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"*To the solid ground*
Of Nature trusts the mind which builds for aye."—WORDSWORTH

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NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"*To the solid ground
Of Nature trusts the mind which builds for aye.*"—WORDSWORTH.

THURSDAY, NOVEMBER 2, 1899.

WATER, WATER, EVERYWHERE.

The Theory of Water Finding by the Divining Rod: its History, Method, Utility and Practice. By B. Tompkins, W.F., author of the "Theory of Water Finding." Second and enlarged edition, with illustrations. Pp. ix + 127. Copyright and all rights reserved. (Published by the author, B. Tompkins, Expert Water Finder, Chippenham, Wilts, 1899.)

BOTH the subject and the method of treatment of the Theory of Water Finding by the Divining Rod, by Mr. B. Tompkins, W.F., are so unlike what are usually met with by those gentlemen whom you, Mr. Editor, honour by a request for a review, and there are such risks of becoming involved in a sort of fourth-dimensional conflict or of giving offence, that I feel the case is one in which the reviewer should write in the first person, and sign his name. Neither the editorial we nor the security of anonymity would, in my opinion, be appropriate.

Mr. Tompkins is a thorough enthusiast; he has discovered that he possesses a power denied to most mortals, and this he practises, so we read in his book, to the great advantage of dwellers mostly in the West of England, in Wales and in South Africa. Evidence of this is given at once in a list, covering seven pages, of patrons, many with handles to one or other end of their names, and of public bodies for whom Mr. Tompkins has found Springs of Running Water.

The divining rod has been known from ancient times, and we are told has been practised for "the tracing of boundaries, murderers, mines, metals, minerals, and hidden sources of water" (mostly things beginning with an "M," as in Alice). "The scientific name given to the art is Rhabomancy."

"The rod is regarded as a symbol of authority, and is often referred to as such in Holy Scripture, and employed in schools. There are, I find, some 130 references to a 'rod,' staff or sceptre as a symbol of power or authority."

Three instances are given in which Moses used a rod with great effect, and Aaron's rod budded. We need not, therefore, be surprised at the success of the Diviner or present Professional Expert Water-Finder.

Mr. Tompkins goes at some length and detail into his own early history and experiences, for which he gives the following excellent reason:—

"My object in giving a detailed account of genealogy and career is to show that the suppositions made by so many persons, that the Water-Finder is some supernatural being, of a low class, possessing a supernatural power, inherited from a race which existed before the flood mentioned in the sixth chapter of Genesis, caused by the amalgamation of these people, resulting in their possessing occult arts, and from these sprung the Water-Finder, are incorrect and most absurd, absolutely without foundation, they being drowned by the Flood; and further there exists no evidence of a supernatural power, which my readers will see later on."

Here is the account of Mr. Tompkins' discovery of his power of water-finding.

"Quite alone and in the month of February 1886, one who was destined to become a philanthropist of some repute, and play an important part in the affairs of life, steps forth quite unconscious of these thoughts being in his mind, or that they were really in existence as regard to his future prospects. Like a nest within a nest . . . I lifted my eyes and saw the trees and hedges just showing signs of life; in one I saw a white thorn twig . . . I held this rod by both prongs in both hands, so—" (here is a picture) "gripping it tightly so that it should not move, and commenced to walk in an upright position, with the apex of the twig downward and some distance from the ground. This was in an orchard where there were no signs of water existing or wells near, or any indication that water could be found at one place more than another. After walking a distance of 80 yards or so, I suddenly felt a running or creeping sensation come into my feet, up my legs and back and down my arms which caused me to look to see what had happened. I noticed the rod began to rise in my hands; I gripped it still tighter to prevent it, and kept walking; still I found the sensation get stronger and stronger, and that I was being led in a zigzag course, the twig at the same time exercising a great determination to turn up. So strong had this influence become that I was powerless to keep it down, and eventually after proceeding some distance further it attained a vertical position, and revolved over and over. So great was this sudden and unexpected pressure or influence on me that I fainted and became very ill. . . ."

I may add for the benefit of those interested that Mr. Tompkins recovered, and is now able to undertake Water-Finding with no other ill results than considerable fatigue.

Of course, people whose reasoning powers have chiefly been developed in the school or the laboratory find a great difficulty in understanding how this power of water-finding can be explained, and Mr. Tompkins makes the following observation, with which few will disagree :—

"The refusal of its acceptance (the gift of water-finding) by some is because scientists have not yet been able to fully explain the marvels, or apparent marvels, in connection therewith, as, if an occurrence that has not been explained by scientific methods, must necessarily be a fraud."

However, this difficulty need not now trouble the public any more because Mr. Tompkins has given a very convincing explanation, which is much more obvious when pointed out than a great deal that is to be found even in these columns or in ordinary scientific books. This is Mr. Tompkins' explanation :—

"It is a well-known scientific fact that water is a generator of electricity, whether in passing through earth in its natural state or any artificial means employed, creates or produces this power through the various fissures or strata through which it passes. The Expert, medium, or Water-Finder, being, as I have previously stated, of a sensitive nature or organism, the moment he passes over or comes across these currents, becomes the receiving instrument for the time being, and there is no question but that the means used (viz. the Divining-Rod) becomes for the time being a part of the Diviner as an indicator in so far as are the hands of a clock, watch, weather-glass, steam-gauge, or the automatic weighing engine and scales seen so frequently in public places of resort."

Then follow two or three pages, too long to copy, and in which the argument would be lost if only extracts were given, but so novel as to be well worth reading, in which Mr. Tompkins proves conclusively, to himself, that electricity or a magnetic influence really does the work. One sentence is beautifully clear:

"The rod immediately points in the direction in which the current flows up to a certain spot, when the rod rises to its full height, and because it cannot go higher than a vertical position it revolves over and over again."

It is interesting to follow the scientific method of elimination made use of by Mr. Tompkins when he is finding other things than water. As already explained, the rod will find all manner of things, but a difficulty must be felt in discriminating. This is how it is done. If you are looking for gold and the rod rises, you then put gold in both hands, when the rod will at once fail to indicate anything if it rose for gold, but it will still rise if it rose for water or silver, or murderers, or boundaries, or things other than gold. The same is true for silver. We can only infer that the murderer can be discriminated by putting a murderer in each hand, but this is not stated. At any rate, Mr. Tompkins proves the gold story by explaining how he found a sovereign under the floor when the Bath and West of England Show visited Gloucester.

While on the scientific explanation of the action of the divining rod, it may be worth while to refer to an article by Mr. John Wallis Mulcaster, late Fellow of the Royal Astronomical Society, and late Member of the London Mathematical Society, quoted by Mr. Tompkins. This gives a good many more details in the proof of the electrical relationship of the divining rod than Mr. Tompkins employed in his more general type of reasoning. He begins :

"All minerals and water, more or less, emit an effluvia, composed of minute particles or physical atoms, of the substance they represent." . . . (Then follows an explanation of the reason why the depth can be judged). . . . "On arrival at the surface of the earth, those minute particles of metal, &c., having a tendency to ascend in vertical lines, the superincumbent air has also a tendency to press them down, whilst the particles are continuously driven forward by those that follow them. Now the divining rod being composed of a porous and fibrous substance, it follows through the natural order of things, that the physical atoms or minute particles of metal being driven up and down by opposing vertical forces, enter the interstices of the light porous wood, which gives them an easy passage."

This, of course, explains why the rod gets parallel to the ascending atoms so clearly that the non-scientific countryman would understand it as well as and perhaps even better than a trained physicist. Mr. Mulcaster goes on to show why it is only running water that will act on the twig, stagnant water being no good, but he has not explained why stagnant metals work. I do not feel equal to the task of supplying the omission with confidence, but on the whole it seems most likely that it has to do with "the natural order of things." Mr. Mulcaster is well aware in conclusion that in his lengthened remarks he has exploded certain ideas hitherto held on this subject for generations, and that the "electro-corpuscle" theory provides the explanation of the so-called mysterious action of the divining rod.

Perhaps enough has been written to give a fair idea of the style and scientific merit of Mr. Tompkins' book. The subject, however, should not be dismissed here. There is no question but that a large number of people of every class, except, perhaps, the purely logical, if there is such a class, are firmly persuaded that the Professional Expert Water-Finder with his Divining Rod can and does find water where ordinary folk, including geologists, fail; and what is more, that in quite a limited locality will, where sinking has failed to produce useful results, make their examination, find no water where failure has resulted, yet within a few yards assert that abundant water is to be found, which is verified on trial. Mr. Tompkins says the subject must be approached with an open mind, and he refers occasionally to X-rays and spiritualists. I hope in the following observations that I shall appear to have done so with a mind sufficiently open, but not gaping open so wide as to be practically turned inside out, a state which at any rate is conducive to sport when chasing spooks guarded by impostors.

Mr. Tompkins, who in many respects appears to be a very able exponent of the Diviner's Gift (not Art) explains how in walking over the ground he feels a sensation, a faculty possessed by only very few people, when he comes to the neighbourhood of running water, and that this sensation gets stronger as he approaches the "Head of the Spring," so that without any stick at all he could be guided to the best place for sinking for water. Further, that the sensation enables him to judge the depth as well as the quantity of water which is to be obtained. The twig serves as a kind of indicator; it is not absolutely essential, but he prefers to go to work in the recognised way; he believes "using a rod is the most successful and satisfactory to the public." So he cuts a forked stick of white thorn or hazel, as he finds these woods best. Ash is too sensitive, oak too sluggish, so the depth is over- or under-rated with these woods, while willow is too soft, so that it turns too easily and becomes useless. The depth of the water is estimated from the

"action or velocity of the rod and the amount of pressure upon the body . . . the yield by the strength and number of strata or streams which converge to the Spring Head. . . . The principle of its action is as a steam gauge on a boiler or engine, indicating the amount of pressure of the steam."

Mr. Tompkins apparently is convinced of the certainty of the method, for he says

"I should like to mention the fact that I have never had an engagement in which I have not found a spring if one existed."

Mr. Tompkins cites X-rays as an instance where a genuine physical agent exists where only a few years ago such action would have been considered impossible by scientific men; why, therefore, should there not be an emanation or "an effluvia" from the running water which might be detected by a sensitive person? I will make Mr. Tompkins a present of another analogy even more to the point. Gravitation, which on a large scale is of the most stupendous importance, so much so that even chemical energy sinks into insignificance by comparison, is yet so feeble when exerted between moderate quantities of matter that it could never have been discovered in the laboratory, and even now, with all our delicate instruments, is not provided against as a disturbing factor. By specially refined means, however, it can be detected and measured in the laboratory. Why should there not be an influence rising vertically from running water which we cannot detect in the laboratory, but which a few sensitive people might feel? We know that quite ordinary people can detect and be greatly affected by the difference in the air of two neighbouring places—one bracing, one relaxing—which cannot be directly traced to a chemical or physical cause. Again, it is maintained that there are people who are instantly aware if a cat is in the room, even though no one in the room may have seen or heard it, and who cannot remain unless the poor beast is removed. I am not referring to those who only find this out after they have seen the cat; that is merely an excess of affectation which should have been spanked out of them when they were young. The first sort, if they really exist, are certainly incredibly sensitive and are far more worthy of being considered supernatural beings than even Mr. Tompkins, if we may judge him by his book. It is hardly logical, therefore, to assert that a specially sensitive person cannot possibly be affected by the existence of water near or below him, but it is very difficult to see by what process the emanation is constrained to move vertically. Any one would have expected that if the "Spring Head" were, say, 50 feet down, there would be a greater effect upon the diviner at, say, 10 feet away from the vertical, but upon the ground, than exactly over it, and, say, 20 feet above the ground; but no, for Mr. Beaven, of Hereford, in a letter quoted, states that Mr. Tompkins in one case located a spring when on the top of a monument, while in another case he actually

"had to climb to the top of a haystack to locate the exact spot where a downward shaft would disclose the spring."

Again Mr. Tompkins on one occasion, much to the surprise of the owner, found indications of water crossing under a lawn where as a fact a water-pipe had been laid. Do the effluvia escape through the metal, or did Mr. Tompkins feel the presence of the metal itself? One of Mr. Tompkins' strongest arguments is that he adopts the professional custom of the water-finder, which is "No water, no pay," even though, to use his own words,

"to-day his name stands boldly before the British Public—in fact absolutely alone—as the only discoverer and guarantor of the 'Head of the Spring.'"

There seem really to be two questions: (1) Can the water-finder by his sensations, whether with or without a divining rod, indicate the position and yield of a hidden spring without employing any knowledge of geological conditions or experience as to the lie and appearance of the land? (2) if so, has the divining-rod anything to do with his success? Of course, if he succeeds in consequence of mere reasoning based upon geological knowledge or experience, while none the less useful to the public, he is, as far as divining is concerned, a fraud.

Reasoning beings would require very strong evidence to be absolutely satisfied that the first question can be answered in the affirmative. Yet a gentleman known to me personally, with mechanical and scientific ability and plenty of common sense, is persuaded from what he has seen that a water-finder (in this case not Mr. Tompkins) can locate hidden water, and that he does so by feeling a sensation. This water-finder asserts freely that the divining-rod has nothing to do with the business at all. This gentleman's son, formerly a student at the Royal School of Mines, now a professional engineer, in whose ability and honesty I have absolute faith, went round with the water-finder, and noticed that he, too, was cognisant of some sensation when the water-finder found indications of water. Mr. Tompkins quotes, and I suppose correctly quotes, a letter from the Chairman of the Quarter Sessions for Herefordshire to the *County Council Times*, in which he states that out of curiosity he went round with a water-diviner and found that he could use the rod successfully himself. While he has no occasion to do this professionally, he now uses it to discover leaks in the embankment of a large piece of water on his estate caused by rats or rabbits which he could not easily find otherwise. Scores of examples might be given.

As I have stated, it does not seem a logical position to take up to say that the gift as distinct from the art is impossible, even though we may require a better quality rather than quantity of evidence than is available to be satisfied as to its reality. But the gift, if it exists, is not sufficiently dramatic to impress the public. It is here, to my mind, that the rod comes in. The forked twig, held as it is, can be made to rise, fall or rotate by an almost imperceptible movement of the hands, possibly after a time unintentionally on the part of the water-diviner, and the public is impressed. For the same reason it may be well to find that water can only be met with in some inconvenient position, such as under a haystack or the cellar of the house, or the corner arch of a large granary. Ignorant and credulous people will have much more faith in you if you put them to a little inconvenience.

If the water-finders would leave it here, there could be no cause of complaint, provided, of course, that they succeed where geologically trained people fail. But when they put forward preposterous "scientific explanations" such as I have extracted, it makes it very difficult not to come to the almost inevitable conclusion that the water-finder has no case, and that the surcharging of his fees by auditors is necessary for the protection of public bodies. Perhaps among the 130 references in the Bible to the rod, staff or sceptre already referred to is this, "a whip for the horse, a bridle for the ass, and a rod for the fool's back."

C. V. BOYS.

HISTORY OF THE ART OF EXPERIMENTING.

Geschichte der Physikalischen Experimentierkunst. Von Dr. E. Gerland und Dr. F. Traumüller. Pp. 427. (Leipzig: Wilhelm Engelmann, 1899.)

THIS work, illustrated by more than four hundred woodcuts, gives a most interesting account of the apparatus used and of the investigations made by scientific inventors from the earliest times at which records exist down to the invention of Morse's printing telegraph in 1843.

One of the most interesting things that appears on the face of this history is the great mechanical ingenuity of many of the inventors of ancient times, as, for example, Hero of Alexandra, who invented a penny-in-the-slot machine, and the almost entire absence of any attempt to carry out what we would now call an experimental investigation. The experimental investigation of natural phenomena is extraordinarily modern, and the looking for mere rules of sequence in the phenomena rather than transcendental souls, spirits, effluvia, and such like efficient causes, is still more modern. This history covers a period of some four thousand years; but experimental science of the modern type is not more than three hundred years old. It is only amongst scientific men that the nature of experimental inquiry has been appreciated for as long as three hundred years. The well-educated man has not appreciated its nature for more than fifty years, and it is only within the last few years that in Britain the characteristic nature of experimental science has been at all generally understood. Even now a person is considered well educated who does not understand how to learn from experiment and observation to regulate his life. As a consequence, many so-called well-educated persons make awful fools of themselves.

In addition to the history of the subject, there are in connection with each period interesting *résumés* of its peculiarities, and of how it was an advance on its predecessors and yet did not attain to the position of subsequent workers. For example, attention is called to the way in which Gilbert, though in many ways imbued with the modern spirit of experimental inquiry, was still so dominated by the notion that magnets were possessed with some sort of soul or spirit that he cannot be rightly classed amongst the moderns, but is a sort of connecting link between them and mediæval superstitions.

There are two interesting questions that are not solved. One concerns the connection between Archimedes' observation in his bath, the method he employed to discover the amount of alloy in King Hero's crown, and the principle he enunciates in his writings as to the loss of weight of bodies immersed in a liquid. There seems no doubt from the description of the experiments he made (by observing the rise of water in a vessel when gold and silver were immersed in it) that he did not use weighings at all in his determination of the alloy in the crown. It would be interesting to know how he then discovered the amount of loss of weight of a body immersed in a liquid. What set him on observing this? The question is the more interesting in that most of the scientific workers of that age seem to have confined themselves to solving practical difficulties in the way of carrying out some project they had in hand, and were not at all imbued with the modern spirit of experimental research. The other question that needs elucidation is as to the observation of the Florentine Academicians that water could penetrate gold. This experiment used to be very commonly quoted to prove the ultimate porosity of solids, but it does not seem to have been repeated, and there are very grave doubts as to the genuineness of this penetration. It seems much more likely that the gold cracked, and that the Florentines did not observe this.

It has several times happened that all the necessary principles involved in subsequent inventions have been discovered, and attempts made to apply them long before the inventions were brought into actual use. In most cases it seems to have been the want of means or of push of the inventor that prevented him from getting his invention into use. There is a generally received notion that this want of success has been usually due to want of practical ability to get over difficulties that arise in actual use. This seems to have been true to only a very small degree. A very remarkable instance of an old invention coming into use is that of heat engines. Hero of Alexandria invented several forms of heat engine, including that latest development of steam engines a turbo-motor; yet it was only during last century that any serious use was made of them, unless imposing on the worshippers in Egyptian temples can be called a serious use. The rate of evolution of the steam engine has been most remarkable. Invented by Hero, it languished in an amœboid condition for many centuries, and then within two hundred years it developed into its present highly organised family of many genera and species. If a future geologist were to exhume the remains of steam engines, and were to have some means of determining the ages that elapsed between Hero's engines and that of Savery, and from these data were to evolve a chronology of the recent developments, he could hardly avoid concluding that it took at least a million years to develop the engines of a modern steamship from Savery's engine. Many other forms of engine have been proposed. Huygens' gunpowder engine is a natural parent of gas engines, and it seems possible that some smokeless explosive might be used for driving motor-cars; for though the fuel would be heavy the mechanism might be simple, and the opportunity for varying the work done at each stroke very considerable, so that its adaptability to the circumstances of motor-car propulsion would be great.

The work is so full of interesting matter that it would be hopeless, in a short review, to call attention to the tenth part of its contents. Accounts of Egyptian, Greek, Roman and Alexandrian inventions are followed by accounts of those of the Byzantines, Arabians and of the Middle Ages. Science progressed slowly in these dark ages. Ten pages suffice for the whole of the inventions of Europe for this thousand years. While the energies of mankind were divided between fasting and praying for others, and fighting and preying on others, there was but little time or opportunity for the study of nature. With the sixteenth century the tide of evolution of the means of studying nature had begun strongly to flow. At first rising slowly it has in this last century come like the bore on the Amazon, almost overwhelming us with the rapidity of its development.

G. F. F. G.

OUR BOOK SHELF.

The Diseases of Children. By G. Elder and J. S. Fowler. Pp. xii + 391. (London: C. Griffin and Co., Ltd., 1899.)

FEW things show more clearly the advance made in the practice of medicine within the last thirty years than the way in which the diseases of children are now regarded as compared with the place assigned to them a generation or so ago.

It was thought then that to attend to the common ailments of women and children, those of children especially, was work that scarcely demanded the preparation of a complete medical curriculum. Even a professor of medicine at one of the leading universities had the courage within living memory to say publicly that a two years' course would be quite enough for successful practice "among women and children."

Nowadays all this has changed. It is universally recognised that the physiology and the ailments of men are not a whit more intricate than those of women, and that both are simpler than those of children. To treat young children successfully requires, not only all the training and knowledge every good practitioner ought to posess, but important additions. Some of these additions, moreover, are natural gifts which cannot be acquired by any amount of training or patience. To be able to read a child's nature easily is as much a gift as a fine ear for music. Some men and women have it, and many more are completely without it. To succeed as specialists in children's ailments it is essential not to be without it.

The work before us is intended mainly for students, and one of its aims is to show them how and what to observe. A large part of the book is concerned with the physiology of growth, of nutrition and of the nervous system. Many of the illustrations are specially good.

The sections devoted to the study of diseases of the various systems, digestive, circulatory, &c., suffer from the condensation necessary in a work of this size. It is a hopeless business to try to make pemmican attractive. But, on the other hand, pemmican has its uses, and a book small enough to be carried to the bedside in a hospital ward will often help a student more, for a time, than larger and more interesting works could do. These he will read later and with a mind more ready to appreciate them.

Fowler and Elder's manual will not displace Ashby and Wright's on the same subject, but it is a sound and trustworthy guide in a difficult department of medical practice.

Analyses Électrolytiques. By Ad. Minet. Pp. 170 (Paris: Gauthier-Villars, Masson et Cie, 1899.)

THIS handy volume, which appears as one of the "Encyclopédie scientifique des Aide-Mémoire," affords another indication of the continually increasing application of electricity to chemical analysis. About a third of the book is devoted to the description of apparatus used in electro-chemical analysis and to general considerations of a practical and theoretical nature. The latter contain certain inaccuracies which indicate that the author is not conversant with the advances made during the last decade, in regard to our knowledge of the nature of salt solutions on the basis of the theory of electrolytic dissociation.

The second and third chapters deal respectively with the analysis of metalloids and with the quantitative determination of the metals when present in solutions free from other metals. The fourth chapter treats of the separation and determination of the metals in a mixture; while the last is devoted to a few technical applications, such as the analysis of industrial copper, of bronzes, and of brass.

The practical portion of the book is clearly written; but on account of the lack of details in the case of a considerable number of the analyses, the book can scarcely be recommended to electro-chemical students for use in the laboratory.

Essais des Huiles Essentielles. By Henri Labbé, Ingénieur-Chimiste. Pp. 187. (Paris: Masson et Cie.)

THIS neat little volume, which forms part of the "Encyclopédie scientifique des Aide-Mémoire," published under the direction of M. Leauté, is intended as an introduction to the analysis of essential oils, substances which, according to the author, are very liable to adulteration.

The directions given for analysis are too general and brief to be of real utility to the practical analyst, but the properties of the pure products, compiled from Schimmel and Co.'s publications and from other trustworthy sources, are carefully tabulated, so that the book will at least be serviceable for purposes of reference.

Chemistry for Organised Schools of Science. By S. Parrish, B.Sc., A.R.C.S. With Introduction by Dr. D. Forsyth. Pp. xiv + 262. (London: Macmillan and Co., Ltd., 1899.)

THE course of experimental work described in this volume is designed for students in Schools of Science of the Department of Science and Art during their first two years of study. It is the outcome of experience, and represents the work which pupils from thirteen to fifteen years of age can do and understand. Following the reformed plan of teaching chemistry, the course begins with simple chemical manipulations, weighing, solutions, distillation, the preparation of common gases, composition of water and air, formation of salts, carbon and its oxides and a few organic compounds. In the second year's course easy quantitative experiments are given, and attention is paid to the laws of chemical combination, symbols, formulæ, &c. The halogens, sulphur and its compounds, the estimation of volume, are among other subjects dealt with. The test-tubing exercises, which once formed the chief part of the work of the student of elementary chemistry, are omitted altogether; and in their place we have a rationally constructed course of work, in which the intimate relation between chemistry and physics is brought out. The pupil who is fortunate enough to receive instruction on these lines will be placed in the receptive intellectual attitude which should be the aim of all scientific education.

Natural and Artificial Methods of Ventilation. Pp. 66 + xvi. (London: Robert Boyle and Son, Ltd., 1899.)

THERE is a considerable difference of opinion among experts as to the most satisfactory system of ventilation. The system by which fresh, warm air is forced into rooms at the top while foul air escapes at the bottom has been introduced into a number of buildings; but the compilers of the present volume give extracts and diagrams from papers and reports to show that this method is wrong in principle, and inefficient in practice. It is held that the heating of a building should always be separate and distinct from that of the air supply, and that the only satisfactory means of ventilation is obtained by extracting the vitiated air near the ceilings of rooms, and admitting the fresh air at lower levels. This "natural" system has been successfully introduced by Messrs. Boyle into several public buildings.

Man, the Microcosm. Part I. The Nature of Man. By Leonard Hall, M.A. Pp. 82. (London: Williams and Norgate, 1899.)

DEFINING a monad as any living organism which consists of only one cell, the author's thesis is that man is a community of monads, each of which is a conscious being, and that "human consciousness must consist of the combined and co-ordinated consciousness of the individual monads." The theory is used to explain many facts concerning the nature of man as an individual and as a member of a social community.

The Reliquary and Illustrated Archaeologist. Edited by J. Romilly Allen. New Series. Vol. v. Pp. 288. (London: Bemrose and Sons, Ltd., 1899.)

MANY articles and notes of interest to all students of archæology are contained in this new volume, comprising the four quarterly numbers issued during the present year. The numerous illustrations of places and objects of archæological significance add to the attractiveness of a volume which appeals to every one interested in antiquities.

LETTERS TO THE EDITOR.

The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*]

Botany and the Indian Forest Department.

IN the issue of NATURE of this date I find the second part of Sir G. King's presidential address of Section K, Botany, delivered at the Dover meeting of the British Association. At the end of that address Sir G. King has made a strong attack on the Indian Forest Department, and on the teaching of botany at Coopers Hill College. He maintains that the forest officers trained in this country go out to India with an insufficient knowledge of systematic botany, and that they, on arrival in India, are not encouraged to familiarise themselves with the contents of the forests under their charge.

These assertions are in some respects not in accordance with the facts of the case, and in others they show that Sir G. King, in spite of his long Indian experience, has failed to grasp the real issues. I trust you will permit me to substantiate these two points.

To begin with, Sir G. King puts the cart before the horse. If, as he maintains, the ordinary forest officer educated in England now arrives in India without sufficient knowledge to enable him to recognise from their botanical characters the most well-marked Indian trees, it is chiefly due to the fact that it is now a days almost impossible to secure a botanical teacher in this country who can impart the necessary knowledge to the students. Sir G. King feels this himself, hence his lamentations, at the end of his address, over the decay of the study of systematic botany in Britain. I feel sure that Sir W. Thiselton-Dyer will bear me out when I state that no botanical teacher has been appointed to Coopers Hill College except with his, and latterly also with Dr. D. H. Scott's, advice. They have been good enough to recommend to us the gentlemen whom they considered most suitable for our requirements, but, alas! not one of them, though all were excellent and even famous botanists in other respects, was a systematic botanist in the sense demanded by Sir G. King. Hence I must turn round upon him and say: "Provide well-equipped systematic botanists, and we shall be only too glad to have one of them." In other words, the main difficulty lies with the botanists of the present age, and not with the Forest Department.

On the other hand, we are not free from blame. Until the year 1890 botany was a compulsory subject in our entrance examination, but in that year it was, against my advice, made an optional subject. This, I believe, was due to the influence of the headmasters of our great public schools, who desired to pass their pupils straight into the service, without being obliged to teach special subjects, such as botany. I do not desire to discuss the general question here involved, but I do wish to state that the action in the direction just indicated was decidedly injurious to our special requirements. I am happy to say that during the last year botany has once more been placed amongst those subjects which every candidate for entrance into the forest branch of Coopers Hill College will have to take up.

As for myself, I may state that, ever since I started the forest branch of this College in 1885, I have constantly urged our botanical teachers to extend the study of systematic botany at the expense of other branches, such as physiology. But what with young men trained on the ordinary lines of our public schools, and with teachers with a decided leaning to branches of botany other than systematic, it has been a hard struggle. The otherwise excellent teachers of botany, whom we have had so far, did their best to take up systematic botany on the lines required by us; but that is a branch not learned in a day, and the first two of our botanists left us, for better appointments than we could offer, when they had fallen in with our requirement.

And yet I think Sir G. King goes too far when he states that the ordinary forest officer educated in England is unable to recognise from their botanical characters the most well-marked Indian trees. Cases like this do, no doubt, occur; but I am sure that Sir G. King's assertion does not hold good in the case of many of the men who have been sent to India. Indeed, several of them have developed a decided leaning towards systematic botany. At the same time, the task is, in a great part of India, far more difficult than would appear from Sir G. King's words. I should like to know what he understands by "the most well-marked Indian trees." There are some 4000 different species of trees and woody shrubs in Burma, and about half that number in Bengal-Assam. If Sir G. King expects our forest officers on arrival in the country to recognise even a moderate fraction of these species, then he aims at impossibilities, and his enthusiasm for systematic botany has carried him far beyond reasonable limits. To do what he requires demands a thoroughly trained botanical specialist; and even such a one would require many years to become acquainted with the trees, shrubs and herbs (as demanded by Sir G. King) of an Indian jungle in Burma, Bengal and many other parts of India. For such things the ordinary Indian forest officer has no time.

The statement made by Sir G. King, that the young forest officer on arrival in India is not encouraged to familiarise himself with the contents of the forests under his charge, is not in accordance with the facts of the case. On the contrary, it is made the first duty of the young officer, apart from the study of the language of the people. Sir G. King himself enumerates fourteen forest officers who, during the last thirty years, have done good botanical work. Of these, five have made important contributions to the systematic botany of India. Of the other nine, one was trained at Coopers Hill. Considering that all the men sent out from Coopers Hill are as yet young, and that to my certain knowledge several of them are likely to become botanists, I think Sir G. King's strictures are not justified. Unfortunately, he looks at the matter entirely from the enthusiastic botanist's point of view.

The Government of India does not wish every Indian forest officer to be a botanist. It is desirable that every now and then one of them should take up the subject as a speciality, but it would be disastrous if all took that line. I have no hesitation in saying that as soon as a forest officer takes up botany as a speciality he is, rare cases excepted, likely to become an indifferent forest officer. The ordinary officer of that class has no time for special botanical study.

Forestry is perhaps not a science in itself, but an industry based upon various branches of science, amongst which botany, geology and entomology are the most important. The forest officer cannot be an expert in each of these. To demand such a thing would be just as unreasonable as to demand that a medical man should be an expert in chemistry. The one is as impossible as the other; to become either takes practically a life-time. With the enormous growth of the several branches of science a very minute specialisation has become an absolute necessity, since only a very small fraction of men can be classed as geniuses, while the rest must be rated at the average capacity of the human race. The student of one branch must depend on the work of students in other branches. Thus the forester, instead of being the assistant of the botanist (as Sir G. King seems inclined to demand), must rely on the professional botanist for all the finer and more intricate problems of botany. All he requires is to acquire a sufficient knowledge of botany, so that he may utilise what the professional botanist tells him. For more he has no time, because he has to attend to quite another class of business. The Indian forest officer is an estate manager on a large scale; he must manage his estates in such a manner that they yield the largest possible amount of useful produce with the least possible outlay. For that end his time is taken up by sylvicultural and administrative duties, leaving but little of it for the special study of any of the branches of science upon which systematic forest management is based.

No doubt many of the pioneers of Indian forestry were botanists, but by no means all. Take, for instance, the protection of the forests against fire, a matter to which Sir G. King gives prominence. He himself states that Lieutenant (now General) Michael was the first who was successful in this direction in Madras. I may add that, as far as Central and Northern India are concerned, Colonel Pearson was the first to introduce successful fire conservancy. And yet neither of these two gentlemen will, I feel sure, claim to be a great botanist.

Sir D. Brandis, to whom, as Sir G. King points out, we owe, for the most part, the organisation of the Indian Forest Department, no doubt was a botanist; but he brought about that organisation, not as a botanist, but as an able forester and administrator of extraordinary energy.

Botany is a branch of science the study of which is most fascinating; but the faculties which produce a great botanist do not necessarily include those which are required to produce a great administrator; and herein lies the difficulty, in so far as the Indian Forest Department is concerned. I could point out more than one botanist who occupied the post of the head of the Forest Department in a province, and who could not possibly be counted amongst the successful forest administrators of India. In nearly all these cases so much time was given to botany that little—or, at any rate, not enough—time remained for the proper administration of the extensive Government forest estates which supply the people of the country with the necessary forest produce, and over and above yield now an annual net revenue of a million pounds. These results would be most seriously imperilled if our Indian forest officers were to take the line which Sir G. King recommends to them.

W. SCHLICH.

Coopers Hill, October 19.

Dark Lightning Flashes.

As an amateur photographer of cloud-scenes, I have taken the image of the setting sun surrounded by clouds on many occasions. I never remember developing a plate in which the image was reversed after an ordinary rapid exposure. Lightning flashes, one would think, ought to be still more rarely reversed, if the chemical reactions of the salts in the gelatine film are solely responsible for the phenomenon; yet dark lightning flashes are not infrequently visible in the developed plates of a thunderstorm.

