the number of students continuously decreased from 3,576 in 1889-90 to 2,825 in 1895-96, above and below which figure they have fluctuated but slightly.

THE Royal British Commission on Tuberculosis is now sitting in London. The experimental part of its work will be carried out near Stansted, in Essex, on two farms that have been placed at the disposal of the commission by Sir James Blyth.

UNIVERSITY AND EDUCATIONAL NEWS.

MR. JOHN D. ROCKEFELLER, has made a further gift of \$1,250,000 to the University of Chicago, making the total amount given by him \$10,251,000.

By the recent death of Mrs. Anne Wentworth, of Lowell, Mass., Dartmouth College will, it is said, come into the possession of an estate worth about \$500,000, bequeathed to it by Tappan Wentworth.

WESLEYAN UNIVERSITY has secured \$100,000 which will be used for an administration building, and \$25,000 toward a fund for the building of an observatory and scientific laboratories.

It is reported that Mr. Carnegie will liberally endow the Carnegie Laboratory of Engineering of the Stevens Institute on the occasion of the dedication on February 6.

DR. PURDIE, professor of chemistry in St. Andrews University, has offered the University a gift of £5,000 for the purpose of building and equipping a small chemical research department at St. Andrews. In his letter to Principal Donaldson intimating the gift, Professor Purdie says that their universities are very poorly provided for research when compared with those of foreign countries, and that scientific industries suffer in consequence.

THE physical laboratory of the University of Michigan will be enlarged next year by taking in the third floor of the building, which has

hitherto been devoted to bacteriology, and possibly by the addition of a large lecture room to seat 300 persons. The present capacity of the building is insufficient to accommodate the 500 students who are taking courses in physics.

FIRE of unknown origin destroyed the main building of the University of Wooster. The loss is estimated at \$250,000, with insurance of about \$70,000. It is supposed that an explosion of chemicals in one of the laboratories was the cause.

THE registration at the Sheffield Scientific School of Yale University this year and last is as follows:

	1900-1901	1901-1902
Graduate Students	105	133
Seniors	134	128
Juniors	143	143
Freshmen	199	245
Special Students	29	26
	<u>610</u>	<u>675</u>

There is thus an increase of 65 students, especially noticeable being the increase in the number of graduate students and of the Freshman class.

The number of dental students in America from foreign countries is increasing every year. In the dental department of the University of Pennsylvania this year 80 of the 364 registered students are foreigners, representing a large number of nationalities.

MR. JOHN A. BRASHEAR has been elected Chancellor of the University of Western Pennsylvania. Mr. Brashear was last year vice-president of the American Association for the Advancement of Science and chairman of the Section of Mechanical Science and Engineering.

DR. HENRY LEFAVOUR, professor of physics at Williams College, and dean of the faculty, has been elected president of the newly-organized Simmons College for Women at Boston.

PROFESSOR E. G. HARRIS, of the Missouri School of Mines, has been elected professor of civil engineering in the University of Pennsylvania.

DR. THEODORE W. RICHARDS has been elected full professor of chemistry at Harvard University. It will be remembered that Professor Richards was recently called to a chair of chemistry at Göttingen.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

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FRIDAY, DECEMBER 27, 1901.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

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REPORT OF THE COMMITTEE ON CONVOCATION WEEK.

THE Committee on Convocation Week has continued its work and has secured the allegiance of a large number of important educational institutions to the plan. The proposal has been so generally accepted and has met with such cordial approval that the committee regards its permanent success as secured.

It will be remembered that the first step taken was to communicate to the Association of American Universities, on behalf of the American Association for the Advancement of Science, the proposition to establish the week in which the first of January falls as Convocation Week, to be set aside for the meetings of national scientific and learned societies. The Association of Universities formally recommended by a unanimous vote the adoption of this proposition, and it has since been adopted by nearly all the universities belonging to that association.

A report of the progress made was published by the committee in SCIENCE, N. S. Vol. XIII, p. 641, and in the same journal, Vol. XIII, p. 996, appeared an editorial article advocating the plan for a convocation week, and defining some of its advantages. The Committee has had its report and the

editorial reprinted for its use, and has distributed copies to the governing bodies of numerous universities and colleges.

At its recent Denver meeting the American Association voted to hold its next meeting at Pittsburg, beginning June 28, 1902, but to hold a special meeting of the Council at Chicago during Convocation Week, 1901-02, and to authorize any section of the Association to organize a meeting at the same time and place. This was the first formal adoption of Convocation Week for scientific meetings. The Association further voted to recommend to its present Council to hold a regular meeting of the Association during Convocation Week, 1902-3, at Washington. Since then important advances have been made in the development of the plan in two ways:

First, it is to be reported that Convocation Week this year will be immediately utilized for the meetings of national societies, the following having already voted to hold their meetings during that period:

The Council of the American Association for the Advancement of Science.

The American Society of Naturalists.

The American Morphological Society.

The Association of American Anatomists.

The American Physiological Society.

The American Psychological Association.

The Western Philosophical Society.

The Society of American Bacteriologists.

The Botanists of the Central and Western States.

The American Folk Lore Society.

Section H (Anthropology), American Association for the Advancement of Science.

The American Chemical Society.

The Astronomical and Astrophysical Society of America.

The Geological Society of America.

The Society for Plant Morphology and Physiology.

The American Historical Society.

The American Economic Association.

Second, it is to be reported that the Committee has sent a formal communication to the president of every university, college and technological school included in *Minerva*. The total number of these is 50,

to which must be added the fourteen universities which had been previously communicated with, making a total of 64 institutions. The formal communication was addressed to the president or corresponding officer of each institution, and read as follows:

BOSTON, September 15, 1901.

Dear Sir:

The American Association for the Advancement of Science has the honor to request the cooperation of your college in setting aside the week in which the first of January falls as 'Convocation Week' for the meetings of learned societies.

At the New York meeting the Association appointed a Committee, consisting of its President, R. S. Woodward; its Permanent Secretary, L. O. Howard; of Professors J. McK. Cattell and E. L. Nichols, and of the undersigned as Chairman, to take charge of the matter. The Committee presented the plan to the Association of American Universities, which body, at its recent meeting, voted unanimously to recommend the adoption of the plan by the universities. Since then, the following twelve universities, members of the Association, have acted favorably upon the recommendation:

The University of California.

The Catholic University of America.

Clark University.

Columbia University.

Cornell University.

Johns Hopkins University.

Leland Stanford Junior University.

The University of Michigan.

The University of Pennsylvania.

Princeton University.

The University of Wisconsin.

Yale University.

For your further information the accompanying documents are enclosed, both reprinted from *SCIENCE*. The first gives the general arguments for the proposed 'Convocation Week,' the second indicates the various plans of cooperation adopted by the different universities, all intended to secure the essential point—releasing the teachers of the university from their official duties to enable them to attend the meetings of 'Convocation Week.'

It will give me pleasure to furnish any further information in my power, should you desire it.

Permit me, on behalf of the Committee, to express the hope that your institution will be able to give its support to the project to establish 'Convocation Week,' for we believe that no more important meas-

ure for the promotion of learning in America has ever been proposed.

I have the honor to remain,

Yours, with the highest respect,

CHARLES S. MINOT,

Chairman.

President A. A. A. S.

Harvard Medical School,
Boston, Mass.

Replies, in every case favorable, have been received from the following institutions :

Woman's College of Baltimore.
University of Buffalo.
Case School of Applied Science.
University of Colorado.
Columbian University, Washington.
Hamilton College.
Knox College, Galesburg, Ohio.
Massachusetts Institute of Technology.
Michigan College of Mines.
University of Minnesota.
University of Nebraska.
New York University.
College of the City of New York.
Northwestern University.
Oberlin College.
University of Syracuse.
Tufts College, Boston.
Vassar College.
Wellesley College.
Wesleyan University.
Western Reserve University.
Williams College.

The action has not been uniform, for in a few institutions no change in the vacation was necessary, but several institutions have changed the dates of their vacation to allow the necessary time for Convocation Week to become free. A small minority of the institutions have voted to allow their teachers leave of absence to attend meetings during Convocation Week. Almost every reply has included an expression of cordial approval of the plan.

The Committee hopes to continue and extend its correspondence with those universities and colleges which have not yet taken action, and to be able later to report their adhesion.

The facts above reported seem to the Committee to justify the expectation that the proposed Convocation Week will be permanently established through its formal acceptance by all the leading higher educational institutions of the country.

CHARLES S. MINOT, *Chairman,*

R. S. WOODWARD,

E. L. NICHOLS,

L. O. HOWARD,

J. MCK. CATTELL.

A CENTURY OF PROGRESS IN ACOUSTICS.

IN selecting the 'Progress of Acoustics,' on its experimental side, as the subject for this year's presidential address, I am fully alive to the fact that this branch of science has been comparatively neglected by physicists for many years, and that consequently I cannot hope to arouse the interest which the choice of a more popular subject might command. It is, however, just because of this neglect of an important field of science that I conceive it to be my duty to direct some attention thereto. This duty I can best perform, it seems to me, by taking a survey of the work accomplished in this particular field during the century that has just closed. Such a survey will make it evident not only that the science of acoustics has made immense progress during that time, but also that many of the experimental methods in use in other branches of physical science were invented and first employed in the course of acoustical research. This latter fact, though not generally recognized, furnishes an illustration of the interdependence which exists between the various branches of physical science, and suggests the probability that the work of acoustical research in the future may be advanced by experimental methods specially designed for investigation in other fields. A revival will, of course, come in time for acoustics, as it has recently come for electricity, and it ought to come all the

sooner because of the cooperation which physicists may naturally look for from those who are cultivating the new fields of experimental psychology.

In order to avoid the tedium of a bare enumeration of discoveries arranged chronologically, I propose to refer in the first instance to the invention of the various experimental methods which have been employed in acoustical research. A separate reference to these methods will enable us to appreciate their potency in the advancement of this science.

The earliest of these methods is due to Chladni, whose work, 'Die Akustik,' appeared in the form of a French translation in 1809, under the title 'Traité d'Acoustique de Chladni.' In this work were collected all the researches on the vibrations of bodies which Chladni had conducted with the aid of the new method (*méthode de sable*). This method consists in distinguishing, on the surfaces of vibrating bodies, the parts which are vibrating from the parts which are in repose, by means of the sand which is driven from the former to collect on the latter. In these experiments of Chladni on plates, etc., the violin bow was used for the first time to produce the necessary vibrations. The bow had previously been used only for vibrating cords, the 'violon de fer,' and other musical instruments. Chladni made his discovery of sand figures in 1787, having been led thereto by Lichtenberg's discovery of electric figures.

The transversal nodal lines given by Chladni's method in the case of rods vibrating longitudinally were readily explained. Not so, however, the complicated nodal lines presented by vibrating plates, or the alternate lines which appear on the two sides of rods vibrating longitudinally, and which sometimes also appear on rods vibrating transversally. It was not until 1833 that an explanation of the former of these phenomena was offered by Wheat-

stone's theory that the nodal lines were due to the superposition of transversal vibrations, corresponding to sounds of the same pitch coexisting with respect to different directions in the plate. This theory was confirmed experimentally in 1864 by Rudolph Koenig, who constructed rectangular plates giving unison notes corresponding to different sets of nodal lines parallel to two adjacent sides of the plate. The theoretical figure results when the plate is vibrated so as to produce the coexisting unison notes.

The alternate nodal lines given by vibrating rods were also explained by the theory of the coexistence of two sounds near unison in the same vibrating rod. In this case, however, one sound corresponds to longitudinal, and the other to transversal vibrations. This explanation was first given by Augusta Seebeck in 1849, whose theory was confirmed in 1859 by Terquem in a very important paper 'Sur les vibrations longitudinales des verges libres aux deux extrémités.'

In 1807, five years after the publication of Chladni's 'Akustik,' appeared Dr. Thomas Young's 'Course of Lectures on Natural Philosophy and the Mechanical Arts' in which we find the earliest description of the graphical method, including its application to chronography. This description is as follows:

"By means of this instrument we may measure, without difficulty, the frequency of the vibrations of sounding bodies, by connecting them with a point which will describe an undulated path on the roller. These vibrations may also serve in a very simple manner for the measurement of the minutest intervals of time; for if a body, of which the vibrations are of a certain degree of frequency, be caused to vibrate during the revolution of an axis, and to mark its vibrations on a roller, the traces will serve as a correct index of the time occupied by any part of the revolution, and the motion

of any other body may be very accurately compared with the number of alterations marked, in the same time, by the vibrating body." Notwithstanding the clearness of this description, the graphical method remained for a long time unknown, and when it was developed later, in 1862, the original discovery was incorrectly attributed to Wilhelm Weber (1830). Between these dates slight applications of the method had been made by Savart, Duhamel, Lissajous and Desains, Wertheim, and others; the most important of such applications being that of Scott, who in 1858 applied it to his phonautograph. Finally, from 1858 to 1862, Rudolph Koenig devoted himself specially to the perfecting of this method, and exhibited the results of his labors at the Exhibition in London in 1862, in the form of a large collection of phonograms. This collection in its seven sections comprises all the applications of the method which have so far been made in acoustics. Whilst the progress of this method was thus slow before 1862, its use from that time onward became general, especially in physiological researches, in connection with which it received its widest development in the publication by M. Marey of his splendid work, 'La méthode graphique' in 1878. Parenthetically I might remark that Edison's phonograph (1877) was doubtless suggested by Scott's phonautograph.

As with the graphical method, the earliest suggestion of an optical method of studying vibratory movements came from Dr. Thomas Young, who in 1807 gave the construction of curves resulting from the composition of two rectangular vibratory movements. The practical realization of these curves was effected in 1827 by Wheatstone in his kaleidophone. The most important advance, however, in the development of this method was made by Lissajous, who, after some preliminary work in 1855, published in 1857

his great paper entitled 'Mémoire sur l'étude optique des mouvements vibratoires.' The optical effects produced by Lissajous' method, especially when the curves were projected on the screen, were so beautiful that the method obtained general recognition, and became immediately popularized. The chief merit of the method, however, does not lie in the beauty of the effects thus obtained, but rather in the fact that by this means we are enabled to determine with facility and with the utmost accuracy both the interval and the difference of phase between two vibratory movements. It is this fact which renders the optical comparator one of the most important instruments at the disposal of the acoustician.

A second optical method we owe to Biot, who in 1820 showed that the changes in density at the nodes of a transparent body vibrating longitudinally could be exhibited when the nodal line of the body is placed between the crossed mirrors of a polarization apparatus. During the continuance of the vibrations the image is highly illuminated in the analyser and becomes darkened when the vibrations stop. This method was developed much further by Kundt in 1864, and by Mach in 1873.

A third optical method was devised by Toepler and Boltzmann in 1870 for the purpose of exhibiting the changes which take place at a nodal point of a vibrating column of air. This method consists in producing interference bands by means of two rays of intermittent light from the same source, one of which passes through the air in its normal state, and the other through a nodal point of the vibrating air column. A vibratory movement of the interference bands results—a movement which can be made as slow as we please, thus rendering it possible to deduce by stroboscopic methods exact measurements as to the movement of the air at the nodal point.

The object of the method of manometric

flames, invented by Rudolph Koenig in 1862, is to furnish an ocular proof of the variations in density at a point of the air traversed by waves originating in another body or in the air itself. A short description of the first apparatus based on this method appeared in Poggenдорff's *Annalen* in 1864. Between that year and 1872 the method was applied to a series of instruments, the experiments being described in the same journal in a long memoir entitled, 'Les flammes manométriques.' Although this method is extremely sensitive and capable of furnishing very accurate results, it has been prevented for a long time from rendering more efficient service on account of two causes: first, the want of sufficient brightness in the reflected images of the jumping flames, and second, the difficulty of observing the details of these images owing to their momentary appearance in the mirror. The former of these difficulties has now been overcome by the employment of acetylene and other gases, which at the same time allow admirable photographs of the flames to be taken, thus obviating the second difficulty also. We owe an important paper on this subject to Professors E. L. Nichols and Ernest Merritt published in 1898 in the *Physical Review*.

In 1865, Kundt published his method of using light powders for the purpose of exhibiting the vibratory character of stationary air waves in columns and plates of air. During the existence of these vibrations the light powders arrange themselves in transversal striæ which collect around the loops, and are wanting at the nodes. As in the case of the nodal lines on Chladni's plates, a satisfactory explanation of these striæ was for a long time wanting. In 1890 Professor Walter Koenig showed, from hydrodynamical considerations, that the particles of the powder necessarily arrange themselves in planes at right angles to the direction of the vibratory movements, and that their

observed distribution at the loops and nodes is in accordance with the same laws.

Before the invention of the preceding methods the acoustician occasionally resorted to the device of deducing the vibrations of a sounding body from the behavior of a similar body whose movements were of sufficient amplitude to be seen by the eye, and so slow that they could be readily counted. In this way Mersenne counted the vibrations of a cord 15 feet long under a stretching force of 7 pounds, and found them to be 10 per second. In shortening the cord to $\frac{1}{20}$ of its length, he obtained an audible sound whose pitch, he concluded, corresponded to 200 vibrations per second. In the same way Chladni employed a long and thin metal rod, which gave in the first instance only 4 vibrations per second. He then shortened the rod until it gave an audible sound whose pitch he determined from the law expressing the relation between the length and the number of vibrations. This method, however, which appears so simple in theory, is subject to large errors and gives in practice very poor results.

Mersenne's and Chladni's method has accordingly given place to another—the stroboscopic—which allows the vibrations of the sounding body to be viewed directly, its movements relatively to a vibrating eyepiece being rendered as slow as we please. The first use of stroboscopic discs for the purpose of observing very rapid periodic movements was made by Plateau in 1836. His discovery, however, remained unnoticed, for Doppler, in 1845, published a note on the same subject, without referring to Plateau's discovery. It was Toepler who first made the method generally known by employing it in a series of acoustical experiments which he published in Poggenдорff's *Annalen*, Volume 128. In the earlier applications of this method, the view of the vibrating body was rendered intermittent by looking through slits which were opened

and closed in rapid succession. This plan was modified by Mach who caused the vibrating body to be illuminated by intermittent light.

If now we allow the stroboscopic images of a moving body to fall on a photographic plate, giving the plate a movement of translation which is arrested before each appearance of the image, we thereby obtain a series of photographs of the successive positions assumed by the body. If, further, matters are so arranged that the beginning and duration of the phenomenon are traced on the images, we have a new method, which is called chronophotography. It was M. Janssen who first conceived the idea of taking automatically a series of photographic images in order to determine the successive positions at different times of the planet Venus in its passage across the sun. It was Janssen also who, in 1876, first suggested the idea of applying successive photographs to the study of animal locomotion. The analyzing of such movements was first accomplished by Muybridge, of San Francisco. The method has been largely extended and perfected by M. Marey, who has employed it in studying the locomotion of all sorts of subjects, from men to insects.

The last of the methods to be noticed is that employed by Rudolph Koenig in his wave-siren. In this instrument a metal band or disc with curvilinear edges passes before a narrow slit from which issues a current of compressed air. By means of these discs we can produce either simple sounds, or sounds of various timbres, containing such harmonics as we please, the intensities and phases of the latter being varied at will. The first wave-siren was constructed in 1867, and the account of the first series of experiments was published in 1881.

The mere enumeration of the methods of acoustical research which have been de-

vised since the days of Chladni is an indication of the enormous advances which have been made in this branch of science. It remains now to state more particularly what these additions to our knowledge of acoustical phenomena have been. This can be most conveniently done under the following heads, viz. : The velocity of sound ; its pitch, intensity and timbre ; and the phenomena produced by the coexistence of two or more sounds.

THE VELOCITY OF SOUND.

Long before the beginning of the last century it had been observed that the propagation of sound was not instantaneous. Mersenne in fact had tried to estimate the velocity by experiments on echoes, and by counting the time which elapses between the flash of a gun and the report. The latter experiments were also repeated by Kircher as well as by the Academy of Florence in 1660. The same experiments were subsequently, in 1738, undertaken by members of the Academy of Sciences at Paris, by savants, such as Kaestner, Benzenberg, Goldingham and others, but the results obtained did not gain the confidence of the scientific world. A new series of experiments was accordingly undertaken in 1822, on the suggestion of Laplace, by members of the Bureau des Longitudes, to determine the velocity in air and other media. These experiments, which were the beginning of truly scientific work in this subject, were performed by Prony, Arago, Mathieu, A. de Humboldt, Gay-Lussac and Bouvard, between Monthéry and Villejuif, cannon being fired at both stations. The result obtained was 331 m. at zero temperature, with an increase of 0.6 m. for each degree above zero. In the course of these experiments it was observed that the cannon fired at Villejuif were all distinctly heard at Monthéry, whilst the reciprocal reports were so faint that only a

small number were heard. Tyndall long afterwards, in 1875, explained this curious phenomenon, attributing it to the existence at Villejuif of a heterogeneous atmosphere, caused by the heated air which came from Paris.

Since the memorable experiments of the Bureau des Longitudes of Paris, various individuals have from time to time undertaken to solve the same problem. Among these may be mentioned Moll and van Beck (at Utrecht), Gregory Woolwich, Stone and Captain Perry in his voyages to the polar regions in 1822, 1824, and Kendall in the Franklin expedition in 1825. In some of these experiments the temperatures ranged from 2° to -40° , the results obtained according with the theoretical values. In 1823 Stampfer and Myrback conducted experiments between two stations in the Tyrol at a difference of level of 1,364 m.; a similar experiment being undertaken in 1844 in Switzerland by Bravais and Martin with a difference of level of 2,079 m. Both experiments confirmed the law that the velocity of sound in air is independent of the pressure.

In all these experiments the exactness of the results was affected by the difficulty of estimating accurately the time between the perception of the flash and that of the report. Different observers of course gave different estimates. This source of error was first eliminated by Victor Regnault, who in his long series of researches between 1860 and 1870 made use of the graphical method and electric signals to measure time intervals. Regnault's experiments were conducted in seven tubes (part of the Paris sewers) varying in length from 70 m. to 4,900 m., and of diameters from 0.11 m. to 1.10 m. Experiments were also conducted in the open air by means of reciprocal shots fired from two stations at a distance of 2,445 meters. The number of shots fired was 334. These researches

of Regnault represent such an enormous amount of work that I shall attempt to give only the principal conclusions deducible from them:

1. In a cylindrical tube the intensity of the wave varies, diminishing with the distance. The narrower the tube, the more rapid is the diminution.

2. The velocity of the sound decreases as the intensity diminishes.

3. The velocity approaches a limiting value, which is higher, the greater the diameter of the tube. The mean value in dry air at 0° in a tube of diameter 1.10 m. is 330.6 m.

4. The velocity is not affected by the mode of producing the sound wave.

5. The velocity in a gas is independent of the pressure.

6. The ratio of the velocities in air and any other gas is $\sqrt{\frac{1}{\rho}}$, where ρ is the density of the gas, supposed perfect.

7. The average of the results of all the experiments in the open air is 330.7 m. at 0° .

Regnault was also the first to attempt direct experiments for determining the velocity of musical sounds. In this case, however, the electric signals and the graphical recording apparatus were not sensitive enough to respond to the front of the wave, and it became necessary to resort to the ear alone. In these experiments Regnault had the cooperation of Koenig as observer, with whose assistance it was shown that:

1. A note does not change sensibly when it traverses long distances in tubes of large diameter.

2. When the sounds are observed by the ear the velocity of high notes appears to be less than that of low ones. This may be due to the more ready response which the tympanum makes in the case of low notes.

3. In traversing tubes of great length, a

note does not preserve its timbre, being resolved into simple components.

Regnault's experiments have recently been repeated by M. Violle in the large sewers near Grenoble and Argenteuil, some of Regnault's apparatus being employed for the purpose. The results of these experiments have not, however, been yet published.

PITCH.

Before the last century, as already mentioned, Mersenne had attempted to determine the vibrations of a cord by deducing them from very slow vibrations of the same cord when lengthened. Cheadni's tonometer, which consisted of a vibrating metal rod of variable length, was based on the same principle. In 1819 Cagniard de la Tour invented the siren, a much superior instrument, but incapable of giving very exact results, notwithstanding the simplicity of its mechanism. The same remark may be made of the toothed wheel invented by Savart in 1830.

A most important step in advance was made in 1834 by Henri Scheibler, of Crefeld, who in that year invented his tonometer, consisting of a series of 56 forks going from A (440) to its octave (880), the vibrations increasing regularly by differences of eight, any two adjacent forks thus giving four beats per second. Curiously enough, although Scheibler went to Paris and exhibited his tonometer there, he was unable to interest savants in his discovery; and it was not until the London exhibition of 1862 that the attention of physicists and musicians was directed to the value of the instrument by Koenig. The apparatus in its new form contained 65 forks going from C₃ (512) to C₄ (1024).

Notwithstanding the great utility of this tonometer to the acoustician, it still left undetermined the absolute pitch of the fundamental note, and hence of the whole series. This problem of realizing a stand-

ard of pitch remained practically unsolved, even after the French Government in 1859 decreed that the standard should be A = 870 v. s., at 15° C. The standard then constructed by Lissajous was found, in 1880, to be too high by $\frac{9}{10}$ of a vibration. The standard employed since 1880 by Koenig is C = 512 v. s. at 20°. The acoustical standard before that date was in reality 512.35 at 20°. The problem of realizing a standard fork, which had given rise to much controversy among physicists, was finally solved in 1880 by Koenig, who in that year published his paper 'Recherches sur les vibrations d'un diapason normal.' In this paper Koenig describes how by means of a clock-fork (horloge à diapason comparateur) he established a standard fork, the error of which did not exceed $\frac{1}{60000}$ of a vibration. The clock-fork method enables us at the same time to determine readily the variations in the number of vibrations due to a rise or fall of temperature. Having established in this way an absolute standard of C₃ = 512 v. s. at 20° C., Koenig commenced the construction of a universal tonometer based thereon, a colossal undertaking which he finished in 1897, after working a score of years. This tonometer, which has a range from 32 to 180,000 v. s., consists of the following:

1. 4 forks giving vibrations from 32 to 128, with differences at first of $\frac{1}{2}$ v. s. and afterwards of 1 v. s.

2. 132 large forks, tuned to give (without the sliders) the 127 harmonics of C₁, C₂, C₃, C₄, C₅, C₆, being in duplicate.

Each fork can be lowered, by means of sliders, to unison with the fork next below.

The differences immediately obtainable by sliders are:

- 1 v. d. between C₁ and C₃; 2 v. d. between C₃ and C₅; 4 v. d. between C₅ and C₇.

3. 40 resonators to reinforce forks of 2.

4. One large resonator of diameter 0.48 m. and of length varying from 0.30 m. to 2.30 m.

5. 18 forks for notes from C_7 to F_9 .

6. 15 forks for notes from Sol_9 to 180,000 v. s.

Under the head of pitch come two very difficult questions relating to the audibility of very low or very high sounds. With regard to the former Helmholtz has shown that if the vibrations are very slow and do not follow the pendular law (the fundamental being thus accompanied by a series of harmonics), the fundamental may be quite inaudible, whilst the harmonic is heard distinctly. In such a case the harmonic is often mistaken for the fundamental. On the other hand, if we employ large tuning forks, vibrating rods, or the wave siren, for the purpose of obtaining pendular vibrations, we are still met with the difficulty of determining accurately the limits of audibility, owing to the fact that it not only depends on the intensity of the vibrations, but varies from one observer to another. In general it may be stated that it requires from 60 to 80 v. s. to produce a sound perfectly continuous and possessing a musical character. In using very powerful high forks to produce beats, which were gradually diminished in number, Koenig found that the sensation of a continuous low sound ceased when their number did not exceed 26.

As to the high notes above $C_7 = 8,192$, the amplitudes of the vibrations are generally so small that the ordinary methods no longer serve to determine the pitch. For this reason it was at first the practice to tune forks above C_7 by means of the ear. The high forks constructed by Marloye and presented to the Academy of Sciences at Paris, in 1848, by Depretz, were constructed in this way. In 1858, however, Koenig showed that even in the upper half of the octave $C_8 - C_7$, the best musicians ceased

to judge the intervals accurately, a fact which seemed to show that it was extremely unlikely that forks giving notes two octaves higher could be tuned accurately by the ear. For this reason Koenig effected the tuning of very high forks by means of the sounds resulting from their beats. The first series of forks tuned in this way were made by Koenig in 1876. A set of similar forks constructed about the same time by Preyer, and going, as he alleged, as high as E_{10} were shown by Melde, in 1894, to be greatly out of tune, the intervals being wrong by as much as a third, and even an octave. In 1897, Melde's results were confirmed by Stumpf and Meyer.

In 1899 Koenig published his researches on very high notes. In this memoir, after showing the exactness of the tuning attained by the sounds of beats in forks between C_7 and F_9 , he proceeds to state that, by means of Kundt's method of using light powders, he had constructed a series of high forks accurately tuned and proceeding according to the intervals of the perfect (major) scale, from C_7 to the enormous pitch of 180,000 v. s., and that without reaching a limit to the number of such vibrations.

As to the audibility of these high forks, it has been remarked by Koenig that those between C_7 and C_9 are generally audible, whilst C_{10} and those above are entirely inaudible. He further remarks that the limit of audibility, which thus lies between C_9 and C_{10} , largely depends, as in the case of low sounds, on the intensity, and varies with the individual.

INTENSITY.

With regard to the question of intensity of sound, it is only necessary to say that there exists here a great lacuna in our acoustical knowledge, as we do not yet possess a means of measuring the physiological intensity of sound.

TIMBRE.

To Helmholtz belongs the credit of first elucidating the question of timbre by showing that the timbre of a sound depends upon the number and intensity of the harmonics accompany the fundamental. The question of timbre is thus intimately connected with the study of the phenomena produced by the coexistence of two or more sounds. With regard to such phenomena, it was stated by Helmholtz that when two notes of different pitch are sounded together, they give rise to two other sounds, the pitch of which is measured, the one by the difference, and the other by the sum of the vibrations of the two primary sounds. Further, that these resultant sounds are not due to beats.

These propositions of Helmholtz are controverted by Koenig, who, on the contrary has proved that the sounds actually heard accompanying two primary sounds are always due to beats. Koenig asserts, moreover, that the sounds referred to by Helmholtz, even if we could prove that they had a real existence, would always be inaudible, and therefore without effect on the acoustical phenomena. He further establishes the curious fact that even interruptions of a sound give rise to another sound.

As to timbre, Helmholtz's theory was that it depended solely on the number and relative intensities of the harmonics which accompany the fundamental, and that it is not affected in any degree by differences in the phases of these components. This latter proposition is combated by Koenig who holds that differences of phase as regards harmonics exercise a very important influence on the timbre of a sound, so that according to him timbre depends on the number, relative intensities and differences of phase of the harmonics which accompany the fundamental. Koenig's experiments on this disputed point were performed with his large wave-siren. Even this wider defini-

tion of timbre is, however, according to Koenig's most recent view and experiments, insufficient, as not being applicable to certain classes of timbres—for example, those produced by most musical instruments, especially stringed instruments. In these cases the fundamental is accompanied not only by harmonics, but also by other sounds which are not harmonic, the superposition of which produces series of waves which change their form successively. These wave forms have been investigated by Koenig in a paper, 'Sur les timbres à ondes de formes variables,' in which he determines the conditions under which such timbres may be considered musical, and concludes that in these cases the fundamental is accompanied by harmonics which continually change their relative intensities and their phase-differences.

In conclusion I may state that, according to Koenig, the fact that differences of phase amongst harmonics produce differences of timbre is explained for the first time by his recent discovery that the intensity of a sound can be increased by the addition of another sound, when the maxima of intensity in the vibrations in the two cases correspond more or less exactly, and that several sounds produced together may reinforce a sound of lower pitch than any of them. For example with the same six primary sounds, by changing their phases only, he produces not only timbres differing in intensity and in richness, but timbres in which, at one time, the octave (2) and at another time the fifth above (3) are heard. The difference between these two timbres is, indeed, so great that when heard in succession, there appears to be an interval of a fifth between them, although their fundamentals are exactly the same. These experiments may be said to be the last on this difficult subject in the years of the century which has just closed. JAMES LOUDON.

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CURRENT QUESTIONS IN ANTHROPOLOGY.*

No idea is more firmly fixed in the mind of the average man than that of monogenesis—*i. e.*, the idea that all mankind sprang from a single pair, and hence came up in a single center. Nor is the prevalence of the idea surprising; engendered by the associations of family life, fostered by honorable regard for worthy ancestors, and nourished by tradition, it grows into a natural intuition; and when intensified by the teachings of biology (whence most modern thinkers derive early lessons), it readily matures in a postulate so simple and so strong that few anthropologists take the trouble to question its validity. Yet once the question is raised, the postulate is seen to be gratuitous; in the present state of knowledge it may not be either affirmed or denied with confidence; but it must be recognized that the intuitive idea of monogenesis is not supported by a single observation in the domain of anthropology, and is opposed by the great body of observations on human development. The first corollary of the monogenetic postulate is that mankind differentiate—that they differentiated in the beginning, that they are differentiating now, or that they differentiated at some intermediate stage, one or all; in any event, that the course of human development is one of progressive differentiation. Of course, if the postulate were a direct inference or a generalization, this mode of statement would be reversed; in that case it would be necessary to say that certain observed facts of differentiation lead to an inference of differentiation in general, and point to a law of monogenesis; but it cannot be too strongly emphasized that the notion of monogenesis in the human realm does not represent observation, generalization, inference or other inductive procedure from

fact to interpretation—it is a pure assumption, imported into anthropology from other realms of thought, introduced as a full-grown foundling, and ever at war with the legitimate offspring of the science of man.