Dr. Lockyer's interesting photographs (vol. lx., p. 570) of dark flashes with bright cores suggest to my mind another interpretation. A lightning flash (and, for the matter of that, an electric spark) is doubtless a complex phenomenon. A disruptive discharge of high tensional electricity through the atmosphere represents, I take it, a core of rarefied (because incandescent) gases surrounded by an envelope of compressed air. Mr. C. V. Boys has shown (NATURE, vol. xlvii. p. 420) that "a wave or shell of compressed air gives rise to an image on the plate in which there is a dark line and a light line within it. Similarly, a wave of rarefaction must produce a light line with a dark line within it." Surely we have then in the lightning flash itself, when rightly illumined, the necessary data for the production of an image—a bright line edged with two dark lines, as represented in Dr. Lockyer's photographs. In such cases the advantages of a diffused illumination of the background of the scape are obvious. Possibly Mr. S. Bidwell's interpretation of the double flash is the correct one.

Hove, October 21. W. AINSLIE HOLLIS.

IT seems to me difficult to compare the photographic brightness of the disc of the setting sun with a brilliant flash of lightning. For my part I consider that lightning flashes give us every chance of obtaining photographic reversals, for they can be photographed at very close distances, amounting to a few hundred yards, while the rays from the sun's disc when near the horizon must pass through a long range of dense atmosphere which cuts off the most actinic and therefore photographic rays.

With regard to the second portion of Mr. Hollis' letter, the illustration in my article (NATURE, vol. lx. p. 573, Fig. 6) disproves rather than proves his suggestion in my estimation. If, as he assumes, the core may be considered the actual spark, and the outer portion the image of the wave or shell of compressed air, then, as the latter is not so luminous as the core, it ought to be best visible by reason of contrast against a bright background. A glance at Fig. 6 shows that this is not the case, for at C the core exists practically alone with an illuminated background, while without the background at A and B it is most developed.

I cannot convince myself that the large dark flash is a double one. A close examination of the negative strengthens the view that it is single, and the general appearance of the ramifications endorses it. WILLIAM J. S. LOCKYER.

Solar Physics Observatory, South Kensington, October 24.

A Gutta-percha Plant.

IN your issue of October 19 you report a communication made to the French Academy of Sciences by Messrs. Dybowski and C. Fron regarding the cultivation of *Eucommia ulmoïdes*, a plant said by them to contain gutta-percha. I am naturally much interested in the possibility of this interesting tree, the "Tu chung" of the Chinese, becoming of economic importance, as some years ago I investigated the bark and leaves of this plant with regard to the peculiar cells containing a rubber-like substance (*Trans. Linnean Society*, 1892, vol. iii., part 7).

Gutta-percha and caoutchouc behave very similarly towards many solvents; but the fact that the contents of these cells were dissolved or partially dissolved by turpentine at ordinary temperatures, whereas gutta-percha is only soluble in hot turpentine, led me to the conclusion that the contents of these cells were caoutchouc. This substance is much more frequently met with in the laticiferous cells than gutta-percha, which is almost restricted to the natural order Sapotaceæ. Eucommia will therefore, I think, be found to be a rubber, and not a gutta-percha yielding plant.

But in either case it is obvious that, with the opening up of China, this plant may become of great economic importance if, as seems probable from the investigations of Dybowski and Fron, it is easily cultivated and propagated.

F. E. WEISS.

The Owens College, Manchester, October 23.

Halo Round a Shadow.

ON a winter morning some years ago I was driving in a dog-cart from the Lizard across the Goonhilly Downs whilst a dense mist or cloud was matted down on the ground.

Our heads were in bright sunshine, which formed a coloured halo round the shadow of each of our heads on the mist as we travelled on. Half an hour later the mist was more diffused, and we saw a white mist bow in the sky. HOWARD FOX.

Falmouth, October 28.

ON THE DISTRIBUTION OF THE VARIOUS CHEMICAL GROUPS OF STARS.[1]

II.

THE results so far referred to have regard to the stars with dark lines in their spectra, but besides these there are many so-called bright-line stars.

I should state that there has necessarily been a change of front in our views with regard to these bright-line stars since they were first classified with nebulæ by Pickering and myself.

The nebulæ are separated from stars by the fact that in their case we have to deal with bright lines, that is to say, we are dealing with radiation phenomena, and not with absorption phenomena, as in the case of the stars so far considered; and in the first instance it was imagined that the bright-line stars were, from the chemical point of view, practically nebulæ, although they appeared as stars, because the brightest condensations of them were so limited or so far away that they gave a star-like appearance in the telescope.

Since that first grouping of bright-line stars, by the work chiefly of the American astronomers it has been found that in a large number of cases *they have also dark lines in their spectra*, and that being so we must classify them by their dark lines instead of by their bright ones; and the bright-line stars thus considered chiefly generality to only two degrees, and the greatest departure, the greatest galactic latitude, was something within nine degrees. That was the story in 1891. Two years afterwards Campbell, another distinguished American astronomer, also interested himself in this question of the bright-line stars, and he discussed them, his catalogue containing fifty-five as opposed to Pickering's thirty-three. He found also that they were collected almost exclusively in the Milky Way, and that outside the Milky Way practically none had ever been observed. The importance of this result I will indicate by and by, but in the meantime I can throw on the screen a very useful map which Campbell prepared. The central line of that map represents the galactic zone, the plane of the Milky Way, and he marks along it the different galactic longitudes, showing above and below the plane just a few degrees of galactic latitude north and south, sufficient to enable him to plot upon it all the bright-line stars which he discussed. The diagram shows that all these bright-line stars really are close to the central plane of the Milky Way. Only one out of the fifty-five is more than nine degrees from it, and this lies in a projecting spur, so that we cannot really say that that is out of the Milky Way. It is remarkable that these bright-line stars are not equally distributed along the Milky Way. They are chiefly condensed in two opposite regions, and there is one region in which they are markedly absent. The glass globe will

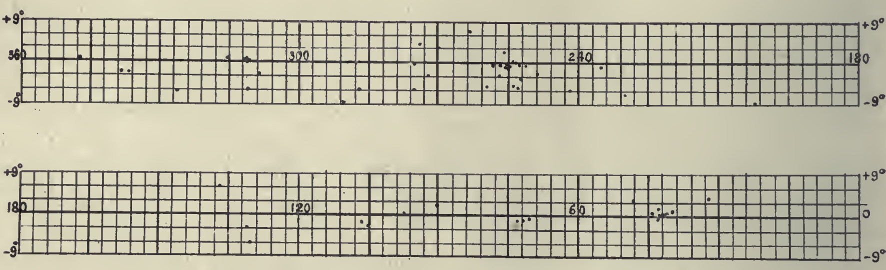

FIG. 3.—Distribution of the Wolf-Rayet stars in the Milky Way.

turn out to be gaseous stars, *with a difference.* What is that difference? It is this, I think: in the case of the bright-line stars we are dealing with the condensations of the most disturbed nebulæ in the heavens; together with the light which we get from the nucleus of that nebula which appears as a star and can be spectroscopically classified with the other dark-line stars, inasmuch as the surrounding vapours close to the star produce absorption, and therefore give us dark lines; other parts of the nebulæ, probably those further afield, give us bright lines which mix with the dark ones. Therefore we get both bright lines and dark lines under these conditions. So far as the result goes up to the present moment, it looks as we have now to consider that these bright-line stars, instead of being nebulæ merely, are gaseous stars at a very high temperature, in consequence of the fact that the nebula which is surrounding them, which is falling upon them, is increasing the temperature of the central mass by the change of *vis viva* into heat. Pickering,[2] in his discussion of these stars, had thirty-three to deal with, and he found that there was a wonderful tendency among these to group themselves along the Milky Way; that very few of them, in fact, lay outside its central plane; that is to say, the galactic latitude, as it is called, the distance in degrees from the plane was limited in the

show how the matter stands, I think, rather conveniently. We have the Milky Way represented by red tape. The secondary Milky Way, which starts from it at one point of the heavens and meets it again, is also indicated. Dark wafers mark the galactic longitudes and latitudes of the bright-line stars. We find that these stars begin just before the doubling commences. They go on, and are sometimes very numerous, and they end just after the doubling ends; and we notice there is a long range of the Milky Way where it is single in which there is absolutely no bright-line star at all. It looks, therefore, very much as if there is a something connected with this doubling of the Milky Way which produces the conditions which generate these bright-line stars.

By the labours of Dunér, Pickering, McClean and Campbell, we are beginning to get very definite notions as to the distribution of the various chemically different stars in relation to the Milky Way. How about the nebulæ from the point of view of chemical distribution? Here we are in difficulties.

I have already stated that with regard to the general question of the nebulæ it is impossible to speak with certainty, because at present there has not been sufficient time and there has not been a sufficient number of observers at work to classify the thousands of "nebulæ" which we now know of into those which give us the gaseous spectrum, and those which are entirely different, apparently, in their constitution, and only give us what is called a continuous spectrum; but still we can go a

[1] A Lecture to Working Men, delivered at the Museum of Practical Geology, on April 10, by Prof. Sir Norman Lockyer, K.C.B., F.R.S. (Continued from vol. lx., p. 620.)

[2] *Astr. Nach.*, No. 2025.

little way in this direction by means of some figures which I have noted. The point is to see whether there is any difference in the distribution of those nebulæ, which are undoubtedly masses of gas, and give us the so-called nebulous spectrum, and those other nebulæ about which at present we know very little, but give us so-called continuous spectra. It is clear that on this point, undoubtedly at some future time, even if we cannot do it now, a great deal will be learned. The table I give brings the results up to the year 1894. If we take the region near the Milky Way, the region bounded by 10° galactic latitude north and south, and consider the planetary nebulæ distinguished by bright-line spectra, we find that there are forty-two; but if we deal with those which are further than 10° from the Milky Way, that number drops to five. If we take other nebulæ, not necessarily planetary, but gaseous like planetary nebulæ, inasmuch as they give us a spectrum of bright lines, we find that there are twenty-two in or near the Milky Way, and only six outside. If we take the so-called nebulæ known to have continuous spectra, which need not be nebulæ at all—we only imagine them to be nebulæ because they are so far away that we cannot get a really true account of them—we find that the conditions are absolutely reversed. There are only fourteen of them in the plane of the Milky Way, but there are forty-three lying outside it; so that the percentage within 10° of the Milky Way comes out to be eighty-four in the case of the planetary and the other nebulæ which give us bright lines, and in nebulæ with continuous spectra only 25. Therefore we get an absolute identity of result with regard to the bright-line stars and the other objects which give us bright-line spectra.

There is another class of bodies of extreme interest. In fact, to some they are more interesting than all the other stars in the heavens put together (because they are "new stars"); each new star being supposed to be a new creation, so that for this reason everybody is very much agog to find out what they are like. When we come to examine these so-called new stars we find that they also are almost absolutely limited to the Milky Way, as shown in the table which gives the number of new stars, so-called, which have been observed in historic times. It begins at 134 years before Christ, and it ends last year. The number of stars thus reported as new stars is thirty-one, and of these only three have been seen outside the Milky Way. The glass globe will show in a convenient way what the facts are with regard to the new stars. The bright line stars being distinguished by dark wafers, the new stars are shown by white wafers. We notice that where we get practically the greatest number of dark wafers we get a considerable number of white ones. That means that these new stars take their origin in the same part of space as that occupied by the bright-line stars, and it is also interesting to point out that the void which I indicated where the Milky Way is single, where there were no bright-line stars, is equally true for the new stars; only one new star has been recorded in this region.

As I have said, a great deal of interest has been attached by many people to the question of the new stars, for the reason that whenever a new star appeared in a part of the heavens where no star was seen before, it was imagined that something miraculous and wonderful had happened. That was justifiable while we were ignorant, but recent work has shown, I think almost to a certainty, that the real genesis of a new star is simply this. We have near the Milky Way a great number of nebulæ, planetary or otherwise; we have more planetary nebulæ near the Milky Way than in any other part of the heavens; the nebulous patches also observed in it may include streams of meteorites rushing about under the influence of gravity; the origin of a new star is due to the circumstance that one of these unchronicled nebulæ suddenly finds itself invaded by one of these streams of meteorites. There is a clash. These meteorites we know enter our own atmosphere at the rate of thirty-three miles a second, and we may therefore be justified in assuming that any meteoritic stream in space, even in the Milky Way, would not be going very much more slowly. If we get this rapidly-moving stream passing through a nebula, which is supposed to be a mass of meteorites more or less at rest, of course we must get collisions; of course, also, we shall get heat, and therefore light. When the stream has passed through the nebula the luminosity will dim and ultimately, attention having been called by this cataclysm to that particular part of space, we shall find that there is a

FIG. 4.—The Milky Way, where double in relation to the Equator and Gould's belt of stars, showing that the bright-line stars (dark wafers) and new stars (white wafers) are limited to the Milky Way.

nebula there. This has always been so; and therefore in the case of new stars we must always expect to get indications of the existence of two bodies, the intruder and the body intruded upon.

We must also expect, if we are dealing with small particles of meteoritic dust, that the action will be very quick, and that the war will be soon over. All this really agrees with the facts. I will, just in order to point my remarks, show what happened in the case of the new star we were fortunate enough to have the opportunity of observing in the northern hemisphere not very long ago, the new star in the constellation Auriga. We have in the diagram the stars in the region in question; a black arrow indicates a dark space in the heavens where there is no star. The next drawing shows the same stars and the same region of the heavens; but we observe that in the centre is a star, which is the new star. In the spectrum of it we obtained undoubted indications of the fact that we were dealing with two different masses of matter; for the reason that if you take the chief spectral lines marked G, *h*, H and K, that is to say, the lines of hydrogen and of calcium, we find both bright lines and dark lines, which being interpreted means that hydrogen and calcium were both giving out light and stopping light. We cannot imagine that the *same* particles of calcium and of hydrogen were both giving out light and stopping light; there must have been different particles of hydrogen and calcium giving light and different particles of hydrogen and calcium stopping light; and if we look at the photograph carefully we find that the bright lines and the dark lines are side by side, and we know that that means a change of wave-length in consequence of movement, and we also know from the change of wave-length indicated that the differential velocity of the particles which gave us the bright hydrogen and calcium, and the dark hydrogen and calcium, must have been something like 500 miles a second. In that way we obtained indisputable proof that we were really dealing with two perfectly different series of particles moving in opposite directions, and that that was the reason we got that sudden illumination in the heavens which as suddenly died out until finally a nebula previously undiscovered was found to occupy the place. The nebula is really not the result, the nebula was the cause, but we did not know of its existence until our special attention had been drawn to that part of the heavens.

So much then for the first statement of facts relating to the distribution of the various star groups and nebular groups in the most general form. The next question is, Can we say anything about the distances of these gaseous stars, bright line stars, and other types? The way in which an astronomer attempts to determine the different distances which the stars occupy in relation to the earth may really be very well grasped, I think, by considering what happens to one when travelling in a railway train. If the train is going fairly quickly, and we look at the near objects, we find that they appear to rush by so rapidly that they tire the eye, and one naturally looks at the objects which are more distant; the more distant the object we look at is the more slowly it appears to move, and the less the eye is fatigued. Now, suppose that instead of the train rushing through the country and passing the objects which we regard under these different conditions, the different objects are rushing past us at rest. Then, obviously, those things which appear to be moving most quickly will be those nearest, and the more distant objects, just because they are distant, will appear to move more slowly; that is to say, we shall get what is called a large "proper motion"—in the case of the objects nearest to us—and a small "proper motion"—in the case of the bodies which are further away.

This question has been attacked with regard to the stars in magnificent fashion by a great number of astronomers. A photograph will show in a diagrammatic form the very various rates of proper motion which have been assigned by careful observation to a very great number of the stars. In the chart the amount of proper motion of the various stars is indicated by the lengths of the lines which proceed from them, and the direction in which the various stars appear to be moving is also indicated by the direction which these lines take. Some of the lines are extremely long; they seem to stretch over a large part of the sky. Of course the scale is an exaggerated one, but it is the *relative* motion that we have chiefly to deal with, and we find that on the same scale in some cases the lines are extremely short; so that the diagram tells us that the amount of proper motion is apt to vary very considerably. We have large proper motions and small proper motions among the stars.

It was Mr. Monck who was the first to show in 1892[1] that the gaseous stars had the smallest proper motion; that is to say, that the hottest stars were further away from us than the cooler ones. That is a good, definite statement, and one which everybody can understand. He next found that the proto-metallic stars—that is to say, the stars not so hot as the gaseous ones, but hotter than the metallic ones—had the next smaller proper motion. This, of course, indicates that the metallic stars are the nearest to us unless proper motion does not depend upon distance, but rather upon a greater average velocity in space. It has been shown, however, by considering the sun's movement in space, that this view probably may be neglected. The first discussion of proper motion then went to show, roughly, that the hotter a star is the further away from us it is; and it made out a fair case for the conclusion that the sun forms one of a group or cluster of stars in which the predominating type of spectrum is similar to its own.

Kapteyn carried the inquiry a stage further.[2] Working upon the idea that stars with the greatest proper motion are on the average the nearest, the part of the proper motion due to the sun's translation in space he considered must depend strictly upon the distance, and he determined this by resolving the observed proper motion along a great circle passing through the point of space towards which the sun is moving, which is called the apex of the sun's way, and reducing to a point 90° from the apex. His results were practically the same as those obtained by taking the individual proper motions. He also found that stars with the greatest proper motion are mainly metallic, and have no regard at all to the Milky Way; that stars with the smallest and no observable proper motion are gaseous and proto-metallic, including a few metallic ones which have collected in the galactic plane. In this he agrees with the prior observations to which I have drawn attention. In the table which I now give the mean proper motion is shown.

Relation between Spectra and Proper Motions of Stars (Kapteyn).

Mean proper motion.	Gaseous and proto-metallic stars.	Metallic stars.	Metallic flutings.	Ratio, metallic to gaseous.
″ 1·39	3	51	—	17·0
0·52	12	66	1	5·5
0·35	14	66	—	4·7
0·24	34	124	—	3·6
0·18	35	67	3	1·9
Inappreciable	79	35	1	0·44

The table deals with something over a second, which may be looked upon as a great proper motion, down to the tenth of a second, which may be regarded as a small one;

1 "Astronomy and Astro-Physics," xviii., 2, p. 876.
2 Amsterdam Academy of Science, 1893.

and we find that the gaseous and proto-metallic stars increase in number as the proper motion decreases. We find also the ratio of the metallic to the gaseous and the proto-metallic. We begin with a ratio of 17, and end with something like a ratio of half, so that the results may be considered to be pretty definite. These results were obtained by Kapteyn with 591 stars which were common to Stumpe's catalogue of proper motions and the Draper catalogue dealing with spectra. The general result may, therefore, be stated that at the nearest distance the metallic stars are seventeen times more numerous than gaseous stars, and at the greatest distance they are not half the number. Here again the question arises, how far the intrinsic brightness of these bodies, in relation to their distance from us and the possible greater or less extinction of light in space, has to be taken into consideration. That is a problem which will require a considerable amount of work in the future. It is rather remarkable that if we take the stars with very great proper motion, very much greater than the average, we find with regard to four that three of them are undoubtedly metallic, but it is possible that the star 1830 Groombridge, which is always looked upon as the star which beats the record in velocity seeing that it would travel from London to Pekin in about two minutes, is not a metallic star.[1]

We are now in a position to make a general summary of the stellar distribution not only in relation to chemistry, but in relation to distance. Taking the chemistry as the basis, we can see what happens to the gaseous, proto-metallic stars and so on, with regard not only to their proper motions, but in regard to the Milky Way.

Summary of Stellar Distribution.

Group.	Proper motion.	Relation to Milky Way.
Gaseous stars	Smallest [2] (Monck)... ...	Condensed in Milky Way (Pickering and McClean)
Proto-metallic	Intermediate (Monck) ...	Brighter ones not notably condensed in Milky Way (McClean) Tend to collect in Milky Way, more especially the fainter stars (Pickering)
Metallic ...	Div. 1. Greatest (Kapteyn)	Not condensed in Milky Way (Pickering and McClean)
	Div. 2. Small (Kapteyn)	Collected in Milky Way (Kapteyn)
Mixed flutings	?	?
Carbon ...	?	?

The gaseous stars, which we have seen have the smallest proper motion, are condensed in the Milky Way. The proto-metallic stars, which have but intermediate proper motion, are notably condensed in the Milky Way according to McClean, and tend to collect in the Milky Way more especially with the fainter stars according to Pickering. When we come to deal with the metallic stars, we find that there is no special condensation in the Milky Way. The greater number are not condensed in the Milky Way.

That being so, then, we may take a still further general view. We find that the bright-line stars, the new stars, are almost exclusively in the Milky Way and are far away from us; that the gaseous stars are chiefly in the Milky Way and are far away from us; that the proto-metallic stars are not so confined to the Milky Way, and they are not so far away from us. But when we come to the metallic stars and the carbon stars they have not much obvious connection with the Milky Way, and they are close to us. Unfortunately, with regard to the metallic fluting stars the information is not certain, so that it is best not to say anything about it. Mr. McClean has dealt with a very small number, and he shows that they, like Dunér's stars, the carbon stars, have very little relation to the Milky Way. We thus obtain a tremendous separation between the hot stars with their great distance and the cooler stars with their smaller distance.

But we can go further. As the stars become hot in consequence of meteoritic collisions, we should expect to find nebulous conditions following suit; seeing that nebulæ are masses of meteorites, we should expect to find especially the gaseous nebulæ and results depending upon their presence in the region where the hottest stars exist.

The planetary nebulæ consist of streams of meteorites moving generally in spirals or in circular paths. There is no very great disturbance. We get a bright line spectrum from them, and we know they are practically limited to the Milky Way. We have found that the bright-line stars are limited to the Milky Way; they are simply stars involved in nebulæ. There again we get a connection between the Milky Way and nebulæ. The new stars are due to fixed nebulæ driven into by moving nebulæ, and they are also limited practically to the Milky Way; there again we have the nebulous touch. A piece of work which has not been done, but which badly wants doing, is to see whether those nebulous regions which Sir William Herschel was the first to chronicle have or have not a strict relation with the Milky Way. I have, in fact, made a preliminary inquiry into this matter, and it suggests that these nebulosities are most profusely distributed in the vicinity of the Milky Way just as is the case with the gaseous nebulæ.

(*To be continued.*)

[1] These stars are—

1830 Groombridge ...	...	7·04 ″ ...	Gaseous or proto-metallic.
Σ 2758... ...	... ..	5·196 ...	Metallic.
Σ 578... ...	... ...	4·049 ...	Probably metallic.
D.C. 583	... ...	3·7 ...	Metallic.

[2] Kapteyn finds small proper motions for gaseous and proto-metallic stars, but does not separate them into two groups.

SOME REMARKS ON RADIATION PHENOMENA IN A MAGNETIC FIELD.[1]

IN many articles which have recently appeared concerning the work which has been done in the study of radiation phenomena in a magnetic field, I find that, from the historical point of view, there are some statements which are not quite correct, and to which I now desire to attract attention. This appears to me desirable, as it is much easier, and much better, to test and correct errors of statement at the outset than after a lapse of time.

In the first place, it has been very generally accepted that the quartet form which occurs in the magnetic effect was first observed by M. Cornu; but on reference to the enclosed paper (*Trans. Roy. Dublin Society*, vol. vi., series ii., p. 385, read December 22, 1897), you will see that the quartet form,[2] the sextet, and other variations of the magnetic triplet were not only observed, but were photographed and exhibited to an audience in Dublin in the latter end of the year 1897. On the other hand, it was not until the following year (1898) that M. Cornu (working quite independently) announced in the *Comptes rendus* that he had observed the quartet form. Now the *Comptes rendus* being a weekly journal which is widely read, lends itself admirably to the rapid diffusion and circulation of new results, whereas the scientific *Transactions* of a local learned society are slow in appearing and little read or known outside their immediate place of publication. For this reason, the observations of M. Cornu became generally known, while mine remained unknown outside Dublin.

It is true, however, that I endeavoured to have them

[1] These remarks were addressed to Sir Norman Lockyer in the course of a correspondence, and have been thought of sufficient interest for publication.

[2] The quartets are clearly shown, as well as the triplet form, in the plate attached to the paper, and reproduced from the photographs shown at the meeting when the paper was read.

FIG. 1.

FIG. 2.—Zinc.

FIG. 3.—Zinc and Cadmium.

EXPLANATION OF PLATE.

In the accompanying plate, Fig. 1 shows the effect produced on the violet line of cadmium 4678. At the top, *a*, we have the line photographed with the magnet unexcited, that is, in the free field. Underneath this, at *b*, the same line is photographed with the magnet excited, but the field is not strong enough to resolve it into its three constituents. It accordingly appears to be merely broadened by the magnetic field. A Nicol's prism was then introduced into the path of the light and the line photographed in the same magnetic field, with the result shown at *d*, where the middle is seen to be removed from the affected line, so that it appears as a doublet. The nicol was then turned through a right angle, and the line again photographed in the same field. The result is shown at *c*, which proves that the sides of the broadened line have been cut off, while the middle has been allowed to pass. This agrees with the supposition that the magnetic field resolves the line into a triplet, but does not absolutely prove it.

The further resolution necessary to prove this point is shown in Figs. 2 and 3. In Fig. 2, a photograph of the zinc lines 4811, 4722 and 4680 is shown, and it will be observed that 4680 shows as a pure triplet, while the others do not. Fig. 3 is a photograph in a still stronger field taken from a spark passing between two electrodes, one of cadmium and one of zinc, so that the lines of cadmium and zinc are obtained simultaneously under precisely the same circumstances. It will be seen that the lines most affected are 4678 of cadmium and 4680 of zinc, and these both show as pure triplets, while the lines 4722 and 4800 show as quartets.

made generally known through the medium of the widely circulated journal NATURE, for on November 19, 1897, I sent photographic negatives to the office of NATURE for reproduction in that journal. These negatives showed the quartets as well as the pure sharp triplets and the diffuse triplets[1] which occur in the spectra of cadmium and zinc. They were produced by me in the end of October 1897, and were, I believe, the first photographic record of the actual magnetic tripling and quadrupling of the spectral lines. These negatives, however, were not considered suitable for reproduction in NATURE (see letter to NATURE, p. 173, December 23, 1897), but were subsequently enlarged and reproduced with great clearness in the *Philosophical Magazine* (April 1898).

In my letter to NATURE accompanying the negatives I did not dwell on the quartet form, as I did not wish to commit myself, or persuade others, to the belief that the quartet was really a magnetic quartet, *i.e.* produced exclusively by the magnetic field. It was quite open to belief at that time that the quartet form might be produced from the triplet by other mechanical causes, for example by reversal of the central line of the triplet, or in other ways, as noticed in my paper mentioned above. After prolonged effort I proved beyond all doubt that these variations of the triplet type (the quartet, &c.) are true magnetic perturbations, and are not due to any other cause; but this required *to be proved*, and for this purpose a very strong magnetic field was necessary.

With this field I found, as already announced in NATURE, that the quartet form becomes resolved into a sextet by the splitting up of the side lines into doublets. It is, therefore, not really a quartet after all, but a sextet.

With regard to other points, namely, the fact that the magnetic effect does not conform to the law deduced by the simple theory (viz. that $\delta\lambda \propto \lambda^2$), and the surmise that some such law might hold for groups of lines, a reference to my first paper, already mentioned (*Trans. Roy. Dub. Soc.*, December 22, 1897), will show both these points clearly emphasised there. On p. 387 I state that while some lines were converted into triplets "others photograph as doublets, or weak middled, greatly broadened lines, having the appearance of quartets; while on the other hand many lines appear to be simply broadened in the same magnetic field, and *others seem to be scarcely influenced in the same magnetic field.*" Thus the effect appeared to be lawless for the spectral lines taken as a whole in any one substance; but I go on to say that "perhaps it might be possible to group the spectral lines of each substance into sets, so that some law of wave-length might apply to the lines of each set."

At this early date I was already seeking for some such law, and I had before the close of 1897 proved that the law, whatever it might be, was *not the same* as that which governs the pressural shift of the spectral lines studied by Messrs. Humphreys and Mohler (see *Proc. Roy. Soc.* of London, January 1898).

My search has resulted in the discovery of a general law which has so far proved to be in complete agreement with all the observed facts.

With regard to the spectrum of iron, you will observe in my note in the *Proc. Roy. Soc.*, January 1898, that I was at that early date of opinion that the spectrum of iron exhibited no peculiarities of its own in the magnetic field. I examined iron early because I thought that by reason of its magnetic properties its spectral lines might show some decided peculiarities (but iron is not magnetic above 700° C., therefore my hopes were not very decided). On the whole I still adhere to that opinion, for although the spectral lines of iron show a variety of effect, yet these effects are the same in character or in kind as those which are observed in other substances. This and other matters I have already treated of fully elsewhere (*Phil. Mag.* and NATURE).

The accompanying illustrations (Figs. 1, 2, 3) have been reproduced from the plate given in the memoir read before the Royal Dublin Society on December 22, 1897. They show that the quartets were observed and photographed by the author certainly before that date.

THOMAS PRESTON.

[1] Really nonets as subsequently determined.

NOTES.

DR. JANSSEN, director of the Meudon Observatory, has issued a circular in which he announces that the success of last year's observations of the Leonid meteors from a balloon has led to arrangements being made to repeat the experiment during the forthcoming shower. Last year, a number of these meteors were observed from a balloon above Paris, though the city itself was at the time enveloped in a thick fog. It is important that numerous observations of the Leonid meteors should be made from as many places as possible; and as balloons render observers independent of cloudy skies, they are evidently of great advantage upon occasions such as that to which astronomers are looking forward. We are informed that two balloon ascents are to take place near St. Denis. The first ascent will be made on the night of November 14–15, with the *Aerostat*, and the second, on the following night, with the *Centaure*. Two seats in each balloon will be at the disposal of Dr. Janssen, who will nominate observers to occupy them, without distinction of nationality. The names of the observers will be announced at the next meeting of the French Astronomical Society, on November 8.

THE opening meeting of the new session of the Institution of Electrical Engineers will take place on Thursday, November 16, when the premiums awarded for papers read or published during the session 1898–99 will be presented, and the president, Prof. Silvanus P. Thompson, F.R.S., will deliver his inaugural address.

A SERIES of monthly lantern lectures has been arranged by the Royal Photographic Society. The first lecture will take place on Tuesday, November 7, when Mr. J. J. Vezey will describe "Some Mediæval Towns of Germany," illustrated with slides by Commander C. E. Gladstone, R.N.

THE death of Mr. Grant Allen, at the age of fifty-one removes one of the most popular of scientific authors whose writings have induced many readers to watch the workings of animate nature. His first scientific work, on "Physiological Aesthetics," was published in 1877, and was followed, in chronological order, by "The Colour Sense," "The Evolutionist at Large," "Vignettes from Nature," "Colours of Flowers," "Colin Clout's Calendar," "Flowers and their Pedigrees," "Charles Darwin," "Science in Arcady," "The Evolution of the Idea of God," &c. In addition, Mr. Allen contributed numerous articles on natural history topics to periodical literature. All his scientific articles and books are attractively composed, and they have been the means of imparting much popular instruction to general readers.

AMONG the privileges which the Hampstead Astronomical and Scientific Society is able to offer its members is the use of a reflecting telescope of 10½-inch mirror, which is erected in a small observatory on the East Heath, by permission of the London County Council. Interest in practical astronomy is aroused by this means, and the instructive lectures given at the meetings of the Society direct attention to facts and things terrestrial as well as celestial. A course of five lectures on astronomy will be given by Mr. P. E. Vizard in connection with the Society on Monday evenings, commencing on November 20. Mr. Vizard will also lecture on November 10, on the subject of the "November Meteors." A popular interest in, and practical study of, various branches of science is encouraged by the Society, and it is to be hoped that residents of Hampstead are actively supporting its efforts.

THE new session of the Royal Geographical Society will commence on Monday, November 13, when the president, Sir Clements Markham, will give a short opening address, to be followed by a paper by Mr. W. Rickmer Rickmers on his "Travels in Bokhara." The paper at the following meeting, November 27, will be by Mr. Vaughan Cornish on "Desert Sand Dunes." At the December meeting, Colonel Sir John Farquharson will probably give an "Account of the Past Twelve Years' Work of the Ordnance Survey," from the directorship of which he has recently retired. Other papers expected to be given during the session are: "An Ascent of Mount Kenya," by Mr. H. J. Mackinder; "The Work of the Yermak Ice-Breaker in the Spitsbergen Seas," by Admiral Makaroff; "Travels in Central Asia," by Captain H. H. P. Deasy; "Travels in the Region of Lake Rudolf and the Sobat River," by Captain Wellby; "Travels in Abyssinia," by Mr. H. Weld Blundell; and "Anthropogeography of British New Guinea," by Prof. Haddon.

THE *Journal* of the Society of Arts states that artificial paving stones are being successfully produced in Germany. The demand in all larger cities is said to be so good, and the expense attached to their production under former methods is so large, that any improvements on the older systems, whether in saving money or in producing a better stone, will be welcomed by almost all countries. The newest process in Germany is to mix coal-tar with sulphur and warm thoroughly; to the resulting semi-liquid mass chlorate of lime is added. After cooling, the mass is broken into small pieces, and mixed with glass or blast-furnace glass slag. This powder is then subjected to a pressure of 200 atmospheres, and reduced to the form or forms wanted. The resistance to wear and tear in use is fully half as great as that of Swedish granite. Thus it commends itself through durability equal to that of many stone roads, resistance to changes of temperature, roughness of surface—giving horses a good foothold—and, finally, non-transmission of sound. Inasmuch as the joinings are very small, dirt is avoided, and cleaning is very easy.

THE Institution of Mechanical Engineers commenced a series of monthly meetings on Friday last, when a paper was read by Mr. W. Ingham on the incrustation of iron pipes at the Torquay water works. The water supply is obtained from a tributary of the River Teign, which rises in the granite hills on a western spur of Dartmoor. The water is conveyed by two cast-iron mains to Torquay, one of them, laid in 1858, ten inches in diameter. At the time the pipes were laid, no one thought that the pure water from the Dartmoor hills would cause much deleterious action upon them. It was, therefore, with considerable surprise that at the end of eight years the delivering power of the mains was found to be reduced to 51 per cent. of their full discharging capacity. A scraper was designed, several years ago, to clean the pipes, and it is now regularly used. The scraper is pushed forward by the pressure of water acting upon pistons a little less in diameter than the diameter of the pipe. As it moves, the knives press outwards against the inside of the pipe and remove projecting nodules. The movement of the scraper through the pipes can be easily followed, when the mains are about three feet deep, by the rumbling noise it makes. The speed varies, of course, and is on the average about $2\frac{1}{2}$ miles per hour, but a speed of as much as $7\frac{1}{2}$ miles per hour can be obtained for about three-quarters of a mile on one part of the line. After scraping in 1898, the delivery was increased from 586 to 708 gallons per minute, and similar results have been recorded for many years.

WATER engineers have to give very serious consideration to the subject of incrustations upon their mains. The deposit varies, of course, according to the nature of the water conveyed. When the water is derived from wells sunk in the chalk, the coating on the pipes is of pure calcium carbonate, which forms a desirable interior surface from one point of view, if not from the other of reduction of pipe area. Mr. W. Ingham states in his paper to the Institution of Mechanical Engineers that, speaking generally, it may be laid down with a fair approximation to the truth that well waters have not as great an action on pipes as those from upland gathering grounds, but where the water is soft the corrosive action will be greater. Filtered water has also a less corrosive power than unfiltered water. Whatever protective covering is applied to pipes, soft waters will cause rusting within a few years of being laid. At Torquay six years is the outside limit when this commences, so every precaution is taken to see that the pipes are well coated. Mr. Ingham remarks that though much has been done to get a satisfactory coating to pipes, there is still considerable room for improvement, and it is hardly necessary to point out that a fortune awaits the man who can invent something that will withstand the action of soft waters.

THERE seems to be some doubt as to the genuineness of a photograph which has been exhibited at the Royal Photographic Society (picture No. 357), as we gather from a letter published by Lieut.-General Tennant (*The British Journal of Photography*, October 13). Although the writer of this note has not seen the said picture, and therefore cannot describe it, General Tennant refers to it as "a very fine picture of clouds, but I am at a loss to understand how it can have been put forward as being like an eclipse of the sun." He states further that "high in the sky there appears a bright disc partly hiding a dark one surrounded by a bright halo . . . it is as though the bright sun were passing in front of the dark surface of the moon." General Tennant, at the time of writing his letter, stated that he was quite certain that it did not represent any phase of a solar eclipse either at Quetta (the place where the photograph was taken) or elsewhere; but in a more recent communication to the same journal (October 20) he is led to alter his opinion after seeing a photograph of the sun passing behind a church spire, saying that the peculiar appearance may possibly be the result of reversion. The latter opinion of General Tennant is no doubt the correct explanation of the abnormal appearance of the photograph in question, but the photographer of picture No. 357 may be glad to learn that a similar photograph was obtained at Sir Norman Lockyer's camp at Viziadrug, India, during the same eclipse. The camera used was a folding kodak, taking pictures 5 by 4 inches, and the exposures, four in all, were made by a blue-jacket. Each exposure lasted fifteen seconds, but, during the last, totality ended before the given time of exposure was concluded. This photograph shows the small crescent of the sun that appeared from behind the moon as black, while the disc of the moon is not black (as it appeared in the other three photographs), but nearly white, the density being just sufficient to differentiate between the corona and the moon's limb. This photograph is seemingly the same as No. 357, mentioned above, and its peculiarity is due, without doubt, to a reversal caused by the extreme brilliance of the uncovered portion of the sun.

THE photographic process of preparing textile designs, invented by Mr. Jan Szczepanik, was referred to by Prof. R. Beaumont in his opening address at the Yorkshire College, and is described in *Pearson's Magazine*. Prof. Beaumont has personally examined the invention, and has seen designs worked out by the new process in the premises of the Szczepanik Company at Paris. The object of the photographic appliances of Szczepanik is to take the artistic sketch, and, without any modification of the same, to enlarge it to scale, to transfer it on to ruled paper or point paper, and mark it with the thousands and millions of dots arranged in the proper orders for the development of the several parts of the pattern, in the weaves necessary for giving to each suitable precision of character when woven. Prof. Beaumont considers that the apparatus of Szczepanik is capable of producing designs in which there is considerable diversity of woven detail, so that it is purely a question of whether the designs thus obtained are legible for all practical purposes. There must of course be limitations to its utility, as there are to all automatic and mechanical appliances. Yet if it can be employed in accelerating the process of designing large patterns, it should have the serious attention of all who desire the further development of the weaving industries.

FROM a note in the *Journal* of the Society of Arts, it appears that there is reason to believe that in the near future mercury will be one of the most valuable of the numerous metallic products of New South Wales. Native quicksilver was found so far back as 1841 in the Cudgegong River, an auriferous stream, which flows through a portion of the western goldfields of the Colony. Cinnabar had previously been found in the same locality. Though efforts were made by the Rev. W. B. Clark to stimulate systematic research for the metal and its ores, little or nothing was done until later years, when cinnabar was found at several places, the richest deposits being discovered near Yulgilbar, in the Clarence River district, about four years ago. The Government geologist has inspected the workings in this locality, and has definitely ascertained the existence of three parallel lodes, which improve as they go down. Machinery is being erected, and a preliminary testing of about one thousand tons of ore will be made. Should the results prove satisfactory the New South Wales quicksilver trade will become revolutionised, as the poorest assays show the ore to be richer than those of the American and Spanish mines. They will also encourage the search for other cinnabar deposits, which, there is every reason for believing, are more numerous and richer than generally assumed. The value of the discovery in connection with the Colonial gold-mining industry can hardly be over-estimated. It simply means that the work of gold production will become enormously stimulated, thereby greatly increasing the already large auriferous output of the Colony.

THE summary of the *Weekly Weather Report* for the September quarter of the thirty-four years, 1866 to 1899, recently issued by the Meteorological Council, shows that mean temperature for both wheat-producing and grazing districts was 2° above the average. The only variations from these values were in the east and west of Scotland, where the excess was only 1°, and in the south and south-west of England, where the excess amounted to 3°. The general mean of the rainfall for the quarter was 2 inches below the average in both the above-mentioned districts; the principal variations were in the north and east of Scotland, where there was an excess of 1 inch, and in the south-west of England, where the deficiency amounted to 4 inches. Reckoning from January 1, the differences from the averages are less marked; in the east of Scotland, the north-west of England and south of Ireland, the excess amounts to about 2 inches, while in the east and south of England the deficiency amounts to 2·7 and 3·5 inches respectively.

DR. E. S. FATIGATI, of Madrid, has sent us a copy of an interesting pamphlet in which he deals with the representations of plants and animals, agricultural operations, and other natural objects and activities found in very old Spanish tombs, in cloisters of the eleventh and thirteenth centuries, corbels of churches, and choir stalls of the fifteenth century. It appears that the leaves, bunches of grapes, and tendrils of the vine, which were used as decorations during the classic period, are also found in the oldest Spanish sculpture of the sixth and seventh centuries. The animal world is well represented. The swan, the gallinaceous birds, the dog, and the lion make up the fauna of the little Asturian churches of the ninth century. In the magnificent cloister of Silos (eleventh century) the indigenous species are found by the side of those of oriental and northern origin. In the capitals of the cloister of Fawagona (beginning of the thirteenth century) are reproduced in stone two snakes devouring a frog, just as they may be seen doing every day in the ponds of the country. In addition, representations are found of the fight of a hunter with a bear of the Pyrenees, the capture of a hare by an eagle, and many others of the same kind. The pictures of nature with its beings and their struggle for life appear reflected in numerous monuments. From these and many other facts given in the pamphlet it seems that the Spanish sculptures of the Middle Ages have not an exclusive symbolic character, and that in those days Spain was not so separated from nature as many have supposed.

MR. JOHN BRILL, writing in the volume of *Proceedings* of the London Mathematical Society just issued, discusses the complete system of multilinear differential covariants of a single Pfaffian expression and of a set of such expressions. An account of the bilinear covariant of a Pfaffian expression is given by Forsyth; this covariant involves the first set of Pfaffians belonging to the given expression, from which latter it is derived by a differential operation. A repetition of this method upon the covariant itself merely produces an expression which vanishes identically. Mr. Brill shows how, by making use alternately of algebraic and differential methods of derivation, a series of covariants of the given expression can be produced which involve the various orders of derived functions associated with the expression. It is to be noted that the places at which differential operations occur are those which mark the passing from one group of cases into the next in the case of a set of equations obtained by equating the Pfaffian expressions severally to zero. Furthermore, the more general derived functions introduced by Mr. Brill play a similar part in regard to these latter covariants to that which the derived functions of a single expression play in reference to its covariants. One of the main difficulties of the subject is the extraordinary complication of the notation.

AN important paper on the development of the carapace of the Chelonia is contributed by Dr. A. Goette to the last number (vol. lxvi., part 3) of the *Zeitschrift für Wissenschaftliche Zoologie*, in the course of which the disputed question as to the relationship of the leathery turtles (Athecata) to the carapaced chelonians (Testudinata) is discussed. If the views put forward by Dr. Goette are correct, they will profoundly modify the generally accepted views as to the relations of the Athecata and Testudinata—more especially the late Dr. Baur's theory as to the former being a specialised group with a degenerate type of carapace.

IN the August number of the *Transactions* of the Connecticut Academy Mr. W. G. Vanhame records some recent experiment in regard to the fertilisation and development of the Planarians. From the ease with which these creatures can be kept in captivity and the number of eggs laid, observations on the development of the group would appear easy, but difficulties have been met with by previous observers, in consequence of which there are discrepancies and uncertainties in regard to many points. The unusually good preparations obtained by the author have enabled him to throw much new light on some of these disputed points. The eggs are laid in clusters or sheets containing from one to two dozens, arranged in a single layer and closely attached together with a white, mucus-like secretion, which is at first very sticky, although it subsequently hardens, Although hermaphrodite, Planarians reproduce by cross-fertilisation. For the details of the author's observations, reference must be made to the original paper.

IN Prof. Verrill's report on the Ophiuroids collected during the Bahama Expedition of 1893 (*Bulletin from Iowa Laboratory*, vol. v., No. 1), the chief general interest centres round the observations connected with the protective resemblances developed by the feather-stars of the Bahamas. According to the author, "most of these species with long, coiled arms, adapted for clinging to the branches of gorgonian corals, are adapted for imitating closely, in various ways, the forms and colours of the corals on which they live. This must afford them a considerable degree of protection against predaceous fishes, in addition to the direct protection due to the stinging powers of the corals themselves, which is sufficient to cause most fishes to avoid them." Many fishes, it is added, have, however, in all probability become immune against coral-stings, and feed on hydroid polyps; and the author argues that if this be so, the additional protection afforded the feather-stars by their resemblance to the gorgonias would be obvious. But, unless the feather-stars form a specially tempting *bonne-bouche* and are liable to be picked off separately, the obviousness of this does not seem quite clear, since feather-stars and gorgonias would be both consumed together by the fish.

THE importance now attached to preparing skins of small mammals for study purposes according to a uniform plan fully justifies the appearance of a paper on the subject by G. S. Miller in the *Bulletin* of the U.S. Museum (No. 39). A list of instruments and material required, as well as the details of manipulation, are given; and a plate illustrates the appearance of the finished specimens.

THE November number of *Science Gossip* is particularly full of interesting articles. Major B. M. Skinner gives a short account of the valley of the Tochi river which he explored during the North-west Frontier campaign; and an account of the foraminifera collected by him from the rocks in Waziristan is given by Mr. Arthur Earland. The limestones fall naturally into two divisions, (1) alveoline, (2) nummulitic, and the article is illustrated by photographs of rock-sections of both of these types.

A SERIES of observations on the "focal depth," or as it is sometimes called the penetrating power, of microscopic objectives is given by Mr. Leon E. Ryther in the *Journal of Applied Microscopy* for September. By plotting the magnifying powers of various combinations as abscissæ and the corresponding focal depths as ordinates, a curve is obtained approximating to an equilateral hyperbola indicating that in the author's experiments the focal depth varied inversely with the magnifying power.

J. ERIKSSON reprints from the *Annales des Sciences Naturelles* a translation of an important paper, which appeared originally in Swedish, on the brown rust of cereals. He proposes to split up into six species the well-known parasitic fungus *Puccinia rubigo-vera*, only one of which species is at present known in the æcidiospore stage. Of the six species described, the first and second only are of great importance in agriculture, the first being very destructive to rye, and the second being apparently the only parasitic fungus which causes rust on wheat in Europe, the United States or Australia. The paper concludes with some practical suggestions for farmers.

THE mineral resources of the Province of New Brunswick form the subject of Part M of the tenth volume of the annual report of the Geological Survey of Canada (1899). The subject is dealt with by Dr. L. W. Bailey. At the outset he remarks that if we except building-stones, gypsum, limestone, brick-clays, and other materials applicable to building purposes, there are but four substances that have been the basis of anything like extended or successful mining operations. These are coal, iron, manganese and albertite, and of these coal only is at the present time being worked. There are, however, large tracts that are still covered with unbroken forest, and consequently are but little known. They comprise rocks whose geological age and character suggest that they may be productive of useful minerals.

A PROGRAMME of lectures received from the Hull Scientific and Field Naturalists' Club shows that the Club is actively engaged in creating and fostering a love of natural knowledge within its sphere of influence.

DURING this month the following popular science lectures will be delivered on Tuesday evenings, at the Royal Victoria Hall:—November 7, Mr. L. Fletcher, F.R.S., on "The Fall of Stars from the Sky"; November 14, Mr. W. J. Pope, on "The Uses of Distillation"; November 21, Dr. J. W. Waghorn on "Bad-Contacts: their application to telephones and wireless telegraphy"; November 28, Mr. Michael Sadler on "A Brother of the Birds" (St. Francis of Assisi).

THE *London Quarterly Review* (Charles H. Kelly) publishes a long article by "A Field Naturalist," in which Darwin's observations and experiments on cowslips and primroses are discussed, and the conclusion is arrived at that the evidence brought forward by him is insufficient to establish the theory that cross-fertilisation is necessary to the full fertility of flowers. "On the contrary," says the reviewer, "we are of opinion that the primrose gives strong confirmatory evidence to Axell's view, that under natural and equal conditions, self-fertilisation of flowers is both the legitimate fertilisation and the most productive."

A NATURAL consequence of the scientific activity of the Liverpool Marine Biology Committee is the preparation of a series of memoirs, edited by Prof. Herdman, on typical British marine plants and animals. Each memoir will be concerned with one type, and the forms selected for description will chiefly be common Irish Sea animals and plants, of which no adequate account already exists in text-books. Three of the memoirs will appear before the end of this year, namely, Ascidia, by Prof. Herdman; Cockle, by J. Johnstone; and Echinus, by H. C. Chadwick. Others will follow in rapid succession, and the complete series of special studies promises to be of value to all marine biologists.

THE additions to the Zoological Society's Gardens during the past week include a Sooty Mangabey (*Cercocebus fuliginosus*) from West Africa, presented by the Rev. A. Clutterbuck; a Young Leopard (*Felis pardus*) from East Africa, presented by Captain J. L. Stanistreet; a Greater Vasa Parrakeet (*Coracopsis vasa*) from Madagascar, presented by Mr. C. Hunt; a Corn Crake (*Crex pratensis*), British, presented by Mr. Collingwood Ingram; a Ring-hals Snake (*Sepedon haemachetes*) from South Africa, presented by Mr. J. E. Matcham; two Red-footed Lemurs (*Lemur rufipes*, ♂ ♀) from Madagascar, an Ichneumon (*Bdeogale*, sp. inc.) from Africa, a Westerman's Eclectus (*Eclectus westermani*) from Moluccas, two Black-tailed Godwits (*Limosa aegocephala*), European; ten Salt-water Terrapins (*Malacoclemmys terrapin*) from North America, deposited; four Common Squirrels (*Sciurus vulgaris*), European, purchased.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN NOVEMBER :—

November 6. 0h. Conjunction of Saturn with the moon, ♄ 1° 1′ N.
11. Saturn. Outer minor axis of outer ring = 16″·11.
12. 11h. 11m. to 11h. 29m. Occultation of κ Piscium (mag. 5) by the moon.
12. 20h. Jupiter in conjunction with the sun.
14–16. Expected brilliant return of the Leonid meteoric shower.
15. Venus. Illuminated portion of disc = 0·966.
15. Mars. Illuminated portion of disc = 0·991.
16. 4h. Mercury at greatest eastern elongation (22° 18′).
17. 10h. 21m. to 11h. 29m. Occultation of A^1 Tauri (mag. 4·5) by the moon.
19. 6h. 10m. to 7h. 1m. Occultation of Neptune by the moon.
19. 10h. 32m. Minimum of Algol (β Persei).
22. 7h. 21m. Minimum of Algol (β Persei).
25. 14h. 11m. to 15h. 21m. Occultation of 55 Leonis (mag. 6) by the moon.

HOLMES' COMET (1899 *d*).

Ephemeris for 12h. Greenwich Mean Time.

1899.	R.A. h. m. s.	Decl. ° ′ ″
Nov. 2	2 36 36·67	+49 14 8·0
3	35 23·08	12 57·8
4	34 9·70	11 24·8
5	32 56·63	9 29·5
6	31 44·00	7 12·1
7	30 31·92	4 33·0
8	29 20·51	49 1 32·6
9	2 28 9·89	+48 58 11·4

COMET GIACOBINI (1899 *e*).—The following ephemeris is given by Herr S. K. Winther, of Copenhagen, in *Astr. Nach.*, Bd. 150, No. 3598 :—

Ephemeris for 12h. Berlin Mean Time.

1899.	R.A. h. m. s.	Decl. ° ′	Br.
Nov. 2	17 18 59	+4 42·4	0·66
3	20 33	4 58·6	
4	22 8	5 14·8	
5	23 43	5 31·0	0·63
6	25 18	5 47·1	
7	26 53	6 3·3	
8	28 29	6 19·4	0·60
9	17 30 5	+6 35·6	

NEW ALGOL VARIABLE IN CYGNUS.—The following *minima* will occur at convenient times for observation during November :—

$$\text{D.M.} + 45°{\cdot}3062 \begin{cases} \text{R.A. } 20\text{h. } 2{\cdot}4\text{m.} \\ \text{Decl. } + 45° 53' \end{cases} (1855).$$

	d.	h	m.
1899. Nov.	6	8	57
	15	12	27
	29	5	43

NEW VARIABLE STAR.—In the *Astronomical Journal*, No. 470, Mr. R. T. A. Innes, of the Cape Observatory, gives the individual results of his observations leading to the detection of a new variable. Its position is :—

$$\text{C.P.D.} - 54°{\cdot}6634 \begin{cases} \text{R.A.} = 15\text{h. } 32\text{m. } 42\text{s.} \\ \text{Decl.} = \ -54° 54'{\cdot}4 \end{cases} (1875).$$

The star was first suspected of variability by Prof. J. C. Kapteyn, who furnished a list of possible variables to the Cape Observatory in December 1896. Mr. Innes, from a discussion of the *fifty-eight* observations he records, finds the period to be about 12·68 days, the variation of magnitude being from 8·7 to 9·3. The fall to, and rise from, minimum seem to be very sharp ; but notwithstanding this similarity to the Algol type, it is not considered likely to belong to that class. The colour of the star is distinctly red.

GEOGRAPHY AT THE BRITISH ASSOCIATION

THE Dover meeting was characterised by the unusual quantity of solid work in physical geography and mainly in oceanography, including polar research, which was brought before the Section. Travel papers were less numerous than usual, though certainly of no inferior type, and the use of the lantern to illustrate nearly every communication added both to the interest and the value of the expositions. The hall was ill-situated and not well adapted for the purpose it was called upon to serve, and this unfortunate environment, not any falling off in the quality of the papers, accounted for the remarkably small audiences, which were the subject of general remark.

The address of the President, Sir John Murray, contained a summary of existing knowledge as to the ocean floor, and concluded with indications as to the direction in which advance during the immediate future is to be looked for. In this respect Sir John Murray gave prominence to the improved prospects for Antarctic research, and emphasised the importance of the forthcoming expeditions aiming at scientific completeness in their work. In seconding the vote of thanks for the address, Sir Michael Foster, the President of the Association, spoke of the interest which the Royal Society as well as the Royal Geographical Society felt in Antarctic exploration, and of the determination of both Societies to make the best possible use of the funds which might be placed at their disposal for the complete scientific study of the south polar area.

ARCTIC PAPERS.

The most recent results of Arctic exploration were described by three explorers who had attacked the problem in very different ways. Admiral Makaroff, of the Russian navy, gave an account of the trial trip of the great Russian ice-breaker *Yermak*, a vessel recently constructed at Armstrong's works on the Tyne for service in the Baltic during winter and in the Kara Sea in summer. The vessel is built of steel, the plates being very heavy and the ribs and cross-girders of very great strength arranged to meet the thrust of ice from all sides. She is built with two hulls, one within the other, is minutely subdivided into water-tight compartments, and fitted with an elaborate system of tanks and steam-pumps which enable the trim of the vessel to be altered very rapidly. Thus the vessel may be depressed at bow or stern, or canted to port or starboard by pumping water from one set of tanks to another. The displacement of the vessel fully equipped is 8000 tons, and her engines have power by acting on three propellers at the stern to drive her at the rate of 14 knots. A fourth propeller at the bow, intended to drive away the broken ice by the currents it generates, was found useful only in light ice, but of no value in breaking ice of great thickness. The trial-trip, which Admiral Makaroff described with many illustrations from photographs, demonstrated the power of the ship to break away through ice as much as 14 feet thick, not so much by smashing the ice as by determining the direction of cracks by which the mass is split. A cinematograph picture was obtained of the *Yermak* forcing her way through the thickest of the Arctic pack-ice north of Spitsbergen, but Admiral Makaroff regretted that the film could not be developed in time for exhibition at the meeting. During the trip the ice was not only broken to make way for the ship, but studied minutely. The powerful derricks with which the vessel is fitted made it possible to capsize large blocks of ice so as to study the parts normally under water, and also to hoist on deck masses of many tons weight, to be studied as to temperature by the insertion of thermometers to different depths, and as to chemical composition, melting point, &c. Admiral Makaroff is convinced of the perfect suitability of strong steel ships for polar research ; and in reply to an inquiry as to whether he hoped to reach the North Pole in the *Yermak*, said that he only wished he might be allowed to try. There was a long discussion on the paper, in which the value of this new method of mastering the ice was generally recognised.

Mr. W. S. Bruce, who had just returned from a voyage to Spitsbergen in the Prince of Monaco's yacht, *Princesse Alice*, gave an account of the physical and biological conditions of the Barents Sea, founded on that cruise and on a voyage last year in Mr. Andrew Coats' yacht *Blencathra*. Only two of the many current floats thrown overboard by the *Blencathra* had as yet been recovered.

Mr. Walter Wellman, in an address on his recent journey to

Wilczekland, dwelt upon the motives and methods of Arctic exploration, advocating the "dash for the pole" as the only practical method of attaining the highest latitude in the short time available during the brief season available for travelling in the Far North. He recounted the incidents of his attempt in 1898-99, which was unsuccessful on account of a serious accident which befel him when camping on an iceflow which was broken up by a sudden pressure.

ANTARCTIC PAPERS.

The records of recent work in the Antarctic were of no less interest, and the display of slides from Antarctic photographs was unique, none of them having been shown in public before.

A short account of the cruise of Sir George Newnes' yacht *Southern Cross*, with Mr. Borchgrevink and his party on board, from Hobart to Cape Adare, was communicated by Dr. H. R. Mill, and illustrated by a few pictures of the Antarctic ice and of the landing at Cape Adare. The *Southern Cross* left Hobart on December 19, reached 50° S. on the 23rd. The first ice was met with on the 30th in 61° 56′ S., and 159° E., and on January 1, 1899, she was practically stopped by the pack in 63° 40′. Every effort was made to proceed southward and eastward, but with small result, as on January 31 the position was only 66° 46′ S. and 165° 28′ E. She then commenced to work northward and eastward to escape from the pack, which she did on February 12 in 65° 43′ S., and then it was found easy to cross the pack to the southward in longitude 173° E., the ship anchoring off the beach at Cape Adare on February 17. Tempestuous weather was experienced, the wind at the most southerly part of the voyage blowing usually from easterly and southerly quarters, and the vessel being more than once in danger of driving ashore. Stores were landed, huts erected, and the *Southern Cross* finally left Mr. Borchgrevink with nine companions and seventy-five dogs on the shore of what he believed to be the Antarctic continent on February 28, 1899.

M. H. Arçtowski, the oceanographer and meteorologist of the *Belgica*, gave a brief account of the voyage and the wintering of the Belgian expedition in the Antarctic ice-pack south-west of Cape Horn. He showed a number of photographs of the newly explored land, and concluded by expressing his views as to the further work required in Antarctic exploration as follows:—

At the present day it is impossible to consider the land alone; the whole Antarctic area exhibits phenomena which remain very imperfectly known, such as the great questions of atmospheric circulation, climate, circumpolar oceanography and magnetic conditions. Hence Antarctic explorations must be conducted in three ways:—

(1) A system of fixed stations arranged between the edge of the continents and the zone of ice. These stations should be supplied with all necessary magnetic and meteorological instruments, and continue at work simultaneously for one year at least.

(2) During the same year two polar expeditions should set out on opposite sides towards the South Pole. This would require two vessels strong enough to withstand the pack, and equipped for wintering.

(3) Finally a circumpolar expedition, planned to follow the edge of the pack right round, and specially equipped for oceanographical and zoological work. This expedition would also survey the accessible parts of the Antarctic coast.

Such a system of exploration must necessarily be the work of several nations. Weyprecht's idea should be revived and followed. Antarctic exploration must be conducted systematically, and it ought to be international. A series of circumpolar stations, where comparable and simultaneous observations are carried on, would make the results of the British and German Antarctic expeditions remarkably complete, and vastly enhance their value.

A polygon of stations should unite South America and the Antarctic lands. The path of the cyclonic storms passes to the south of Cape Horn, and—at least during part of the year—to the north of Palmer Land. The polygon should include stations on the east and west coasts of Graham Land, and one of the South Shetland Islands, on South Orkney and on one of the Sandwich Islands, together with stations at Cape Pillar, Cape Virgins, Cape Horn, Staten Island and the Falklands. With such a system of observation it would be possible to determine exactly the track of every cyclone crossing the polygon of stations. This is a matter of very great practical importance. These cyclones seem to travel in the general direction of the upper winds from west to east, and they seem to follow the outline of Alexander, Graham and Palmer Lands, but how and why this is so we cannot tell as yet. Between South America and the Antarctic land there is a belt of low pressure which seems to encircle the Antarctic region where there is apparently a permanent anticyclone; but observations are wanting to determine the associated conditions of atmospheric circulation.

It seems scarcely necessary to insist on the advantages which two other polygons of stations would present, one to the south of the Indian Ocean, the other between New Zealand and Victoria Land. The second polygon would be formed by the islands of Prince Edward, Crozet, Kerguelen and a station on Enderby Land. The third polygon would include the Balleny, Macquarie and Auckland Islands. This would be a particularly interesting polygon on account of its comparative proximity to the magnetic pole.

The two vessels designed to winter in the pack should approach along the meridians of 145° W. and 35° E. Imprisoned in the pack as the *Belgica* was, these vessels would be able to carry on oceanographical and zoological work, and also to collect magnetic and meteorological observations, thus adding two stations near the pole to the various polygons. From the meteorological point of view it would be extremely interesting for these vessels to reach high latitudes, for the region near the pole will probably differ greatly from the northern edge of the Antarctic lands in everything regarding atmospheric pressure, wind and storms.

As to the circumpolar expedition, the vessel intended for this purpose should be quite independent of those which penetrate the pack. The region is too great to admit of the whole voyage being completed in one season—three would probably be necessary. It is not easy to indicate the route which should be followed, for everything depends on circumstances. Still, it may be observed that—in summer at least—easterly winds predominate near the edge of the south polar pack, and therefore it would be advantageous to proceed from east to west.

Mr. J. Y. Buchanan, F.R.S., treated of the physical and chemical work required for an Antarctic expedition, and pointed out that the principal object at the outset of the expedition should be to push energetically southwards, and effect a landing in the most suitable place in the highest possible southern latitude, and there establish the principal station. The locality should be chosen where the ship, or one of the ships, would find safe winter quarters. As the principal object is to establish the expedition as advantageously as possible on land, no time should be spent unnecessarily at sea. For this reason magnetic observations at sea should not be contemplated. They take up an enormous amount of time, and besides, if they are to be of any use, the distribution of iron in the ship has to be arranged under such restrictions as to interfere materially with the usefulness of the ship in other directions. On land, the magnetic observations would occupy a first place, also pendulum observations for the determination of the intensity of gravity and tidal observations. It has been the general experience of Antarctic navigators that the heavy pack-ice is met with at a considerable distance from land, and between it and the land there is comparatively open water. The ice which would cover this water in winter would probably loosen earlier than the heavy pack, and the ship, if wintering inside, might be able to move much earlier than it would be possible for her to pass the pack; and this would be an additional advantage of finding winter quarters for the ship.

Perhaps the most important work to be done is to obtain a complete meteorological record during the whole of the sojourn of the expedition in Antarctic regions, whether at sea or on land. At present, any view as to the meteorological conditions on the Antarctic land may be held, because we have no facts by which to regulate our speculations. The expedition should be fully supplied with instruments for this purpose, and especially with self-recording instruments. As the station must necessarily be on land, and not on ice, geological observations will be made as a matter of course.

What distinguishes the Antarctic regions above everything is the development of ice as a geological feature, whether it is met with at sea as icebergs, or on land as glaciers, or a continuous covering. It is almost certain that any station on land will be within easy reach of a glacier, and means should be taken to establish marks as early as possible which will enable its motion to be observed before darkness sets in and after the sun reappears.

The Greenland glaciers appear to move about three times as fast as the Swiss ones. Do the Antarctic ones move faster still? In Spitsbergen the glacier streams sometimes take very large proportions. How does it stand with the Antarctic ones in this respect? The "grain" of the Spitsbergen glaciers does not seem to be larger than that of the principal Swiss glaciers. The Antarctic land ice must be dissected with a view to the determination of the size and the articulation of the grain. It is, therefore, of the first importance that the chemist and physicist should have spent some time, both in summer and in winter, examining for himself the conditions of one of the Swiss glaciers. This is quite as necessary for him as having spent a certain time in a chemical or a physical laboratory.

The papers on Antarctic exploration gave rise to an animated discussion. Prof. Rücker, speaking of the requirements for magnetic work, expressed his preference for observations on board a wooden ship cruising round the Antarctic, to the concentration of observations on a few fixed stations; although he allowed that excellent results could be obtained from fixed stations if they were numerous enough, and not established upon magnetic rocks: series of well-distributed stations being more important than a position in high southern latitudes or equipment with apparatus of remarkable delicacy. Major Darwin observed that such differences of opinion as had been expressed regarding the work to be attempted in Antarctic exploration arose simply from the want of funds to provide for the complete representation of all departments; and he indicated two guiding principles. (1) If a special Antarctic ship is to be built, it should spend the whole of the available time in the Antarctic regions proper. (2) The greatest unknown feature should be selected for study; that is, the Antarctic continent. For any kind of south polar expedition it is of the utmost importance to select the scientific staff with the greatest possible care. Mr. George Murray said that he had been carefully studying the question of the cost of ships, and had come to the conclusion that for two well-equipped vessels, each with an adequate scientific staff, a sum of 150,000*l.* would certainly be required. Dr. Koettlitz laid stress on the importance of expert supervision in the preparation of all the tinned foods of an expedition. Sir John Murray, in summing up the discussion, said it was plain that for a proper study of the Antarctic regions two ships would be required, one specially designed for magnetic work and for penetrating the ice, the other equipped for circumpolar oceanographical observations.

OCEANOGRAPHICAL PAPERS.

Dr. Gerhard Schott, of the Hamburg Marine Observatory, the oceanographer of the German deep-sea expedition, gave an account of the chief results of the voyage of the *Valdivia*, illustrated by many photographs, including some fine pictures of tabular and peaked Antarctic icebergs. The expedition, sent out at the expense of the German Government, was practically a circumnavigation of Africa, though in wide curves including the invasion of the Antarctic region to the edge of the pack-ice off Enderby Land. Apart from the exploration of the edge of the southern ice and the rediscovery of Bouvet Island, the cruise was of great geographical importance on account of the exact oceanographical study of the whole of the tropical Indian Ocean for the first time. The oceanographical results include deep-sea soundings carried out with two different machines, one the Sigsbee, of American manufacture, which acted remarkably well, even in very stormy weather.

The utilisation of an electromotor for winding up the wire was a new and very successful application much to be commended, especially for polar work, when steam-pipes are apt to freeze. The most important soundings were those made between Capetown and Bouvet Island, thence southward to the edge of the ice, and eastwards along the margin of the pack, and thence north to Kerguelen. This region had previously been almost unknown. During this part of the trip great attention was paid to ice-conditions, the ice being distinguished into *Drift-ice*, consisting of low fragmentary masses, often obviously portions broken off glaciers; *Pack-ice*, greenish stratified masses of frozen sea-water; and *Icebergs*, which in the east near Bouvet Island were rugged, much waterworn, and had obviously come from a distance; while in the east, near Enderby Land, they were tabular in form, quite fresh and unworn: their height was usually from 100 to 180 feet. The meteorological conditions were also studied throughout the cruise with great care.