The great fact attested by all observation on human development, and susceptible of verification in every province and people, is that mankind are not differentiating in either physical or psychical aspects, but are converging, integrating, blending, unifying, both as organisms and as superorganic groups. The population of the world is steadily increasing, but the number of races is not; while the number of distinct peoples is progressively decreasing and the racial boundaries are slowly but surely melting away. This present condition is in accord with the past so far as history runs; races have not come up, tribes have not multiplied, but distinct peoples have coalesced, dialects and languages have blent into common tongues, throughout the known world—indeed, the processes of integration have been so characteristic of human progress throughout the historical period that it is now possible to enounce, if not to establish, the proposition that peoples are preminent in proportion to the complexity of their blood and culture. These salient facts of the present and of the recorded past fall naturally into a generalization of integral or convergent development, which in turn points toward a hypothesis of polygenesis. The major indications are supported by minor ones too numerous for easy counting; and the burden of the testimony is amply sufficient to compel the open-minded anthropologist to tolerate the polygenetic hypothesis, if not to accept it as a working platform alternative with that of the monogenesis so long yet so gratuitously assumed.

Several students, like Keane in recent publications, have, indeed, held that the black, brown, yellow and white races cannot have sprung from common parents;

* Abstract of address before Section H, Denver Meeting, American Association for the Advancement of Science.

yet it may be questioned whether even this position is not merely a stepping-stone toward a more general view of humanization beginning with many varieties of the unknown prototype in different regions, coming up through the multifarious tribes of scientific record, and approaching the dominant types of to-day. Certain it is that when a race or congeries of tribes measurably similar in physical features—*e. g.*, the Amerinds—are considered with respect to the intertribal relations established by record and tradition, their history is found to be one of coalescence, through the growth of stronger groups and the assimilation or elimination of weaker, through the interchange (whether inimical or amical) of artifacts and industrial processes, through more or less frequent intermarriage, through the giving and taking of linguistic elements, through the interchange of custom, faith, ceremony, law and other factors of culture which react on mental and bodily exercise and thus shape development; the interchange and coalescence may be slow and incomplete, as between the Seri and Guayaqui tribes and their respective neighbors, or rapid and comprehensive, as in the Iroquois and Dakota confederacies, yet it is ever-present, and when the lines of development are traced backward they are invariably found to diverge more or less widely and point toward more or less distinctive origins.

What is true of the Amerind tribes in this respect is even more conspicuously true of the African tribes, ranging from the pigmy Akka to the gigantic Zulu and other widely diverse physical and cultural types; most of these tribes, too, have been observed in actual coalescence with their neighbors, while not a single satisfactory indication of differentiation or increasing distinctiveness has ever been detected; so that here, too, the developmental lines traced backward are found to diverge and

multiply up to the very verge of the unknown—the prehistoric, or at least the scriptless, past. And what is true of America and Africa is more or less conspicuously true of other continents and other peoples; everywhere the developmental lines converge forward and diverge backward, just as the lines of biotic development diverge forward and converge backward. How this discrepancy is to be removed is a question whose importance increases with every advance in the science of anthropology.

It seems not too much to say that the leading question before the anthropologist of to-day is that relating to the trend of human development and its bearing on the alternatives (postulate and inference, respectively) of monogenesis and polygenesis; for it is easy to see that most of the other questions are affected by this primary one. The definition of race, the discussion of human antiquity and various civil problems of the day are all involved; and while it is too much to hope for general agreement concerning the fundamental question at any early day, it is none the less desirable to note the trend of multiplying facts and observe their steady set toward the inductive hypothesis of polygenesis rather than toward the deductive assumption of monogenesis.

W. J. MCGEE.

BUREAU OF AMERICAN ETHNOLOGY.

THE ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS.

THE eighteenth convention of the Association of Official Agricultural Chemists held its meetings in Columbian University, Washington, D. C., November 14, 15 and 16, 1901, under the presidency of Dr. L. L. Van Slyke, Chemist of the New York Agricultural Experiment Station, at Geneva. The attendance at this meeting was the largest in the history of the Association, reaching 118 members, representing nearly all the States and Territories of the Union.

A notable change has taken place in the character of the meetings of the Association of Official Agricultural Chemists, which at first was organized chiefly for the unification of methods of the analysis of commercial fertilizers. This branch of the work has now reached such perfection as to require little or no attention. The great work of the Association is now directed to other subjects, especially to investigations, researches and studies of foods and food adulterants.

The two most important events of this meeting were the reports of the committee on uniform methods of food investigation, of which Dr. W. D. Bigelow, of the Bureau of Chemistry, of the U. S. Department of Agriculture, is chairman, and of the committee on food standards, of which Dr. Wm. Frear, of the State College of Pennsylvania, is chairman. Since nearly all the States have pure food laws, it is of the utmost importance, from both a scientific and a legal standpoint, that uniform methods of investigation be followed and that some definite standards may be fixed whereby the court and jury may follow a uniform method in determining variations from the normal.

The officers elected for the ensuing year are Dr. H. J. Wheeler, Chemist of the Rhode Island Experiment Station, Kingston, R. I., president; Professor R. J. Davidson, Chemist of the Virginia Agricultural Experiment Station, Blacksburg, Va., vice-president; Dr. H. W. Wiley, Chief of the Bureau of Chemistry, U. S. Department of Agriculture, Washington, D. C., secretary; Dr. C. G. Hopkins, Chemist of the Illinois Agricultural Experiment Station, Urbana, and Mr. Fred. D. Fuller, Assistant Chemist at the Agricultural Experiment Station of New York, at Geneva, additional members of the executive committee.

The next meeting of the Association will be held in Washington, at the call of the executive committee, probably in November, 1902.

H. W. WILEY.

SCIENTIFIC BOOKS.

Tierleben der Tiefsee. Von OSWALD SEELIGER, Professor der Zoologie an der Universität Rostock. Leipzig, Verlag von Wilhelm Engelmann. 1901. Pp. 44.

While it can hardly be claimed that this work is a distinct addition to our knowledge of deep-sea life, it nevertheless serves an important purpose in presenting a compact resumé of the more notable facts relating to the animals of the deep and the conditions under which they exist. The author has been fortunate in his method of treatment, which is popular rather than technical, and covers the field as well as could reasonably be expected in the space occupied. There is hardly any 'padding,' and the more technical parts of the work are wisely segregated under the heading 'Anmerkungen' at the end.

An introductory sketch of the development of deep-sea investigation, from the ancient pearl fisheries of the Indian Ocean to the recent German deep-sea expedition, includes notices of the work of John Ross, Edward Forbes, Michael Sars, Lovén, the cable surveys and the resultant discoveries of animal life in abyssal regions, and the expedition under the direction of the naturalist Chun. It is, to say the least, unexpected to find no mention whatever of such notable expeditions as those of the *Porcupine*, *Challenger*, *Travailleur*, *Blake* and *Albatross*. A similar surprise awaits the reader who peruses the pages devoted to a description of methods and instruments of deep-sea research without finding the slightest mention of the many instruments of precision invented by British and American investigators, such as Sir William Thomson, Alexander Agassiz, Professor Brooke, and Captains Sigsbee and Tanner of the U. S. navy.

The discussion of the physical conditions of the deep sea includes a presentation of the more important facts regarding temperature, but presents to greater length the matter of pressure. The author estimates that the total pressure exerted on a human body, if sunk to a depth of 4,000 m., would equal the weight of ten loaded freight trains, each consisting of an engine, tender and 32 cars. The American reader should remember, however, that these are con-

tinental, and not American trains. As a matter of fact, this pressure has little effect on the organisms inhabiting the depths on account of their being themselves so largely composed of and permeated by sea water. But the release of pressure experienced by individuals suddenly transferred from deep to shallow water is most disastrous in its effects, as illustrated by the fate of deep-water fishes when brought to the surface.

In discussing the chemical composition of sea water the author states that the oxygen is derived from the atmosphere, and that the carbonic acid increases with the depth, and that this latter fact explains the lighter calcareous skeletons of deep-sea forms as compared with their shallow-water relatives. On the other hand, silicious skeletons from great depths are proportionately heavier than those from shallow water, although actually smaller. In this connection the point might well be raised that the heavier calcareous skeletons are not needed in the depths for weight or protection against waves or currents, and that their comparative fragility could be accounted for on other grounds than the solvent action of carbonic acid.

The problem of the penetration of sunlight is treated at considerable length. This subject has been made a matter of investigation by means of experiments with sunken photographic plates, the greatest depth at which even the most sensitive are in any degree affected being 500 to 550 m., according to Fol and Sarasin. Red rays, however, might still be present without affecting the photographic plates, and the reddish yellow twilight of Agassiz and Haeckel might result.

Professor Seeliger denies the red-light theory, and maintains that the blue or blue-green rays penetrate most deeply. He substantiates his argument by an ingenious reference to the well-known and beautiful illumination of the famous 'Blue Grotto' of Capri, where the light penetrates a considerable depth of sea water and is reflected upward into the cave. Spectroscopic investigation confirms this blue-light theory, which appears to be now well established by the arguments here recorded. The author believes that no light from the sun reaches the greater depths, and says that no

conditions of existence in the deep sea have so strongly influenced the organization and manner of life of animals as the absence of sunlight and heat.

The coloration of deep-water forms is regarded as protective in the main. In explanation of the red color so often found, the claim is made that this color would be protective, on account of its being inconspicuous in a blue light. This point is debatable, in the opinion of the reviewer, as any neutral tint would be just as inconspicuous as red, and thus the utterly useless production of such quantities of bright pigment be avoided. After noting the frequency of dark-colored or black hues among the abyssal fishes, and the contrast between this rich pigmentation, on the one hand, and the bleached, often colorless condition of cave animals on the other, the author fails to grasp the significance of the contrast. He doubts the effective presence of attractive coloration as an aid to sexual selection in the deep 'wo die tiere gar nicht oder nur unvollkommen sehen' (*sic!*). Indeed the discussion of the coloration of deep-sea forms is the most unsatisfactory part of the work.

The loss of sight in abyssal animals is frequently compensated for by the special development of other organs, usually tactile, such as the extremely elongated spines of certain fishes, the immensely lengthened antennæ of crustaceans such as *Nematocarcinus gracilipes* and *Sergestes magnificus*. Such structures are often coordinated with degenerate eyes. Sense hairs are sometimes greatly developed in deep-sea annelids and on the lengthened legs of certain crabs.

The author claims that a light, aside from that of the sun, is found in the depths in the form of phosphorescence, and this he discusses in a very interesting manner. The fisherman at night draws up his net filled with 'tausenden glühender Fünckchen.' The light-emitting forms increase in the deeper waters, "Hier finden sich zeitlebens festgeheftet am Meeresgrund lebhaft phosphoreszierende Rindenkoralen, stark bläulich leuchtende Seefedern. Hier leben zahlreiche leuchtende Würmer und Protozoen, prächtig glühende Seesterne (*Brisinga*) und Cephalopoden."

Light-producing organs may be found, often in great numbers, in various parts of the body. Often such organs are coordinated with eyes, and in some cases—*e. g.*, *Ipnops**—the eye itself has become degenerate and replaced by a phosphorescent organ. Among the crabs, as well as fishes, the light-emitting organs serve as dark-lanterns to illuminate the immediate surroundings, and also as lures to attract the prey. The author claims that there is, in general, a decreasing degeneration of the eye with increasing depth. In *Ethusa granulata*, a crab, specimens from shallow water have good visual organs, while those from 900 to 1,300 m. are usually blind. It appears to be a fact that the eyes of deep-sea forms tend either to a great increase in size, on the one hand, or degeneration on the other, as ordinary eyes are of little use in the depths.

The possession of light-emitting organs in blind animals is explained on the ground of utility in terrifying hostile animals or alluring the prey.† There are also instances in which very similar light-producing organs have been developed by widely differing animals by a process of approximation.

In discussing the systematic relationships of deep-sea animals the author states that they do not differ among themselves more than do shallow-water forms. It was at first thought that the abyssal region would yield many ancient types, and, indeed, this is in a measure true. It appears that the older forms were often driven to the depths to escape competition with newer and more specialized rivals. Many deep-sea sponges and echinoderms resemble cretaceous and jurassic types. It can be stated as a generalization, however, that deep-water ani-

* It should be noted, however, that the eyes of *Ipnops* still appear to be functional, although exceedingly modified to form the immense phosphorescent lantern that occupies about half of the dorsal surface of the head.

† In the discussion of phosphorescence in the deep sea, the conclusions of Professor Seeliger are so nearly identical with those presented by the present writer in the number of SCIENCE issued May 31, 1901, that attention should be called to the note at the bottom of page 852, referring to a previous article on 'The Utility of Phosphorescence in Deep-sea Animals,' published in the *American Naturalist*, Oct., 1899.

mals are no nearer mesozoic forms than are those from lesser depths. In sustaining this latter claim the author cites the many cases of so-called 'living fossils' among shallow water mollusks, and also the old-fashioned mammals still existing, such as the proboscidiens. On the other hand, deep-sea animals can often, indeed usually, be referred to existing genera of shallow-water forms, and the author claims that the former were originally derived from the shallow-water inhabitants of the past. The conditions of life in the abyssal regions are not conducive to developmental changes, neither are they such as to favor the evolution of the organic from the inorganic.

Professor Seeliger, like most other writers on this subject, cannot refrain from having his fling at the '*Bathybius* theory' of Huxley, which was exploded through the chemical researches of Buchanan, who demonstrated that the apparently vital movements of '*Bathybius*' were purely physical.

Our author believes that animal life becomes less abundant in the greater depth, but that there is no zone that is entirely uninhabited, a conclusion directly opposed to the one so thoroughly demonstrated by Alexander Agassiz, who maintains that there is an intermediate zone which is practically lifeless. The argument against the existence of an uninhabited zone is based on considerations affecting the food supply. In shallow water the food basis is largely vegetable, but plant life becomes sparse below 200 m. and practically vanishes below 400 m. But the inhabitants of the underlying zone ascend to what may be called the plant zone for their nourishment, and then retire satisfied to the deep. The bottom-inhabiting species, whether free-moving or fixed, are nourished by the organic substances sinking, in changed form, to the bottom.

The bottom deposits are briefly described as diatom ooze, radiolarian ooze, globigerina ooze and red clay.

The author concludes by emphasizing the intimate connection between the animal inhabitants of the upper and deeper zones, and the dependence of the abyssal forms upon the upper regions for their food supply. The animal world of the deep is in general a reflected rep-

resentation (Spiegelbild) of that of the upper waters.

The last sentence in the body of the work is well worth quoting for the beauty and grandeur of the conception involved:

“Denn alles, was oben im Spiel der Wellen und im Sonnenlicht lebt und vegetiert, muss endlich doch noch in irgend einer Form zur Tiefe gelangen, um in der dunklen, von keiner Welle erregten Riesengrabstätte des Meeresgrundes den Kreislauf des Stoffes zu vollenden.”

Following the body of the work are twenty closely printed pages of notes of a more technical character, embodying the actual facts which form the basis for the statements and conclusions of the author. These are of real value to those who study more carefully the fascinating problems of the deep.

The work as a whole will form a welcome addition to the library of the general student, and the specialist will find it well worthy his careful perusal and frequent consultation.

C. C. NUTTING.

Ind.
Agricultural Bacteriology: A Study of the Relation of Bacteria to Agriculture with special Reference to the Bacteria in the Soil, in Water, in the Dairy, in Miscellaneous Farm Products, and in Plants and Domestic Animals. By H. W. CONN, Ph.D. Philadelphia, P. Blakiston's Son & Co. 1901. Pp. 412. Figs. 40.

This is a new book on a new subject. There have been books treating of separate phases of the subject, as dairy bacteriology, but heretofore no book has been issued in English which has attempted to cover the whole range of bacteriology in its relations and applications to agriculture. As the sub-title explains, it has special reference to the bacteria in the soil, in water, in the dairy, in miscellaneous farm products and in plants and domestic animals.

Professor Conn shows that while in the popular mind bacteria have come to be almost synonymous with disease, they are intimately associated with many normal processes which are going on in the soil, water and elsewhere, and are important and very often essential factors in the operations of farming as well as in every-day life: “From beginning to end the

occupations of the agriculturist are concerned in the attempt to obtain the aid of these micro-organisms when they may be of advantage, and in preventing their action in places where they would be a detriment”; and he adds that “farming without the aid of bacteria is an impossibility.” As yet only a beginning has been made in studying their application. In the section on bacteria in the soil, the author shows that they have important relations to agricultural processes in at least five different directions, namely, in the decomposition of rocks, the fixation of free atmospheric nitrogen in the soil, the decomposition of all complex organic bodies and compounds in the soil, the formation of nitrates, and, in connection with the legumes, in reclaiming nitrogen from the air. He prophesies that “in the future the problem of the proper treatment of soil for the use of agriculture will be, in a very large degree, a problem of the proper control of bacteria. Agriculturists must learn to stimulate the bacterial actions which are advantageous, and check those which are disadvantageous, if they would insure the continuance of soil fertility.” There is perhaps no phase of agriculture where bacteria play such an important part as in the dairy. It is appropriate, therefore, that this subject, to which Professor Conn has himself been an important contributor, should receive quite extended treatment. The advances made in the control of bacteria in milk, as a result of better understanding of their sources and of pasteurization, have contributed to a better milk supply of cities, as well as to superior quality of the butter produced. The author contends that the introduction of pure cultures for ripening the cream in butter-making has resulted in improving the general quality of butter and has led to greater care in the preparation of the ‘starter’ where pure cultures are not employed. The part played by enzymes, especially galactase and rennet, in the ripening of cheese is pointed out, but the author is inclined to ascribe considerable importance to lactic bacteria in this connection. Elsewhere the importance of enzymes in explaining various phenomena formerly ascribed to the direct action of bacteria is discussed at some length. This opens up an interesting

line of study in a field where comparatively little beyond the result is known at present. The book is written in a clear and entertaining style that should commend it to the general reader as well as the student. It is an important addition to our agricultural literature, and will be welcomed by many who have felt the need of a general treatise on the subject.