Mr. H. N. Dickson discussed the observations of temperature of water and air round the British Islands. The mean monthly and annual temperatures of the surface waters of the sea during the period 1880-97 are shown for sixty-five stations distributed round the coasts of England, Scotland and Ireland. The average for the year at the entrance to the English Channel is nearly 54° F., it falls as the Channel narrows to 52° between the Start and Cape la Hogue, and remains steady to beyond the Straits of Dover, at least as far as the East Goodwin light-vessel. On the south-west coast of Ireland the annual mean is about 52°, falling to 51° in St. George's Channel, and 50° in the Irish Sea. A slow fall from 52° to 50° takes place on the west coast of Ireland until the N.W. corner is reached. The mean of 49° persists along the north coast of Ireland to the North Channel, and along the whole of the west coast of Scotland to Stornoway. On the east coast temperature falls very quickly, as soon as we get out of range of the Straits of Dover, to 50° off Suffolk and Norfolk, and then there is a gradual fall northwards, to 48° off the coast of Northumberland, 47½° off Aberdeenshire, and 47° at the Orkneys and Shetlands. The effect of the tidal streams in mixing the waters is exceedingly well marked. The annual minimum of temperature rarely occurs in March, most frequently in January, especially at stations open to the Atlantic. The annual maximum occurs almost everywhere in August.

Mean temperatures of the surface water are compared with the forty-year averages for the air, recently published by Buchan. A comparison shows that the mean annual difference has hitherto been somewhat over-estimated, especially on the western coast; in no case is the mean excess of sea over air greater than 2° F. The maximum difference occurs everywhere in November and December, and is greatest on the south coast of England between Portland Bill and the Straits of Dover.

Mr. Dickson also contributed a paper on the temperature and salinity of the surface water of the North Atlantic during 1896 and 1897. The completed series of forty-eight monthly charts of surface temperature and salinity, the mode of construction of which was described in a paper read before the Section last year, was exhibited, and along with it maps showing the departures from the mean distribution of air pressure and temperature during the same period. A number of new features in the movements of surface waters were disclosed, notably in connection with the distribution of polar waters from the western Atlantic.

Dr. H. R. Mill suggested a system of terminology for the forms of sub-oceanic relief. He said that the fact that the forms of the ocean floor cannot be seen, but only felt out by soundings, makes their study one of peculiar difficulty. Some distinguished authorities believe that our present knowledge of the deep sea is too slight to justify any systematic terminology. Meanwhile each investigator introduces a set of names of his own, for the most part based on analogies with land forms visible to the eye. It is obvious that there are two great classes of forms, elevations above and depressions below the general level of the ocean floor; but the question is how many subdivisions of each can be recognised as distinctive and deserving of generic names. The following general scheme of terminology is put forward tentatively, premising that no attempt be made to localise any precise type of form unless a considerable number of soundings exist to define it:—

Depression—The general term for any hollow of the ocean floor. *Basin*—A relatively wide depression, with comparatively gently sloping sides. *Caldron*—A relatively wide depression, with comparatively steeply sloping sides. *Furrow*—A relatively narrow depression with comparatively gently sloping sides. *Trough*—A relatively narrow depression with comparatively steeply sloping sides. *Wall*—Any submarine slope comparable in steepness to a precipice on land. *Floor*—Any very gentle submarine slope or nearly level surface. *Elevation*—Any inequality above the general level of the ocean floor. *Rise*—A relatively narrow elevation. *Bank*—A relatively wide elevation. *Shoal*—An elevation coming within five fathoms of the surface, so as to be a danger to shipping. *Shelf*—A nearly horizontal bank attached to the land and bordered seaward by a much more abrupt downward slope.

Mr. C. W. Andrews, in a paper on the relation of Christmas Island to the neighbouring lands, referred to the peculiarities of the geology and biology of the island, and traced the resemblances which seemed to associate it with the Cocos-Keeling group on one side and Java on the other. The occurrence of earthworms in Christmas Island was an anomaly in the biology of oceanic islands, and difficult to explain.

Sir John Murray and Mr. Robert Irvine discussed the distribution of albuminoid matter and saline ammonia in sea-water; and Sir John Murray with Mr. F. P. Pullar exhibited and described the sounding-machine they employed in their bathymetrical survey of the fresh-water lakes of Scotland, and gave an account of the configuration of the beds of the lakes of the Loch Katrine group. The authors expressed their intention of extending the work to the other lakes in Scotland, although they felt that it was rather for the nation than for individuals to carry out work of the kind.

OTHER PAPERS.

Colonel Sir John Farquharson, late Director General of the Ordnance Survey, gave an account of the progress of the work of that department during the last twelve years, and exhibited a number of illustrative diagrams and specimen maps. He said that during the twelve years (1887-99) there have been probably more changes made in the character of the work done by the Survey than in any other equal period of its history; and, as regards the areas covered by its operations, they have been largely in excess of the areas covered during any previous equal period. This is, of course, due to the fact that revisions have now largely taken the place of original surveys. The most important advances made were:—

The progress (to completion in 1890) of the original cadastral survey of England and Wales, including the 6-inch surveys of uncultivated districts. The progress made on re-surveys for the larger scales of various counties of England and Scotland which had been originally surveyed for the 6-inch scale only; and the progress made on the revision of the original cadastral surveys of England and Scotland, whether on the 25-inch or 6-inch scale. The progress made on the re-survey of Ireland for the $\frac{1}{2500}$ or 25-inch scale. The progress made on the completion of the original new series engraved 1-inch maps of Great Britain and Ireland, both in outline and with hills. The progress made on the revision of the new series of 1-inch engraved outline maps of Great Britain and Ireland, and the commencement of the issue for Scotland and the North of England (and for Ireland ultimately) of the same revised 1-inch map with hills in brown by double printing. The progress made with coloured 1-inch maps of the South of England. The progress made with maps on scales smaller than 1 inch to a mile.

A short account was given of the nature, causes, and results of the changes made since 1887 in the system of carrying out the survey, some of which were due to the reports of committees, or suggestions from the general public, while others have been necessitated by the changes which have taken place in the character of the work done by the Department.

The Ordnance Survey Department, in 1887, published town maps at the cost of the State, on the scales of 10 feet ($\frac{1}{500}$) and 5 feet ($\frac{1}{1056}$) to a mile. It does so no longer. The reason for this change was stated. The sales of the Ordnance Survey maps were in 1887 in the hands of the Stationery Office; they are now in the hands of the Ordnance Survey Department itself. The reasons for and results of this change were stated.

Some remarks were also made as to the organisation and superintendence of the department and of its work; as to the use made of the Ordnance Survey maps by other departments of the State and by the public generally; and as to the important work which still remains to be done by the Ordnance Survey.

Mr. Vaughan Cornish described the sand-dunes bordering the delta of the Nile dealing with the ripples, sand-dunes, and dune-tracts in turn.

Ripples.—The author had previously measured twelve wind-formed ripples in the blown sea sand on the Dorset coast. The average ratio of length to height was L/H = 18·4. The least height was ·06 inch, and the greatest ·34 inch. These measurements were, for the most part, of one or two individual ripples. Mr. E. A. Floyer measured six of the largest kind of ripples on the El Arish route, and obtained L/H = 17·7 with H from 6 to 10·6 inches. The author measured thirty-seven *consecutive* ripples to leeward of a sand-dune near Ismailia. The ripples had an average height of 1·43 inches, and the average L/H was 16·57. The appearance of these was intermediate between that of ripples where accumulation is rapid (which never grow large), and the large and nearly symmetrical ripples (? analogous to sastrugi), as much as 11 feet in wave-length, the formation of which is apparently accompanied by a considerable lowering of the general level.

Dunes.—A tract of a few hundred acres of small, but true, dunes (not ripples) on a sandy foreland, exposed during the fall of the Nile, afforded an opportunity for similar measurements.

Higher and lower dunes succeeded one another, and, viewed transversely, the ridges were strongly undulating. Nevertheless, a line having been marked out in the up-and-down-wind direction, the *average* L/H for twenty-four consecutive dunes was found to be 18·04, average height 20 inches. Another set of measurements taken near the same line on the succeeding day gave L/H = 17·89 for twenty-three consecutive dunes. Apparently the ridges are formed of the nearly uniform (L/H = 18) shape, and lateral inequalities are subsequently developed in the manner explained in the *Geographical Journal*, June 1898, pp. 637–9, but these do not affect the *average* L/H. The author hopes to make similar measurements of trains of larger dunes.

The straight, slipping lee cliff of dunes is caused by the undercutting of the eddy. In the dunes near Ismailia a progressive development of the profile form was observed. At first both windward and lee slopes are very gentle, and the highest point is near the middle. The summit apparently moves to leeward, and the lee slope becomes steeper; a slipping cliff is formed on the upper part of the lee slope. This pushes back towards the summit, and the windward slope grows steeper. Finally, windward and average leeward slope become of nearly equal steepness, and the top of the cliff coincides with the summit of the dune.

Dune Tracts.—The condition for formation of a dune tract in a sandy district is that the rate of travel of the sand should be locally diminished without a corresponding diminution in the supply of sand. The persistence of such a condition may cause a stationary dune massif without fixation.

In the sandy district visited by the author the formation of a dune tract or dune massif appears to be chiefly determined by the presence of ground moisture, which gives coherence to the sand. Thus the boundaries of these massifs frequently appear inexplicable when an explanation is sought in the wind. Within the bounds of the massif, however, the modelling of the surface is explicable by the action of the winds. In the neighbourhood of Helwan, wind erosion of limestone and other rocks is very active over areas where there are no dunes. An examination of the wind-formed detritus showed a quantity of sand-sized particles sufficient for the formation of dunes; and the explanation of their non-formation seems to be that the sand-sized particles are too small a *proportion* of the whole. According to this line of reasoning, dunes will only be formed where dust formation proceeds slowly, for if dust be produced rapidly the proportion of sand-sized particles remains low.

Travel papers, for the most part accompanied by graphic illustrations, were contributed by Mrs. W. R. Rickmers on the rarely visited region of Eastern Bokhara, by Mr. W. R. Rickmers on the Karch-Chal mountains in Transcaucasia, by Dr. H. O. Forbes on the island of Sokotra, by Mr. O. H. Howarth on the province of Oaxaca in Mexico, by Dr. A. C. Haddon on some geographical results of the recent Cambridge anthropological expedition to the Malay Archipelago and New Guinea, and by Captain Wellby on a remarkable journey through the western borderlands of Abyssinia. Mr. E. Heawood contributed a paper on the date of the discovery of Australia, in which he brought forward evidence for discrediting the rumours of the discovering of Australia in the fifteenth century or the early part of the sixteenth.

The eighth report of the Committee on the Climatology of Tropical Africa was presented, giving records from forty stations.

MECHANICS AT THE BRITISH ASSOCIATION.

MEETING under the presidency of Sir William White, Chief Constructor of the Navy, naturally the papers which came before the Section dealt mainly with marine engineering, canal and harbour works, and allied subjects.

Owing to the energy of the President a very complete programme was secured; and the papers read and discussed were certainly considerably above the average. The attendance at the sectional meetings was also much better than usual.

On the opening day, after the presidential address, a paper by Messrs. Coode and Matthews on the Admiralty harbour works at Dover was submitted to the Section. It was taken early in the programme in order that the engineers present at the meeting who naturally wished to carefully inspect the magnificent works now in progress at Dover, which will render that port one of the finest in the kingdom, should hear beforehand an account of what it is intended to do from the engineers responsible for the design. In the discussion the difficulties which have been brought about by the more rapid advance of the Commercial Harbour Pier, as compared with the extension of the Admiralty Pier, were much in evidence; but this, after all, is only a question of a more or less ephemeral character, and it is a pity that the discussion did not turn more upon the merits of the particular plan which has been adopted in the construction of this great harbour. It is noteworthy that the general scheme of the present plan differs but little from previous proposals; only that additional deep-water space has been obtained.

If the sanguine expectations of the people of Dover are in any way fulfilled, Dover on the completion of these works will prove a formidable rival to Southamption; before, however, any such rivalry can become serious, Dover must be provided with a railway service on an entirely different scale from that now supplying the wants of the town. The service is inadequate; it is frequently unpunctual, and contrasts most unfavourably with the splendid service which the South-Western Company have organised between Southampton and London.

The other paper taken on the opening day was one descriptive of a process for rendering wood non-flammable. Specimens of wood treated by this process were exhibited, and a practical demonstration of its non-flammability was given at the meeting. The President mentioned in the discussion that the Admiralty have not been satisfied with other people's experiments; they have themselves experimented on wood treated in this way, and have satisfied themselves that the process is a successful and valuable one. It is, however, not only in ships of war, but also in passenger steamers and in the gigantic modern hotels that the use of non-flammable wood will have its application, in spite of the extra cost of the finished wood when treated by this process.

On Friday a paper prepared by Sir Charles Hartley, descriptive of the engineering works of the Suez Canal, was read by Sir John Wolfe Barry in the absence of the author. This paper was one of the greatest interest, giving a complete history of the engineering features of the canal, of the enormous growth of the traffic through the canal, and of the gradual steps which have been taken to provide for that increased traffic, both by widening and deepening the original cutting. How great a change has been brought about in the time of transit by the use of the electric light for enabling night passages to be made can only be realised by a study of the figures given by the author as to the present time of transit compared with what it was ten years ago.

The second paper on Friday was the one that proved, perhaps, the most attractive of all on the programme of the Section. It was a short paper by Mr. Parsons, with details of the fast cross Channel and Atlantic liners which he proposes should be driven by his steam turbines. Models of the proposed vessels were shown, and a working model of a set of steam turbines to show how simple it was to run astern.

Considering how frequently the wildest statements are made as to the possible speed of mail steamers and smaller fast passenger boats, it is noteworthy that Mr. Parsons proposes quite moderate speeds in his liners and cross-Channel steamers. This paper was made more interesting from the figures which the President had given, in his address to the Section, on the question of the relation of power to speed and displacement.

The President had shown conclusively how impossible it was to apply results deduced from small vessels to large vessels; and his calculations as to the enormous power required to drive one of the large vessels at high speeds show that we have little hope of obtaining such speeds with present conditions.

Mr. Parsons in his paper fixed the speed of his cross-Channel boat at thirty knots, and although the boat is only to have a 1000 tons displacement, it will require 18,000 horse-power to maintain that speed. He did indeed hint at an express-Channel steamer which should attain a speed of forty knots, but only at the expenditure of 50,000 horse-power: figures which are likely to damp the enthusiasm of any ship-owner or ship-builder. His Atlantic liner was to have a displacement of 18,000 tons and a speed of twenty-six knots, with an indicated horse-power of 38,000.

The paper which followed Mr. Parsons' was an extremely interesting and valuable one by Mr. Mark Robinson, on the Niclausse water-tube boiler. It came as a natural corollary to Mr. Parsons' paper, because Mr. Parsons had stated in his communication that his proposed steamers would be fitted with the water-tube type of boilers. The interest which has been aroused, and the controversy which has arisen over the introduction of water-tube boilers into the Royal Navy also made this paper one of considerable importance. The author only described fully the particular type of boiler with which he was most familiar, namely, the Niclausse; but the general conclusions and the general results apply equally to all boilers of this type.

Mr. Robinson pointed out in his paper that the Niclausse boiler as now made in this country, or rather as it will be constructed in this country when the plans now being made are completed, is very different from the Niclausse boiler which was fitted into one of the ships of the navy some years ago.

For reasons which are quite satisfactory the Admiralty have not yet been able to satisfactorily test these Niclausse boilers; and now in view of the great changes in the mechanical details of this type of water-tube boiler, interest in the results of their tests will be more or less discounted.

There is no doubt that this boiler will be one of the most satisfactory in its mechanical details of all the water-tube type, and will have a great future, both for sea-going purposes and on land as well.

One set of figures given by the author to show the advantage of the extremely short time required for removing and replacing a tube or tubes is worth quoting. In one instance the boilers were blown down, three tubes removed and replaced by others, and pressure got up again in thirty-five minutes from the time the operation started.

The concluding paper on Friday was one by Captain Lloyd, describing a method which has been developed at Elswick for discharging torpedoes below water from the broadside of a ship when steaming at a high speed. The problem, a most difficult one in all its mechanical details, has been successfully surmounted, and a considerable number of these submerged tubes have been already fitted, and a large number are in the process of fitting at the present time. The paper was, of course, a highly technical one; but the admirable diagrams which had been prepared rendered it easy to follow the working of the mechanism from the firing of the cordite charge to the exit of the torpedo from the tube.

Saturday was fixed by the authorities as the day upon which the French Association would pay their official visit to the British Association, and the paper which was read before the Section, reinforced by a considerable number of French engineers, was one by a distinguished French engineer, M. Alby, describing the construction and erection of the Alexander III. bridge over the Seine in Paris. This bridge forms part of the Great Exhibition of 1900, and is situated on the line of the Great Avenue which will connect the Champs Elysée with the Esplanade des Invalides. Æsthetical considerations, therefore, have played a most important part in the design which has been adopted. A low-arch form of bridge was the only acceptable one, and the great horizontal thrust produced by such a type of arch has given the engineer a very anxious task in the design of his abutments. A full description of the bridge was given, and of the costly but necessary temporary structure or travelling bridge, as the author termed it, by means of which the erection of the bridge proper has been carried out. During next year engineers will have an opportunity, when visiting the Exhibition, of admiring the beauty and harmony of the design, and the skill with which the great difficulties met with have been overcome.

Monday, as usual the electric day, was not in this instance productive of anything very striking. Perhaps the most interesting communication was one by Mr. Cowper-Coles on some recent applications of electro-metallurgy to mechanical engineering. The author described a very beautiful process for the electrolytic manufacture of projectors for search lights for naval and military operations. A projector made by this process was exhibited to the meeting, and figures were given to show that the fine coating of palladium used protects the silver-faced projector from any injury owing to the intense heat of the arc-light, the pure silver face being found to tarnish very rapidly in consequence of the intensity of the heat.

Some brief notes by Mr. A. Siemens on electrical machinery on board ship were interesting because they gave the President the opportunity of refuting the common notion that we are behindhand in the application of electricity to ammunition hoists and other purposes in our navy. The President pointed out that in matters of this kind the opinions and the wishes of those who have to work the appliances must be taken into account.

The concluding day was devoted to several papers of extreme interest. The business was begun with the consideration of a paper by Mr. Thornycroft on recent experiences with steam on common roads. After dealing with the impediment to progress due to the Locomotives on Highways Act of 1896, and making suggestions as to the steps which should be taken to remove these obstacles in future legislation, the author gave an extremely valuable *résumé* of his own work in this field of mechanical science. He described the different types he has built since 1896, and the chief changes in the mechanical details which experience has convinced him to be necessary. He has built vehicles both for heavy goods traffic and for passenger traffic, and has adopted a method of chainless transmission in his most recent type. The author in conclusion pointed out that, after all, in motor work a good deal depended upon the care and intelligence of the driver employed.

A paper by Mr. Edward Case, who, we regret to say, died only a few days after the paper had been read, descriptive of the Dymchurch sea-wall and the reclamation of the Romney marshes, was next taken. These reclamation works are of great antiquity; in modern times the erection of high groynes for the protection of the wall brought about that which they were expected to prevent, namely, the undermining of the wall. Mr. Case decided, when he took over control in 1890, to adopt an entirely different system, and since 1894 a number of low groynes have been run out; the result of which has been to raise the level of the fore-shore as much as 8 feet at the east end of the wall. These groynes have been constructed in such a way that they can be gradually raised as the level of the beach gets higher, at a very trivial expense and with very little difficulty.

The Section meeting was, as has been stated before, an extremely successful one: the quality of the papers being high, the discussions good, and the attendance throughout thoroughly satisfactory. There can be no doubt that a great deal of this was due to the energy and the interest taken by the President in the work of the proceedings. It is too often forgotten by Presidents of Sections that the success of any particular Section is almost entirely in the hands of its President.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The 204th meeting of the Junior Scientific Club was held in the University Museum on Friday, October 20. Mr. Hartley (Balliol) read an interesting paper on the history of the discovery of the law of isomorphism.—Owing to the length of important private business Mr. Gibson (Ch. Ch.) was unable to read his paper on the retention of food by plant soils, as announced.—The following are the officers for the ensuing term:—J. T. Mance (Balliol), pres. H. E. Stapleton (St. John's), chem. sec. C. H. Barber (non-coll.), biol. sec. F. W. A. Fleischmann (Magd.), treasurer. F. W. Charlton (Merton), editor.

The examiners have notified to the Vice-Chancellor that they recommend for election to the Burdett Coutts scholarship, which is of the annual value of about 115*l.* and tenable for two years, Mr. J. B. Scrivenor, Commoner of Hertford College. They also recommend that Rev. E. C. Spicer, Commoner of New College, be appointed an extra scholar, to retain his scholarship for one year.

CAMBRIDGE.—St. John's College has once more shown its appreciation of scientific merit by electing to fellowships Mr. J. J. Lister, University Demonstrator of Comparative Anatomy, and Mr. A. C. Seward, University Lecturer in Botany. Mr. Lister, who has done important work on the *Foraminifera* and other groups, is a nephew of the President of the Royal Society, and son of Mr. Arthur Lister, who was last year elected a Fellow of the Society. Mr. Seward is a Fellow of the Royal and Geological Societies, and has attained a high position as an authority on fossil plants. The first volume of his treatise on this subject was reviewed in NATURE (December 15, 1898). He has held the Harkness Studentship in Palæontology, and gained the Sedgwick Geological Prize in 1892. Both gentlemen are Masters of Arts of the College of some years' standing, and have been elected out of the ordinary course.

Mr. J. L. Tuckett, Fellow of Trinity College, has been appointed an additional Demonstrator of Physiology by Sir M. Foster.

Prof. G. Sims Woodhead has been elected to a Fellowship at Trinity Hall.

THE details of the reorganisation of the Education Department and the transference of its duties to the new Board of Education are under consideration by a departmental committee; and the committee of the City and Guilds of London Institute have signified their willingness to give any help which may be needed to secure the proper recognition of technological teaching in the arrangements about to be made. Reference to this matter is made in the report of the examinations department of the Institute issued a few days ago. It is remarked that, having regard to the Institute's close connection with technical teaching in all parts of the country, no organisation of education can meet existing requirements which does not take into consideration the educational work now under the immediate direction of the Institute. The report further states that the committee fully recognise how desirable it is to avoid, as far as possible, any overlapping in the organisation of the classes and examinations directed respectively by the Science and Art Department and by the Institute; and they are of opinion that, with the view to the due encouragement of practical instruction in the technology of the different trades in which artizans are employed, the teaching of technology should be placed on the same basis, with respect to State aid, as that of science or art.

MR. A. E. BRISCOE, the principal of the West Ham Municipal Institute, sends a few particulars of the loss caused by the disastrous fire which occurred a few days ago. The whole of the upper floor of the building, including the chemical, art and women's departments, the engineering and physical lecture theatres, the drawing office and the engineering laboratories have been completely gutted. The chemical and art departments are the greatest sufferers, but there is not much to choose between them and what has happened to the others. The electrical and physical laboratories were flooded by the water, and a great many expensive instruments have been damaged by water; but the galvanometers and some of the other expensive things were on shelves covered by dust-covers, so that they have escaped damage. The expensive machinery in the engine and dynamo laboratories and in the engineer's workshop has not suffered by fire, but, of course, tons of water have fallen upon it, and a very great amount of damage has been done. The institute was covered by insurance to the extent of 47,000*l.*, and it is believed the total damage will not reach this amount. Of course, nothing can compensate for the large amount of work that has been done by the staff in the equipment of the institute, and will now have to be done all over again. Though the borough is not a rich one, it is satisfactory to know that the institute will be rebuilt and probably enlarged, as the classes were already too great for the accommodation. The fire commenced in the advanced chemical laboratory, but the origin is absolutely unknown. The building had not been used for thirty-six hours prior to the outbreak.

SCIENTIFIC SERIALS.

Symons's Monthly Meteorological Magazine, October.—Meteorological extremes. II. Temperature. Mr. Symons has collected a large amount of useful information upon this subject from all trustworthy sources. For yearly mean temperatures preference is naturally given to Dr. Buchan's isothermic charts published in the *Challenger* volume, "The Circulation of the Atmosphere." The highest yearly isotherms are 85°, and these occur only in three localities, the largest covering a portion of Central Africa, bounded on the north by latitude 18° N. Two smaller areas exist, one in Central India and the other in the northern portion of South Australia, respectively in latitude 15° N. and 15° S. The absolute range of the shade temperature in the northern hemisphere, and probably in the world, is 217°·8, depending on the absolute maximum of 127°·4 in Algeria, July 17, 1879, and the absolute minimum of −90°·4 at Verchoiansk, Siberia, January 15, 1885. The hottest region is on the south-western coast of Persia, where the thermometer has been known not to fall lower than 100°, night or day, for orty consecutive days during July and August, and often to reach 128° in the afternoon. Among the highest shade temperatures we may mention one at night during the Italian occupation of Massowah, when the thermometer is said to have recorded 122°. Temperatures above 120° are occasionally met with in India; 121°·5 was recorded at Dera-Ishmail-Khan (lat. 32° N.) in 1882, and 126°·0 at Bhag (lat. 29° N.) in 1859. At Wilcannia on the Darling River, New South Wales, shade temperatures varying from 107° to 129° were recorded on each day from January 1 to 24 in 1896. Among the low temperatures (in addition to the extremes mentioned above) we may quote −63°·1 at Poplar River, North America, in January 1885. During the intense frost in Scotland on December 4, 1879, −16° was reported from Kelso and −23° from Blackadder, in Berwickshire. The extremes in or near London for 104 years were 97°·1 in July 1881, and 4° in December 1796 and January 1841.

THE *Journal of the Royal Microscopical Society* for October contains a short paper (with plate) by Mr. James Yate Johnson on some sponges belonging to the Clionidæ obtained at Madeira, in which three new genera are established, named *Acca*, *Nisella* and *Scantilla*. In the section on microscopy is a description of an old compass microscope taken from a German work on the microscope by Martin Frobenius Ledermüller (1763), called Russwurm's "Universal Microscope," which appears to have been a combination of compass and tube microscope in an unusual number of forms; also a description of "Adams' Compendious Pocket Microscope" (1771), which more nearly conforms to the microscopes of the present day than any of those which preceded it. In the section on technique several new pigments are described, also two new methods for orienting small objects.

Bollettino della Società Sismologica Italiana, vol. v., Nos. 2, 3. 1899–1900.—Vertical component microseismograph, description and results, by G. Vicentini and G. Pacher. A reprint of a paper already noticed in NATURE.—Supplementary considerations with regard to the Umbria-Marches earthquake of December 18, 1897, by A. Issel.—The earthquake in the Parma-Reggio district of the Appennines during the night of March 4–5, 1898, by C. Agamennone. The shock was felt over an acre of about 70,000 sq. km., and was also recorded by horizontal pendulums at Strassburg and Shide; the velocity of the earth-waves will be considered in another paper.—The Hereford earthquake of December 17, 1896, by C. Davison. A summary (in English) of the writer's report on this earthquake.—Notices of the earthquakes recorded in Italy, February 5 to April 23, 1898; the most important being those of Asia Minor on February 5, Cividade (Udine) on February 20 and April 12, Reggio and Parma on March 4, Ferrara on March 9, and distant earthquakes on February 18 and April 15 and 23.

SOCIETIES AND ACADEMIES.

Physical Society, October 27.—Prof. W. E. Ayrton, F.R.S., Vice-President, in the chair.—Dr. S. W. Richardson read a paper on the magnetic properties of the alloys of iron and aluminium. Observations were made upon four alloys containing respectively 3·64, 5·44, 9·89 and 18·47 per cent. of aluminium. The alloys were used in the form of anchor rings, and were wound with primary and secondary coils separated by asbestos paper. The temperatures used ranged from −83° C. to 900° C. The low temperatures were produced by the rapid evaporation of ether surrounded either by ice and salt or by carbon dioxide snow. The high temperatures were obtained either electrically or by gas muffles. In both cases the actual temperatures were deduced from the resistance of the secondary, which was made of platinum wire and wound next the metal. The author employed Maxwell's null method of measuring mutual induction, increasing the sensitiveness by the introduction of a secohmmeter making about three revolutions per second. In order to test the accuracy of the method some of the experiments were repeated with a ballistic galvanometer in the ordinary way, and the agreement obtained between the results in the two cases was well within the limits of experimental error. The chief conclusions to be drawn from the experiments may be summed up as follows: (1) The alloys behave magnetically as though they consisted of two distinct media superposed. (2) The general roundness of the curves and their lack of abruptness near the critical point seems to indicate that the alloys are heterogeneous in structure. (3) The permeability decreases with rise of temperature near the critical point until a minimum value is reached, when further rise of temperature produces very slight diminution, if any, in the permeability. (4) The experiments suggest that the maximum value of the permeability for an alloy containing 10 per cent. of aluminium is reached at about −90° C. (5) An alloy containing 18·47 per cent. of aluminium has a critical point at about 25° C., and gives no indication of temperature hysteresis. This alloy probably has a maximum permeability much below −90° C. The author has found that at high temperatures there is a second maximum on the induction curve. This maximum becomes less and less noticeable as the field is increased.—The Secretary read a note from Prof. Barrett on the electric and magnetic properties of aluminium and other steels. The first part of the note dealt with the electrical conductivity of various alloys, and discussed the effect of composition and annealing upon the value of the conductivity. The second part of the note referred to magnetic effects. The most remarkable effect produced by aluminium on iron is the reduction of the hysteresis loss. The permeability of nickel steels is shown to be very much influenced by annealing. It is found that the addition of a small quantity of tungsten to iron hardly affects the maximum induction, yet increases the retentivity and coercive force. The experiments show that the best steel for making permanent magnets is one containing 7½ per cent. of tungsten. The magnetometric method was employed throughout. Prof. S. P. Thompson drew attention to the wide range of temperature over which the author had conducted his experiments, and also to the small number of alloys used. He said a very much finer connection between the properties could be obtained from the examination of more alloys, and expressed his interest in the existence of the second maximum on the induction curve. He would like to know how the percentage composition of the alloys had been determined. Turning to Prof. Barrett's note, Prof. Thompson referred to the difference in the breadths of the hysteresis curves for aluminium and chromium alloys. Mr. Appleyard asked for information upon the permanence of the curves. Dr. Richardson, in replying, said the compositions were determined by analyses made after the experiments had been performed. It was proposed to carry on the research upon a series of aluminium alloys which he had obtained. The Chairman expressed his special interest in the agreement which the author had obtained between the ballistic method and the null method of Maxwell increased in sensitiveness by the secohmmeter.—Mr. Addenbrooke exhibited a model illustrating a number of the actions in the flow of an electric current. The model consisted of a spiral of steel wire in the form of a closed circuit. Inside the spiral was placed a wire which was supposed to be carrying the current, and which directed the motion of the spiral. A rotational movement given to one part of the spiral was transmitted by the wire, and produced a rotational movement at another part of the spiral. The resiliency of the spring represents capacity, and the torque electromotive force. Self-induction can be represented by weighting the spring. Prof. Everett expressed his interest in the way that the correspondence between the propagation and rotation agreed with that between the direction of a current and the direction of the magnetic force. Prof. S. P. Thompson agreed that many analogies could be worked out by the model, but gave one or two examples to show that erroneous conclusions might be drawn by pushing the analogy too far.—Mr. W. Watson repeated some experiments with the Wehnelt interrupter devised by Prof. Lecher. The experiments showed in a clear and striking manner the fact that subsequent sparks tend to pass through the portion of air heated by the first one. In the first experiments motion of the heated air was caused by differences in density, and in the later experiments by allowing the sparks to take place in a strong electromagnetic field. The continuous rotation of the spark in a given field proved the unidirectional nature of the discharge. In reply to Mr. Blakesley, Mr. Watson said he used the word "ionised" in his explanations to express simply the fact that the air had been rendered a conductor by the passage of the spark. The Chairman referred to one of the first experiments performed. In this experiment the electrodes consisted of two copper wires in a vertical plane, slightly inclined to one another and nearest together at their lowest points. On switching on the current the spark passed between the lowest points; but as the ionised air ascended so did the most conducting path, and consequently the spark worked its way to the top of the electrodes. Here the heated air passed away and the spark returned to the lowest point to rise again. The Chairman thought that these effects might be due to the magnetic forces produced by the circuit itself. That similar effects in the arc light were due to this cause had been proved many years ago. Mr. Watson repeated some of the experiments under new conditions, and proved that the explanation of the phenomena was not to be found in the tendency of the circuit to enlarge itself owing to magnetic forces. Mr. Boys pointed out that the relation of the heating effect to the current, which was small in the arc light, was very large in the case of the spark discharges used, and therefore the movement of the spark in the latter case was practically determined by the heating effect in consequence of the relatively small importance of the electromagnetic effect. Prof. S. P. Thompson remarked that similar effects could be produced by an alternating current working an ordinary induction coil. —The Society then adjourned until November 10, when the meeting will be held in the Central Technical Institute.

PARIS.

Academy of Sciences, October 23.—M. van Tieghem in the chair.—On the simultaneous occurrence of phenomena of oxidation and hydration at the expense of organic substances under the influence of free oxygen and light, by M. Berthelot. Experiments were carried out on the slow oxidation of ether in presence of water and air, or of hydrogen peroxide. Practically no oxidation of moist ether takes place in the dark, either with air or hydrogen peroxide. After five months' exposure to light in a sealed tube, the air remaining over the ether contained no trace of free oxygen, but some aldehyde, acetic acid, and alcohol were found in the ether. A little methane is formed at the same time. Two chemical reactions are thus shown to go on together, a hydration and an oxidation. The author considers that similar reactions go on in nature, such substances as the sugars and carbohydrates, glycerides, &c., undergoing simultaneous hydration and oxidation.—Equilibrium of a vessel carrying liquid, by M. Appell. The author has shown in a previous paper on the same subject that the determination of the positions of equilibrium of a vessel with a liquid cargo may be reduced to the determination of the smallest value of the distance between two parallel planes tangential to two given surfaces. The problem is now simplified to finding the shortest distance of a fixed point to a tangent plane to one surface.—Observations on a note by M. Blondel, relating to the reaction of induction in alternators, by M. A. Potier.—On certain remarkable surfaces of the fourth order, by M. G. Humbert.—On the determination of the coefficient of solubility of liquids, by MM. A. Aignan and E. Dugas. In a previous paper by the authors it is shown how to determine the coefficients of reciprocal solubility of two non-miscible liquids when no contraction takes place. In the present paper, expressions are developed in which this restriction is removed, and the results are applied to experiments on mixtures of aniline and water, and amyl alcohol and water.—On merogonic impregnation and its results, by M. Yves Delage. The results published by the author a year ago showing the possibility of producing an embryo from a portion of an egg not containing a nucleus have now been extended. The fertilisation of non-nucleated ovular cytoplasm is not limited to the echinoderms. It is found in some molluscs, and in the annelid *Lanice conchylega*. Since it can no longer be looked upon as a biological curiosity, but is a process which may be generalised, the author proposes to give it the name of merogony.—The affinities and the property of absorption or arrest of vascular endothelium, by M. Henri Stassano. It is shown that it is the affinity of the vascular endothelium for mercury which is the cause of the predominance of this poison in the organs containing the most blood. This endothelium also appears to act in the same way with other poisons, such as strychnine and curare.—Death by the electric discharge, by MM. J. L. Prevost and F. Battelli. From a series of experiments on dogs, rabbits and guinea-pigs, the authors conclude that the fatal effects of the electric shock are proportional to the energy of the discharge, and are not proportional to the quantity of electricity passing.—The grafting of some monocotyledons upon themselves, by M. Lucien Daniel. After many unsuccessful attempts, it has been found possible to graft a part of a monocotyledon (Vanilla and *Philodendron*) upon itself. The success depends largely upon the extent of the surfaces in contact.—*La graisse*, a bacterial disease of the haricot, by M. Delacroix. The disease is probably identical with that recently described by M. E. F. Smith as affecting the haricot in the United States, and the bacillus from which is named *Bacillus phaseoli*. No curative treatment of the living plant would appear to be possible.—Observations relating to the deposit of certain calcareous travertins, by M. Stanislaus Meunier.

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 2.

LINNEAN SOCIETY, at 8.—On the Proliferous State of the Awn of Nepal Barley: Rev. Prof. Henslow.—On the Hyobranchial Skeleton and Larynx of the New Aglossal Toad, *Hymenochirus Boettgeri*: Dr. W. G. Ridewood.—On the Eye-spot and Cilium in *Euglena viridis*: Harold Wager.

CHEMICAL SOCIETY, at 8.—The Theory of Saponification: J. Lewkowitsch. —The Action of Dilute Nitric Acid on Oleic and Elaidic Acids: F. G. Edmed.—Tetrazoline: Siegfried Ruhemann and H. E. Stapleton.—On Ethylic Dibromobutanetetracarboxylate and the Synthesis of Tetrahydrofurfuran-$\alpha\alpha'$-dicarboxylic Acid: Dr. Bevan Lean.—(1) Camphoroxime. Part III. Behaviour of Camphoroxime towards Potassium Hypobromite; (2) Optical Influence of an Unsaturated Linkage on certain Derivatives of Bornylamine: Dr. M. O. Forster.

CAMERA CLUB, at 8.15.—Scenery in the Canary Islands: T. C. Porter.

TUESDAY, NOVEMBER 7.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Address by the President, Sir Douglas Fox, and presentation of Prizes.

ANTHROPOLOGICAL INSTITUTE, at 8.30.—Notes on the Ethnology of Tribes met with during progress of the Juba Expedition of 1897–99: Lieut.-Colonel J. R. L. Macdonald, R.E.

THURSDAY, NOVEMBER 9.

MATHEMATICAL SOCIETY, at 8.—Certain Correspondences between Spaces of n Dimensions: Dr. E. O. Lovett.—On the Form of Lines of Force near a Point of Equilibrium; The Reduction of Conics and Quadrics to their Principal Axes by the Weierstrassian Method of reducing Quadratic Forms; and on the Reduction of a Linear Substitution to a Canonical Form; with some Applications to Linear Differential Equations and Quadratic Forms: T. J. I. Bromwich.—On Ampère's Equation $Rr+2Ss+Tt+U(rt-S^2)=V$: Prof. A. C. Dixon.—The Abstract Group isomorphic with the Symmetric Group on k Letters: Dr. L. E. Dickson.

FRIDAY, NOVEMBER 10.

ROYAL ASTRONOMICAL SOCIETY, at 8.

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THURSDAY, NOVEMBER 9, 1899.

THE GEOLOGY OF THE SOUTHERN UPLANDS OF SCOTLAND.

The Silurian Rocks of Britain. Vol. I. Scotland. By B. N. Peach, F.R.S., and J. Horne, F.R.S.E.; with Petrological Chapters and Notes by J. J. H. Teall, M.A., F.R.S. Pp. xviii + 749; plates xxvii, and a coloured map. (Memoirs of the Geological Survey of the United Kingdom, 1899.)

THE student of historical geology, in his endeavour to obtain a comprehensive view of the sequence of events in a particular area, is too frequently conscious that he is gazing at a distorted picture. It is probably beyond the power of any one person to gather together the tangled mass of detail, and by a process of anamorphosis, to illustrate the geology of even a single country in such a manner that while the proportions of the whole work are harmonious, every important detail is also presented with conspicuous clearness. But that which is too much for one person may be carried out by a band of workers under the direction of one chief; and fortunately we in Britain, the mother-country of stratigraphical geology, not only possess this band, but know that it is actually engaged in the accomplishment of the desired work.

It is now some years since the first volume of a series of memoirs devoted to a detailed study of the various great groups of the British stratigraphical rock-column was issued by H.M. Geological Survey. This series, when complete, will place within reach of the geologist a history of the British strata, of which we cannot overestimate the value. The Jurassic rocks of Britain have already been described in two volumes: one, by Mr. Fox-Strangways, treating of the Jurassic rocks of Yorkshire; the other, by Mr. H. B. Woodward, describing those of the other British areas. Another volume, by Mr. Clement Reid, is devoted to the Pliocene strata, and we are now presented with the first volume of the series in which the British Silurian rocks will be described, the particular volume under consideration containing an account of the Silurian rocks of Scotland.

The most important area of Silurian rocks in Scotland is developed in the Southern Uplands, and to consideration of this area the present volume is essentially confined. It is noted, however, that igneous rocks and radiolarian cherts have been detected along the southern border of the Eastern Highlands; and in this connection it is interesting to note that Hugh Miller in his "Rambles of a Geologist" records, on the authority of Dr. Emslie, the occurrence of graptolites in a slate quarry at Gamrie Head, near Banff.

In glancing at the memoir by Messrs. Peach, Horne and Teall, we are at once struck with the fact that the great bulk of the contents consists of records of fresh observations. The amount of work which the authors have performed in the field and the laboratory is surprising even to the general reader, still more so to any one who from some knowledge of the area is cognisant of its extraordinary complexity.

Great as the amount of new work recorded in this volume undoubtedly is, the authors took up their study of the region subsequently to its description by a number of other geologists, of whom the illustrious Hutton was the first, while Prof. Lapworth, as is well known, reduced the stratigraphy of the area to order in several masterly papers appearing in the *Quarterly Journal of the Geological Society*, the *Geological Magazine*, and the *Annals and Magazine of Natural History*. The importance of Prof. Lapworth's work is acknowledged in the volume under notice, in the fullest manner, both in the chapter devoted to the history of previous researches in the south of Scotland and in those which treat of the geology of the region in detail.

Though Lapworth led the way to appreciation of the complicated nature of the geology, the authors of the memoir have not only verified his conclusions, but added a great deal of confirmatory matter, and have furthermore made a series of discoveries which throw light upon questions of prime importance to geologists.

Among the discoveries which are of general interest as shedding light upon geological matters of widespread importance, we may notice the discovery of Arenig graptolitic mudstones, radiolarian cherts and contemporaneous volcanic rocks over very wide tracts of country in the Southern Uplands and South-eastern Highlands; the detection of the occurrence of further volcanic outbursts in Llandeilo and Caradoc times; the evidences of the lateral variations in the sediments of different ages indicating a source of supply of terrigenous sediment to the north-west of the area, and of the gradual encroachment of the coarser sediments to the south-east, in the later periods of Silurian times; the definition of a Downtonian period between Ludlow and Old Red Sandstone times, and the description of the rocks of this period; and the discovery of a remarkable fauna of fishes in these Downtonian strata, which has been described by Dr. Traquair. The above discoveries are mainly due to Messrs. Peach and Horne, who, like Lapworth, have chiefly utilised the graptolites as a means of comparing the strata of different localities, though they have also obtained much assistance from the persistent cherts, which, as shown many years ago by Dr. G. J. Hinde, were largely formed by the accumulation of tests of radiolaria. The writers appear to adopt the suggestion that these radiolarian cherts are deep-water deposits, though, in consideration of the evidence which they adduce in support of the existence of a tract of land at no great distance to the north-west, it seems doubtful whether the cherts are strictly comparable with the abyssal radiolarian oozes of modern oceans. Mr. Teall gives a petrographical account of the remarkable volcanic rocks associated with the radiolarian cherts, and of the contemporaneous volcanic rocks of higher strata; also a description of the intrusive rocks of the Girvan and Galloway district, with details of the nature of the metamorphism impressed upon the rocks surrounding the irruptive igneous masses. One exceedingly significant suggestion is made to the effect that the coarsely crystalline plutonic rocks were consolidated beneath a small thickness of overlying rock-cover, though it is stated that the evidence for this is imperfect.

The results of the palæontological investigations are summarised in lists of fossils, occupying about fifty pages at the end of the work; these, and the detailed lists of fossils appearing throughout the book, will be of the utmost value to the stratigraphical palæontologist.

The form in which the book is presented to the reader is excellent, and the work is well illustrated. In addition to the numerous diagrams and sections illustrative of the geology of the area, which are scattered through the memoir, there are seventeen plates reproduced from photographs illustrating the appearance of some of the sediments, including the radiolarian cherts, and especially of the volcanic rocks, both lavas and fragmental accumulations; in connection with the lavas, we may particularly note the illustrations of the remarkable rocks with "pillow-form" structure which are associated with the radiolarian cherts. Of the remaining plates, eight represent microscopic sections of various rocks, while two are devoted to illustrations of characteristic graptolites. In addition to these plates, there is a well-coloured geological map of the area, on the scale of ten miles to the inch.

The third chapter of the book, in which the authors give a general description of the Silurian rocks of the Southern Uplands, will be read by all geologists; the detailed descriptions in the other chapters will be largely utilised by those who visit the region; and, if we mistake not, these visitors will in future become very numerous, attracted to the district owing to the publication of a memoir upon a region of exceptional complexity but also of exceptional interest—a memoir which will at once take its place as a classic in geological literature. J. E. M.

THE PHILOSOPHY OF ATOMIC THEORIES.

Essai critique sur l'Hypothèse des Atomes dans la Science contemporaine. Par Arthur Hannequin, Professeur à la Faculté des Lettres de l'Université de Lyon. Second edition. Pp. 457. (Paris: Alcan, 1899.)

PROF. HANNEQUIN attempts, in the first of the two books into which his work is divided, by a discussion of the first principles of mathematical knowledge and a study of the progress of physical and chemical science, to establish at once the necessity and the contradictions of atomism; in the second book it is sought to reconcile the contradictions by an appeal to metaphysics.

According to M. Hannequin it is by a necessity of its nature that human science reduces all to the atom as it has already reduced all to motion—the need to render intelligible all that falls under the intuition of the senses or all phenomena. Our mind can only take hold of or comprehend what comes from itself, it only knows fully what it creates. Thus science in the measure of its rigour and certainty is a creation of our mind. The science *par excellence*, the science derived entirely from the mind is the science of number. Physical atomism is not imposed on science by reality, but by our method and by the nature of our knowledge. It does not necessarily imply the real discontinuity of matter; it implies only that we make it discontinuous in order to comprehend it. It has its origin in the universal use of number.

"The atom is found at the end of all analysis as the product of the struggle of quantity against magnitude, of unity and number against the multiplicity and continuity of space and time."

In Chapter i. of the first book M. Hannequin discusses the question whether pure geometry itself involves the notion of quantity, and therefore of number, and concludes that it does. Amalytical geometry more obviously does so, and the author discusses at some length what is involved in the process of differentiation. Infinitesimal analysis appears to him to lead the mind necessarily to postulate in every geometrical object indivisible elements. On the other hand he concludes that all attempts, such as that of Cantor, which is criticised at some length, to express continuity by means of number must fail.

The analysis which gives us the concept of the geometrical element would not of itself, according to M. Hannequin, have given us that of the atom, had not our mind demanded the mathematical explanation of nature.

With mechanics our mathematics approaches as closely as it can phenomena and reality. In Chapter ii., on "Atomism and Mechanics," the author sets out to show that our ideas of motion lead us straight to the discontinuity of matter. His treatment of the fundamental notions of mechanics, of motion, force, mass, is interesting but not always convincing. For instance, it scarcely seems legitimate to make the first law self-evident by saying that when a body is in a state of uniform rectilinear motion or is at rest, one has the right to affirm by definition that it persists in an identical state, and that to no change corresponds no cause; on the other hand, to every definite variation of velocity or to every acceleration must correspond a definite cause which we call a force.

The hypotheses of centres of force, such as that of Boscowich, are condemned by Hannequin on what appear to be inadequate grounds. Vortex rings meet with no better fate.

When we come to "kinetic atomism" the necessity of postulating atoms becomes more apparent than the author has thus far succeeded in making it, and at the same time contradictions also appear. The difficulties of kinetic atomism as brought out by M. Hannequin are twofold. In the first place, we have the contradiction between the indivisibility of the atom and its perfect elasticity. In the second place, the number of atoms can neither be infinite nor finite. It is apparently atomism of the most thorough-going kind that is here considered, action at a distance being excluded and gravitational energy being taken as kinetic; otherwise there is no difficulty in holding the number of atoms to be finite.

In Chapter iii., on atomism and nature, the author attempts to show that the particular sciences of nature arrive at atoms of different and decreasing orders.

The chemical atom is first considered; the laws of definite and multiple proportions, and the methods of determining the relative masses of the atoms with the aid of Avogadro's and Dulong and Petit's laws being discussed. The possibility of the existence within the chemical atoms of smaller primordial atoms is next treated with reference to Prout's hypothesis and the facts of thermal chemistry and chemical affinity.

From the facts of optics we deduce the existence of an æthereal medium, which according to Fresnel's view is discontinuous. (A good account is given in this section of the struggle between the corpuscular and undulatory theories.) The dispersion of light as interpreted by Cauchy lends support to the discontinuity of the medium.

Unfortunately, the luminiferous æther cannot be made to explain gravitation. The author discusses some of the theories of gravitation, such as that of Lesage. Moreover, the elastic æther which transmits light cannot account for electro-magnetic actions. Prof. Hannequin also finds difficulties in the electro-magnetic theory of light; these appear to rest, however, not on any impossibility of accounting for optical phenomena on the electro-magnetic theory, but on the irreconcilable differences in the properties of the æther as originally invented to explain light and those of the electro-magnetic æther.

In this way we arrive at a multiplicity of irreconcilable æthers as well as a multiplicity of irreconcilable atoms.

The necessity and the contradictions of atomistic explanations of nature having thus been brought out, the author concludes his first book as follows:—

"Why should atomism be found everywhere in modern science to such an extent that it is, as it were, its vital principle, if its contradictions were final, and if they had not their last reason in the very substance of a reality which only appears to us under the obscure veils of space and time, but which perhaps will reveal its law to him who will seek it above extension and duration, or in a word above the appearances which science analyses?"

We are thus led to the purely metaphysical part of the work, which it would be out of place to attempt to discuss here. The final chapter, however, sums up the conclusions arrived at. Science will never attain to the indivisible towards which she seems to be incessantly marching; if she did reach it, she would be unable to explain nature by means of it. Our difficulties vanish if we render to the atom its true sense—the element, definite but always complex, with a minimum of extension in space and a minimum also of dynamical attributes. And instead of seeing in it the real individual stripped of all activity and of all quality, all that we ought to see in it is the work of the mind pursuing in space the reduction without end of phenomena which, though pure appearances, are appearances which have their basis in reality.

There can be no question of the interest and importance of a philosophical examination of the foundations of science such as M. Hannequin has attempted.

He has, we think, exaggerated the inconsistencies of the "atoms" postulated for different purposes. So long as we do not imagine that we have ever to deal with absolute indivisible structureless atoms the contradictions do not exist. Most of us would agree with M. Hannequin as to the barrenness of any system of absolute atomism.

There is no reference in the book to any of the more direct methods in which matter is proved to have a discontinuous structure, and by which an estimate is obtained of the size of the molecules; such methods as are described in Lord Kelvin's lecture on the size of atoms (Popular Lectures and Addresses). This is surely a serious omission.

OUR BOOK SHELF.

Elements of Physics. By Henry Crew. Pp. xiv + 347. (London: Macmillan and Co., Ltd. New York: The Macmillan Company, 1899.)

THE writer of this review possesses a collection of text-books of physics written during the first half of this century, all the volumes put together occupying a length of about six feet on his book shelves. He sometimes wonders where a future collector would find the space for all the text-books written now, when professors who have not written their own text-books are beginning to be rare curiosities. The proportion of books, however, that possess any originality has not increased, and may be put down, roughly speaking, as one in ten. The rest may be good because they have been inspired by good books, but there is a dreary similarity between them.

It would be ungracious to make these remarks while reviewing one of the average class of productions, and it must therefore at once be stated that Mr. Crew's volume cannot help striking the reader at once as having been the result of a good deal of thought, both in wording and arrangement. The book is very elementary. I think it is customary in this country to enter somewhat more fully into many parts of the subject, even in a first course. On the other hand, it treats of several matters which it is customary to omit, and it is on this point that we wish specially to commend the volume.

I note with great satisfaction a general chapter on waves, before the special consideration of sound waves is entered upon, also the introduction—at an early stage—of the wave theory of light. The great amount of time which, owing to examination requirements, we are forced—often against our will—to devote to geometrical optics, would much more usefully be spent in explaining (as the writer seems to do) the elements of diffraction and interference.

It is, further, a satisfaction to see frequent allusions to the phenomena of every-day life, and this feature might have been still further extended by including, for instance, some reference to the principal meteorological phenomena. No doubt very often the most common occurrences are most difficult to explain, and it may be impossible to give to elementary students a satisfactory explanation of, *e.g.*, the rainbow or the blue colour of the sky. But unless the attempt be made the students generally carry away the impression that what they learn in the lecture room belongs to a different part of their existence from what they can see and observe outside the college buildings. The book begins with mechanical and kinematical principles, including among other matters the consideration of harmonic oscillation and a well-considered chapter on the properties of matter.

Altogether it forms an admirable introduction to the study of physics. The only criticisms I should like to make, refer to some of the illustrations; but as the book only suffers to a slight extent from the prevailing epidemic of bad illustration caused by the spreading microbe of cheap processes of reproduction, we must be satisfied and say no more about it. ARTHUR SCHUSTER.

A Laboratory Outline of General Chemistry. By Alexander Smith. Pp. 88. (Chicago: Kent Chemical Laboratory of the University of Chicago, 1899.)

THIS book comes with a strong claim to attention. I is an untrammelled attempt to lay down a course of practical chemistry in an educational and scientific spirit, and the author's introduction sounds a pleasing note.

Much thought, care, and experience are embodied in the work, and though no claim to originality of material is made there are a good many things included that are fresh to books on practical chemistry The author makes some very just remarks on the difficult question of the correlation of lecture and laboratory work, and it is to be remarked that the efficacy of the course he lays down must depend very largely on the adjustment to it of lecture and tutorial instruction. How successfully this difficulty has been met in the University of Chicago we have not the means of judging. The book as it stands leaves the reader under the necessity of constructing in imagination the whole course of lectures or preferably "conferences" to which it is essentially related, and it is hardly likely to be put in use by English teachers unless they are prepared to recast their oral teaching to suit it.

The particular order in which the topics of general chemistry are to be treated, the particular points to be elucidated by the student's own experiments, are matters which may afford room for endless choice, but after that, in the point of method, there is a clearer right and wrong to choose between. We believe that some chemists may take exception to Dr. Smith's order and choice of topics, but his method of bringing them before the student will probably meet with general approval. He strives throughout to cultivate the investigator's attitude of mind, bearing in mind however that it is impracticable for the laboratory training of a chemist to be wholly carried out on this plan. The text is interspersed with question marks and with parenthetical injunctions to the student to interpret and correlate his facts.

The exercises are all drawn from inorganic and physical chemistry, and include an elementary study of the cardinal points of theory. We can well believe that this course of practical work, combined with properly conducted class meetings, will furnish a much more effectual introduction to the study of chemistry than students ordinarily obtain in Universities, where the continuous expository lecture to junior classes, unlimited in size and containing all sorts and conditions of students, is still the customary, if not the inevitable, method of procedure. A. S.

Ueber den Habitus der Coniferen. Von Dr. A. H. Burt. Pp. 86. (Tübingen: Verlag von Franz Pietzcker, 1899.)

THIS inaugural dissertation is mainly concerned with an analysis of the forms exhibited by the different groups of conifers. Following Vöchtung, the author recognises two principal types—the monocormic and polycormic respectively. The former is characterised by the presence of a decided main axis, the lateral axes being dominated by its growth; the common spruce fir is an example of a monocormic conifer. Polycormic forms are met with in cypresses and junipers, in which the lateral branches are not all reduced to subordinate and graduated positions; whilst in the cedars, forms are met with which combine the characters of both of the principal types.

Elaborate tables of measurements of the relative lengths of main and lateral shoots, and of the angles made by them, are given in the text, and clearly bring out the factors on which the shapes of conifers depend.

Beasts: Thumb-nail Studies in Pets. By Wardlaw Kennedy. Pp. xvi + 152. (London: Macmillan and Co., Ltd., 1899.)

THE spirit of a true naturalist prevails throughout this book. The author records his experiences with a number of uncommon animal pets, among which were a young crocodile, a python, an armadillo, and a mongoose. His observations are of real scientific interest, and his humorous descriptions are pleasant to read as well as instructive. Though natural history cannot be learnt from books, the boy who reads the essays in this volume will be encouraged to observe the habits of animals for himself, and will thus learn to depend upon the evidence of his senses rather than to trust upon second-hand information. The book would be an acceptable Christmas present for any boy interested in natural history.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Next Week's Leonid Shower.

THE anticipated return of the great Leonid shower within a few days is looked forward to with so much interest that it appears desirable to examine what data we possess for forming a forecast in relation to it.

In a paper on the perturbations of the Leonids, which is published in the *Proceedings* of the Royal Society for March 2, 1899, we gave the perturbations which have during the last thirty-three years affected those meteors which are situated near a particular station in the stream, namely the station through which the earth passed in 1866 and of which Adams had computed the orbit. It will be convenient to speak of this position in the immensely long stream of ortho-Leonids as station A.

By these calculations it was ascertained that this portion of the stream has been subjected to an unusual amount of perturbation during the revolution which has occupied the last thirty-three and a quarter years; so much so, that the advance of the node, upon which the epoch of the coming shower largely depends, has during this revolution been of more than three and a half times its average amount. Its having had this exceptional value has been caused by unusually close approaches of the great planets Jupiter and Saturn to the meteors during this revolution.

Another effect of these abnormal perturbations has been to shift the position of the ellipse in which station A moves in a direction perpendicular to the earth's path, so that the point in which it pierces the plane of the ecliptic will, on the 15th of the present month, lie inside the earth's orbit at a distance from it of 0·0141 of the earth's mean distance from the sun. This would be a sufficiently large displacement to carry the stream entirely clear of the earth, if it were a mere cylindrical stream; in which case we should have no great shower this year. But we have satisfied ourselves, by an examination made by one of us into the dynamical conditions which prevailed when the Leonids were drawn by the planet Uranus into the solar system, that the stream is not thread-like but strap-shaped, so that its intersection with the plane of the ecliptic is an oval of some sort—probably a long oval—of which the longer axis originally lay nearly perpendicular to the earth's path. On account of this oval form of the section of the stream, the earth is likely to receive one of the great showers this year, notwithstanding the fact that the situation in the stream through which the earth passed in 1866, will on its return pass at some distance from the earth.

If the longer axis of the oval now lay perpendicular to the earth's path, the most probable epoch for the middle of the shower of this year would be 1899 November 15d. 18h., which epoch we offered with careful reservations in the paper which is above cited. A further examination, however, has shown us that perturbations have been acting on this oval ever since the Leonids became members of the solar system, tending very slowly to rotate its major axis in a retrograde direction through an angle which will ultimately become nearly a right angle. The data at our disposal do not enable us to compute how far this retrogade shift has carried the axis in the seventeen centuries during which perturbating forces have been acting upon it. Under these circumstances we must have recourse to observation to ascertain the amount of the shift. A laborious attempt to estimate it in this way has furnished 52° as the angle of shift, which would indicate that the epoch for the shower of this year is as much as twenty-two hours earlier than 1899 November 15d. 18h., that is it would bring it back to 1899 November 14d. 20h.; but we do not attach any value to this particular determination, inasmuch as the data which are as yet at our disposal are too uncertain for us to rely on them. What appears tolerably certain is that *some* shift of the position of the oval section of the stream has taken place, and that the middle of the shower is accordingly likely to come earlier than 1899 November 15d. 18h., probably some hours earlier, and possibly a considerable number of hours. Under these circumstances it appears desirable that a watch shall be maintained in the atter part of the night between the 14th and 15th, as well as throughout the night between the 15th and 16th of this month, beginning the watch at 10.30 p.m. Before that hour observations cannot be made, the radiant point of the Leonids being below our horizon.

A computation of the perturbations of two other stations in the stream, in which we have made use of Dr. Berberich's results to supplement our own, has established a fact which we had anticipated, viz. that different parts of the immensely long ortho-stream have been so variously affected by perturbations that the stream cannot now be a uniform one evenly extended along a portion of its elliptic orbit. We must accordingly recognise that it is more or less sinuous, and that, moreover, the distribution of meteors along it is uneven. All such circumstances introduce further elements of uncertainty into any attempt which we may make to form a forecast.

On account of the abnormal amount of the perturbations within the last thirty-three years, the method by which the prediction was made in 1866 is not sufficient on the present occasion. It was based on the average amount of the shift of the node. If employed on this occasion, it would assign for the shower of this year the epoch 1899 November 14d. 12h., which is almost certainly too early.

London, November 4. G. JOHNSTONE STONEY.
A. M. W. DOWNING.

Undercurrents.

I AM much obliged to Admiral Makaroff for so courteously answering my queries in my letter to NATURE in the number for August 3, p. 316; and I regret that having mislaid my copy of his book, the "Vitiaz," I have not been before able to reply. On now studying his observations in the Strait of Bab-el-Mandeb, and his remarks in his letter (NATURE, October 5, p. 544), I fear I cannot any more share his opinions than I did before.

My point is that it is not sufficient to ascertain that there is a difference of specific gravity either between the surface water or either side of a strait, or between the surface and lower strata of water in a strait, to be able to come to the conclusion that such difference is the primary cause of surface and undercurrents in opposite directions. It has been shown by experiment that such differences give rise to a slow interchange of water, and to this extent I am of course prepared to agree that differences of specific gravity cause opposing currents; but the currents we are dealing with are of a vastly different character and strength.

I have already pointed out that my observations in the Dardanelles and Bosporus in 1872 showed that the currents did not always run in the normal directions, and that their variations were traceable to the varying winds; and to that I have nothing to add.

On looking at Admiral Makaroff's density observations in the Strait of Bab-el-Mandeb, I see that the specific gravity varied from 1·0279 at the surface to 1·0292 at 200 metres, while the surface waters of the Red Sea itself and of the Arabian Sea near Sokotra are given as 1·0300 and 1·0279 respectively.

In saying that "here are none of the differences of specific gravity demanded by Admiral Makaroff's hypothesis," I was referring to the great contrast between the difference in the densities of the Black Sea and Mediterranean, viz. ·017, and those of the Arabian Sea and Red Sea, viz. ·002, and never thought for a moment that the very small variation in density in the latter case could be held capable of setting up currents of 1½ knots in opposite directions at surface and bottom, as found by "Stork's" observations in the N.E. monsoon.

No observations have yet been made on the undercurrent in Bab-el-Mandeb in the S.W. monsoon; but the surface current is known to run in the contrary direction to what it does in the N.E. monsoon, *i.e.* again with the wind, or *out* of the Red Sea, and I should be much surprised to find that the undercurrent does not also run in the contrary direction, probably with much greater strength than the surface current, because the great evaporation of the sea has also to be made up.

Absolute proof of the causes of such phenomena as these under discussion comes slowly, and only after laborious observation; but I certainly think that the work of the last twenty-five years has tended to show that the influence of density as compared with wind is insignificant. W. J. L. WHARTON.

Florys, Wimbledon Park, November 4.

"Anlage" and "Rudiment."

SOME months ago Prof. Herrick, who is in charge of the department of Neurology in the "Dictionary of Philosophy and Psychology," which I am editing (now in the press of Macmillan and Co.), addressed a circular to various authorities asking their opinion on certain matters of terminology. The results were collated and discussed by Prof. Herrick in the *Journ. of Comp. Neurology*, vii. 3–4, 1898. Among the matters in question was the English equivalent of the German term *Anlage*. Prof. Herrick came to the conclusion that *Proton* and *Rudiment* were more available than any other words suggested (ruling out the use in English of *Anlage* with its German inflexion).

It now happens that the French and Italian committees, who are recommending equivalents, in their respective languages, for the terms in the Dictionary, make reports which I think are of importance. Prof. Delage, of Paris, for the French committee, recommends *rudiment*, and, as it happens, Prof. Morselli, of Genoa, sends in *rudimento* as the preferred Italian term. This agreement—and to say this is my aim in writing—affords a strong argument for the adoption of *Rudiment* in English. It is evident that it would be of immediate and very great advantage—for example, to translators from any one of these languages into any other—if *Rudiment* were made the common rendering of *Anlage* in the three other languages of modern science. The other great advantage would be that we already have the adjective form, *rudimentary*, in use.

Furthermore, the psychologists may use the same term for the German *psychologische Anlage* which has crept into recent German discussions. In English, biologists and psychologists will then have the common term *rudiment* with a well-understood signification. I am recommending this to the committee on terminology of the American Psychological Association, of which I happen to be secretary. J. MARK BALDWIN.

Oxford, October 22.

Interference Curves depending on Perspective.

CLOSELY allied to the halo round an observer's shadow (referred to in Mr. S. Newcomb's letter in NATURE, October 5) are a number of phenomena due to perspective, which may be seen every day by any one who is on the look out for them.

Among these may be mentioned the dark waves which seem to accompany a traveller when he looks through two series of upright palings which lie parallel to each other and his course; also the patterns like the grain of wood which appear when two superposed sheets of gauze are held against the light.

As these and the like appearances have not, as far as I know, hitherto been looked at from a mathematical point of view except in one instance,[1] the three following examples, which are typical but simple, may be of interest:—

(1) Interference rings due to parallel lines on a spherical surface, and their shadow or reflection on a plane or in a plane mirror.

Let a small part of a sphere of radius r be ruled with equidistant parallel lines, the distance between the lines being small compared with r. Let the convex surface of the sphere touch a plane mirror, and let surface be viewed from a distant point, the line joining the distant point, and the point of contact making an angle i, with the normal to the plane.

Taking the plane containing the point of view and the normal through the point of contact as the plane of reference, let a be the angle between the plane containing a line and its reflection and the plane of reference. Let θ be the angle which a point on the spherical surface distant ρ from the normal through the point of contact subtends at the centre of the sphere (so that $r \sin\theta = \rho$), and ϕ the angle which ρ makes with the plane of reference.

It is plain that where, from the point of observation, any part of any line hides the reflection either of itself or any other line, the field will look brighter in that direction than where the line and the reflection are both visible, and the condition which must be fulfilled in order that one line may hide the reflection of another n lines off is (neglecting second order quantities) that the distance between the hidden reflection and the line reflected (that is, twice the distance of the line from the reflector) multiplied by tan i should be equal to n times the projection of a on the plane of reference, or in symbols,

$$2r(1-\cos\theta)\tan i = \frac{na}{\cos a},$$

[1] Lord Rayleigh's "Theory and Manufacture of Diffraction Gratings" (*Phil. Mag.*, 1876).

since this equation does not contain ϕ, ρ is constant whatever the value of ϕ may be; hence the bright parts of the field are circular rings surrounding point of contact of the plane and spherical surface.