E. W. ALLEN.

The Feeding of Animals. By WHITMAN H. JORDAN. New York, The Macmillan Co. 1901. Pp. 450.

This book by the director of the New York State Experiment Station, is the latest contribution to the excellent Rural Science Series. Several books on feeding have been published by American writers, but in some ways this is the most systematic and comprehensive treatment of the subject, especially as adapted to the needs of the student. While the teachings of European experiments and experience are taken account of, American conditions are kept constantly in mind, and this gives the book a distinct advantage over some which have adhered too closely to the German feeding methods. Dr. Jordan has combined a quite thorough review of the important scientific teachings on the subject, with a plain and clear statement of the application of these facts in practical feeding. He has digested the investigation relating to feeding at home and abroad, and gives the reader the benefit of his judgment and insight into the subject in interpreting and applying them. The applications which he makes of the science of feeding to practical conditions show that he is not bound down by any theoretical ideas or teachings but is thoroughly familiar with the standpoint of the practical feeder. He breaks away, in a measure, from the mathematical doses of nutrients prescribed in feeding standards, but at the same time he admits the value of these formulas as an aid in selecting adequate, uniform and well-proportioned rations. The first part of the book is taken up with the principles of feeding, the relations of plant and animal life, the composition and digestibility of feeding stuffs, the function of nutrients and the laws of nutrition; while the second part considers the practice of feeding, the selection and compounding of rations for

maintenance, for milk and meat production, for growing animals and for work, as well as questions of general management. The arrangement of the book is logical and orderly, and it is well suited to the needs of the student and the class room; in fact it may quite possibly prove more popular as a text-book than as a manual for the farmer or practical feeder, and for such a text-book there is perhaps the greater need at present.

E. W. ALLEN. w.

A Text-book of the Physics of Agriculture. By F. H. KING. Second edition. Madison, Wis., Author. 1901. Pp. xvi + 604. Figs. 276.

In this book, which is by the professor of agricultural physics in the University of Wisconsin and physicist of the experiment station, "the aim has been to present to the student who expects to be a farmer some of the fundamental principles he must understand to become successful." The author states that it is his purpose to present these principles from the physical rather than from the chemical or biological standpoint, and from that of the general student and farmer rather than from that of more technical scientific agriculture. Nevertheless, the book will be found to be a notable contribution to the literature of scientific agriculture in a field which has not heretofore received the attention its importance demands. The introduction deals briefly with certain general physical principles, laws and factors, a knowledge of which is necessary to an understanding of their subsequent practical application. Other chapters deal with the nature, origin and waste of soils; chemical and mineral nature of soils; soluble salts in soils; physical nature of soils; soil moisture; physics of plant breathing and root action; movements of soil moisture; conservation of soil moisture; relation of air to soils; soil temperature; objects, methods and implements of tillage (especially the plow); ground-water, farm wells, and drainage; principles of rural architecture, including strength of materials (posts, barn frames etc.), warmth, light and ventilation, principles of construction, construction of silos; farm mechanics, including principles of draft, construction and maintenance of country roads, farm motors (animal power, steam and gasoline

engines and windmills); farm machinery (general principles, belting, farm pumps, hydraulic rams); principles of weather forecasting, including discussions of the atmosphere and its movements and weather changes.

W. H. BEAL.

Chemische und medicinische Untersuchungen.

Festschrift zur Feier des sechzigsten Geburtstages von Max Jaffe, mit Beiträgen von M. ASKANAZY, P. BAUMGARTEN, M. BERNHARDT, R. COHN, TH. COHN, W. ELIASSOW, A. ELLINGER, J. FROHMANN, P. HILBERT, LASSAR-COHN, D. LAWROW, E. v. LEYDEN, W. LINDEMANN, W. LOSSEN, H. MEYER, E. NEUMANN, H. NOTHNAGEL, E. SALKOWSKI, W. SCHEELE, L. SCHREIBER, A. SEELIG, S. STERN, O. WEISS, R. ZANDER. With 8 plates. Pp. 472. Braunschweig, Friedrich Viewig und Sohn. 1901.

Such volumes as this 'Festschrift' are always of interest in recalling definitely the position and achievements of the scientist to whom they are dedicated, since they come at a time when his great creative work is generally completed. They reveal also something of that side of scientific investigation, unnoticed in the journals and text-books, but of so much importance in the development of thought, the personal relations of the investigators, their influence upon each other, and the inspiration derived by both from the association of teacher and pupil. The papers contributed to volumes of this character are, indeed, frequently distinguished for kindliness of intention, rather than for intrinsic merit. Such is not the case in this volume. Most of the papers are the first presentation of important investigations, which might take their place worthily in any scientific or medical journal. The remaining articles, although presenting no new facts, are interesting on account of the ability and reputation of their writers, and afford suggestive discussions of some of the problems which are of special importance at the present time.

This volume is in every respect a fitting tribute to Jaffe. Although, of course, no word of it was written by him, there is throughout a tone which clearly reflects his influence. The firm grasp of the purely chemical aspects of the problems, even when dealing with clinical or

pathological subjects, the definiteness of the problems set before the investigator, and the clearly devised and vigorously executed experiments employed for their solution, show in the pupils the imprint of the teacher; in the friends, the influence of the coworker. It is one of the most hopeful signs for the future of medical investigations that they are adopting from chemistry and physics that habit of measuring without which science would be mere empiricism. If that quality be sought in Jaffe's researches which most entitles them to their place, it would probably be found in the exactness of the chemical methods employed. They are excellent examples of the application of pure chemistry to the problems of biology. Jaffe has rarely left an investigation of the complex organic substances, whose origin or influence in the animal body he has discovered, without having established also their structural formulæ. He seems to possess the even rarer gift of impressing this trait on others.

The contents of the volume are arranged in three parts, of which the first is devoted to clinical medicine. In the opening article, v. Leyden, as the oldest friend and coworker of him in whose honor he writes, reminds the reader that they two were the first to introduce into medicine, as long ago as 1866, the use of oxygen gas. After reviewing briefly the opposition or rather indifference with which this method of treatment was long regarded, especially in Germany, the writer dwells with just pride on the universal acceptance at the present day of the value of oxygen inhalation, not only in cases of morphine, strychnine and carbon-monoxid poisoning, extreme chloroform narcosis and dyspncea from many other causes, but also as a therapeutic agent in several of the diseases of the respiratory organs. Following this paper are articles by Nothnagel on 'Intestinal Hemorrhages,' Scheele on 'Subphrenic Abscesses,' and Frohmann on 'Primary Sarcoma of the Intestine.' To these are added a report and discussion by Eliassow on 'Three Cases of Degenerative Chorea,' and by Bernhardt three reports upon cases of 'Localized Convulsions in the Upper Extremities,' 'Localized Convulsions in the Lower Extremities,' and 'Infantile Facial Paralysis.' To

this section also Stern contributes an interesting description of a case of 'Traumatic Neurosis and Simulation,' which, after being diagnosed repeatedly by others as simple imposture, the writer was led to regard as the manifestation of real suffering and deficiency. He closes a discussion of the views of Charcot and others on hysteria, hypnotism and allied phenomena, with a plea for a more sympathetic attitude on the part of physicians toward patients so affected.

The second part of the volume is devoted to morphological subjects, and contains an article by Schreiber, which is in the main a review of the recent work on the so-called 'Clasmatocytes' and an investigation of their probable origin and purpose. This is followed by Zander on 'Schistosoma in Man—A Contribution to the Mechanics of Development under Normal and Pathological Conditions,' and Askanazy on the 'Pathology of Bone' in cases of grafting and in the stump of a bone at the point of amputation.

The third and by far the largest part of the volume contains investigations in pure chemistry, physiology, toxicology, experimental pathology and bacteriology. The first of these subjects is represented by Lossen on 'Phthalylhydroxylamin and Related Compounds,' and 'An Improved Nitrometer' by Lassar-Cohn. On the side of physicochemical methods in physiology and medicine, Baumgarten discusses 'Hæmolysis' from the standpoint of the changes in the osmotic pressures of the blood; and Th. Cohn advocates the introduction to clinical use of the freezing-point method for the determinations of alterations in the fluids of the body.

By investigations on 'The Influence of Alterations in the Kidney (either spontaneous nephritis or from cantharides) on the Course of Pancreas-Diabetes in Dogs' Ellinger and Seelig find that the elimination of sugar falls both absolutely and relatively to the nitrogen, but that this diminution in the glycosuria in no wise diminishes the hyperglycæmia, since it is accompanied by an increase in the sugar content of the blood. From experiments, also on dogs, 'On the Functional Capacity of the Heart in Fatty Degeneration' induced by 'Pulegon'

(a substance like phosphorus in its effect on metabolism, but without direct influence on the heart) Lindemann finds the force and rhythm of the beat to remain long unaffected, and concludes that the abnormalities which ultimately result are due to the alterations in the cardiac muscle itself, and not to any influence on its nervous connections.

Four articles represent physiological chemistry. Salkowski contributes an analysis of the 'Hydrocephalus Fluid,' in which, like other observers, he finds an extremely small content of solids (100 cc. containing only 0.43 gram organic substances, mainly urea and dextrose, and 0.77 gram inorganic); Lowrow reports a study of the 'Decomposition Products of the Hæmoglobin of the Horse'; and Weiss the 'Separation of Methylpentose from White of Egg,' its presence or absence depending upon the food of the hen. In a study of the 'Glycocol Supply of the Animal Organism,' by R. Cohn, the methods used are essentially the same as those employed by Lusk in this country, and the results confirm the conclusions of the latter.

In one of the two papers devoted to bacteriology Hilbert is led by his experiments (on white mice) to answer the question, 'Are Toxic or Immunizing Substances Recognizable in the Filtrate of Streptococcus Bouillon Cultures?' in the negative. Finally, in perhaps the most valuable contribution in the volume Hans Meyer, on the basis of experiments performed by him in conjunction with J. T. Halsey and Fr. Ransom on 'Localized Tetanus,' shows that the toxin when injected into a nerve acts not only more quickly, but also more intensely, than when injected subcutaneously, since by the former method the spinal cord is reached more completely and in more concentrated form by the poison. It is further shown conclusively that the action of tetanus is entirely central, and that the greater part of the time of incubation is consumed in the slow passage of the poison to the central ganglia, and only a brief period in the performance of the chemical reaction in the cells affected. Finally, Meyer concludes that the neutralizing action of the antitoxin must occur outside the nervous system, since this substance never penetrates into either the peripheral or central ganglia, and

that the tetanus poison reaches the ganglia of the central nervous system, not by way of the circulation, but along the peripheral nerves.

YANDELL HENDERSON.

YALE UNIVERSITY.

SCIENTIFIC JOURNALS AND ARTICLES.

THE *Botanical Gazette* for November contains the following leading articles: G. T. Moore has published, with three plates, his second paper entitled 'New or Little Known Unicellular Algæ,' giving a detailed account of the life history of *Eremosphæra viridis*, and coming to the conclusion that for the present, at least, the genus should be classed with the Protococcoideæ; and also describing as a new genus a form which has been confused heretofore with *Eremosphæra*, and naming it *Excentrosphæra*. T. C. Frye has published, with one plate, an account of the development of the pollen in certain Asclepiadaceæ, his investigation having been suggested by the record that in certain members of this family there is no tetrad division. The development of the sporangium was found to be of the general type, the primary sporogenous cells passing over directly into pollen-mother cells; these latter divide in the usual tetrad manner, but subsequently through mutual adjustment the four spores are arranged in a linear series. Miss F. Grace Smith has published the results of a large number of observations upon the distribution of red color in vegetative parts in the New England flora. A general conclusion is reached that the statistical observations obtained fit no one theory of color in all particulars. Mr. George A. Shull has published, with illustrations, the results of observations upon 'Some Plant Abnormalities.' He records instances of fasciation in *Erigeron canadense* and *Echium vulgare*; abnormal foliage leaves in *Pelargonium* and *Hicoria*, and abnormal floral organs in *Lathyrus odoratus*, as well as in certain species of *Clematis*. Under the head of 'Briefer Articles,' E. B. Copeland has discussed Meissner's paper on evergreen needles, answering certain criticisms of the author, and presenting new observations; M. L. Fernald publishes a final paper upon the instability of the Rochester nomenclature, being an answer to papers of Messrs. C. L. Pollard, L. M.

Underwood and N. L. Britton; and Charles Robertson has published a third set of observations of flower visits of oligotrophic bees.

ANNOUNCEMENT has been received of the establishment of a new scientific journal entitled *Archivio Italiano di Anatomia e di Embriologia*, under the editorship of Professor Chiarugi, of Florence, already favorably known as the editor of the excellent little journal, the *Monitore Zoologico*. It is published with the cooperation of the professors of anatomy of Pisa, Padua, Sienna, Perugia, Ferrara, Genoa, Catania and Bologna. There has been a great awakening of anatomical and embryological study in Italy, but it has long been a matter of regret that although many important investigations have been published they have appeared in the proceedings of societies or in journals of very limited circulation, so that it has been very difficult for foreigners to secure access to this Italian work, much of which is extremely valuable. We shall, therefore, welcome a journal which will gather together and render more thoroughly accessible the results of anatomical and embryological research in Italy. The list of supporters of the new enterprise is a guarantee of its high character so that we may reasonably expect the new journal to rank as the equal of the best French and German journals. The subscription price for America is 31 francs, 50 centimes. The publisher is Luigi Niccolai, Via Faenza 44, Florence, Italy.

SOCIETIES AND ACADEMIES.

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON.

THE 322d meeting was held November 19. Dr. Walter Hough occupied the session with an account of the explorations among the ancient pueblos of northeastern Arizona, carried on by him last season. The paper was illustrated with maps and selections of artifacts from the two thousand specimens secured during the work. The paper was discussed by F. W. Hodge, J. D. McGuire, Hon. H. M. Baker, Mrs. Matilda C. Stevenson, and President W. H. Holmes.

The 323d regular meeting was held December 3. Mr. S. P. Langley presented a paper on 'The Fire Walk of the Tahitans.' Mr. Langley

gave an interesting account of his voyage to the Society Islands. A number of lantern views of the scenery of Tahiti, the natives, their houses and their arts, were thrown on the screen, accompanied by instructive remarks. The incidents leading up to the ceremony of walking over the heated stones of the taro oven were detailed and a series of instantaneous views on the screen showed graphically the fire walk in progress. Mr. Langley dissipated the mystery that has enveloped this startling ceremony since it was first described. Briefly, his investigations show that the volcanic rocks employed are non-conductors, and though very hot on the under surface, are cool enough above to be walked upon with bare feet.

The paper was discussed by Mr. Townsend, W J McGee and Walter Hough. A vote of thanks of the Society was tendered to Mr. Langley for his valuable paper.

Dr. John E. Walsh, of the Peary Relief Expedition, read a paper, entitled, 'The Eskimo, their Country and Habits.' Dr. Walsh gave an account of the environment of the northern Eskimo as affecting their mode of life, their dwellings and arts. He found no evidences of social organization or religion among these Arctic Highlanders beyond certain minor customs. Dr. Walsh's paper was favorably received. In reference to the tattoo marks of the women spoken of by Dr. Walsh, W J McGee discussed the kinship of the Eskimo, adducing evidence that these marks were for the purpose of indicating relationship. Dr. D. S. Lamb and Dr. Frank Baker remarked upon the series of Eskimo skulls presented by Dr. Walsh. These skulls are notably scaphocephalic. Dr. Walsh also exhibited a number of ethnological specimens from his collection.

WALTER HOUGH.

PHILOSOPHICAL SOCIETY OF WASHINGTON.

THE 541st regular meeting was held November 23, 1901. Dr. W. H. Dall spoke on 'The True Nature of Tamiosoma,' a fossil found in California in 1856 and described by Conrad. Its nature has been much discussed for nearly half a century and there has been great diversity of opinion as to its relationships. The speaker has recently acquired sufficient material to

show that some former studies were based on broken specimens, and some on an inversion of the object. It is now clearly seen to be a barnacle.

Mr. J. F. Hayford discussed the question, 'What is the Center of an Area or the Center of a Population,' with especial reference to the general popular notion that the latter is the point which has as many people on one side of it as on the other. The difficulty with this definition is that the point varies according to the direction chosen; the only point that remains fixed, whatever fundamental directions are chosen, is that analogous to the center of gravity of an area; the sum of the squares of the distances from *this* center to all the elements of the area (or population) is a minimum. An ingeniously cut figure showed at a glance the absurdity of the popular idea. Mr. O. H. Tittmann read from an article written by Professor Hilgard in 1872 giving predictions on the movement of the center of population of the United States.

The 542d meeting was held December 7, 1901, Vice-President Gore in the chair.

Mr. Radelfinger presented a curious series that he had met with in differentiating a complex variable.

Professor T. J. J. See, of the Naval Observatory, presented the results of his recent measures of the diameters of the planets by daylight: the observations were made near the close of the day, when the sky was sufficiently lighted to prevent or at least to diminish the error from irradiation. Professor Campbell had made daylight measures on Mars in 1894, but all other published diameters are based on night work. The daylight observations are remarkably consistent, so that the speaker thought the results on Jupiter and Saturn might be relied on to 1 part in 1000. All the results are sensibly lower than former measures gave, *e. g.*, Jupiter, 38".40 by night, 37".65 by day; Neptune, 2".25, and 2".00, respectively. The densities of the planets as computed from these new values of the diameters are much increased. Similarly the diameters of Jupiter's satellites and Titan were measured. (The paper will appear in the *Astronomische Nachrichten*.)

Dr. A. F. A. King read a paper on the 'Etiology of Intermittent Fever,' in which he discussed *sunlight* as a factor in promoting sporulation of the malarial parasite, which he maintained would not take place in continued darkness. Hence 'chills' do not occur at night; races with non-translucent skins are immune; sunshine increases fever, cloudiness decreases it; spontaneous cures were explained by the shade of hospitals; the red light of the blood promoted the vital activity of the parasite, violet light restricted it, hence the cure by Prussian and methylene blues; quinine cured by its fluorescence accentuating the violet rays. (The paper will appear in the *American Journal of Medical Sciences*.)

CHARLES K. WEAD,
Secretary.

BIOLOGICAL SOCIETY OF WASHINGTON.

THE 344th meeting was held on Saturday evening, November 30.

William Palmer read some extracts from an illustrated article in one of the Sunday papers, on the alleged occurrence of toads in solid rock, and exhibited plaster molds from which some of the illustrations had been made. One of these molds, made over a dead frog, appeared in the picture labeled, 'a mold in which a frog lived for four days,' while the cast of a salamander was figured as 'a salamander emerging from a plaster mold in which it had remained for several days.'

E. W. Nelson presented a paper entitled 'A Naturalist in Yucatan,' describing the country and its flora, touching also on the ruins at Chichenitza, Uxmal and other points. The little known east coast was partly explored and Cozumel Island visited during Mr. Nelson's trip, and a number of colored lantern slides illustrated some of the most interesting features of plant and animal life observed.

H. J. Webber spoke of 'Strand Flora of Florida,' illustrating his remarks with many views of both the eastern and western coasts and describing the manner in which certain plants aided in forming sand dunes, and others such as the mangroves, in making small islets which later on were added to the mainland. The characteristic plants of various portions of the

coast were noted, and the speaker drew attention to the marked difference shown by some plants, the grape nut for example, according as they grew inland or were exposed to the salt winds from the ocean.

F. A. LUCAS.

THE AMERICAN CHEMICAL SOCIETY, NEW YORK SECTION.

AN unusual degree of interest has been manifested in the work of the Section during the present season. Very full programs have been offered at every meeting, and the attendance has been unprecedented. It has been necessary to hold a special meeting in order to dispose of the great number of available papers, and other special meetings will probably have to be held in the spring. The membership of the Section has increased steadily, and is now over four hundred and fifty. The committee to secure funds for the endowment of the research medal and for the encouragement of research among the members of the Section consists of Mr. Clifford Richardson, Professor C. F. Chandler, Mr. Maximilian Toch, Dr. Theron C. Stearns and Dr. William Jay Schieffelin. It shall be the endeavor of this committee to secure a large endowment fund and to suggest an appropriate name for the Section medal, as well as the detailed conditions governing its award. Since the last report of our meetings appeared in SCIENCE, the following papers have been presented:

Special Meeting, November 1.—Edmund H. Miller, 'On the Composition of the Ferrocyanides of Cadmium'; Marston Taylor Bogert and David C. Eccles, 'On the Production of the Imides of Succinic and Glutaric Acids by the Partial Hydration of the Corresponding Nitriles'; W. G. Lindsay, 'On a Colorimetric Method for the Estimation of Sulphur in Pig-iron'; Thomas F. Hildreth, 'On the Determination of Manganese in Spiegel'; John A. Mathews and William Campbell, 'The Alloys of Aluminium.' This paper was profusely illustrated by lantern photographs. It was presented in two parts. The first part being a review of recent work upon the constitution of alloys, with explanation of the nature of solid solutions, eutectics, pyrometric and metallographic methods of alloys, research, etc., the second part embodied the results of the re-

searches of the authors while in Professor Sir William Roberts-Austen's laboratory.

Regular Meeting, November 8. C. W. Volney, 'The Decomposition of Sodium Nitrate by Sulphuric Acid,' in which he showed that the reactions were much more complicated than has been generally supposed. Martin L. Griffin, of Mechanicsville, N. Y., 'The proximate analysis of the spent alkali liquor from the reduction of poplar wood for paper stock by the soda process, with a description of the method.' Mr. Griffin said that these liquors contain nearly 10 per cent. of acetic acid. The possible recovery of this great quantity of acid offers an interesting problem for chemists. Phoebus A. Levene's 'Preliminary Communication upon Glucoposphoric Acid' was read by the secretary. William Campbell, of London, gave an illustrated talk upon his studies of the constitution of 'The Alloys of Copper and Tin.' Daniel D. Jackson, 'The Photometric Determination of Sulphates,' with exhibition of the apparatus. John A. Mathews, continuing his talk upon the constitution of alloys begun at the meeting of November 1, spoke upon 'Alloys and the Phase Rule.' This paper was illustrated with lantern diagrams and showed how the phase rule may be of use in explaining problems of equilibrium in such complex substances as alloys.

Regular Meeting, December 6. W. H. Birchmore presented an introductory paper, 'Notes and Studies on Molds and their Allies,' accompanied by an exhibit of many specimens. Professor Edgar F. Smith spoke on 'The Value of Electrolytic Methods in Chemical Analysis,' urging upon chemists their use or at least a fair trial of them. He contrasted the advantages of the electrolytic methods with the usual gravimetric methods. Professor Smith stated that twenty-five of the seventy elements could be conveniently determined in this way, and that more than one hundred and fifty separations were possible. Particular mention was made of the electrolytic determination of copper, mercury, bismuth, cadmium, molybdenum and uranium. He also mentioned a rapid electrolytic method for the oxidation of sulphur in natural sulphide minerals, by means of a current of ten or fifteen volts and one ampere. The sulphide is

mixed with fused caustic potash in a nickel crucible which is made one of the electrodes, and a stout rod dipping into the fused caustic alkali is the other electrode. Fifteen minutes serves to oxidize completely the sulphur in pyrites, and most other natural sulphides require less time. Professor Wilder Bancroft read a paper upon 'Analytical Chemistry and the Phase Rule Classification.' Dr. Francis G. Benedict, in a paper upon 'Some Aspects of Ventilation,' gave experimental evidence to show that the high temperature and excessive humidity of expired air is a more potent factor in producing discomfort among those who have to breathe it, as, for example, the inmates of a crowded and ill ventilated room or hall, than is the presence of a high percentage of carbonic acid. The experiments were made with human subjects in Professor Atwater's laboratory, and the results are interesting in that they are very much opposed to general ideas upon this subject and to the results which have been published by previous experimenters as well.

JOHN ALEXANDER MATHEWS,
Secretary.

THE NORTHEASTERN SECTION.

At the last regular meeting of the Section held on November 19, 1901, the following officers were elected for the year 1901-1902: President, L. P. Kinnicutt; Vice-President, Charles R. Sanger; Treasurer, B. F. Davenport; Secretary, Henry Fay.

Professor A. A. Noyes addressed the Society on the 'Importance of Catalytic Agents in Chemical Processes.' The lecture was illustrated by numerous experiments, and was discussed under the following headings: (1) Catalytic Action in which the Catalyser Combines Temporarily with one of the Reacting Substances. (2) Catalytic Action by Absorbent Contact Agents. (3) Catalysis by Electrolytic Agents. (4) Water as a Catalyser. (5) Catalytic Action of Acids, Bases and Salts. (6) Catalysis by Enzymes. (7) Colloids.

At the next regular meeting to be held December 17, Professor C. F. Chandler will address the Section on 'Electro-Chemical Industries at Niagara Falls.'

HENRY FAY,
Secretary.

THE LAS VEGAS SCIENCE CLUB.

THE usual monthly meeting was held November 12. Mr. Cockerell briefly reviewed the work of the members during the past summer. At the end of June the top of the Las Vegas Range (11,000 feet) was revisited, and a considerable collection was made, including a number of species of insects new to New Mexico. The insects of this collection are now being recorded in *Psyche*. Mr. Cockerell exhibited two stone spear-heads, which he found on the top of the Las Vegas Range. Seven members of the club spent a part of the summer on the coast of California, where special attention was paid to the Mollusca. Mrs. Cora W. Hewett exhibited a series of shells which she had collected at Coronado, Point Loma and La Jolla. Mr. Cockerell exhibited the internal shell of *Tethys* (*Neaplysia*) *ritteri*, a new species which he found at San Pedro, and named after the director of the University of California Marine Station at that place. This *T. ritteri* was about 21 cm. long, and differed from *T. Californica* in wholly lacking the bars of white and dark brown on the inner surface of the swimming lobes, these parts being of a pale seal green; it also differed in having oblique, flame-like, blood-red markings on the sides of the body. Outside of the Mollusca, some study was made of the insects of the California coast, and several new species of bees were obtained. Mrs. Cockerell found at San Pedro the hydroid *Aglaophenia octocarpa* Nutting, new to the United States.

Mrs. W. P. Cockerell described how she had succeeded in obtaining the eggs of *Argynnis nitocris nigrocærulea* at Beulah. The larvæ which hatched from them had gone into hibernation without feeding. A communication by Mr. Cockerell and Miss Mary Cooper on the genus *Ashmunella* was presented, and a series of the shells was exhibited. The most interesting was a new species, proposed to be called *Ashmunella antiqua*, found fossil in the Pleistocene beds of Las Vegas, N. M. It resembled in most respects *A. thomsoniana*, but wholly lacked the parietal tooth. Miss Ada Springer exhibited the vertebra of a bison which she had found in the charcoal zone of the Las Vegas (Arroyo Pecos) Pleistocene.

Mr. Emerson Atkins showed a series of drawings of the mouth-parts of wasps and bees. The series indicated an evolution from the type with six-jointed maxillary palpi and four-jointed labial palpi, the joints in each case about equal in length, to forms with five-, four-, three- or two-jointed maxillary palpi, and labial palpi with the joints much elongated and very unequal. It was remarked that the maxillæ increased in size, while their palpi diminished. Mr. John McNary communicated a series of drawings illustrating the venation of the middle of the tegmina in various genera of grasshoppers, viz., *Trimerotropis*, *Leprus*, *Arphia* and *Dissosteira*. It was possible to recognize the same veins as are found in the upper wings of Lepidoptera, but whereas in the Lepidoptera they are very constant and very useful for generic classification, in the grasshoppers, which are more primitive insects, they are found to be extraordinarily variable. If one were to depend on the venation for generic characters in Orthoptera to the same degree that one does in Lepidoptera, *Trimerotropis laticincta*, for example, could be split into three genera.

T. D. A. C.

THE TEXAS ACADEMY OF SCIENCE.

THE first regular meeting of the Texas Academy of Science for the present academic year was held in the chemical lecture room of the University of Texas, at Austin, on the evening of October 26, 1901, when Professor J. C. Nagle, of the Agricultural and Mechanical College of Texas, the newly elected president of the Academy, presented his inaugural address on 'The Influence of Applied Science.'

"My purpose," he said, "is to touch upon a few only of the general features of the world's progress, in which applied science has been an aid not only to material development, but to researches in pure science as well, and to suggest, if possible, some means by which the workers in applied science may be brought to contribute more largely towards advancing the purposes and aims of the Texas Academy of Science."

Continuing, the speaker said: "If the recorded history of the world's progress in thought and material prosperity for the last

two thousand years be roughly divided into two parts—the latter one dating practically from the beginning of the nineteenth century—and if the causes making for the amelioration of man's condition during these two periods be examined, we shall see that a single century of applied science has done more for the world's direct advancement in enlightenment, tolerance and real culture, as well as in material progress, than was accomplished in the preceding nineteen hundred years. Furthermore, a comparison of the opportunities and advantages possessed by man at the beginning, the middle and the end of the nineteenth century will show how much the rate of progress was accelerated during the latter half of the century, and if, judging by this, any prediction for the future may be ventured, we may gain some faint idea of the place applied science is destined to fill in the next fifty years."

Among the subjects dwelt upon somewhat in detail were astronomy, physics, especially electricity, civil engineering, chemistry and biology, with special reference to bacteriology. This address will appear in full in Part II. of Volume IV. of the *Transactions* of the Academy soon to be published.

The second meeting for the year was held on November 22. Mr. T. U. Taylor, professor of applied mathematics in the University, read an abstract of his report to the Hydrographic Division of the United States Geological Survey on the 'Water Power of Texas.' In this report he treats of the water power of the State, both existing and prospective, with special reference to that of the following rivers: Pecos, Devils, San Felipe, San Antonio, Guadalupe, Comal, San Marcos, Colorado and tributaries, Brazos and tributaries. The potential water powers at Llano and Marble Falls are considered in detail, and the latter is pronounced as having the grandest possibilities of any place in Texas. Llano and Marble Falls are in the heart of one of the finest granite regions of the country, and every unit of power could be made to pay in that industry alone.

A translation of a part of the introduction to Dr. Ferdinand Roemer's 'Kreidebildungen von Texas,' by Dr. Frederic W. Simonds and Edmund Wild, was read by the latter. 'Die Krei-

debildungen von Texas' contains observations upon the geology of the State made fifty years ago. It is, in fact, the foundation of Texas geology, and won for its writer the title 'Father of the Geology of Texas.' This work has been a fruitful source of inspiration to later writers upon the geology of this region, and it is now the intention of Messrs. Simonds and Wild to make it accessible to all by means of a carefully prepared English translation.

The midwinter meeting of the Academy will be held simultaneously with that of the State Teachers' Association in Waco during the holiday recess.

FREDERIC W. SIMONDS,

Secretary.

UNIVERSITY OF TEXAS.

THE BOSTON SOCIETY OF NATURAL HISTORY.

At the meeting of the Society, held November 6, 1901, Professor William Morris Davis spoke on 'River Terraces in New England,' with a view to supporting a recent theory to account for the successive stair-like terraces with concave fronts found in many New England valleys. A buried ledge of gradual slope encountered by a meandering stream in its sidewise swingings, throws the stream to one side, and prevents its further cutting action at that point. When the stream, in subsequent swinging across the valley floor, returns once more to the attack, it encounters the ledge at a lower level, and is again turned back; thus the terraces as formed are protected from erosion.

At the meeting of November 20, 1901, Professor E. S. Morse presented the results of his researches on living Brachiopoda. He gave an account of the habits of *Lingula* and *Glottidia* and called attention to their marvelous vitality. He described in detail the structure of the leading forms and announced for the first time the œsophageal glands in *Lingula*. A correlation was shown between the presence or absence of setæ and the development of the pedicle; the errantian forms and those moving freely on the pedicle having the setæ greatly developed, those more restricted in their motion having shorter and fewer setæ, while those with lower valve fixed to the rock, such as *Mergerlia*, *Crania*, etc., are without setæ. In the young of all forms studied, the setæ were present, and of great

length. The cœcal tubes, which Dr. Sollas has shown to be probably organs of tactile impression, were wanting in the errantian forms, more or less abundant in those moving freely on a fixed pedicle, and in those fixed by the lower valve, abundant, and in *Crania* even branching. He described the external glands of *Terebratulina*, as well as the strand-like bundle of sperm cells. He insisted that the Heart of Hancock was not a pulsating organ, and was inclined to believe that the 'accessory hearts' were genital in their nature.

GLOVER M. ALLEN,
Secretary.

DISCUSSION AND CORRESPONDENCE.

CONNECTICUT RIVERS.