The radii of the dark rings can be deduced from the relation

$$2r(1-\cos\theta)\tan i=\frac{2n-1}{2}\,\frac{a}{\cos\alpha};$$

and from these equations it is easily shown that for the bright rings

$$\rho=\sqrt{\frac{ran}{\tan i\cos\alpha}},$$

and for dark rings

$$\rho=\sqrt{\frac{\frac{2n-1}{2}ra}{\tan i\cos\alpha}}.$$

This may be compared with the corresponding values for Newton's rings.

In both cases the radii of the bright and dark rings vary as the square roots of the even and odd numbers, and as the square root of the radius of the sphere and the wave length (which is analogous to a in the present case), but here the likeness ceases.

The rings here considered diminish as i increases, and increase as α diminishes.

Of course, in Newton's rings there is nothing which answers to the angle α.

The easiest way of examining these rings is to mould a small circle of wire gauze to form part of a sphere (which can readily be done by pressing it with a ball against any yielding substance) and laying it, convex surface downwards, on a piece of looking glass.

In general two sets of rings will be seen, one due to the wires of the warp, and the other of the woof of the gauze.

When the eye, however, looks parallel to one set of wires, the rings of that set are all infinite, and only the set due to the wires at right angles to the line of sight are visible.

If the gauze is made to turn slowly on the point of contact, both series appears, one growing, and the other diminishing, which are exactly superposed when $\alpha = 45°$.

A curious effect may be observed when a thick plate of glass is placed between the gauze and the looking glass.

The rings in this case become coloured, showing blue on their inner, and red on the outer margins of the dark bands.

The explanation is obvious, for the pencils of white light entering through the meshes of the gauze are dispersed on entering the glass, and in the neighbourhood of the dark rings only part of the dispersed pencils are cut off on their second passage through the gauze, so that the light which reaches the eye is coloured.

If t is the thickness of the glass plate, the greatest colour effect is obtained when $t=b\mu/2d\mu\tan r$, where b is the diameter of the wire and r the angle of refraction in the glass.

When the glass plate is used, of course the smallest visible ring is not that for which $n=1$, but it is unnecessary here to enter on the alteration in the formula for ρ caused by putting $2r(1-\cos\theta)+t)$ for $2r(1-\cos\theta)$.

(2) Interference rings caused by two series of straight lines, radiating at equal angles, from two centres in the same or parallel planes.

Let there be n lines in each series, then the angle between successive lines in each series is $2\pi/n$.

Let the lines of the first series be numbered 1, 2, 3 . . . p . . . n and those of the second $1'$, $2'$, $3'$ . . . q' . . . n, and let the line 1 be parallel to the line $1'$. Then the angle made by any line p of the first series with another q' of the second is $(p-q)2\pi/n$, hence the intersections of all pairs of lines for which $(p-q)$ is the same will lie on a circle passing through the two centres and having this segmental angle.

When the distance between the centres is a, the radius of the circle is

$$\rho=a\operatorname{cosec}2\pi(p-q)/n$$

if both centres are in the same plane, or

$$(a+b\sin i)\operatorname{cosec}2\pi(p-q)/n$$

if in different planes, where a = distance between the normals to the planes through the centres, b the distance between the planes, and i the angle made by the line of sight with the normal.

The loci of the intersections appear brighter than any other part of the field of view, hence the intersections of the two series show as a family of bright and dark circles which all pass through the two centres, and whose radii are as the cosecants of the multiples of $\frac{2\pi}{n}$.

This is shown in Fig. 1.

A pair of wheels of a carriage, one viewed through the other, show the phenomenon very well, especially when the wheels are turning fast enough to make the individual spokes indistinct.

Under favourable circumstances as to light and background, the appearance of the rings, contracting and expanding as the angle of view changes, is very striking.

(3) Interference curves from two series of straight lines, one radiating and the other parallel.

From a point P in the axis of Y let radiating lines be drawn to cut the axis of X at equal intervals a, and at a, $2a$, $3a$, &c., let lines be drawn parallel to Y.

Then, if the distance of P from the origin is h, to determine the coordinates of the intersection of the nth parallel line with the $n+p$th radiating line, we have, since $x=na$,

$$\frac{h-y}{h}(n+p)\,a=na,$$

hence

$$\frac{y}{h}(n+p)=p.$$

The locus, therefore, obtained by giving the value 0, 1, 2 . . ∞ to n will be a series of points on a rectangular hyperbola passing through P with its centre at $y=0$ $x=-pa$.

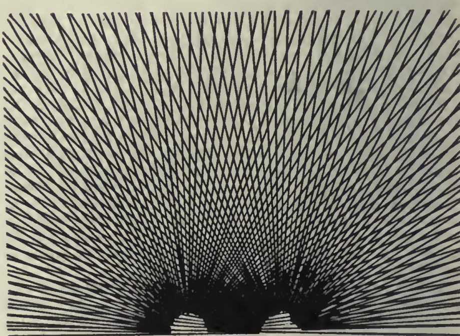


FIG. 1.

Thus the field of view will show a family of hyperbolæ (one for each value of p), all passing through P, the parameters being $\sqrt{pha}$.

In the same way, for the intersections of the nth parallel with the $2n+p$th radiating line we have

$$\frac{y}{n}(2n+p)=p,$$

which indicates a second family of hyperbolæ, the coordinates of the centres being $\frac{h}{2}$ and $-\frac{p}{2}$.

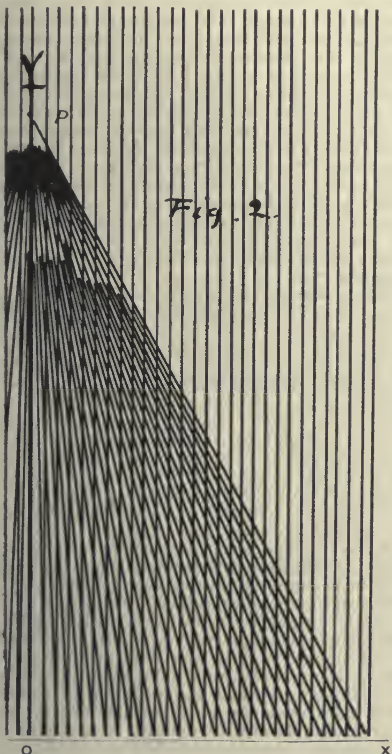
Similar families are formed by the intersection of the nth parallel, with the $3n+p$th . . . $4n+p$th . . . &c., radiating lines, the corresponding centres being $y=\frac{2h}{3}$, . . . $\frac{3h}{4}$, &c. and $x=-\frac{p}{3}$, $-\frac{p}{4}$, &c.

It will be readily seen that the dark and bright bands formed by the interfering lines follow the short diagonals of the quadrilaterals into which the two series of lines divide the field, and that for the bands to be conspicuous, there should be a great difference in the length of the two diagonals, and only a small difference in the length of the sides of the quadrilaterals.

For this reason only a part of each hyperbolic family is recognisable.

In Fig. 2 the first two families are both well seen in parts, and some of the curves of the third family can be recognised.

We may, if we choose, consider the radiating lines as the perspective view of a series of parallel lines in a plane inclined to X Y.



We then have the case of a row of vertical railings and their shadows on the ground.

In passing a line of such railings when the sun is low, the curves, which appear to travel with the observer, may often be noticed. A. MALLOCK.

3 Victoria Street, S.W., October 16.

The Indian Forest Service.

I AM very glad to see Prof. Schlich's defence of the Indian Forest Service in NATURE of November 2. I have myself been very closely connected with forest administration in the Bombay Presidency from 1871 to 1894. I may say that I have seen the Department there grow up from little better than chaos into a well-organised corps of spirited and well-trained officers; and there is not one word in Prof. Schlich's letter that I cannot heartily support.

Botanists can hardly be too abundant in India; but if we want good systematic botanists there, we must call them by that name, and either train them specially to that science, or get men so trained in the market.

It is to me surprising that the Indian forest officers have done so much botanical work as they have, to say nothing of the services of several of them to zoology; and it must be remembered that their appointments are even now won at a considerable cost in toil and money, that their pay is not high, and that their duties involve at least as much hard work of body and mind, as much hardship, and as much risk, as those of any other service in India.

Forestry is not all botany. It may, perhaps, be best defined as the "proper management of hardy life upon large areas." And the man who does that best is the best forester. We have a great many who do it well, and amongst these there will always be some to whom systematic botany is labour of love. But to insist upon any great general proficiency in one of the many subjects that a forester must study, will simply injure the general efficiency of the forest corps; and probably fail in the case of the favoured subject. W. F. SINCLAIR.

November 3.

Peripatus in the Malay Peninsula.

IN a recent issue of NATURE (October 19) the interesting fact is mentioned of the discovery by the Skeat Expedition of several specimens of Peripatus in the Malay Peninsula. Will you allow me to remark that in 1886 I described in the Notes from the Leyden Museum a specimen of Peripatus from East Sumatra, found among a lot of insects collected by Mr. Hekmeyer, of our Indian Medical Service. As it was the first specimen recorded from the Oriental region, Prof. Sedgwick, in his elaborate monograph of the genus Peripatus, considered the Sumatra species to be somewhat doubtful. The specimens, however, found by Mr. Evans in Kalantan appear to correspond so well with our specimen, as well in the number of pairs of feet (24) as in the colour, that I think a more detailed account will prove the identity of the animals found on both sides of the Malaka Strait. R. HORST.

Leyden Museum of Natural History, October 30.

A Wooden Ball of Unknown Origin.

ON the shore of the island of Hadod, latitude 68° 40′ about, in Vesteraalin, north of Lofoten, there was found, probably in the autumn of 1897, a wooden ball, 4½ centimetres in diameter, covered by a thin layer of gum. The ball is of fine workmanship, and just able to float in the water. Circles are engraved upon four parts, and form small rhumbs over the whole surface; and on two places there is engraved with Latin Majuscles the name *Melfort*. Perhaps some of your readers can say from whence this ball has come. I am writing to the man who has the ball now, to ask him to send it to me. H. MOHN.

Det Norske Meteorologiske Institut, Kristiania, October 30.

Large Nicol Prisms.

IN the account of Dr. Spottiswoode's physical apparatus, lately given to the Royal Institution, there are allusions to several large Nicol prisms said to have been made by Mr. Ladd and by Messrs. Sisley and Spiller. Although it is no doubt the trade custom to mention only the names of opticians who sell pieces of apparatus, and not of any of those whom they employ to make them, I still venture to hope that in this case, where skill and labour of a very special kind were required, the name of the actual maker of the above-mentioned prisms may not be forgotten. I would therefore respectfully ask permission to give a few particulars as to size, &c., of some of the larger Nicol prisms which I have myself made from blocks of Iceland spar within the last thirty years.

(1) In 1873 Dr. Spottiswoode bought a very fine block of spar from Mr. Tulinius, of Copenhagen (who then owned and worked the spar quarry at Eskifiördkr in Iceland). Out of this, which was absolutely flawless, I made a Nicol prism having a clear field of 3⅜ inches diameter, the length of each side being 12 inches.

(2) In 1874 I made a second prism from the same block of spar just mentioned, and also a third from another piece of spar bought by Dr. Spottiswoode. Both of these prisms had a clear field of 3½ inches, the length of the sides being 11½ inches. These are now at the Royal Institution.

(3) In 1875 I made a Nicol prism for Mr. Frank Crisp, of 3½ inches field and 11½ inches in length, which he used in a polariscope in conjunction with the first one mentioned above, which he had acquired from Dr. Spottiswoode. These Mr. Crisp sold, and are now in England.

(4) In 1876 I made two more large prisms for Dr. Spottiswoode, one of 3-inch and the other of 2½-inch field, as spar was

even then beginning to get scarce. These are now at the Royal Institution.

In all these prisms the end faces were the natural crystal faces, only smoothed and polished; and the plane of section made an angle of 87° 30′ with them, or 21° 30′ with the length-axis of the prism.

In none of them was Canada balsam used as the cement (I have not used it for this purpose for thirty years past), but a special material. C. D. AHRENS.

Swiss Cottage, King's Road, Upper Teddington,
October 13.

AN ENGLISH STATION FOR BOTANICAL RESEARCH IN THE TROPICS (CEYLON).

THE Royal Botanic Gardens of Ceylon, under the direction of Thwaites and Trimen, to go no further back, have long been known as one of the most important centres of scientific work in systematic and economic botany. Thanks to the British Association for the Advancement of Science, a small room next to the director's office was fitted up as a laboratory, in which have worked many botanists, chiefly English. Among those who have worked in Ceylon during the last decade may be mentioned Profs. Bower, Farmer, Goebel and Potter, and Messrs. Freeman, Keeble, Pearson, Parkin, and others. During the last two years the laboratory has been very much overcrowded, being used by the staff of the gardens as well as by visiting botanists. With the commencement this year of a new research laboratory, now being erected by the Department of Public Works, and to be completed probably before the end of the year, this difficulty will be overcome, and there will be ample room for several workers from abroad in addition to the members of the staff. This being so, it may not be amiss to give at this time an account of the facilities now available in Ceylon for research in the tropics. While the laboratory is primarily intended for botanical research, there is no intention of excluding workers in other lines so long as there is room for them, though of course money cannot be spent in providing special apparatus for their work.

The Royal Botanic Gardens form a department of the public service in Ceylon, under a director. The head-quarters of the department are at Peradeniya, near Kandy, where the principal garden was established in 1821 by Moon. There are now smaller branch gardens in four other places in different climatic regions of the island. A brief account of these may be of interest.

The original Peradeniya garden lies within the municipality of Kandy, about four miles from the centre of the town. It may be reached by driving in a carriage or rickshaw, or by trains which run at intervals to a station near the garden. The roads here, as almost everywhere in the island, are excellent for cycling. The garden has an area of about 150 acres, and lies in a very beautiful situation, in a loop of the Mahaweli river, and in very mountainous country. Its elevation above sea is about 1550 feet, so that it has a much more pleasant climate than the low country. During the day the difference is but little, but the nights are very much colder than in Colombo, so that refreshing sleep can always be had; indeed, during most of the year a blanket is necessary. The mean annual temperature is 76° F., that of the hottest months (March and April) being 79°, that of the coldest (January and June) 74–75°. The highest shade temperatures ever reached are not excessive, rarely exceeding 90°, and in the present laboratory the highest in the last two years has been 82°, the lowest 65°. Work can thus be carried on with as little discomfort as in any European laboratory. The annual rainfall is about 90 inches, but owing to the great violence of tropical rain the number of rainy hours or days is very much less than in England. The number of days with rain averages 170 per annum, and it rarely rains more than four hours on any one day. Rain in the morning is also rare. The weather of the year depends on the monsoons. In the end of May the south-west monsoon begins to blow, and there is much wind and rain, the weather gradually becoming finer through the months of June and July. August and September and the first half of October are delightful months. In October the north-east monsoon begins, and until Christmas it is very wet. In January begins the "dry season," and during the next two or three months there is less rain than at any other time of year, and the weather becomes gradually very hot, though until April the nights are cold. March and April are the only really unpleasantly warm months in the year. The best time on the whole to visit Peradeniya is from October to March, but from July onwards is very nice, the objection to travelling at this time from Europe being the heat in the Red Sea, which, however, is much less formidable than is usually supposed in these days of swift boats and ice chambers.

The garden contains a splendid collection of tropical plants, and, being arranged like an English park, with wide spaces of lawn, the specimens are easily seen and photographed. In the centre lie the buildings of the museum, library, herbarium and laboratory, close together. The museum is chiefly devoted to the economic products of Ceylon, and contains a very good and interesting collection. The herbarium consists primarily of Ceylon plants; but there is also a general tropical herbarium, and a herbarium of the plants contained in the gardens. In the same building is the library, which contains about two thousand books and papers. There is an excellent collection of books relating to economic and systematic botany, and recently a large number of works on the other branches of botany have been added; a considerable number of journals is also received regularly, including such periodicals as the *Annals of Botany*, *Botanical Gazette*, *Botanische Zeitung*, *Flora*, &c.

The laboratory lies a few yards to the north of the herbarium (a plan is given on p. 33). It consists of a one-story bungalow of brick on a stone foundation, and with cement floor and tiled roof. The length of the building runs approximately east and west, and on the north and south sides there are no verandahs. At the east end is a verandah 8 feet wide, the ends of which are built up so as to form—one a lavatory, the other a dark room for photographic work, fitted with sink, &c. At the west end is also a verandah of the same size, not built up in any way.

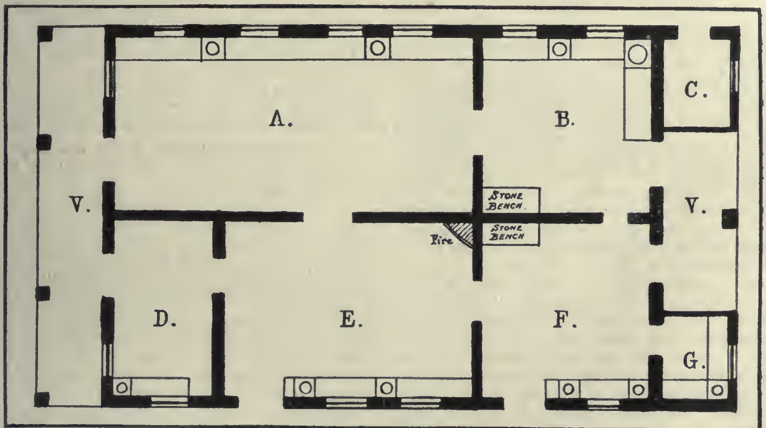
The building has six entrances, provided with French windows, two at each end and two on the south side. The other windows stand above the ground, and open outwards. There are doors leading from each room into all the adjacent rooms, so that free ventilation can be obtained, and at the same time any room can be completely shut up if required to prevent draughts without interference with the accessibility of the others.

The principal room, the general microscopic and morphological laboratory, lies to the north-west, and is 36 feet long and 18 feet wide. It has four working windows facing north, each with table, shelves, sink, &c., and two other windows facing into the west verandah, which can also be used as microscoping windows if required. The central part of the room will contain larger tables for microtome and other apparatus, and writing table.

To the east of this room is the smaller room devoted to physiological and pharmacological investigations. Leading out of this room is a French window, which gives access to the little eastern verandah, which may be used for cultivation experiments, &c. This room has two good working windows facing north, besides the French window. It is provided with three sinks and a large stone bench. South of the physiological is the chemical laboratory, of the same size and construction, and with the dark room opening out of it. West of the chemical laboratory is the economic, a large room 26 feet by 18 feet, with two good working windows, one French window, and a fireplace. This room is intended for experiments in the preparation, &c., of economic products, such as rubber, fibres, &c. Lastly, in the south-west corner of the building, is a small private laboratory for the director or for work requiring special privacy from interruption. This room is 18 feet by 10 feet, with one working window on the south side, and another looking into the western verandah.

The whole laboratory is well supplied with water from a pipe running round it, and starting from a cistern in the museum, at a height of about 15 feet above the laboratory. Gas unfortunately is not at present available, but of course there is no need for artificial light, the day in this country always lasting until 6 p.m.

When ordinarily filled, therefore, the laboratory can accommodate eleven workers, and at a pinch room can be made for four more. For persons working at systematic botany there is accommodation in the herbarium.



Plan of the new Laboratory, Royal Botanic Gardens, Peradeniya. A, General laboratory; B, Physiological laboratory; C, Lavatory; D, Private laboratory; E, Economic laboratory; F, Chemical laboratory; G, Dark room; V, Verandahs. Scale 1/16 inch to 1 foot.

Of the eleven places, the present staff and workers living in the colony will use five or perhaps six, so that there is room now available for five or six workers from Europe and elsewhere. The value to a botanist of a period spent in the tropics can scarcely be overrated, and with the accommodation now afforded at Peradeniya and in Java, the ease and comparative cheapness of the journey, and of living and travelling in Ceylon, there is no reason why many more should not visit and work in a tropical station than have so far done so.

The neighbourhood of Peradeniya is very beautiful; it is mostly cultivated in rice, tea, coco-nuts, fruit, &c., but there are some interesting pieces of wild vegetation within easy reach, and many fine pieces of forest, &c., can be reached within a short time by rail or road. The river below the gardens contains most of the known Ceylon species of that very remarkable order the Podostemaceæ. Kandy is within easy reach, and contains several good hotels, a good English club, tennis, croquet, cricket and football clubs, &c.; and there is a considerable society of English people in the town and suburbs. Colombo can be reached in four, Nuwara Eliya in five, hours by rail. The trains are comfortable, and provided with refreshment and sleeping cars.

For a few economic and other plants the climate of Peradeniya is somewhat too cold at night for complete success, and for trial of these and for the supply of the needs of the populous low-country of the south-west of the island, a second botanic and experimental garden is maintained at Henaratgoda, on the main line of railway, seventeen miles from Colombo. It lies only about twenty feet above the sea, in a very uniform steamy climate, with a mean temperature of about 82° F. The garden comprises forty acres, about twelve of which are still covered with jungle, forming an interesting feature in the garden. There is a very fair collection of plants in this garden, especially economic, including the original rubber trees sent to the East through the agency of Kew Gardens and the Government of India. *Helminthostachys zeylanica* is abundant in the district, and many interesting plants can be seen in paddy fields and elsewhere. There is a rest-house close to the railway station, a mile from the garden, and the garden contains a small laboratory with two working places.

A third garden is maintained at Hakgala, about six miles from the chief sanatorium of Ceylon, Nuwara Eliya. The garden occupies an extremely beautiful situation on the side of Hakgala Mountain, with an extensive view over a wide expanse of mountain country. It comprises about 550 acres of land, only about thirty-five of which are in cultivation, the rest being untouched natural country, some covered with jungle, some being grass land (pătănă, as it is locally called). The vegetation in the district all around here is very interesting, having been but little interfered with by cultivation in any way, and that only in a few spots. The interesting Horton Plains are eighteen miles from Hakgala, through wild country. There is a rest-house at the Plains, which lie 7200 feet above sea-level. The flora of these up-country regions is of great interest to a botanist. Many European genera are here represented, such as buttercups, violets, valerian, brambles, &c. Lycopods, Selaginella, Psilotum, &c., are very common. Many interesting biological features exhibit themselves in this vegetation.

The garden at Hakgala lies at 5600 feet above sea-level, and has a comparatively cold climate, with a mean annual temperature of 61° F. Frost never occurs, though it is frequent at slightly higher elevations, such as Nuwara Eliya (6200 feet). There is, unfortunately, no accommodation for visitors at present nearer than Nuwara Eliya, six miles away; but it is hoped to erect a small laboratory in the garden, with a small living room attached, where workers may live and sleep.

A fourth garden is kept up at Badulla, the capital of the Uva province, at an elevation of 2200 feet, on the eastern side of the mountains. The chief botanical interest of this district lies in its somewhat drier climate, so that it has much more pătănă land than the western side of the mountains, and in the fact that its dry season comes, not in the north-east but in the south-west monsoon, so that the periodicity of the vegetation is different. Fruit, which at Peradeniya ripens in March and April, ripens at Badulla in August, and so on.

Yet another garden is maintained at the ancient capital of the island, the famous "buried city" of Anuradhapura, the capital of the north-central province. This lies in the middle of the dry country, which makes up about three-fifths of the island, and has an Indian climate, with rain almost confined to the last three months of the year, and drought during the remainder, including the south-west monsoon. The flora of this district is therefore, as might be expected, very different from that of the rainy south-western and central provinces.

The island can show, within an area of rather less than that of Ireland, a most remarkable range of climate and flora, rendering it very interesting to the traveller and naturalist; in this respect it is unrivalled in the tropics. The working botanist or student has, further, the great advantage of having at his hand the excellent flora prepared by Dr. Trimen, and finished after his death by Sir Joseph Hooker. There are doubtless many new species still to be found in the eastern and south-western districts, as well as many unrecorded species; but the student who does not desire to specialise in this department of botany will be grateful for the useful flora, which renders the identification of his collections, or of the plants he may be experimenting with, a matter of comparative ease. The vascular cryptogams and many of the mosses have been identified, but there is much to be done at the lower forms of vegetation.

Peradeniya is easily reached from any part of the world, Colombo being one of the greatest ports of call. Direct lines of steamers run to Europe, China, Japan, Java, Queensland, Adelaide, Melbourne and Sydney, Mauritius, South Africa, and all Indian ports. Madras may be reached in thirty-eight hours by boat and rail. To England there is a very large choice of steamers. The favourite lines with Ceylon people are perhaps the Bibby and the Norddeutscher Lloyd, but the P. and O., the Orient, Messageries Maritimes, British India, and many others, are much used. The first-named is the cheapest of the large English lines, but is first-class only. First-class returns to Colombo, available for six months, are from 70*l.* to 90*l.* Second-class, which is very comfortable on the largest lines, is from 50*l.* to 60*l.* A few pounds are necessary on the voyage for tips, sports, trips on shore, &c. Banking accounts may be opened in Kandy, and money easily remitted to and from Europe. The value of the rupee is now 1*s.* 4*d.*, and seems likely to remain at that figure.

Very little is necessary in the way of outfit. Drill and khaki clothes can be bought here for less than half their price in England; also topees (sun-hats). At Kandy the usual dress is similar to that worn in England in summer; at Nuwara Eliya it is colder, and tweed suits are often worn. All articles of clothing can be bought here, and usually as cheaply as, or more so than, in Europe.

The usual division of the day is as follows: Rising at daylight, a light early tea of eggs and toast is taken about 6.15, after which a walk in the garden is pleasant, commencing laboratory work at 7.30, and continuing till 11, which is the breakfast hour. After breakfast follows a rest indoors, but not sleep, and work may be resumed at about 1.30 for a couple of hours or so. After tea the remaining two hours of light are given to tennis, cycling, and other forms of exercise, followed by a bath, and dinner at 7 or 7.30. The evening is devoted to amusement.

Travelling in Ceylon is easy in all but the most out-of-the way or sparsely populated parts. Railways and good roads intersect the greater part of the island, and there are coach services to a great number of places not served by the railways. Rest-houses or Government inns are found in all towns that have no hotels, and at intervals of 14 miles along all main roads. The average cost of living while on tour may be put down as about Rs. 7 or 8 per diem exclusive of fares by rail or coach. Steamers run round the island, calling at all the chief ports.

There is at present no rest-house or hotel at Peradeniya itself, and visitors must live in Kandy, where arrangements have been made with some of the hotels to board persons working in the laboratory at from Rs. 5 to Rs. 7 per day. There is a convenient service of trains, but the most satisfactory way is to cycle in and out. The road is in excellent order, and the distance from the furthest hotel under five miles. It is hoped that accommodation may be provided at Peradeniya itself before long.

Assuming that six months are spent from starting to date of arrival back in Europe, the cost of the trip should not much exceed 185*l.*, made up thus:

Fare (first return)	£85
Twenty weeks' board	66
Travelling	20
Sundry	12 to 20
	£191

This might be much reduced by economy, and by travelling second-class from Europe, and the proportionate cost would of course be less if the visit were of longer duration. If much travelling is to be done in the island the amount shown above will have to be increased, the 20*l.* being allowed for four weeks only. By very close economy and reduction of travelling, and by travelling second-class, the total might be reduced to perhaps 140*l.*

Trustworthy information about Ceylon may be obtained in various books. The most interesting are Sir E. Tennent's "Ceylon," which is now out of print; and to a botanist, Trimen's paper "On the Flora of Ceylon as affected by Climate," in the *Journal of Botany* for 1886. Ferguson's Handbook and Directory contains a vast mass of information and statistics, and his "Ceylon in 1893" is also of interest.

Intending visitors should communicate some time in advance with the director, mentioning what line of work they propose to take up, and any special facilities they may require.

JOHN C. WILLIS.

THE STOCKHOLM INTERNATIONAL FISHERIES CONFERENCE.

THE International Conference, which met in Stockholm from June 15 to June 23 last, and had for its object the arrangement of a scheme for the exploration of the northern seas in the interests of fisheries, has now issued its report. The Conference assembled at the invitation of the Government of Sweden, and official representatives attended on behalf of the Governments of Germany, Denmark, Great Britain, Norway, Holland, Russia and Sweden.

The formal resolutions unanimously passed by the delegates—Messrs. Archer, Cleve, Drechsel, Ekman, von Grimm, Heincke, Hensen, Herwig, Hjort, Hoek, Knudsen, Krümmel, Lehmkuhl, Lundberg, Murray, Nansen, Petersen, Pettersson, D'Arcy Thompson, Trybom, Åkerman—were as follows:—

Considering that a rational exploitation of the sea should rest as far as possible on scientific inquiry, and considering that international co-operation is the best way of arriving at satisfactory results in this direction, especially if in the execution of the investigations it be kept constantly in view that their primary object is to promote and improve the fisheries through international agreements, this International Conference resolves to recommend to the States concerned the following scheme of investigations, which should be carried out for a period of at least five years.

Programme for the hydrographical and biological work in the Northern parts of the Atlantic Ocean, the North Sea, the Baltic and adjoining Seas.

A.—THE HYDROGRAPHICAL WORK.

I. The hydrographical researches shall have for their object: the distinction of the different water-strata, according to their geographical distribution, their depths, their temperature, salinity, gas-contents, plankton and currents, in order to find the fundamental principles, not only for the determination of the external conditions of the useful marine animals, but also for weather-forecasts for extended periods in the interests of agriculture.

II. As the hydrographical conditions are subject to seasonal changes, and as these strongly influence the distribution and life-conditions of useful marine animals and the state of the weather and other general meteorological conditions, it is desirable that the observations should be made so far as possible simultaneously in the four typical months, February, May, August and November, at definite points along the same determined lines.

III. The observations referred to in II. would consist of:—

(*a*) Observations of temperature, humidity and pressure of the air every two hours; self-registering instruments for interpolation, and Assmann's aspirator should be used.

Opportunities should be afforded to the meteorological offices to make on board the ships physical observations on the higher levels of the atmosphere by means of kites.

The other meteorological observations are to be carried out according to the methods adopted by the meteorological offices of the nations represented.

The observations, meteorological as well as hydrographical, made on board the special steamers at the time of the survey in the typical months, are to be immediately worked out under the supervision of the central bureau (see C) for publication in a bulletin, wherein the conditions of the sea and the atmosphere are to be represented by tables and synoptical charts in cooperation with the meteorological institutes of the nations represented.

(*b*) The temperature of the surface water shall be taken every two hours, or, when necessary, more frequently. It is desirable that self-registering apparatus should be used for interpolation.

Observations on the vertical distribution of the temperature are to be taken at the points mentioned in II., and should be taken regularly at intervals of 0, 5, 10, 15, 20, 30, 40, 50, 75, 100, 150, 200, 250, 300, 400 metres, and so on; but all *critical* parts of the curve must be determined by extra-readings.

The bottom-temperature is to be investigated with all possible care.

(*c*) At every point and from every depth where the temperature is observed, a sample of water shall be collected for the determination of its salinity and density.

By *salinity* is to be understood the total weight in grammes of the solid matter dissolved in 1000 grammes of water.

By *density* is to be understood the weight in grammes[1] of one cubic centimetre of water of the temperature *in situ* $t°$, *i.e.* the specific gravity *in situ* referred to pure water of $+4°$C. $\left(=S\frac{t°}{4°}\right)$.

For orientation, preliminary determination of the salinity should be made on board ship with expedient instruments, but the exact determination of the salinity and density of all samples shall take place in a laboratory for scientific work.

(*d*) At certain depths of the points mentioned in II., and elsewhere on the surface, water samples should be collected for analysis of the gas-constituents (oxygen, nitrogen and carbonic acid).

[1] Units of weight are here used instead of mass-units.

IV. For measurement of depth the *unit* to be adopted is the metre, together with which the depth may be also recorded in English fathoms.

Geographical points are to be referred to the longitude of Greenwich, and horizontal distances are to be expressed in sea-miles (=1852 metres).

Thermometers to be used for the determination of the surface-temperature may be either centigrade or Fahrenheit, but for publication all numbers are to be reduced to centigrade.

In the centigrade thermometers the distance between two degree-marks should be at least 5 mm. and the degree divided at least in two parts; the Fahrenheit thermometer to be divided in a corresponding manner.

The use of Pettersson's insulated water-bottle is recommended for moderate depths, and the thermometers used for this apparatus should have a space at least 10 mm. between the marks of one degree, and the degree should be divided in ten parts.

For greater depths of the ocean Negretti-Zambra's or other thermometers of a similar type should be used.

The glass to be used for the thermometers as well as the thermometers should be tested and approved by the central bureau (see C, *a*).

For the determination of salinity and density either chemical or physical methods may be adopted, provided that the salinity can be determined with an accuracy of $0{,}_{05}$ in a thousand parts (and the density up to $0{,}_{00004}$).

The determination of these constants can be founded either upon chemical analysis of the halogen by weighing or titration; or upon physical determination of the specific gravity by means of hydrostatical balance pycnometers and hydrometers, provided that measures be taken to exclude disturbances arising from thermal effects, capillarity, viscosity, &c.

The chemical analysis shall be controlled by physical methods, and the physical determinations by chemical analysis in the following manner:—

From every collection of samples examined at least three shall be selected and sent to the central bureau. *Standard samples* shall be sent in return.[1]

The *specific gravity* is to be represented in the tables by the formula $S\left(\frac{0°}{4°}\right)$.

V. Samples for gas analysis are to be collected each time in a pair of sterilised vacuum tubes.

It is desirable that the existing tables of absorption of nitrogen and oxygen should be revised.

VI. Qualitative plankton-observations should be made every six hours by pumping through a silk net (N: r 18) for the space of fifteen minutes, and at the same time a sample of water (III. *c*) should be taken.

At the points mentioned in II. samples for quantitative analysis are to be collected according to the method of Prof. Hensen at different depths depending on the hydrographical circumstances.