IN the issue of SCIENCE of November 29, 1901, Professor W. M. Davis reviews my paper on 'The River System of Connecticut' (*Journal of Geology*, IX., 1901, pp. 469-485) and expresses his doubt respecting the principal thesis of the paper; namely, that Connecticut rivers betray by their orientation a controlling influence of joint or fault planes. The subject of stream orientation is a large one and the explanation offered a somewhat new one for American rivers at least. The thesis is one not easily demonstrated as respects the larger area treated, and the review seems to me to be in the main an eminently fair one. From it I infer, however, that my paper may in some particulars be susceptible of misinterpretation, and, therefore, take this opportunity to correct certain impressions which appear in the review, so as, if possible, to prevent further misunderstanding.

If I have omitted to speak at length of the particular controls of stream orientation other than by joint and fault planes, it has not been because I would ascribe little importance to them, but because in a general paper dealing with a special kind of control it was obviously impossible to treat all at length. On page 474 it was stated:

"It is not to be expected that the actual course of a stream will now be coincident with or even absolutely parallel to any fault direction, for there have unquestionably been many local conditions which have produced larger or smaller migrations of the river channels. Their

general direction has, however, it would seem, been maintained despite the minor accidents which have marked their life histories, and even under so revolutionary a change as complete reversal of drainage."

I should certainly agree with Professor Davis when he says that, "it is inherently improbable that the Pomperaug fault lines possess an extension all over the State in systems so rigid as are here postulated." And it was a matter of some surprise to me when the natural trough lines were found in so many instances to correspond to known fault directions of the Pomperaug Valley. Some explanation of this may, however, be found in the fact that the lines noted for the master streams of the State correspond in direction, not to the prevailing faults in the Pomperaug Valley, but rather to the exceptional ones. In the Shepaug Valley immediately adjacent to the Pomperaug, however, the only control observable is from the four directions of faulting which prevail in the Pomperaug Valley. It is my anticipation that when the theory is applied in detail to the broader area of the Connecticut Valley, and the directions of streams carefully compared with the directions of the actual *minor* as well as major faults of that Newark basin, a control will be recognized to have gone out from the planes of faulting. That the directions which were discovered in the Pomperaug Basin will be found to be the only ones I do not of course expect, and it is quite likely that in certain areas they may not appear at all. That an elaborate system of joints and faults, analogous to that of the Pomperaug Valley exists and is accountable for the zigzag outlines of the trap hills scattered over the Connecticut Valley seems to me, however, hardly to admit of doubt. That such a system ceases to exist beyond the border of the Newark is, in my view, inherently improbable.

I should be the last to wish to push the theory of control of streams by fault and joint planes beyond what the facts warrant. In the Pomperaug Valley itself the faults supposed to control the drainage were in the majority of instances discovered. In the near-lying area, *e. g.*, the Shepaug river basin, where the rivers adhere to the four prevailing fault directions of the Pomperaug Valley, this explanation seems

almost a necessity. As regards, however, the extension of the system throughout the State, where individual work in the field should be done in order to familiarize the worker with special and local conditions, I fully recognize the incompleteness of the evidence. It deserves to be emphasized, however, that the student of a carefully prepared map has always at hand the accumulated knowledge acquired by the corps of topographers whose painstaking labor it represents—labor which the modern school of physiographers has been quick to use as the basis of their conclusions. It is not assumed that along every trough line of the map lies the course of a fault. In my article it is stated (p. 478):

“The term ‘trough lines’ * * * may, for the present, be given no further signification than lines so favored by nature that the waters of the region have been induced to adopt them for their channels over longer or shorter distances. On a map of this scale the trough lines, if rectilinear, should be slightly curved, but inasmuch as the present river courses, because of the many accidents of their history, can only roughly approximate to the directions initially given them, it would be an over refinement to introduce a correction of this nature.”

Evidence obtained from the examination of a map by this method can only be of value when cumulative. A single stream which persists in a given direction even for a long distance affords little support to the theory, when compared with that yielded by a number of smaller streams each approximating to a rectilinear course for a shorter distance, *provided the rectilinear courses are parallel*. A harder layer of rock, or a barrier of drift may conduct one stream or the other in its course, but it is inherently improbable that one of these causes or the other, or both combined, have controlled the parallel river series in an area of such geological structure as we find in the State of Connecticut. As was pointed out in the paper, it is worthy of note that so few of the master streams of the area follow the slope of the plain of erosion. As regards the larger area of the State the theory may, perhaps, as Professor Davis says, ‘be regarded as standing in an interrogative rather than in a demonstrative at-

titude,’ but it would be doing injustice to the facts to consider the trough lines as isolated lines while ignoring their arrangement in parallel series.

WM. H. HOBBS.

PHYSIOLOGICAL EFFECT OF DIMINISHED AIR PRESSURE.

TO THE EDITOR OF SCIENCE: The interesting communications of Messrs. Clayton and Ward upon the physiological effects of the diminished air pressure due to mountain climbing recall some records which I made in 1896 during an ascent of El Misti, Peru, similar to that described by Professor Ward. As the effect of the high altitude upon my condition was in part different from that experienced by him, it may be of interest to describe it. The journey from the observatory at Arequipa, elevation 8,050 feet, to the summit of El Misti, elevation 19,200 feet, was made on four occasions. The distance is about 25 miles. It is possible to ride on horseback or muleback to the very summit, following a caravan trail across the pampa to the base of the mountain, and ascending by a winding path constructed with great skill by Professor S. I. Bailey when the meteorological station was established. The journey from the observatory to a hut at an elevation of about 15,400 feet occupies one day, during which the rider is usually obliged to endure the scorching rays of the sun. The night is passed at the hut, and the final ascent to the summit made on the second morning. This occupies several hours, as the animal stops to rest every fifteen or twenty feet at this altitude. On two occasions I was obliged to walk a short distance to cross snow which had drifted across the path, and realized the extreme difficulty of breathing during the exertion required. The return from the summit to the observatory is easily made on the second day, but on two occasions I spent a second night at the hut.

The effect of the altitude upon me was chiefly to cause headache, sleeplessness and partial loss of appetite. On one occasion while at the summit I experienced a decided feeling of faintness for a short time. During the nights at the hut the temperature was about 32° Fahr., but it seemed impossible to keep the body warm, in

spite of arctic sleeping bag and blankets and overcoats so numerous that one could hardly lift the weight in breathing. On the trips in which a second night was passed at this height, more sleep was secured, indicating that the body was getting adjusted to the altitude. The headache disappeared and the appetite revived on the return trip. On the first of these trips, records were made of the pulse and respiration, as accurately as could be made by a person upon himself. They are as follows: Aug. 18, 10 p. m., at observatory on retiring, pulse 80, respiration 16; August 19, 6.00 a. m., on rising, pulse 80, respiration 16; 3.30 p. m. at *tambo de los huesos*, elevation 13,300 feet, pulse 96, respiration 12; Aug. 20, 6.25 a. m., at hut 15,400 feet, on rising, pulse 90, respiration 12; 12.30 p. m., at summit, 19,200 feet, pulse 86, respiration 11; Aug. 21, 10 a. m. at hut, 15,400 feet, pulse 86, respiration 11. The rather small increase in the pulse and the decrease in the respiration are noteworthy. While I made no records on other trips, I noticed frequently that my tendency was to breathe more slowly than usual, except when moving about.

WINSLOW UPTON.

PROVIDENCE, R. I.,
December 7, 1901.

SCIENTIFIC ORNITHOLOGY.

THE following remarkable misuse of terminology occurs in Mr. Robert Ridgway's 'Birds of North and Middle America,' Part I., The Finches, just from the press of the Government Printing Office. He says in his Introduction: "There are two essentially different kinds of ornithology: *systematic*, or *scientific*, and *popular*. The former deals with the structure and classification of birds, their synonymies and technical descriptions. The latter treats of their habits, songs, nesting, and other facts pertaining to their life-histories." And he continues: "Popular ornithology is the more entertaining with its savor of the wildwood, green fields, the riverside and seashore, bird songs and the many fascinating things connected with out-door nature. But systematic ornithology, being a component part of biology—the science of life—is the more instructive and therefore the more important." And are, indeed, life-habits and life-history not biology, not, if scientifically

studied, science of life, not more important than the mere forms which result from this part of bird biology? Could there be found a worse misconception of where science and popular writing differentiate!

X.

SHORTER ARTICLES.

THE RESULTS ATTENDING THE EXPERIMENTS IN LOBSTER CULTURE MADE BY THE UNITED STATES COMMISSION OF FISH AND FISHERIES.

IN April, 1900, the United States Commission of Fish and Fisheries appropriated several thousand dollars to be used in devising, if possible, a practical method of artificial lobster culture, and the undersigned was appointed to take immediate charge of the experiments.

The breeding period of the lobster, continuing as it does only through a few weeks of the late spring and early summer, is so brief that extended experiments have been impossible, but the experiments that have thus far been made (during the spring of 1900 and of 1901) would indicate that very large numbers of lobsters may be hatched and retained in captivity until they have reached an age when they are well able to take care of themselves. Indeed, it would seem that the enormous mortality among lobster young (which results either from boiling females 'in berry,' or stripping the eggs from the female as the lobsters are taken from the traps) may not only be lessened, but that the young enclosed in these eggs may, with very little expense, be hatched in the more important fishing ports and hamlets and protected until they have passed through the critical stages.

It seems advisable to defer the rendering of the final report until the Commission has profited by the experiments of another season. Inasmuch, however, as the problem is of considerable economic importance, it would seem desirable to make some report at the present time, although only a report of progress.

In the spring of 1900 a number of experiment stations were established along the New England coast, namely, at Orrs Island, Freeport, Annisquam, Gloucester, Woods Holl, Naushon and Wickford. Experiments had been made previously at Woods Holl, but without encour-

aging results, and it was thought that the establishment of several stations might result in the discovery of some locality having physical and biological conditions more favorable than those found at the government laboratory. The officers of the stations at Gloucester and Woods Holl and the officers of the *Grampus*, *Fish Hawk* and *Phalarope* cordially cooperated in the work of the special committee, but the experiments at all the stations excepting that at Wickford were discouraging. The lobster fry, even in the cold clear water of the Gulf of Maine, would soon become covered with a chenille-like growth of diatoms and would die, no matter what kind of enclosures were used.

At Wickford, however, where the Rhode Island Commission had courteously given the use of their floating house-boat, the fry seemed to find a more congenial environment. In what respects the water and the plankton at Wickford were more favorable to the fry cannot at the present time be stated; it was, nevertheless, a fact that the young taken from the hatchery at Woods Holl would quickly perish when confined at various localities near Woods Holl, but would thrive when placed in the same kind of enclosures at Wickford. The water at Wickford is rather fresh and of high temperature (often ten degrees higher than at Woods Holl). It is charged with vegetable and animal life, and the current is sufficiently strong to assist materially in the aeration of the water in the enclosures.

Many different devices for enclosures were adopted and tried. Large salt-water ponds, smaller pools, artificial pools made by the building of dikes, enclosures made of wire screen and floated and wire screen and submerged, huge canvas boxes and cars, cars of scrim floated and anchored at the bottom, glass jars of various sizes, running water in vessels of wood, metal, glass, porcelain and stone, and various rotary devices, all proved efficient agents for the killing rather than for the rearing of lobster fry.

The only enclosures which gave encouraging results were made out of scrim in the shape of huge bags some sixteen feet in diameter and several feet in depth and so leaded at the bottom that they would rise and fall with the current and agitate the enclosed fry. But the current

was not sufficient at all times to keep the young lobsters from settling to the bottom, devouring one another and gathering into a confused mass of maimed and struggling individuals. At these times it was necessary for the staff at Wickford to agitate the water artificially, and this was done by the use of paddles.

To Dr. A. D. Mead, who was the director of the Wickford laboratory, is due the credit of having demonstrated the importance of keeping the young lobsters from the bottom of the enclosure, by either natural or artificial means.

Under favorable conditions the growth of the young fry is phenomenal. The first molt takes place about six days after the young have left the egg, the second molt some six days later and the third about five days later still. The third molt takes the fry into the fourth stage, when they assume the characters and habits of the adult. Under the most favorable conditions this fourth stage may be reached in nine days from the time the lobsters are taken from the hatching-jars, but under less favorable conditions, within the same enclosures, certain individuals may be found in the second stage after a lapse of several weeks. In both structure and habits the young that have reached the fourth or 'lobsterling' stage are very different from those of the previous stage. These older individuals (known at the laboratory as 'four-ses') are provided with pinching-claws, hardened shell and vigorous muscles. They are very active, have a voracious appetite, and are pugnacious and secretive.

It is well known that the planting of a few young trout in the fingerling stage will accomplish much more toward restocking our streams than the planting of many thousand fry, and I think it safe to conclude that the planting of many thousands of lobsters in the 'lobsterling' stage would do much more toward rehabilitating the waning lobster industry than the planting of many millions of helpless fry as they leave the hatchery.

No special effort was made in 1900 to treat the fry after they had reached the fourth stage, but a few were retained. Those of the United States Fish Commission office at Washington have been obliged to endure the more artificial environment of an aquarium. Those at Wick-

ford have had a somewhat more natural environment, having spent the winter in a submerged crate. They are hardy, voracious and seem to thrive.

The plans for the second year were based on the successes and failures of the first, and it was thought best to take advantage of the favorable environmental conditions at Wickford, to discontinue the work elsewhere, and to put all the energy into devising some economical contrivance for keeping the water so agitated that the fry would not and could not settle to the bottom.

After many experiments, a relatively simple and inexpensive device was adopted. Several bags of scrim about three feet in diameter and four in depth were so suspended in the pool of the floating laboratory that the current could not change their general shape or cause them to collapse. In each bag was placed a dasher, the blades of which in rotation would constantly lift the water through the mesh at the bottom of the bag and urge it with obviously less velocity through the pores of the vertical walls. The dashers were kept in motion by means of a small gasoline engine, the motor apparatus as a whole having a striking resemblance to the aerating equipment of a second-class restaurant. The scrim bags looked like so many vertical cylinders. We found that when the mechanism was in actual operation the current in rising through the bottom of the bag brought with it large numbers of pelagic animals, while the reduced current of the water passing through the greater expanse of the vertical walls was not sufficient to carry this living material out of the bags; thus the apparatus sufficed not only for keeping the fry and artificial food from the bottom, but it also provided the fry with living natural food. To Mr. George H. Sherwood is due the credit of devising and installing this aerating and feed apparatus.

In practice it was found that the eggs stripped from the abdomen of the female would hatch in these scrim enclosures under much more favorable conditions than in McDonald jars. Indeed, I am inclined to believe that a far higher percentage of eggs would hatch in these bags than in the McDonald jars, and I am sure that the young are in a much more healthy condition

than when hatched by the older method. Even a superficial examination of the young that have spent some hours in the trituration of the McDonald jars will show that a large proportion of them have the appendages broken, bent or indented.

The number of fry that were available for the purpose of experimentation during the first season was considerably less than in 1900, and the period of experimental work was also materially reduced. Nevertheless, Dr. Mead, who had the work immediately in charge, reports that by actual count in no case was the number of lobsters that reached the fourth stage less than 16 per cent. of the number of fry originally placed in the enclosure. In a few cases it was above 40 per cent. and in at least one case it was as high as 54 per cent. In previous years no experiments had yielded more than a fraction of one per cent. The total number of lobsters raised to the fourth stage during the season of 1901 (in the twelve cylinders) was a little more than nine thousand.

Encouraged by these results, the United States Commission of Fish and Fisheries is now planning to equip one or more stations with the aerating, hatching and brooding apparatus above described, and to actually test the feasibility of raising large numbers of fry to the fourth stage, and I feel convinced that the liberation of large numbers of these more hardy young will result in the restocking of our depleted waters.

H. C. BUMPUS.

AMERICAN MUSEUM OF NATURAL HISTORY.

ON THE STRUCTURE OF THE MANUS IN BRONTOSAURUS.

During the past season, while engaged in collecting vertebrate fossils for the Carnegie Museum, Mr. Charles W. Gilmore had the good fortune to discover in the Jurassic exposures on Sheep Creek, in Albany Co., Wyo., a very considerable portion of the skeleton of *Brontosaurus*.

This skeleton was very carefully taken up by Mr. Gilmore and has been received at the museum. Among the more important parts secured was a nearly complete fore limb and foot with the different elements for the most part still retained in their normal position, making it possible for the first time to definitely deter-

mine most of the more important points regarding the structure of the manus in this genus of the Sauropoda.

The entire limb and foot were taken up in two sections, in one of which was the humerus, while the other contained the radius, ulna, and such portions of the manus as were preserved, consisting of the supposed scapholunar, the complete series of metacarpals, the five proximal phalanges, and the ungual of the first digit. All these elements when found, except the scapholunar, lay in approximately their normal positions, with reference to each other, and thanks to the skill and care of Mr. Gilmore, they were so taken up and packed that their original positions had not been disturbed when the limb and foot were unpacked in the laboratory.

The radius, ulna and manus have already been partially freed from the matrix by Mr. Gilmore, and throw considerable light upon the structure of the latter.

The limb when found lay with the palmar side up. The proximal end of the radius lay in the radial groove on the anterior surface of the ulna, these bones still articulating with the distal end of the humerus. Lying between and upon the palmar side, near the distal end of the radius and ulna, was a large flat bone presenting on one side a gentle but regularly convex surface, and on the other two flat, subequal surfaces separated by a low ridge. This bone I have interpreted as the scapholunar, and it seems to be the only carpal element retained in the *Brontosaurus* manus.

Metacarpals I., II., III., IV., V. were in regular order at the distal extremity of the radius and ulna, though the first and fifth were closely applied to the external lateral surfaces of the distal ends of the radius and ulna, indicating that in life they articulated directly with these bones, perhaps through the intermedium of heavy cartilaginous pads, while the three median metacarpals were a little more removed in order to accommodate the scapholunar mentioned above.

The proximal phalanges of all the digits were present and nearly in their normal positions with relation to their respective metacarpals. That of digit I. was in contact with its meta-

carpal, but shifted from its normal position so that its external lateral surface was opposed to the distal end of the metacarpal, with its proximal articular surface turned inward toward the median axis of the foot, and the distal outward. The proximal phalanx of digit II. was in position at the extremity of metacarpal II., but very much flexed, so that its longitudinal axis lay almost at right angles to that of metacarpal II. It is much the larger and stronger of the series of proximal phalanges, and has the distal articular surface deeply grooved for the keel of the second phalanx. The first phalanx of digit III. is much smaller than that of the second, and presents distally a small, but well-formed and slightly grooved, surface for the articulation of the succeeding phalanx. It (the first) was found in its proper position at the extremity of metacarpal III., and there was on the palmar side, interposed between it and that bone, a small rounded sesamoid. The proximal phalanx of the fourth digit was in position articulated with metacarpal IV. It is the smallest of the series and presents distally an ill-defined articular surface. That of digit V. lay at the extremity of its metacarpal, but with its external lateral surface opposed to the distal end of the latter. This phalanx is slightly larger than the corresponding one of digit IV., but its distal extremity scarcely shows any trace of an articular surface for a succeeding phalanx. These were the only phalanges found with this foot except the ungual of the first digit, which lay in its normal position with reference to that of the first phalanx as the latter has been described above, except that it was turned on its side and had been moved slightly backward, and lay with its articular surface abutting against the external border of the distal articular surface of the first phalanx and the external lateral surface of metacarpal I.

There was a slight vertical displacement in the carpal region, so that the distal ends of the radius and ulna were a little lower than the metacarpals. Metacarpals I. and V. lay in such position with reference to II., III. and IV. as to indicate that the proximal ends of these bones were arranged in the arc of a circle, and not horizontally.

From the above brief description it will readily appear that the Sauropod manus in *Brontosaurus* at least was like the pes, arranged on the entaxomic plan, and not mesaxomic as Professor Osborn was led to believe from a study of the abundant but isolated material in the collections of the American Museum of Natural History.

This foot and limb will be more fully described and adequately illustrated in the coming number of the *Annals* of this Museum.

J. B. HATCHER.

CARNEGIE MUSEUM,
December 2, 1901.

GOLDFISH AS DESTROYERS OF MOSQUITO LARVÆ.

IN Professor L. O. Howard's recent excellent volume on 'Mosquitoes,' etc. (p. 161), reference is made to a reported employment of 'carp' as destroyers of mosquito larvæ and doubt is expressed as to the facts in the following words:

"It was stated a number of years ago in *Insect Life*, that mosquitoes were at one time very abundant on the Riviera in South Europe, and that one of the English residents found that they breed abundantly in the water tanks, and introduced carp into the tanks for the purpose of destroying the larvæ. It is said that this was done with success, but the well-known food-habits of the carp seem to indicate that there is something wrong with the story. If top-minnows or sticklebacks had been introduced, however, the story would have been perfectly credible, and it points to the practical use of fish under many conditions."

An examination of *Insect Life* (Vol. IV., p. 223) and also of *Nature* (Vol. XLIV., 1891, p. 591)—the original source of the statement in question—fails to reveal the precise species of 'carp' here referred to, but if, as seems likely, it was the common goldfish, *Carassius auratus*, I happen to be in a position to confirm the general truth of the story.

About six years ago at my home in Belmont, near Boston, Massachusetts, I constructed a small artificial pond in which to grow water-lilies and other aquatic plants, and also to breed, if possible, some varieties of goldfish—though the latter object was a secondary consideration.

The advisability of making this pond had been somewhat questioned on account of its close proximity to my house and the fact that such ponds are likely to become excellent places for the propagation of mosquitoes. Nevertheless, the plan was carried out and the pond was stocked with goldfish taken from natural ponds in the vicinity where they had been living and breeding, to my personal knowledge, for a number of years.

The aquatic garden has proved a success and the goldfish have meantime thriven and multiplied. Moreover, no mosquitoes attributable to the pond have appeared and I have been unable to find any larvæ in it, although I have searched repeatedly and diligently for them. I have always believed that the absence of mosquito larvæ from this pond was due to the presence of the goldfish, and I have so stated in a paper 'On the Drainage, Reclamation and Sanitary Improvement of Certain Marsh Lands in the Vicinity of Boston' in the *Technology Quarterly*, XIV., 69 (March, 1901), as follows: "In the water [of this pond] are hundreds of goldfish that feed upon the larvæ of mosquitoes and serve to keep this insect pest in check."

On observing the statement referred to in Professor Howard's book I determined to make careful observations, to settle the point in dispute. Within fifty feet of the pond in question stands a large tank which for a long time last summer was filled with rain water. Here I found constantly large numbers of mosquito larvæ, of both *Culex* and *Anopheles*. Between this tank and the pond runs a cool brook, fed by a spring. Here also I found abundant mosquito larvæ, those of *Anopheles* being more prevalent than those of *Culex*. Reflecting upon this fact it seemed more probable than ever that the goldfish were holding the mosquitoes in check in the artificial pond while in the brook the insects were breeding in comparative safety.

To test the correctness of my theories I took from the pond a small goldfish about three inches long and placed it in an aquarium where it could, if it would, feed upon mosquito larvæ and still be under careful observation. The result was as I had anticipated. On the first day, owing perhaps to the change of environment,

and to being rather easily disturbed in its new quarters, this goldfish ate eleven larvæ only, in three hours; but the next day twenty were devoured in one hour; and as the fish became more at home the 'wrigglers' disappeared in short order whenever they were dropped into the water. On one occasion twenty were eaten in one minute, and forty-eight within five minutes. This experiment was frequently repeated, and to see if this partiality for insect food was a characteristic of those goldfish only which were indigenous to this locality, I experimented with some said to have been reared in carp-ponds near Baltimore, Maryland. The result was the same, though the appetite for mosquitoes was even more marked with the Baltimore fish than with the others. This was probably due to the fact that they had been in an aquarium for a long time before I secured them, and had been deprived of this natural food. I also tried the experiment of feeding commercially prepared 'goldfish food' and mosquito larvæ at the same time, and found that in such a case the goldfish invariably preferred the larvæ.

It is not as generally realized as it should be that goldfish will thrive in our natural northern waters. In my experience they can easily be bred in any sheltered pond where the water is warm and not fed by too many cold springs, and form any years they have been breeding naturally in many small ponds in the vicinity of Cambridge, Massachusetts.

When it is once understood that these fish are useful as well as ornamental and comparatively hardy, it is to be hoped that they will be introduced into many small bodies of water where mosquitoes are likely to breed, and thus be employed as a remedy for mosquitoes sometimes preferable to kerosene.

WILLIAM LYMAN UNDERWOOD.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, November 27, 1901.

NOTES ON INORGANIC CHEMISTRY.

NEW WORK ON RADIUM.

A NEW series of experiments has been carried out by Berthelot on radium, with reference to its chemical action, as shown upon several compounds. The radium used was enclosed in one sealed glass tube within another, and in

some of the experiments within a third, so that its influence was much weakened and some of the active rays were altogether cut off. The action took place in the dark and was exceedingly slow. Iodin pentoxid was decomposed by the radium rays just as by light, and the same was true of nitric acid. Since both of these reactions are endothermic, the rays must furnish chemical energy. The change of rhombic sulfur into the insoluble variety, an exothermic reaction which is effected by light, was not affected by the radium rays. The rays have no influence upon acetylene, which is very sensitive to the action of the electric current but is unaffected by light. Oxalic acid also was not changed, though it is readily oxidized even in diffused light. The glass tubes in which the radium was contained were blackened, owing probably to a reduction of the lead. A purple color was also noticed in the glass near the blackened portions, which was attributed to an oxidation of the manganese present.

In this connection it may be noted that the existence of the radio-active lead, recently described by Hofmann and Strauss, is denied by Giesel. He considers it to be a mixture of lead with a little radium. He confirms, however, the observation of several workers, that water can be rendered strongly radio-active by radium. He enclosed half a gram of radium-barium bromid in one arm of a sealed U-tube, distilled the water of crystallization over into the other arm, and then sealed it off by fusion. Both the water and the air in the sealed tube were strongly active, more so indeed than the original salt. That this was not due to minute particles of radium which had been driven over mechanically was proved by the fact that the radio-activity disappeared within a few days.

AMMONIA ON METALS.

IN endeavoring some years since to find a metal which would withstand the action of ammonia gas at high temperatures, G. T. Beilby noted the fact that every metal tested soon become brittle and spongy. In conjunction with G. G. Henderson, Mr. Beilby has now investigated the phenomenon more closely and the results are published in the last number of the *Journal of the Chemical Society* (London). It has

long been known that ammonia is rapidly decomposed into nitrogen and hydrogen by the action of red-hot iron, but the effect upon the iron has attracted less attention. The authors find that whatever the metal used, it becomes changed in its appearance and very brittle. With some metals, as iron, the action is very rapid, with others slower, but even gold and platinum cannot resist this action of ammonia. Under the microscope the metal gives evidence of having been fused or semi-fused, and of bubbles of gas having escaped through the fused metal. The authors conclude that under the influence of the ammonia a nitrid of the metal has been formed, which is stable only within narrow limits of temperature, and which is fusible at the temperature of its formation. At slightly higher temperatures than that of its formation, it is decomposed into the metal and the escaping nitrogen gives the peculiar appearance to the metal. Pure iron was found to be rendered hard and brittle by the absorption of small quantities of nitrogen and a rod of charcoal iron was made so hard that it could be used as a drill. The thought naturally suggests itself that the presence of nitrogen may play some part in the manufacture of cement steel. The results of this investigation make it clear that there is no metal of which pipes can be made for the conveyance of ammonia at high temperatures, and that porcelain is the only available material for this purpose.

FITTICA'S LATEST TRANSMUTATION.

PROFESSOR FITTICA has been heard from again, and this time he claims to convert boron into silicon, or rather he considers boron to be an oxid of silicon, contaminated perhaps with carbon. By heating boron in a silver dish with sodium or potassium or their hydroxids, he obtains a dark, oily mass, from which carbon can be isolated by acidifying. The chief constituent of this mass, however, is silicic acid, as shown by familiar tests. The alkali was proved to be originally free from silicic acid, but no evidence is presented that the boron used did not contain silicon. Other methods for effecting this conversion were successful, but all seem to be open to the same criticism.

J. L. H.

CIRCULAR OF INFORMATION OF THE NATIONAL BUREAU OF STANDARDS, NO. 1.

ANNOUNCEMENT OF ORGANIZATION.

By an act of Congress approved March 3, 1901, the Office of Standard Weights and Measures of the Treasury Department was, on July 1, 1901, superseded by the National Bureau of Standards, the functions of which are as follows: 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 is authorized to exercise its functions for the Government of the United States, for any State or municipal government in the United States, or for any scientific society, educational institution, firm, corporation, or individual within the United States engaged in manufacturing or other pursuit requiring the use of standards or standard measuring instruments.

For all comparisons, calibrations, tests, or investigations, except those performed for the Government of the United States or State governments, a reasonable fee will be charged. Provision is also made for the purchase of a site and the erection of a suitable laboratory, its equipment with the most improved facilities and the personnel necessary for the organization of the Bureau.

A suitable site has been selected in Washington in a locality free from mechanical and electrical disturbances, and yet easy of access. Plans are being prepared for a physical laboratory which will be equipped with apparatus and conveniences for carrying on investigations, and for testing standards and measuring instruments of all kinds. Also a somewhat similar building, to be known as a mechanical labora-

tory, which will contain the power and general electrical machinery, the instrument shop, refrigerating plant, storage batteries, dynamos for experimental purposes, and laboratories for electrical measurements requiring heavy currents.

The construction of the buildings will be pushed as rapidly as possible, and it is expected that they will be ready for occupancy by January 1, 1903. For the present, additional quarters have been secured in the building occupied by the former Office of Standard Weights and Measures, with a view to the organization of the bureau and the immediate development of the more needed extensions of the work heretofore carried on, such as photometric measurements, the testing of instruments for determining high or low temperatures, clinical thermometers, chemical glass measuring apparatus, electrical apparatus used to measure alternating currents, pressure gauges, and meteorological instruments.

For the present, however, the work of the bureau will be limited to the comparison of the following standards and measuring instruments, either for commercial or scientific purposes:

Length Measures.—Standard bars from 1 to 10 feet, or from 1 decimeter to 5 meters; base bars; bench standards; leveling rods; graduated scales; engineers' and surveyors' metal tapes 1 to 300 feet or from 1 to 100 meters.

Weights.—From 0.01 grain to 50 pounds, or from 0.1 milligram to 20 kilograms.

Capacity Measures.—From 1 fluid ounce to 5 gallons, or from 1 milliliter to 10 liters.

Thermometers.—Between 32° and 120° Fahrenheit, or 0° to 50° centigrade.

Polariscope Apparatus.—Scales of polariscopes, quartz control plates, and other accessory apparatus.

Hydrometers.—Alcoholometers, salinometers and saccharometers whose scales correspond to densities between 0.85 and 1.20.

Resistances.—Coils of the following denominations: 1, 2, 5, 10, 100, 1,000, 10,000, 100,000 ohms; low resistance standards for current measurements of the following denominations: 0.1, 0.01, 0.001, 0.0001 ohm. Coils of resistance boxes; potentiometers; ratio coils.

Standards of Electromotive Force.—Clark and other standard cells.

Direct Current-Measuring Apparatus.—Millivoltmeters and voltmeters up to 150 volts; ammeters up to 50 amperes.

It is the desire of the Bureau to cooperate with manufacturers, scientists, and others, in bringing about more satisfactory conditions relative to weights and measures in the broader meaning of the term, and to place at the disposal of those interested such information relative to these subjects as may be in possession of the Bureau.

S. W. STRATTON,
Director.

WASHINGTON, D. C.

*MEETINGS OF SCIENTIFIC SOCIETIES AND
CONVOCATION WEEK.*

WE call special attention to the calendar of the meetings of scientific societies which begin shortly after the issue of the present number of SCIENCE. They are as follows:

The American Association for the Advancement of Science. A meeting of the council will be held at the Quadrangle Club, University of Chicago, on the afternoon of January 1. Section H (Anthropology) will meet in the Field Columbian Museum, Chicago (December 31 and January 1 and 2). The next regular meeting of the Association will be held at Pittsburg, Pa. (June 28 to July 3). A winter meeting is planned to be held at Washington during the convocation week of 1902-3.

The American Society of Naturalists will hold its annual meeting at the University of Chicago (December 31 and January 1). In conjunction with it will meet the Naturalists of the Central States and several affiliated societies, including the American Morphological Society (beginning on January 1); The American Physiological Society (December 30 and 31); The American Psychological Association and the Western Philosophical Association (December 31 and January 1 and 2); The Society of American Bacteriologists (December 31 and January 1), and The American Association of Anatomists (December 31 and January 1 and 2).

The Astronomical and Astrophysical Society of America will meet in Washington (beginning on December 30).

The Geological Society of America will meet at Rochester, N. Y. (December 31 and January 1 and 2):

The American Chemical Society will meet at the University of Pennsylvania, Philadelphia (December 30 and 31).

The Society for Plant Morphology and Physiology meets at Columbia University, New York City (December 31 and January 1 and 2).

The American Mathematical Society and the American Physical Society meet at Columbia University, New York City (December 27 and 28).

SCIENTIFIC NOTES AND NEWS.

DR. ADOLF MEYER has been selected as director of the Pathological Institute of the New York State Hospitals. Dr. Meyer is at present director of the clinical work and laboratory of the Worcester Insane Asylum and docent in psychiatry in Clark University.

THE Paris Academy of Sciences has filled the vacancy in the section of physics, caused by the death of Dr. Raoult, by the election of M. Gouy, of Lyons, to corresponding membership.

LORD AVEBURY has been elected a foreign member of the Swedish Academy of Sciences.

PRESIDENT REMSEN, of the Johns Hopkins University, was entertained by the alumni in Boston on December 16. Speeches were made by President Remsen, President G. Stamley Hall, of Clark University, Professor A. L. Kimball, of Amherst College, Professor L. P. Kinnicut, of the Worcester Polytechnic Institute, Professor W. T. Sedgwick, of the Massachusetts Institute of Technology, and others.