Petersen's modification of Hensen's net is recommended.

Observations on transparency and colour of the water should be made at the points mentioned in II.

Opportunities should be afforded to bacteriological institutions to carry out investigations in the ocean.

VII. Observations on currents and tides should be carried out as frequently as the circumstances allow.

The currents should be examined, when possible, by direct current-meters and by surface and intermediate floats and by bottom-rollers.

The ship should be anchored occasionally in order to make frequent observations during a complete period of tide.

VIII. It is desirable that a chart should be prepared of the bottom of the seas examined, showing the nature of the sea-bottom.

The description of the deposits is to be carried out on a definite plan, to be afterwards settled (see Appendix III.).

IX. The normal observations are to be carried out along the

[1] By *standard* water shall be understood samples of filtered sea-water, the physical and chemical properties of which are known with all possible accuracy by analysis, and statements of which are sent to the different laboratories, together with samples.

In respect to halogen the ordinary water-samples have to be compared with the standard water by analytical methods.

lines provisionally drawn on the annexed chart, where *R* denotes the Russian, *F* the Finnish, *S* the Swedish, *G* the German, *Da* the Danish, *Du* the Dutch, *N* the Norwegian, and *B* the British lines.

The special points are to be decided by the respective nations, and when once chosen the subsequent observations are to be repeated at the same points.

The particular instructions for the stations will be given by the respective nations, and the communications as to the extent and the nature of the observations shall take place through the central bureau (see C, *a* and *e*).

X. It is desirable, in carrying out these investigations, to make use of regular liners, light-ships, &c., and coast stations for the purpose of taking temperature-observations and collecting samples of sea-water and plankton.

These observations are to be taken not only in the typical months, but also during the intervening periods.

abundance, and average size of economic fishes, and the causes of the same.

II. (*a*) Experimental fishings *on* the known fishing grounds during the time of the fishery, as well as *outside* these areas and seasons.

(*b*) Preparation of uniform statistics of the experimental catches, with particulars of the number, species, size, weight and condition of the fish; for example, as done on board the *Garland* by the Scottish Fishery Board.

(*c*) The uniform use of appropriate apparatus for the experimental capture of the different species and sizes of fish.

(*d*) The experimental marking and liberation of fish, for instance, of plaice, on as large a scale as possible and over extensive areas; for example, as carried out by Dr. C. G. Joh. Petersen and Dr. T. W. Fulton (Reports of the Danish Biological Station and the Fishery Board for Scotland) and others (see Appendix IV.).

Division of Areas for Investigations in connection with Fisheries.

B.—The Biological Work.

I. (*a*) Determination of the topographical and bathymetrical distribution of eggs and larvæ of marine economic fishes; for example, by quantitative methods, such as those of Hensen, and with special reference to the most important species, such as plaice, cod and haddock, herring, &c. (see Appendix I.).

(*b*) Continued investigation of the life-history and conditions of life of young fishes of economic species in their post-larva stages and till they reach maturity, with special reference to their local distribution.

(*c*) Systematic observation of mature marketable fishes with reference to their local varieties and migrations, their conditions of life, nourishment (as, for instance, by investigation of the contents of the stomach), and natural enemies; also observations on the occurrence and nature of fish food at the bottom, the surface and intermediate waters down to depths of at least 600 metres (see Appendix I.).

(*d*) Determination of periodic variations in the occurrence,

III. (*a*) It is desirable to collect uniform statistics of the number, weight and value of the fish landed, of the means of capture, and of the persons engaged in the industry; for example, as in the General Reports of the Scottish Fishery Board.

(*b*) It is desirable to collect material for the preparation of maps, showing the fishing grounds and the kinds of fishing here practised (*cf.* A. VIII.).

C.—Organisation of a Central Bureau.

I. The Conference recommends that there should be for the international hydrographical and biological researches of the seas an international Council with a central bureau, furnished with a laboratory (see Appendix II.). The central bureau will be:—

(*a*) To give uniform directions for the hydrographical and biological researches in accordance with the resolutions drawn up in the programme of the present Conference, or in accordance with such modifications as may be introduced later with the consent of the States represented.

(*b*) To control the apparatus and to insure uniformity of methods.

(*c*) To undertake such particular work as may be entrusted to it by the participating Governments.

(*d*) To publish periodical reports and papers which may prove useful in carrying out the co-operative work.

(*e*) To decide the graphic representations, scales, signs and colours to be used in the charts for the purpose of obtaining uniformity in the publications.

(*f*) To make, in connection with the investigations, application to the telegraph administrations for the purpose of obtaining determinations from time to time of the changes in the resistance of the cables which cross the areas in any direction.

II. (*a*) The permanent international Council should consist of commissioners elected by the Governments interested. Each Government may appoint two commissioners who may be represented at meetings by substitutes.

(*b*) The Council elects its president and vice-president, and appoints all officials connected with the central bureau. Should the general secretary represent hydrographical sciences, his principal assistant should represent the biological sciences, or *vice versâ*.

(*c*) The Council shall draw up its own order of proceedings.

(*d*) The expenses of the central office are approximately estimated at 4800*l*. (96,000 marks) yearly.

(*e*) The place of the central bureau, to be decided by the Governments concerned, shall at the same time be the residence of the general secretary, and should be conveniently situated for hydrographical and biological researches.

(*f*) It will be for the Governments concerned to decide among themselves the share to be borne by each.

Scheme for the Expenditure of the Central Bureau.

	£
(1) General Secretary	750
(2) Principal Assistant	500
(3) President, for incidental expenses other than travelling expenses	200
(4) Vice-President, for incidental expenses other than travelling expenses	100
(5) Office, laboratory, scientific and technical assistants, draughtsmen, clerks, servants, postage, telegrams and similar expenses	2250
(6) Travelling expenses	300
Note: Travelling expenses of commissioners attending meetings of the Council shall be borne by their respective Governments.	
(7) Printing	500
(8) Incidental expenses	200
	£4800

D.—It is desirable that these investigations should begin May 1, 1901.

E.—The Conference declares that it is of the greatest importance, both for high sea fisheries and for the weather forecasts for long periods, that the Faröe Islands and Iceland should be included in the European telegraph system as soon as possible.

F.—The relation between the quantity of halogen contained in the water and the density of the water shall be carefully investigated by an experimental revision of the tables compiled by Knudsen (Ingolf Exp. ii. 37). The tables compiled by Makaroff, Krümmel and others for the relation of specific gravity to density and salinity are likewise in urgent need of experimental revision.

It is proposed to undertake these investigations in the technical institute at Copenhagen under the direction of a committee consisting of Sir John Murray, Messrs. Knudsen, Pettersson, Nansen, Krümmel, H. N. Dickson, and Makaroff. The means for carrying out these works are to be requested from such learned societies as have funds for such purposes.

G.—The Conference recommends that these resolutions be brought by the nations concerned to the knowledge of the Governments of France and Belgium.

H.—In case the resolutions of the Conference should be accepted by the States, it is anticipated that some length of time will elapse before the organisation of the central bureau is completed. In the meantime the Governments may wish to possess an organisation in connection with this Conference which may be useful in constituting the Council and the central bureau.

The members of the third committee—Åkerman, Drechsel, Von Grimm, Herwig, Hoek, J. Murray, Nansen, Pettersson—hereby offer their services for this purpose.

Appendix I. is on the quantitative estimation of pelagic fish-eggs and larvæ, by Prof. Hensen; Appendix II., on the Central Laboratory, by Prof. Nansen; Appendix III., on plankton investigations, by Profs. Cleve and Pettersson; and Appendix IV., on the marking of fishes in the waters of the region of the Baltic and the North Sea, by Dr. Trybom.

NOTES.

ONE of the most transcendent sights that it is given to man to witness is due next week. Those who saw the "falling stars" of 1866 readily acknowledge that there is no other phenomenon which is equal to it in majesty and enthralling beauty; and although comparisons are always odious, and generally misleading, some have held that the 1866 display was far more striking than a total eclipse of the sun. It is to be hoped, therefore, that the sky will be clear during the early mornings of next week. It appears from a communication of Messrs. Johnstone Stoney and Downing, which appears in another column, that it is not yet known whether the densest part of the meteors will be encountered on the morning of the 15th or during the next night. It is to be regretted that bright moonlight will certainly prevent the shower from being seen with the same effect as in 1866, ir it should happen before the morning hours.

CERTAINLY not for many years has there been so much anxiety, either expressed or silently borne, as since some days ago, when the wire joining Ladysmith and civilisation was broken. Not only have the relatives of the 10,000 Britons beleaguered there been anxious, but all who take interest in the severe struggle which is now going on. It has been a matter o. general surprise that in a campaign in which the cutting of telegraph wires was the first thing to be expected, and the investment of several isolated garrisons for a time was to be taken for granted, Marconi apparatus was not installed as a matter of course. We do not share this surprise; science, and especially the latest developments of science, are the last things to interest our Government and the Government Departments; they do not believe in science, they care to know very little about it, and the scientific spirit is absent from too many ot their plans and doings. Hence we have now to be thankful that they have reached the level of the pigeon post, which has been the only official means, and that on the part of one or two birds, to keep us in touch with our beleaguered forces. It is stated that even the Commander in Chief, Lord Wolseley, has expressed some surprise that the so-called "Intelligence Department" ot the Army allowed the Ladysmith force to go to the front with mountain guns against a Boer force which they should have known might be armed with Schneider-Canet cannons of large calibre; and it would seem that probably a terrible disaster has been prevented, not by our Intelligence Department, not by the outfit of our Army, but by the apparently accidental arrival of naval guns and *personnel* at the last moment. Why is there not a Scientific Committee to do what it can in advising the military authorities? If they could do nothing, nobody would be the worse, but they might be able to do much to the nation's advantage.

AT the anniversary meeting of the Royal Society on November 30, the following Fellows will be recommended by the President and Council of the Royal Society for election into the Council for the year 1900. The names of new members are printed in italics:—President: Lord Lister. Treasurer: Alfred Bray Kempe. Secretaries: Sir Michael Foster, K.C.B., Prof. Arthur William Rücker. Foreign Secretary: *Dr. Thomas Edward Thorpe.* Other members of the Council: *Horace T. Brown,* Captain Ettrick William Creak, R.N., Prof. James Dewar, *Prof. Edwin Bailey Elliott, Dr. Hans Friedrich Gadow,* Prof. William Dobinson Halliburton, Prof. William Abbott Herdman, *Sir John Murray, K.C.B.,* Sir Andrew Noble, K.C.B., *Prof. Arnold William Reinold,* Dr. George Johnstone Stoney, *George James Symons, J. J. H. Teall,* Prof. Joseph John Thomson, *Prof. Edward Burnett Tylor, Sir Samuel Wilks, Bart.*

The gold medal of the Highland and Agricultural Society of Scotland has been awarded to Prof. Cossar Ewart in recognition of his intercrossing and other experiments. Seeing that the Scottish Agricultural Society has a reserve fund of well nigh 100,000*l.*, and that there was a clear profit of over 4000*l.* at the last show—the show at which Prof. Ewart's zebra hybrids attracted so much attention—it is a matter of some surprise that the directors of the Society have not ere this voted a substantial sum in aid of the extremely costly experiments which for some years have been steadily carried on in the vicinity of Edinburgh.

Dr. W. H. Corfield, professor of hygiene and public health in University College, London, has been appointed to the newly-created post of consulting sanitary adviser to Her Majesty's Office of Works, for the Royal Palaces and Public Buildings in charge of the Department.

At the recent annual meeting of the Royal Academy of Medicine in Ireland, the following distinguished men of science were elected honorary Fellows of the Academy: Sir J. Burdon-Sanderson, Bart., F.R.S.; Prof. Howard Kelly, Baltimore; Prof. Koch, Berlin; Prof. Kocher, Bern; Prof. Th. Leber, Heidelberg; Sir W. MacCormac, Bart., K.C.V.O., London; Prof. Martin, Berlin; Prof. Nothnagel, Vienna; Prof. Osler, Baltimore; and Sir W. Turner, F.R.S., Edinburgh.

An egg of *Aepyornis maximus*, measuring nearly a yard in circumference, was sold at Mr. J. C. Stevens's auction rooms on Tuesday, the price realised being forty-two guineas.

We regret to see the announcement of the death of Dr. Edward Orton, the distinguished geologist, and president of the American Association for the Advancement of Science.

Six public lectures on "England in South Africa," illustrated by maps and lantern slides, will be given at the Imperial Institute on Thursday evenings during this month and next, by Mr. Basil Worsfold. The first lecture will be delivered this evening.

We learn from *Science* that Mr. J. B. Hatcher, and his assistant Mr. O. A. Peterson, have returned from their third exploration of Patagonia, where they were sent by the Geological Department of Princeton University. Very extensive collections have been made of both vertebrate and invertebrate fossils of Patagonia, and much material illustrating the zoology and botany of that region has been obtained.

The leases of the auriferous deposits of the north-western shore of the Sea of Okhotsk, in Siberia, recently discovered and explored by a special commission sent into the region referred to by the Russian Imperial Government, are to be put up for auction at St. Petersburg in February 1900. The conditions of the leases may be seen on application at the Intelligence Branch of the Commercial Department of the Board of Trade.

It is stated by the *Daily News* that Prof. Starr, of Chicago, who for many years has made a study of the ethnographical aspects of the interior of Mexico, has presented his valuable collection of objects, gathered during various expeditions into the heart of Mexico, to the Folk Lore Society, and the latter have, through the medium of their president, Mr. E. Sidney Hartland, offered to place the collection on permanent deposit in the Museum of Archæology and Ethnology at Cambridge.

The new session of the Society of Arts will be opened on November 15 with an address from the chairman of the Council, Sir John Wolfe Barry, K.C.B., F.R.S. In it it is probable that he will develop the subject of his address last year, "London Communications," and will make some suggestions as to the practical means of carrying his proposals into effect. The first paper after the opening meeting will be by Mr. D. E. Hutchins, who will draw attention to the want in this country of measures for the proper conservation of woods and forests. At the next meeting Mr. Allan Wyon will give a paper, principally of an antiquarian nature, on the Great Seals of England. At the other meetings before Christmas it is probable that Mr. Joseph Cash will describe the substitutes which have recently been introduced to replace silk, and the methods of their production. Mr. F. G. Aflalo will draw attention to the necessity for some legislation to restrict sea anglers from catching immature and undersized fish; and Mr. H. Bloomfield Bare will describe and illustrate the methods, which have recently achieved considerable success in America, of teaching drawing by the use of the blackboard, both hands being employed. Mr. H. H. Cunynghame, who has devoted a great deal of attention to the subject, will give a course of Cantor Lectures before Christmas on the art of enamelling. It is intended to demonstrate practically the whole process of enamel-making during the course. The Juvenile Lectures will be by Mr. Herbert Jackson, of King's College, who will lecture on phosphorescence.

An important article on Mangabeira rubber appears in the current number of the *Kew Bulletin*. Partly in consequence of an improvement in the purity of the rubber, the price has recently advanced and the price of the best sorts is not much less than that obtained for Para rubber. The chief centres for export of Mangabeira rubber are Bahia and Pernambuco. Although but little is known so far of the cultivation of Mangabeira, it may be said that there is a considerable probability of its becoming an important tree in rubber-culture. The apparently easy accommodation of the tree to soil and climate, its early and considerable yield, together with the fact that even under the rough treatment of the Indians it preserves its fruitfulness, and also the facility with which it can be cultivated, promise a future. And, taking a wide view of its possibilities, from its presence in the red coffee-growing soils of the west of the Province of São Paulo, it appears suitable for the red earths of the German colonies of Africa, Usambara and Togoland alike, such, for instance, as occur at Misahöhe in the latter Colony. For these soils it promises to be considerably better suited than the Ceara rubber plant and the Para rubbers, and will probably give better results than *Castilloa*, than which it is more hardy, earlier maturing, and smaller.

The information at present available on the subject of injurious insects in India forests is brought together in an illustrated pamphlet (pp. 152) by Mr. E. P. Stebbing, which has been issued from the office of the superintendent of Government printing, Calcutta. Locusts and white ants or termites are among the most destructive pests of the insect kingdom. The former invades the fertile plains of India from its home in the sandy deserts of Rajputana, Sind, and the Punjab, and in the line it takes not a green leaf or shoot is left either in the forest or field. It is pointed out that as the life-history of the pest readily proves that forests and moisture are its greatest enemies, the reclamation of arid sandy areas by means of plantations would tend to check its multiplication. As to the white ant, though it is a most unwelcome intruder in any building, it renders service to man in the forest by rapidly converting fallen branches, dead trees and decaying wood of all kinds into mud, each particle of wood eaten being replaced by earth. Where termites are numerous, the insects only feed on the outer dead portions of the bark of the trees, and do no damage to healthy trees. The instinct of these insects is marvellous. Mr. Stebbing states that he has often noticed that should a tree have a dead branch on its trunk, no matter at what elevation, an earthen gallery is run up by the white ants, and the branch attacked, the decaying wood being replaced by soil, which soon falls to the ground.

A NOTE on a new departure which has been made in connection with the artificial hatching of salmon in Norway appears in the *Journal* of the Society of Arts. Formerly the young fry were allowed to escape as soon as they began to require food, and, therefore, when in a very delicate and defenceless condition. They are now retained in captivity, and fed four times a day upon the raw liver of slaughtered animals, until the autumn, after the system which obtains in America. According to Consul Nelson, of Bergen, the results of the first year's experiment at the Government hatchery on the Drammen were satisfactory; on 280,000 ova treated, the loss was only 2 per cent., and in the middle of October about 211,000 fry were turned out, while the percentage of loss has been still further reduced of late years. A belief is prevalent among the coast fishermen that salmon and sea-trout spawn successfully in salt water, and in this connection a series of experiments were conducted under proper supervision, from which it appeared that (1) roe taken from salmon captured in a river, or from sea-trout which have remained until the spawning time in sea water, cannot be successfully developed in salt water, and (2) salmon and sea-trout roe impregnated in fresh water may be hatched out in brackish water containing a small percentage of salt up to eight or nine per mille—that is to say, rather less than one-third of the salt contained in the sea water on the Norwegian coast.

FEW people are aware that a number of European rivers which were once almost destitute of fish are now well stocked with species propagated from fry obtained from America. An idea of the extent of the operations of the U.S. Fish Commission, by which this change has been brought about, may be obtained from an article in the *Scientific American*. About ten years ago young fry of American landlocked salmon were shipped to Scotland, and since then they have multiplied rapidly, much to the detriment of the Scotch fish. A shipment of American black bass fry was made to France for stocking the rivers and streams, and, like the American salmon in Scotch waters, they have flourished so marvellously that to-day they are quite common articles of diet at the French hotels and restaurants. The French streams, since the introduction of the American bass, have doubled in their productive value, and there is every reason for the French anglers to be grateful to the U.S. Fish Commission for stocking their waters with a new species of food fish. Other varieties of fish have been shipped to France and elsewhere for scientific experiments. The American rock bass has been introduced into several English streams, and the American brook trout is to-day in flourishing condition in the clear, cold streams of Russia and other northern countries of Europe. The waters of Switzerland abound with many American common river and brook fish, which make the angling there superior to anything in the past. It is even reported that the fine American muskalonge has found a satisfactory home in the Rhine and Danube rivers.

WE have received the Report of the Meteorological Commission of the Cape of Good Hope for the year 1898, a folio Blue Book of 168 pages, containing valuable results of meteorological observations made under the direction of the Commission, which has been collecting systematic information since the year 1861. The system now embraces two stations of the first order, 54 of the second order (barometric stations), 17 thermometric stations and 370 rainfall stations. These include observations made in the South African Republic, the Orange Free State, and at various other stations outside Cape Colony. The most noteworthy feature of the present Report is the inclusion of returns from the splendidly equipped station established by the De Beers' Company at Kenilworth, near Kimberley, at which hourly observations have been made during the whole year. It is believed that this is the only station of its kind, not only in South Africa, but in the whole African continent. An interesting ocean-current bottle notice was found on the coast, about latitude 34° 2′ south, and longitude 20° 47′ east. It was thrown from the *Blengfell* in latitude 39° 58′ south, and longitude 23° 22′ east, and had taken two years one hundred and thirty days in travelling 4° 56′ north and 35′ east, having evidently been caught in the Agulhas current. Among other useful information, the Report contains notes on the weather of each month and the whole year, drawn up by the Secretary, with a series of diagrams giving the mean monthly rainfall over the whole Colony, with the percentage differences from the means for ten years (1885–94).

THE Report on the administration of the Meteorological Department of the Government of India in 1898–99, which has just been issued, is divided into two parts: (1) a general account of the more important work of the department, and (2) details of administration. The total number of stations (including four first-class observatories) amounted to 174, and the number of rainfall stations from which monthly statements have been published was 2280. Seismographs have been established at three suitable observatories, and a brief list of the earthquake shocks is now given in the *Monthly Weather Review*; a full account of the work done is promised in the next year's Report. Some important observations of the direction and velocity of the upper clouds have been made, and the results will be published in due course. The seasonal forecasts, based on the snowfall of the mountain districts, show only a moderate agreement with the actual weather experienced, but storm warnings appear to have been carried out very satisfactorily, timely warning being given of all the more important storms which visited the Indian coasts; the opinions of the warnings of floods are also generally satisfactory. The Department is greatly assisted in its useful work by the liberality of the Eastern Telegraph Company, and the Indo-European Telegraph Department, for the concession of free telegrams from Aden and Persia.

IN the Bradshaw Lecture, delivered before the Royal College of Physicians of London on November 2, and published in the *Lancet*, Dr. A. Foxwell points out that the first result of exercise is an increase in the rate and depth of the respirations—that is, of the respiratory exchange. The respiratory quotient, CO_2/O_2, is not increased, but if anything diminished: in other words, the tissues are as rich (or richer) in oxygen during exercise as during rest. This necessitates a great increase in the absorption of oxygen at this time; for it has been shown that a man gives off ten times as much carbonic acid when on the treadmill as he does when asleep. But it is a remarkable fact that arm work, per unit of work done, requires a greater absorption of oxygen than climbing, and climbing than walking on the level. If the amount of oxygen absorbed during sleep per minute be 100 grams, then in a minute's walking at three miles an hour on the level it would be 500 grams; in climbing a yard high 5000 grams, and in doing the same amount of kilogram metres by turning a wheel (arm work) 7000 grams. Such an enormous increase in the absorption of oxygen and giving out of carbonic acid must seriously strain the resources of the organs concerned. Dr. Foxwell considers that the lungs and the right ventricle of the heart bear the brunt of the extra labour involved in short strenuous exertions.

IN the *Physical Review* for September, Messrs. W. O. Atwater and E. B. Rosa give the first part of a paper describing a new respiration calorimeter and certain experiments made with it on the conservation of energy in the human body. The apparatus described has been devised and the methods of experimenting have been elaborated for use in inquiries bearing (1) on the question as to whether the principle of conservation of energy holds good in the living organism, and (2) assuming this law to be true, on the acquisition of more definite knowledge of the ways in which the body is nourished and of the values and uses of food. We would suggest that in experiments upon the living organism, the second law of thermodynamics opens up a much more interesting field of study than the first law. It has been suggested that vital processes afford the most likely region in which to seek for the existence of Maxwell's "demons," and should their non-existence be established, information as to the relative efficiency of the human individual as compared with a perfectly reversible thermodynamic engine is much to be desired.

THE Soulanges Canal, which has recently been opened for traffic, completes the scheme for providing a 14-feet water-way from the Great Lakes to Montreal, in place of 9-feet, which previously had been the ruling depth for the navigation. It is considered that owing to the increased size of the vessels which will now be able to reach Montreal from the Great Lakes, the price of conveyance of wheat and other products of the North-west will be so reduced as to lead to the diversion of the principal part of the traffic which now finds its way to this country through America by the Erie Canal and New York. The St. Lawrence has been dredged and deepened below Montreal, so that large ocean-going vessels navigate the river up to that city, which has become the head both of the ocean and inland navigation. The Soulanges takes the place of the old Beauharnois Canal, it being found less costly to construct an entirely new water-way over this length than to widen and deepen the old one. The new canal connects Lake Francis with the Ottawa River. The fall in this length is 82 feet, which is overcome by four locks, this descent forming about half the total fall between Lake Ontario and the St. Lawrence. Electricity is used for lighting the locks and for operating the machinery for opening and closing the gates and sluices. The canal has cost 1,000,000*l.*; the total sum expended by the Dominion on the improved water-ways amounting to nearly 8,000,000*l.*

THE current number of Petermann's *Mittheilungen* contains a valuable paper on the fundamental lines of structure of the Eastern Alps, by Dr. C. Diener. An examination of the new material collected during the last few years leads the author to the opinion that the old division of the Eastern Alps into three zones, one crystalline and two limestone zones, is inadequate: the division is rather into five zones, which radiate eastward. The "Flysch" zone forms part of a tectonic unit running to north-eastern Switzerland and the western Alps, next comes the northern limestone zone, and then the central zone, which is made up of a number of different parts. The fourth zone is the "Drauzug" of Suess, and the fifth the southern limestone zone.

THE Smithsonian Institution has just issued a reprint of two old papers, by Dr. Otis T. Mason, on the Latimer Collection of Antiquities from Porto Rico, and on the Guesde Collection from Pointe-à-pître, Guadeloupe. There seems to be some doubt whether the wonderful examples of stone carvings were the work of Caribs or of their more peaceful neighbours; the evidence seems rather to point in favour of the former view. At Porto Rico are found mammiform stones which consist of a human or animal image associated with a conical projection; there are also found so-called "collars." These are slender ringed stones shaped something like a horse-collar; they average about seventeen inches long and twelve inches wide. They are beautifully worked and usually decorated with elaborately carved panels; the significance of these two groups of objects is unknown. Those interested in aboriginal stone-work should consult these papers, which have numerous illustrations; those in the second paper are in that queer dotted American style in which even contour lines are usually omitted. The wonderful results that can be obtained by savages without metal tools are here well demonstrated.

WE have received the parts of the Brazilian journal *Lavoura* for May, July and August 1899. They include articles on imported insect-pests, the Soja bean, agriculture, and various other observations, mostly illustrated, principally of local agricultural interest.

THE seventh edition of Foster and Langley's well-known "Course of Elementary Practical Physiology and Histology" (Macmillan) differs in several respects from preceding editions. Most of the lessons have been rewritten, a few have been added, and the lesson on the dissection of the rabbit and dog has been omitted. Dr. L. E. Shore has revised and rewritten the portions of the book dealing with chemical physiology, and with the physiology of muscle and nerve, and his name appears with Dr. Langley's, on the title-page, as joint editor of the new edition. The volume will doubtless be as widely used and appreciated in the future as it has been for more than twenty years.

WE have received from Mr. C. L. Wragge, chief of the Weather Bureau, Brisbane, a set of weather charts of Australasia for January 1898. The isobars are extended seawards over the Great Australian Bight and to New Zealand. These curves are to a great extent problematical, as indicated by the broken lines, and even over the land they appear to have been drawn from insufficient data in the western and north-western districts; the charts are also too much after date to be of general interest. We should prefer to see charts drawn by each Colony separately, from its own materials, and published within reasonable time after date.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*, ♂) from India, presented by Mr. Charles Dallas; a Vulpine Phalanger (*Trichosurus vulpecula*) from Australia, presented by Mr. D. Woosman; a Shag (*Phalacrocorax graculus*), European, presented by Mr. E. S. Montague; a Herring Gull (*Larus argentatus*), two Glaucous Gulls (*Larus glaucus*), European, presented by Mr. H. J. Pearson; seven Cape Scorpions (*Opisthopthalmus capensis*) from South Africa, presented by Dr. W. F. Purcell; a Cardinal Eclectus (*Eclectus cardinalis*) (habitat?), a Grand Eclectus (*Eclectus roratus*) from Moluccas, a Mealy Amazon (*Chrysotis farinosa*) from South America, four Blanding's Terrapins (*Emys blandingi*), five Prickly Trionyx (*Trionyx spinifer*) from North America, deposited; twelve Golden Carp (*Carassius auratus*), European, purchased.

OUR ASTRONOMICAL COLUMN.

HOLMES' COMET (1899 *d*).

Ephemeris for 12h. Greenwich Mean Time.

1899.	R.A. h. m. s.	Decl. ° ′ ″
Nov. 9	... 2 28 9·89	... +48 58 11·4
10	... 27 0·16	... 54 29·8
11	... 25 51·41	... 50 28·4
12	... 24 43·76	... 46 7·7
13	... 23 37·30	... 41 28·3
14	... 22 32·11	... 36 30 7
15	... 21 28·27	... 31 15·7
16	... 2 20 25·87	... +48 25 43·7

COMET GIACOBINI (1899 *e*).

Ephemeris for 12h. Berlin Mean Time.

1899.	R.A. h. m. s.	Decl. ° ′
Nov. 9	... 17 30 5	... +6 35·6
10	... 31 42	... 6 51 8
11	... 33 18	... 7 8·0
12	... 34 55	... 7 24·2
13	... 36 33	... 7 40·4
14	... 38 10	... 7 56·6
15	... 39 48	... 8 12·9
16	... 17 41 26	... +8 29·2

THE COMING METEOR SHOWER.—Much has recently been written respecting the necessary preparations for obtaining photographic record of the Leonids, but hitherto these instructions have only taken into consideration the determination of the position and appearance of the meteor trail. There must be many, however, who are in a position to attempt to obtain a record of the composition of the meteorites. The only additional apparatus will be either a prism or a diffraction grating. After the camera has been focussed, the prism or grating can be very simply attached to the hood of the lens, and the whole then constitutes a small prismatic camera which will give the spectrum of any meteor whose image falls on the plate. A grating is preferable, as the reduction of the spectrum is more easily made, and there is also the advantage that an ordinary picture of the object is obtained in addition to the spectrum. Practically perfect transmission gratings can now be obtained very cheaply of sufficient size to cover the lenses of ordinary cameras. If a prism is used, it should preferably be set at minimum deviation to allow of subsequent comparisons being made.

LONG FOCUS PHOTOGRAPHIC TELESCOPE.—Prof. E. C. Pickering some time ago asked for donations to enable a photographic lens of unusually long focus to be made for the use of the Harvard College Observatory. We hear that now the whole of the necessary amount has been subscribed by anonymous donors, and that a lens of about 12 inches aperture and over 100 feet focal length will probably be ready for trial during the ensuing year.

SECULAR PERTURBATIONS OF VENUS.—Prof. Eric Doolittle, of the Flower Observatory, has completed his investigation of the perturbations of Venus by the computation of those caused by the planet Neptune. The perturbations arising from the six inner planets have been published in the *Astronomical Journal*, Nos. 409, 428, 418, 434, 438 and 465, and the present communication appears in No. 470.

The planetary elements used have been adapted from Dr. G. W. Hill's "New Theory of Jupiter and Saturn."

All the equations are given in tabular form, and the variations arising from the combined action of all the disturbing planets are given in the form of six equations, one for each element.

ENGINEERING PROGRESS AND PROBLEMS.

THE eighty-first session of the Institution of Civil Engineers was opened on Tuesday with an address by the president, Sir Douglas Fox. A general survey of engineering progress during the present century was given in the address, the following being a few of the points to which reference was made:—

British engineers have two chief bodies of competitors to reckon with—the engineers of the great and growing empire of Germany and those of the United States, who have been thoroughly trained in theory and practice, and are proving their ability and courage by the vast works they originate and carry out.

German and other continental engineers are greatly assisted in many ways by paternal Governments, whose officers they generally are, and who lay down valuable regulations, and in many instances establish standards of quality and design.

American engineers are encouraged by the vast demands of a comparatively new country, in which nature exists on a magnificent scale, only equalled by Switzerland and India, and of a rapidly rising civilisation calling loudly for the most recent improvements in locomotion, in building, in lighting, in telephonic and telegraphic communication.

An important matter demanding careful consideration by civil engineers, if not by the Institution itself, is whether competition in the world's race could be facilitated by the establishment, upon sufficient authority, of standard specifications for such materials as steel and cement, and the introduction of standard types for bridgework, roofing and other structures frequently occurring in practice, and for locomotives and rolling stock.

The question of the adoption of the metric system has been ably dealt with by others. I therefore only desire to record my opinion that it is of the utmost importance to the engineers and traders of this empire, that this simple and effective mode of measurement, already in force in almost every other civilised nation, should be introduced here. Having had occasion for many years to work under both systems, I can bear testimony to the great saving of time and of labour effected by the use of the metrical weights and measures, and to the ease with which the system is acquired, even by those trained to use our antiquated and complicated standards. I am strongly of opinion that the two great Anglo-Saxon nations, Great Britain and the United States, must fall into line with the rest of the world in this matter, and it would be a notable and interesting mark of our entry into a new century if, as has already been suggested to our Government, the metric system could be made compulsory as from A.D. 1900. One great obstacle to British designs and manufactures finding their way upon equal terms through the continent of Europe and into the vast empire of China, Japan and elsewhere, would thus be removed, and engineers throughout the world would be thinking and designing upon a basis of like dimensions.

Nothing has more largely contributed to engineering successes of late years than the introduction of cheap steel of good quality and of high tensile strength, both for rails and for plates and rolled sections. Remarkable uniformity of quality has been attained, and, whilst the life of rails has been greatly increased, structures such as the Forth Bridge have been rendered practicable. At the present time mild steel is almost exclusively used for the construction of ships, thus greatly increasing their carrying capacity. Some anxiety is being caused to engineers by the manifest signs in rails and axles of fatigue after considerable wear, and the report of the Board of Trade Committee upon this subject is awaited with much interest.