PRESIDENT ELIOT, of Harvard University, has planned a trip to the Pacific Coast and the South, during which he will make many addresses. He will leave Cambridge about February 20, and will return the latter part of April.

PRESIDENT HARPER, of the University of Chicago, has declined the directorship of the International Congress at the St. Louis Exposition.

PROFESSOR W. W. ROWLEE, of the botanical department of Cornell University, and Professor J. C. Gifford, of the College of Forestry, have gone on an expedition to Cuba to study the forests and botany of western Cuba and the Isle of Pines.

PROFESSOR JOHN MACFARLANE and a party of students from the University of Pennsylvania are spending the Christmas holidays in botanical field work in Florida.

M. IZARE WEILLAR has come to the United States commissioned to study the organization of our technical schools and business methods.

DR. L. O. HOWARD, chief of the Division of Entomology, Department of Agriculture, lectured before the Biological Club of the Woman's College of Baltimore last week, on 'Mosquitoes and their Relation to Disease.'

PROFESSOR F. W. CRAGIN has recently obtained a new Colorado meteorite. It is from the eastern part of the State, and, like the three or four others hitherto found in Colorado, is an iron; the date of the fall is unknown. It is of square-lenticular form, strongly pitted, and weighs forty-two pounds.

DR. SVEN ANDERS HEDIN, the Swedish traveler, who has been exploring in the Gobi Desert and Thibet, has reached Ladakh, Kashmir, on his way home.

BARON TOLL says that his winter quarters have been established on the Nerpenskiye coast, in the neighborhood of the Lena Delta, and that an observation station has been opened at Kotelnys Island. During the summer the expedition reached latitude 77 degrees 32 minutes, in New Siberia.

THE memorial to Robert Fulton in Trinity Churchyard, New York City, to which we have already referred, was unveiled on the occasion of the recent meeting of the American Society of Mechanical Engineers.

A BUST of Alphonse Milne-Edwards has been completed by the sculptor Marqueste and will be placed in the Hall of Zoology in the Paris Museum of Natural History.

AT the anniversary meeting of the Royal Society, held on November 30, attention was called to the deaths of the following fellows and foreign members. The deceased fellows were Sir John Conroy, died December 15, 1900, aged 55; Lord Armstrong, died December 27, 1900, aged 91; Dr. William Pole, died December 30, 1900, aged 86; Professor George Francis Fitzgerald, died February 22, 1901,

aged 50; Dr. George Mercer Dawson, died March 2, aged 52; John Christian Malet, died April 9, aged 53; Professor Henry G. Hennessy, died March 8, aged 76; Professor John Viriamu Jones, died June 2, aged 45; Dr. Charles Meldrum, died August 28, aged 80. The foreign members were Charles Hermite, died January 14, 1901, aged 78; Henry A. Rowland, died April 16, aged 53; Henri de Lacaze-Duthiers, died July 21, aged 81; Professor Aleksandr Kowalewski, died November 22.

PROFESSOR HENRY FULTON, dean of the School of Applied Science of the University of Colorado at Boulder, died on December 7, aged 55 years. Dean Fulton was prominent in educational affairs of the State for many years. By his death the University loses an able professor and valued administrative officer.

PROFESSOR ALEKSANDR ALEKSANDROVIC KOVALEVSKI, professor emeritus of zoology at the University of St. Petersburg, died in that city on November 22.

DR. ARTHUR KÖNIG, associate professor of the physiology of the sense organs at the University of Berlin, and director of the physical section of the Physiological Laboratory, died on October 26 at the age of forty-five years. Dr. König was an assistant of Helmholtz's and aided in the preparation of the second edition of the *Physiologische Optik*. He had carried out important researches on vision, and, with Professor Herm. Ebbinghaus, edited the *Zeitschrift für Psychologie und Physiologie der Sinnesorgane*.

THE death is announced of Dr. A. A. Tokasky, head of the Moscow Physiological Laboratory.

JACOB HEINRICH KRELAGE, a Dutch botanist and horticulturist, died on December 1, at the age of seventy-six years. He was head of a well-known firm engaged in the growing of bulbs.

REPRESENTATIVE WOODS, of California, has introduced a bill in the House creating a department of mines and mining. The department would have a secretary with a seat in the cabinet.

THE recent changes in ownership and plans of the *Botanisches Centralblatt* have already been referred to in these columns. The Committee of the Society for Plant Morphology and

Physiology, to which the selection of American editors for that journal was entrusted by the officers of the International Association, will make a full report to the Society at its Columbia meeting on December 31, and the substance of the report will also be announced to the botanists at the Chicago meeting. In the meantime we are authorized to announce the names of the American editors already chosen, who, with their respective departments, are as follows:

Phanerogams (systematic), and Chairman of the American Board, Professor William Trelease, Missouri Botanical Garden.

Morphology, Professor D. H. Campbell, Leland Stanford University.

Physiology, Professor D. T. MacDougal, New York Botanical Garden.

Cytology, Dr. C. J. Chamberlain, University of Chicago.

Paleontology, Professor D. P. Penhallow, McGill University.

Fungi, and Secretary of the American Board, Dr. Hermann von Schrenk, Shaw School of Botany.

Algae and Archegoniata, Dr. G. H. Moore, of Washington, D. C.

Further announcements as to the organization of this board, etc., will later be made, but in the meantime it is desirable that the authors of all papers published in America should send separates directly to the respective editors. It is expected also that at the Columbia meeting nominations of the two members of the General Committee, to be voted for by the American members of the International Association, will be suggested.

THE sixth annual meeting of the New York State Teachers' Science Association will be held at Syracuse, N. Y., on September 27 and 28. A full and carefully selected program is offered including papers and discussions interesting to all teachers of science.

SENATOR WM. A. CLARK has made a donation of \$250 to facilitate the work of the University of Montana Biological Station at Flathead Lake. This is the fourth contribution from Senator Clark for this purpose.

ONE of the American delegates to the Pan-American conference in Mexico City has presented a plan looking to the creation of an inter-

national sanitary commission to be composed of not more than five members of each government, this commission to hold annual or periodical meetings, probably at Washington. At its meetings it would discuss and make recommendations on sanitary matters in general, particularly on the condition of dangerous or infected ports and other places, and the means of improving them.

THE Bibliographical Society of Chicago, an organization founded 'to encourage and promote bibliographical study and research,' has requested the Committee on Education of the St. Louis Exposition to appoint a Commissioner of Bibliography for the Louisiana Purchase Exposition whose duties shall be: (1) To have supervision and final control of all bibliographical publications that may be issued in connection with the Exposition, and to undertake, for his own part, the editing of a series of bibliographies of subjects relating to the Louisiana purchase, and the political, industrial and intellectual development of the territory concerned, and other subjects that may prove pertinent. (2) To collect a complete set of all printed matter relating to the Exposition and to compile an accurate catalogue thereof, and (3) to arrange for an international bibliographical exhibit, with the idea of keeping the same intact after the close of the Exposition as a permanent bibliographical library.

WE have already called attention to the Yellow Fever Institute, organized under the direction of the supervising surgeon general of the U. S. Marine Hospital Service. The work of the Institute has been divided into four sections by which the following topics will be investigated:

SECTION A.—HISTORY AND STATISTICS.

- Topic 1. The early history of the disease.
- Topic 3. History of recent epidemics (since 1850).
- Topic 4. Relation to modern sanitation, especially paving, drainage, etc., in cities.
- Topic 5. Why did not New Orleans have it in early times while Boston did?
- Topic 6. Mortality statistics.
- Topic 7. Maps showing yellow fever zones.
- Topic 8. Maps showing the infectible territory in the United States.

SECTION B.—ETIOLOGY.

- Topic 1. The cause of the disease.

SECTION C.—TRANSMISSION.

- Topic 1. The transmission of the disease by the mosquito.
- Topic 2. Can any other mosquito than the *Stegomyia fasciata* carry the infection?
- Topic 3. Is the progeny of the mosquito also infected?
- Topic 4. How many generations?
- Topic 5. Can the mosquito become infected by any other means than by sucking the blood of a patient sick with the disease?
- Topic 6. Can the mosquito become infected by contact with the dried blood discharges or other infected materials upon fomites?
- Topic 7. Can the disease be transmitted by any other means than through the mosquito?
- Topic 8. Can the disease be conveyed by fomites, or through the air, soil or water?
- Topic 9. The geographical distribution of *Stegomyia fasciata* in relation to the disease.
- Topic 10. Is the immunity enjoyed by certain localities due to the absence of this variety of mosquito?
- Topic 11. A study of the life and habits of the *Stegomyia* and allied species, especially with a view to their extermination.

SECTION D.—QUARANTINE AND TREATMENT.

- Topic 1. Is disinfection of baggage necessary to prevent the spread of the disease?
- Topic 2. Is any treatment of baggage necessary?
- Topic 3. Mosquitoes in baggage, in merchandise, in cars, in ships.
- Topic 4. Treatment of the patient.
- Topic 5. Guards against mosquito bites.
- Topic 6. Immunity of individuals, of races.
- Topic 7. Individual prophylaxis.
- Topic 8. Communal prophylaxis—sanitation.

THE Academy of Natural Sciences at Philadelphia announces the following Ludwick Institute Courses of Free Lectures. Each course contains five lectures and they are given in the evening. The courses are as follows:

Course I., Physiology and Hygiene, Seneca Egbert, A.M., M.D., professor of hygiene, Medico-Chirurgical College, Philadelphia. On Thursdays, beginning on November 7.

Course II., Entomology, Henry Skinner, M.D., conservator of the entomological section, Academy of Natural Sciences, Philadelphia. On Mondays, beginning on November 11.

Course III., Parasites and Parasitism, J. Percy Moore. On Thursdays, beginning on January 2.

Course IV., Structure and Life Histories of Some Common Birds, Witmer Stone, M.A., Conservator of the ornithological section, Academy of Natural Sciences, Philadelphia. On Mondays, beginning on January 6.

Course V., Sedimentary Rocks, their Origin and Formation, Amos P. Brown, Ph.D., professor of mineralogy and Geology, University of Pennsylvania, Philadelphia. On Thursdays, beginning on February 6.

Course VI., The Principles and Methods of Zoology, Philip Calvert, Ph.D., instructor in zoology, University of Pennsylvania. On Mondays, beginning on February 11.

Course VII., Studies of Plant Life in the Vicinity of Philadelphia, Stewardson Brown, conservator of the botanical section of the Academy of Natural Sciences, Philadelphia. On Thursdays, beginning on March 13.

Course VIII., Mollusks, Henry A. Pilsbury, conservator of the conchological section of the Academy of Natural Sciences, Philadelphia. On Mondays, beginning on March 17.

UNIVERSITY AND EDUCATIONAL NEWS.

A MEETING has been held in Halifax to consider a plan for the affiliation of the colleges in the provinces of Nova Scotia, New Brunswick, and Prince Edward Island, and the establishment of a university in the maritime provinces.

THE American residents of Montreal have given the sum of \$9,000 to McGill University to found a political science fellowship in honor of the late President McKinley.

THE Berlin correspondent of the London *Times* states that the estimates for the army include a vote for the new military technical college which the Government proposes to open in the course of next year. The necessity for some such institution has been impressed upon the military authorities by the advancing scientific requirements of modern warfare, which are now too numerous and too varied to be adequately provided for by the resources at the command of the existing Staff College. There are branches of technical knowledge which, although they cannot strictly be classed as military, are, nevertheless, indispensable for the soldier. Among such subjects are steam-power,

electricity, mechanics, the construction of boats and bridges, and the establishment of means of communication. In recognition of this fact the college which is shortly to be opened will have for its objects the extension of general technical knowledge in the army and also the special technical training of engineer officers, as well as of those officers who desire to prepare themselves there for a career in the railway, ballooning and other special departments of the service. The college will provide for the instruction of 200 officers, the course of study will be completed in three years, and the students will pass through three grades. One hundred officers will take the first year course, and of these 50 will subsequently proceed to the second and third grades. It is expected that the college will be opened on October 1, 1902. The ordinary annual expenses are estimated at 300,000 Marks.

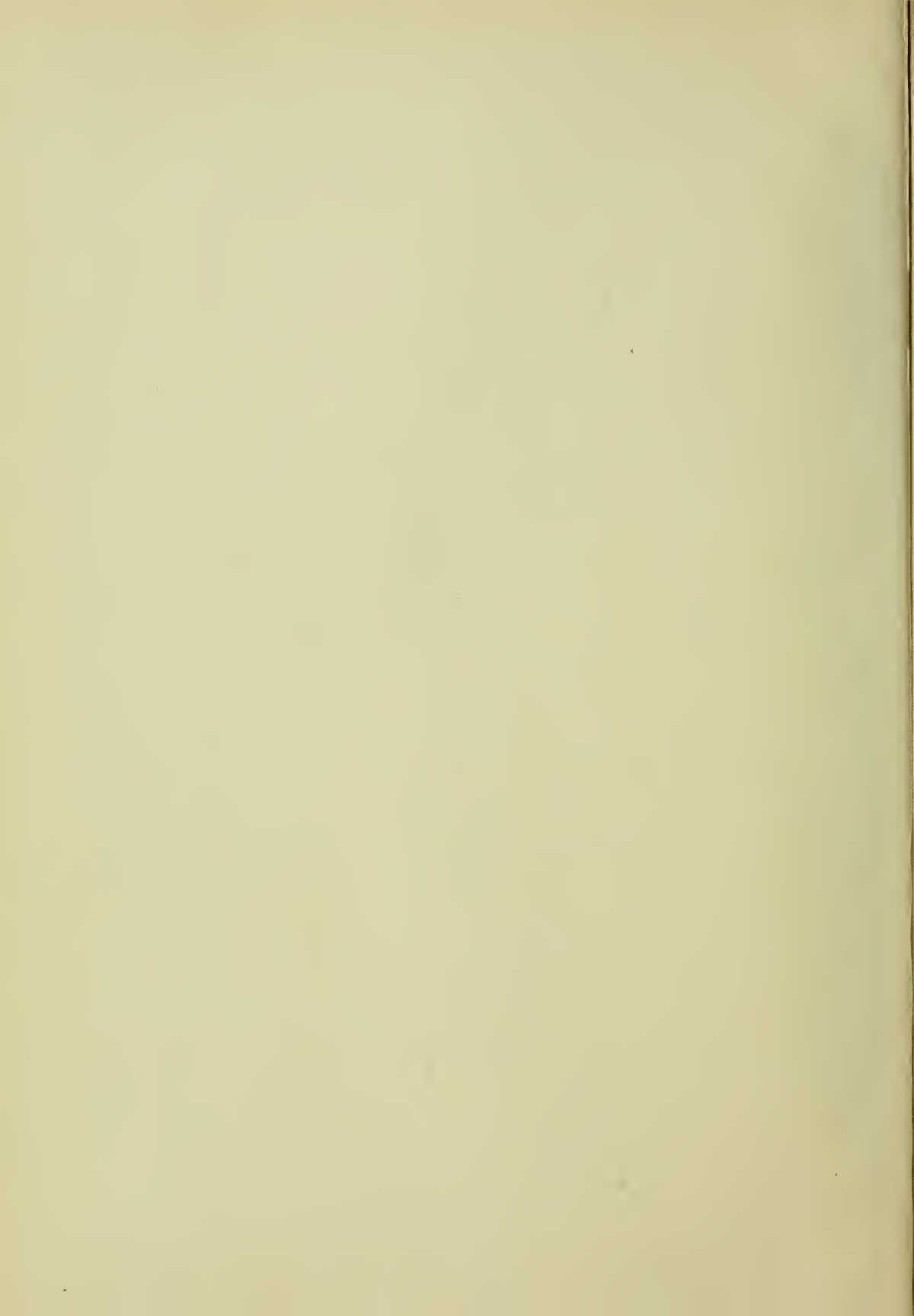
PROFESSOR ADRIAN J. BROWN, director of the British School of Malting and Brewing, of Birmingham University, has issued a report in which he says that they have now more students than the laboratories ought to accommodate, and he has been compelled to refuse others who have applied for admission. There are 18 students at present working in the school, and of these 16 devote their whole time to their work.

FOUR students of the University of Pennsylvania have been awarded scholarships by the Institute for Medical Research, founded by Mr. John D. Rockefeller. Those receiving the scholarships are Dr. George H. Gildersleeve, of the hygienic laboratory, and E. B. Vedder, C. M. Duval and Dr. F. P. Gray, of the pathological laboratory.

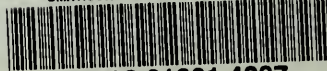
MR. WILLIAM MAXWELL REED has been appointed assistant professor of astronomy at Princeton University to fill the position left vacant by Mr. Taylor Reed.

MISS EDITH M. TEWKESBURY, B.A. (Wellesley), has been appointed instructor in chemistry at Wells College.

THOMAS SHAW, professor of animal industry at the Minnesota State Agricultural College, has resigned to become editor of an agricultural journal.



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