With reference to this matter and to other questions involving scientific research, the resources of this Institution might, I suggest, be advantageously employed. Large numbers of experiments upon steel and other materials have been made with small specimens, but the testing to destruction of full-sized members of bridges and other structures, and experiments upon the effects of impact and of loads running at high speeds have been generally beyond the limits of private enterprise. As a result comparatively few of such records are available, whilst the value to our members would be very great.

There is no department of engineering which has benefited more by the inventive genius of the century than that of mining. Improved methods of sinking deep shafts, tubbing back water, and winding at high speeds from great depths, have enabled much coal to be opened up. Electricity has been impressed into the service with most beneficial results, not only of economy, but of safety and improved sanitation, and is now largely used for underground haulage, for lighting, for pumping at the face, and, in the shape of telephones, for communication. In dealing with gold and other ores, chemistry, electrolysis and mechanical engineering have combined to reduce cost and waste. Every effort is still necessary on the part of our mining engineers to face the competition, and the labour-saving appliances, not only of Belgium and Germany, but still more of the United States. It is surely to be regretted that it has been found necessary to obtain so large a portion of the mining machinery for our Colonies from our Transatlantic cousins.

It seems probable that liquid air, which can now be produced at a very cheap rate, will prove a most valuable auxiliary for cooling, and thus assist in ventilating mining drifts and railway tunnels. Experiments in this direction are being made in connection with the works of the Simplon Tunnel, which are now in full activity.

The problems now opening up to the civil engineer are of surpassing importance. Trunk railways through Russia, China, Persia, Africa; irrigation works to supply the wants of growing populations; harbours large enough to receive the vessels of the future (already eclipsing the *Great Eastern*, of which the chief shortcoming was that she was before her time); central installations to furnish lighting, power, traction and heating to whole counties; the extension of the telephonic communication—with and without wires; the abolition of the smoke and smell of cities; the replacement of horses by mechanical power in the streets; the increase of the speed of trains to 100 miles per hour; the erection of buildings of great height where land is valuable; the utilisation of waste products, especially the refuse of cities; the improvement of the water-supply; the reclamation of land; the profitable working of deep seams of coal.

These are but some of the branches in which engineering progress in the twentieth century may be expected to develop. They will call with increasing force for engineers sanguine for the future, educated upon a basis of sound scientific attainment, trained in experimental research, and qualified by practical experience—obtained, I trust, by means of that regular course of pupilage under members of the Institution which, in the less favourable circumstances of the past, has nevertheless produced the engineers who have achieved the results to which I have referred.

ANTHROPOLOGY AT THE BRITISH ASSOCIATION.

THE chief point of interest on the first day of the meeting of the Section, apart from the President's address, was a discussion on the rival systems for the identification of criminals of the Bertillon method and that based on finger-prints as propounded by Mr. E. R. Henry and adopted in British India. Mr. Henry, who is the Inspector-General of Police in the Bengal Civil Service, gave a demonstration of his system. The author referred to the importance of fixing human personality so that no efforts made to confuse it subsequently may prove availing. Of this problem the Bertillon system offered first scientific solution. But experience in India has shown that the "Personal Equation" error of measures predominates so much as to vitiate seriously the correctness of the recorded results under that system. Finger-prints, on the other hand, being absolute impressions taken from body under conditions which eliminate error in transcribing or recording, the "Personal Equation" error is reduced to a minimum. Taking the impressions of all ten digits occupies only a fraction of the time required for measuring, while search is more exhaustive and many times more rapid. This new system has been introduced on a most extensive scale throughout British India, and the Legislature has recognised it by passing an Act to amend the law of evidence so as to make relevant the testimony of finger-print experts.

The main difficulty hitherto experienced had been that of providing an effective system of classification. But this difficulty has been overcome. A thin film of printer's ink is spread over a piece of flat tin, and each finger in turn is pressed on the film, and after being thus inked is pressed on paper where a clear, sharp impression is left. Fingers are impressed in their natural order of thumb, index, middle, ring, and little, those of the right hand being above, and the corresponding digit of the left hand below them.

All impressions must be either arches, loops, whorls, or composites—there is a great preponderance of loops and whorls. In primary classification arches are included under loops, and composites under whorls, and therefore, for purposes of primary classification, an impression must be either a loop or whorl. The digits are taken in the following pairs: (1) right thumb and right index; (2) right middle and right ring; (3) right little and left thumb; (4) left index and left middle; (5) left ring and left little finger. Taking first pair and denoting loop by L and whorl by W, we get the following arrangements. Right thumb may be L and right index L; right thumb may be L and right index W; right thumb may be W and right index L; and right thumb may be W and right index W. So there are four, and not more than four, arrangements possible. Similarly, in second pair, there are four such arrangements, which, taken with those of the first pair, yield 16 combinations; taking the third pair we get 64 combinations, and by adding the fourth and fifth pairs, this number rises to 256 and 1024. Now 1024 equals 32 squared; in other words, a cabinet containing 32 sets of 32 pigeon-holes arranged vertically would provide all the locations required. A diagram was shown how this works in practice. But the following rule is very simple. The first of each pair is shown as numerator, the second of each pair as denominator, yielding for the five sets of pairs some such formula as the following: $\frac{L}{W}$; $\frac{W}{L}$; $\frac{L}{L}$; $\frac{W}{W}$; $\frac{L}{W}$. A whorl in the first pair counts 16, in the second pair 8, in the third 4, in the fourth 2, in the fifth 1. No numerical value is given to a loop. Substituting these values in the formula we get $\frac{0}{16}$; $\frac{8}{0}$; $\frac{0}{0}$; $\frac{2}{2}$; $\frac{0}{1} = \frac{10}{19}$. Add 1 to both numerator and denominator and invert the fraction which becomes $\frac{20}{11}$, and this is the primary classification number, and represents that the card containing these impressions will be found on the twentieth pigeon-hole of the eleventh vertical row. The secondary classification required to break up accumulations is equally simple, and the search formula or legend for each card can be prepared rapidly without any key and brings search down to groups of very small volume.

Naturally Dr. Garson argued in support of the French system as taught by him to the English police. He had previously read a paper on the "Personal equation in anthropometry," and had fully described the well-known Bertillon system; he admitted there was always a margin of uncertainty in measurements, but denied that it need be so large as Mr. Henry asserted. He expressed regret that the Indian Government had abandoned the Bertillon system for one based solely on finger-prints.

A paper, also illustrated by lantern slides, was read by Francis Galton on "Finger-prints of young children," in which he demonstrated that clear prints of all ten fingers of a baby would suffice for after-identification by an expert, but by an expert only. Although new ridges may appear in infantile life the type of each pattern persists all through life, and is never doubtful to a practised eye.

The whole of Friday was devoted to samples of the work accomplished by the Cambridge Expedition to Torres Straits and New Guinea. Dr. A. C. Haddon, the organiser and leader of the expedition, led off with a short report on the work done (*cf.* NATURE vol. lx. p. 413), and illustrated with lantern slides the physical character of the inhabitants. A communication on the linguistic results of the expedition, by Mr. Sidney H. Ray, was laid before the Section.

The language of the Eastern tribe of the Straits bears no resemblance to the Melanesian, and but little to the Australian group of languages, while that of the Western tribe is decidedly of the Australian type. Most of the coast languages of the Port Moresby and Hood Bay districts are very closely akin to the languages of the Melanesian Islands, except some, such as the Koitapu, Koiari and Cloudy Bay dialects, which approach the Australian type, but has nothing in common with the Melanesian. Mr. C. S. Myers gave an interesting paper on savage music, based on his observations in Murray Island and Sarawak.

As our modern orchestra admits the noises of drums and cymbals, and our harmony allows chords which in a more classical period were inadmissible, we, in our inquiry into past and primitive music will not refuse to consider certain sounds as musical even though they be noisy. Sympathy should be our sole test of music. In savage life the songs of a tribe are its chief heritage. Certain songs recorded on the phonograph in Murray Island, Torres Straits, are now obsolete, and will probably die out with the old men. Neither there nor in Borneo could any trace of the notes of birds be found in the music. Of the two fundamentally distinct elements in music, rhythm and melody, the one has its basis in bodily movement, the other in the emotional recitative. In Murray Island the drum is beaten to accentuate the words of the old songs, the music being singularly lacking in rhythm; among the North American Indians, on the other hand, rhythm is well developed. The extraordinary complexity of rhythm in certain Malay music was graphically recorded. The Murray Islanders have a wonderfully developed idea of rhythm, as is proved by their being able regularly to continue accurately recorded beats of prescribed rapidity for a considerable period. Many suggestions have been made as to which of the intervals came most naturally to the human voice. The Murray Islanders have no polyphonic music, but in a chorus accompanying the songs of the Kenyah and allied races in Borneo a long-drawn note a fifth below the key-note runs drone-like through the song. A similar interval has been noted in one of the rare examples of polyphonic music found in North America.

Writers have been led to conclude that various peoples employed far smaller intervals than our own, misled apparently by viewing the numerous intervals as if they formed a scale instead of a series of notes from which various scales were derived. In this way travellers have been induced to look for quarter-tone music in uncivilised parts of the world; but the author had no doubt that those quarter-tones, which have been written down as occurring between any two whole (or semi-) tones, merely express a gradual descent in the voice from one of these tones to the other. The insensitiveness of the ear of the Murray islanders to minute differences of interval was estimated by means of tuning-forks. The common incorrect intonation in savage music was alluded to.

Mr. C. G. Seligmann followed with an account of the seclusion of girls at puberty in Mabuiag and other of the Western islands of Torres Straits and also on the mainland at Cape York. The girl is surrounded with bushes in a dark corner of her parents' house, and for months is only allowed to go out at night. The sun may not shine on her; no man may come into the house; ill-luck would befall her father if he saw her; she may not feed herself; and there are other restrictions. Various modifications of the seclusion were described. These observations are of especial interest, as it is a new locality for these interesting customs, the significance of which have been discussed by Frazer in "The Golden Bough." The same author read a paper on some customs of the Otati tribe of North Queensland; and another, illustrated with lantern slides, on the Club Houses and Dubus of British New Guinea. In the Papuan Gulf the club houses of the men are of large size and highly decorated; no women may enter them. Further down the coast their place is taken by platforms, or dubus, the posts of which are generally carved, in some instances probably so as to resemble crocodiles' heads. As a general rule women may not approach the dubu.

The morning's session concluded with a very interesting report on the investigations on comparative psychology made in Torres Straits and New Guinea. Dr. W. H. R. Rivers gave a general account of the work done, with observations on vision, &c. The natives show very considerable variability in character and temperament; they do not appear to be especially susceptible to suggestion, but exhibited very considerable independence of opinion. One hundred and fifty natives of Torres Straits and Kiwai were tested for colour-blindness without finding one case; about eighty members of other races were tested with a similar result, but of eight Lifu islanders three were colour-blind. The names used for colours by the Torres Straits islanders were very fully investigated; there were definite names for red, less definite for yellow, and still less so for green, while a definite name for blue was either absent or borrowed from English. Corresponding to this defect of colour terminology, there appeared to be an actual defect of vision for colours of short wave-length. Numerous observations were made on writing and drawing; the most striking result was the care and correctness with which mirror writing was performed. Unexpected success attended the experiments on the estimation of time. Nearly all the investigations gave some indication of the liability to fatigue and the capability for improvement by practice. Mr. C. S. Myers gave an account of his observations on hearing, smell, taste, reaction-time, &c. Few Murray Islanders surpass a hyper-acute European in auditory acuity, while the majority cannot hear as far. The sense of rhythm is remarkably accurate. There is no reason to believe that they are able to perceive such traces of odour as would be imperceptible to the most sensitive European noses. Experiments were made to determine the appreciation and recognition of the common tastes. The time of simple reaction is probably somewhat shorter than would be that given by a corresponding class of Europeans. The observations of Mr. W. McDougall on the sense of touch showed that the natives have a greater delicacy of discrimination than white men, and at the same time less sensibility to pain.

In the afternoon Dr. Haddon gave a lantern exhibit that lasted for a couple of hours; over one hundred slides were shown, illustrating native handicrafts, customs and mode of life. A number of sacred stones and spots were shown, and their legends narrated. A series of sixteen slides fully illustrated the process of pottery-making at Port Moresby; other slides showed men cutting out canoes with stone adzes at Keapara; raising a pile, and the process of tattooing at Bulaa; and a number of beautiful photographs portrayed the singing games of Papuan children. Most of the photographs exhibited were taken by Mr. A. Wilkin.

Saturday was devoted to archæological papers, and several members of the French Association were present at the session. The most important communications were: one by Mr. A. J. Evans on the occurrence of "Celtic" types of Fibula of the Hallstatt and La Tène periods in Tunisia and Eastern Algeria; the appearance of Celtic types of Fibula among the Numidians finds its complement in the discovery of large hoards of Carthaginian and Numidian coins on the transit line of the amber trade between the Save and the Adriatic. The other, by Mr. G. Coffey, on Irish copper Celts; of these there are eighty-two examples in the Dublin Museum; they are found all over Ireland, and appear to represent a transition from stone to bronze types, and can be arranged in series showing development of form from stone to bronze implements. It would thus appear that, prior to a knowledge of bronze, copper was known and used for cutting implements in Ireland.

Physical anthropology was represented on Monday morning. Mr. J. Gray read a paper, with lantern illustrations, on recent and most excellent ethnographical work in East Aberdeenshire, based on observations on nearly 14,000 children. The maps showed very clearly the penetration up the valleys of an immigrant fair type among a dark population. A very valuable paper, also illustrated by numerous lantern slides, was read by Mr. D. MacIver on recent anthropometrical work in Egypt.

The author gave examples of the ways in which anthropometry may aid archæological investigation, and pointed out the unusually favourable conditions for such anthropometrical work which exist in Egypt. He gave a summary of the series of Egyptian measurements at present available, of the difficulties which have arisen in their interpretation, and of some new methods of publishing measurements specially designed to meet them; these graphic methods were suggested by Flinders-Petrie, and will doubtless prove of value to other investigators.

Details were given of three important series of specimens from Egypt, viz.:

(1) Prehistoric Series; from the excavations of 1898–9.

(2) VI. to XII. Dynasties; from the excavations of 1898.

(3) XII. to XVI. or XVII. Dynasties; from the excavations of 1898–9.

These series were considered (*a*) separately, with the object of ascertaining the race type represented in each; (*b*) in comparison with one another, to show their affinities and differences. The paper concluded with a most instructive and suggestive essay on the light which such comparison throws on Egyptian history.

Prof. A. Macalister followed with notes on a collection of 1000 Egyptian skulls, and exhibited curves compiled from the indices.

In the afternoon Prof. W. M. Flinders-Petrie read a paper on sequences of prehistoric remains. In written history the value of chronology lies almost entirely in its defining the sequence of events; and if the order of changes in a civilisation can be fixed, the reference to a scale of years is but a secondary matter. Hitherto only very vague and general terms, referring to places and not to age, have been used in naming prehistoric remains. But if we possessed a perfect record of an unlimited number of contemporary groups of objects all of which have had a time of invention, popularity, and decay, and the use of which overlap each other, it is clear that with patience it would be possible to arrange all the series of groups in their order of time, and so establish definite sequences among the various objects. If then a sequence can be established, a scale of notation is needed. As a scale of years is impossible, a scale of equal activities is the most reasonable. This may be reached by placing all the available material in order and then dividing it into a scale of equal parts. Such a scale, though not equal in time, will yet give a fair unit for measuring a civilisation. This

Prof. Flinders-Petrie has accomplished for prehistoric Egypt, and his demonstration indicated that his system is an important addition to precision in dealing with undateable archæological remains. A second paper by the same indefatigable and brilliant investigator dealt with early Mediterranean signaries and the sources of the alphabet.

The large series of signs used in Egypt about 2500 B.C. is now shown—by such signs existing as far back as 5000 B.C.—to be independent of the hieroglyphic system or any derivatives of that. Similar signs in Crete show this system to have extended to the Mediterranean by about 2000 B.C.

On looking at the more extended forms of the Greek alphabet found in Karia and Spain, about sixty signs are seen in use, representing about forty-three sounds. Three-quarters of these signs are common to the system found in Egypt and Crete.

The only conclusion at present seems to be that signs were in use from 5000 B.C. onward, and developed by 2500 B.C. to over 100 in Egypt, of which half survived in the fuller alphabets of Karia and Spain. The compression and systematising of these signs was due to twenty-seven of them being adopted for a numerical system by the Phœnicians, and thus the *alpha beta* order was enforced by commerce on all the Mediterranean. This accounts in the only satisfactory way for the confusion of the early Greek alphabets, and is a view forced on us by the prevalence of these same signs long before Phœnician commerce.

On Tuesday Dr. A. C. Haddon read some notes on the Yaraikanna Tribe of Cape York:—

The Yaraikanna are fairly typical Australians in appearance; six men were measured, average height 1·625 m. (5 ft. 4 in.), cephalic index 74·7 (extremes, 72·4–77·7). A lad is initiated by his *mawara*, apparently the men of the clan into which the boy must subsequently marry; he is anointed with "bush-medicine" in the hollow of the thighs, groins, hollow by the clavicles, temples, and back of knees to make him grow—the bull-roarer is swung. In the *Yampa* ceremony the initiates (*langa*) sit behind a screen in front of which is a tall pole, up which a man climbs and catches the food thrown to him by the relatives of the *langa*. Then the bull-roarer is swung and shown to the *langa*; lastly, a front tooth of the *langa* is knocked out, with each blow the name of a "land" belonging to the boy's mother or of her father is mentioned, and the land, the name of which is mentioned when the tooth flies out, is the territory of the lad. Water is next given to the boy, who rinses out his mouth and gently empties his mouth into a palm-leaf water vessel; the clot by its resemblance to some animal or vegetable form determines the *ari* of the lad. The *ari* appears to be analogous to the *manitu* or *okki* (or "individual totem" of Dr. J. G. Frazer) of the North American Indians. After the ceremony the boy is acknowledged to be a man. Other *ari* may be given at any time by men who dream of an animal or plant, which is the *ari* of the first person they meet on awakening. The *Okara* ceremony was alluded to, and various customs, among which may be noted—children must take the "land" or "country" of their mother, a wife must be taken from another country, all who belong to the same place are brothers and sisters.

Mr. W. Crooke discussed the primitive rights of disposal of the dead, as illustrated by survivals in modern India; the points considered were: customs connected with the preservation of the corpse, such as various forms of mummification; platform burial; direct exposure of the dead to beasts of prey; general exposure of the dead; the question of the priority of burial to cremation; transitions from burial to cremation, and *vice versa*: disposal of those dying in a state of taboo; shelf or niche burial; crouched or sitting burial; disinterment of the corpse; jar or urn burial; and dismemberment of the corpse.

A theoretical paper on pre-animistic religion was read by Mr. R. R. Marett, his general thesis being:—

The term religion denotes a state of mind embracing emotional and ideal constituents, whereof the former constitute the universal and constant, the latter the particular and variant element. Self-interpretation in ideal terms on the part of the religious emotion of the savage has found most complete and definite expression in animism, the "belief in spiritual beings." Animism, however, as compared with "supernaturalism," namely, that state of feeling almost uncoloured by ideas which is the primary form taken by man's awe of the supernatural (or extraordinary) is, but as the strongest sapling in a thicket of heterogeneous growths, which, in the struggle for existence, has come to overshadow the rest and give a character to the whole. The vagueness of primitive "supernaturalistic" utterance is illustrated by, *e.g. andriamanitra* (Malagasy), *ngai* (Masai), *mana* (Melanesians), *wakan* (North American Indians), *kalou* (Fijians). A "pre-animistic" validity as manifestations of religion thus attaches to a variety of special observances and cults; and it may therefore be interesting in the case of some of the more important of these to distinguish between the original basis of "supernaturalistic" veneration and the animistic interpretation that as the result of successful competition with other modes of explanatory conception (notably "animatism," namely, the attribution of life and will, but not of soul or spirit, to material objects and forces) is thereon superimposed in accordance with the tendency of the religious consciousness towards doctrinal uniformity.

In the afternoon Colonel R. C. Temple discoursed on the thirty-seven Nats (or Spirits) of the Burmese.

The belief in the Nats, or supernatural beings who interfere in the affairs of mankind, is universal among all the native inhabitants of Burma of every race and religion. Every writer about the Burmese and their customs mentions the Nats. The subject is, however, still but vaguely understood. The Nats are of three distinct kinds: (1) the supernatural beings due to the Buddhist cosmogony; (2) the supernatural beings familiar to the creatures, objects and places with which man is concerned due to the prehistoric animistic beliefs of the people; (3) the supernatural beings who are ghosts and spirits of the notorious dead. Of the many orders of Nats thus created, that of the Thirty-seven Nats is by far the best known among the people. These are the ghosts of the departed royalties of fame, and their connections. About them nothing seems to have been previously published in England, and this paper was a preliminary attempt at an adequate representation of them, and of the history, real or supposed, connected with them during life. The paper was illustrated by a map in order to explain the relative position of the places chiefly connected with the very complicated political history of Burma and its numerous dynasties, so far as these are concerned with the stories related of the Thirty-seven Nats. The paper was further illustrated by a beautiful lantern slide of an image of each of the Thirty-seven Nats from the unique and authentic collection of large carvings of them in teak wood by Burmese artists in the possession of the author.

The most important communication on Wednesday morning was a description of two new methods of anthropological research by Dr. W. H. R. Rivers. He commenced by emphasising the importance of great accuracy in all anthropological investigations. His first exhibit was a contribution to exactitude in recording colours, more especially those of the skin of natives. Lovibond's tintometer proved of great service in matching colours, but it is not very suitable for matching skin-colours; for this a colour-wheel is most suitable, the only objection being that the paper discs are liable to fade, and it is not always certain that any two issues of coloured discs would be of exactly the same tint. By having a large number of discs the original records could be filed for future reference and, if kept in the dark, they would not fade. If permanent and absolutely comparable discs could be produced the colour-wheel would answer all practical purposes. The second was a most important sociological method, and consisted in accurately recording the genealogies of all the individuals of an island or limited community for as far back as the informants can remember. It is necessary to use only the terms of "father," "mother," "wife," "children," "man," "woman," "boy" and "girl." The first two were qualified by "proper" or "true," so as to avoid ambiguity. By asking what A calls B, &c., the names and system of relationship can be obtained with absolute precision. In a totemistic people their totems were also recorded, which yielded evidence as to marriage restrictions. This method also furnishes definite statistics on the size of familes, proportion of sexes, number of early deaths, prevalence of adoption, and various other sociological data which are very difficult to obtain with accuracy by any other method. This method of Dr. Rivers' should be adopted by all investigators, as it is almost impossible to overrate its value.

The rest of the day was devoted to African ethnography. Dr. R. Koettlitz exhibited some interesting ethnographical specimens from Somali, Galla and Shangalla, including some scales and weights of seeds and stones for weighing gold-dust, and the first example of salt-money that has been brought to England. Papers by Lieut.-Colonel J. R. L. Macdonald on the ethnography of the lake region of Uganda, and by Lieut.

H. Pope Hennessy on notes on some West African tribes north of the Benue, were laid before the Section.

The usual reports of various Committees were read at various times, the most voluminous being that of the Ethnographic Survey of Canada. It stated that during the past year the work of the Committee had been extended in important directions. The introduction into the North-west of large bodies of Europeans who were to become permanently incorporated in the population suggested the importance of securing as soon as possible such facts relating to their general ethnology as might seem to establish a suitable basis for the study of these people under the influence of their new environment. Satisfactory arrangements had been made with respect to Russian refugees known as the Doukbohors, and it was probable that similar arrangements might be completed during the coming year with regard to other large bodies of immigrants. The exceptional circumstances in British Columbia, the fact that it was becoming more difficult each year to obtain trustworthy accounts of its people, the rapid disappearance of old customs, dress, and modes of living had seemed sufficient reasons for devoting to their study a much larger share of the resources of the Committee than might otherwise appear justifiable. An appendix contained an account of early Canadian settlers and studies of the Indians of British Columbia. On the whole Section H may be congratulated on the very uniform high excellence of the papers, it probably being one of the very best meetings that the Section has ever had.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—A meeting of the Junior Scientific Club was held in the University Museum on Wednesday, November 1. After private business, Mr. F. C. Lees (Hertford) read a very interesting paper on geysers in action, exhibiting also an excellent working model. A brisk discussion afterwards ensued.—Mr. Gibson (Ch. Ch.) also read his paper on the retention of plant-food in the soil, which had been postponed from the previous meeting.

CAMBRIDGE.—At the annual election on November 6, at St. John's College, the following were elected Fellows: Mr. W. A. Houston, fifth Wrangler 1896 and Smith's Prizeman 1898, Lecturer in Mathematics at University College, Liverpool; Grafton Elliot-Smith, B.A. 1898, M.D. of the University of Sydney. Dr. Elliot-Smith, who entered the University in 1896 as an Advanced Student, has made a number of highly important contributions to the comparative anatomy of the brain, and is one of the assistant-demonstrators of anatomy under Prof. Macalister.

The Council of the Senate propose that, having regard to the extensive and valuable collections procured for the University by the Torres Straits Expedition, a further grant of 100*l.* (making 550*l.* in all) be made from the Worts Travelling Scholars' Fund to Dr. Haddon towards the expenses of the expedition.

Mr. C. Hose, of Borneo, has presented to the Museum of Zoology a fine example of the ourang outan's nest. A collection of skeletons and skulls of the extinct Moriori race, which formerly inhabited the Chatham Islands, has been acquired for the Museum of Anatomy.

Mr. Timothy Holmes has been added to the Medical School Buildings Syndicate. It is understood that the plans for the buildings are in a forward state of preparation.

Mr. F. W. B. Frankland, third Wrangler in 1897, has been elected to a Fellowship at Clare College.

MR. HORACE PLUNKETT, M.P., has been appointed vice-president of the new department of Agriculture and Technical Education for Ireland.

THE educational movement in Wales has afforded an exceptional opportunity of bringing the Principality into the front rank in the matter of scientific education, and it cannot fail to be a matter of regret to well-wishers of the movement to notice indications that the "modern side" of education is not developing to the same extent in Wales as in other countries. In the recent scholarship examination at the University College of North Wales only six science candidates presented themselves, of whom three were not Welsh, while twenty-five candidates intending to qualify in arts entered.

AMONG other agencies by which the Technical Education Committee of the Essex County Council is cultivating scientific knowledge is the County School of Horticulture at Chelmsford, the prospectus of which is before us. The aim of the School is to impart sound elementary instruction in the best methods of cultural treatment, based upon a knowledge of the structure and physiology of plants. The garden attached to the School covers an area of three acres, and is entirely devoted to educational uses. Horticultural and botanical students in Essex are fortunate in possessing an institution in which wisely planned courses of work upon plants can be followed under such good conditions as are available at Chelmsford.

THE purposes for which the Technical Education grant is used in the various counties are shown concisely in a document just published by the County Councils Association. The counties are arranged alphabetically, and under each is given information concerning the work done in regard to (*a*) schools of science and art, (*b*) technical institutes, (*c*) agricultural schools and institutes, (*d*) domestic economy schools and institutes, (*e*) day or other schools or classes giving instruction in agricultural, commercial, domestic, manual or technological subjects. The Returns (which refer to 1897-98) also show the number of scholarships and exhibitions given by each County Council, and the provision made for examination and inspection of classes.

REPORTS received from time to time, referring to the work carried on under the auspices of Technical Education Committees of County Councils, show that in many agricultural counties the committees are gradually building up a system of teaching and experiment which serves much the same purpose as the educational branches of the agricultural experiment stations in the United States and elsewhere. In Somerset, for instance, the committee, of which Mr. C. H. Bothamley is the director, have organised courses of instruction in most branches of agricultural work; and the instructors not only lecture, but visit farms, gardens and orchards for the purpose of giving information and advice, for which no fees are charged, on points, both general and special, arising in agricultural practice, such as the manuring of arable and grass land, the treatment of wire-worm, farm buildings, water supply, and similar matters. On one farm the failure of the mangold crop for the second year in succession was found to be due to an attack of large numbers of a very minute beetle, which Miss Ormerod identified as what is known as the pigmy mangold beetle, an insect which rarely occurs in sufficient numbers to be injurious, and which was in fact first recognised in this country in 1896. It is satisfactory to read that information has been given by several farmers to whom previous visits have been paid, to the effect that favourable results have followed the adoption of the methods suggested by the county instructor. A scheme for the establishment of an experimental farm has been drawn up, and will be put into effect as soon as the Secondary Education Bill is passed. School gardens are already carried on at several places in the county, and with much success. In other sciences, as in agriculture, the Somerset Education Committee appear to be proceeding on the right lines, and good results must attend efforts so wisely directed.

THE U.S. *Experiment Station Record* gives information concerning an extensive system of agricultural education which the Government of Russia is organising. The scheme provides for (1) higher education, furnished by independent agricultural institutes situated in the chief agricultural zones of Russia, and by chairs of agriculture and allied sciences in the universities; (2) agricultural high schools, which are in the nature of technical schools, and schools with courses in agriculture; (3) lower agricultural schools,; and (4) the diffusion of general agricultural information. The schools for the so called lower education include (*a*) secondary agricultural schools, (*b*) primary agricultural schools, (*c*) agricultural classes, and (*d*) practical agricultural courses. These lower schools are to be under the jurisdiction of the minister of agricultural and imperial domains. They are to be maintained at the expense of municipalities, local communities, associations, &c., but may receive a part of their support from the Government. The secondary schools are to be established on Government land, or land donated for that purpose. The other lower agricultural schools may be established on private estates. The secondary schools are open to young men of all conditions who have completed the course in the primary public schools. The diffusion of general agricultural information is to be provided for by the organisation of public readings or lectures on agricultural questions for the benefit of different classes of the population, instruction of the teachers in public schools in agriculture, horticulture, gardening, apiculture, &c., and providing the public schools with small plots of land and means for cultivating the same; also by the teaching of agriculture in the normal schools, and the introduction of supplementary courses in agriculture in the village schools. There are now in Russia three schools for higher agricultural instruction, nine agricultural high schools, eighty-three lower schools, and fifty-nine special courses. Steps have already been taken for the establishment of about fifty additional agricultural schools.

SCIENTIFIC SERIALS.

American Journal of Mathematics, vol. xxi. No. 4, October.—Memoir on the substitution-groups whose degree does not exceed eight, by Dr. G. A. Miller (pp. 287–338), is an exhaustive piece of work, amply furnished with bibliographical notes. The author's aim is to give enough of the general theory of group construction to find all the possible groups whose degree does not exceed eight without any tentative processes. The earliest work that gives considerable attention to substitution-groups is stated to be that by Ruffini, entitled "Teoria generale delle equazioni, in cui si dimostra impossibile la soluzione algebraica delle equazioni generali di grado superiore al quarto" (1799). The author has won his spurs in this field, and the present memoir shows a thorough mastery of his subject. There is a good table of contents appended.—On a class of equations of transformation, by J. Westlund. In this paper the writer discusses those equations whose roots are the $n + 1$ values of

$$y_{\underset{\nu}{\mu}} = \prod_{1,m}^{p} sn^{2\alpha} . \, cn^{\beta} . \, dn^{\gamma} \, (4p\omega/\kappa),$$

where α, β, γ, are any positive or negative integers, and

$$\omega = \frac{4\mu\kappa + 4\nu i\kappa}{n},$$

μ and ν being integers. For the notation reference is made to Weber, "Elliptische Functionen," § 67.—Dr. Wilczynski, in an article entitled "On Linearoid Differential Equations," follows up a previous article in the *Journal* (April 1899). This he looks upon as being a reconnoissance upon a new field of promise. *Linearoid* "suggests" the relation of the present equations to linear differential equations.—Prof. W. H. Metzler contributes a short note on the roots of a determinantal equation. The theorem is similar to one discussed by Dr. T. Muir in vol. xix. (pp. 312–318).—Non-quaternion number-systems containing no skew units, by Dr. Starkweather, opens with a brief statement of a few properties of number-systems in general. Then follows a proof of a statement made by Scheffers (*Math. Ann.* xxxix. 306, 310) as to the possibility, in this special class of number-systems, of a selection of units having certain simple multiplicative properties. He then shows that the units can be chosen so as to give in general a very much simplified form of multiplication table, and a method is given for deriving systems of the type considered in n units from those in $(n-1)$ units. Application of the principles he deduces is made to systems, the degree of whose characteristic equation is two less than the number of units. Other points are discussed, and a table of all the possible non-equivalent orms is given.

VOL. VI. of the *Anales del Museo Nacional de Buenos Aires* contains the following papers:—Contributions to our knowledge of the herpetological fauna of Argentina and the neighbouring countries, by C. Berg; some cases of vegetable teratology, fasciation, proliferation, and synanthy (three plates), by A. Gallardo; species of *Ampullaria* of the Argentine Republic, by H. von Ihering; diagnostics of new South American Diplopoda, by F. Silvestri; new or critical Argentinian fungi (two plates), by C. Spegazzini; observations on Argentinian and other South American Lepidoptera, by C. Berg; brief comparative description of *Lepidocampa* and *Campodea* (two plates), by F. Silvestri; new South American Tenthredinidæ, by F. W. Konow. Of these the fifth only is in Latin, and the last in German; the remainder are in Spanish.

THE numbers of the *Journal of Botany* for October and November are chiefly occupied by papers on descriptive and geographical botany. These are varied by an article, by Mr. E. S. Salmon, on certain peculiar structures found on the peritheces of the parasitic fungus *Phyllactinia corylea*, which appear to have a function in connection with its dissemination. The degeneration of these structures produces mucilage, by which the perithece of the fungus is firmly attached to the leaf of the host-plant.

SOCIETIES AND ACADEMIES.

LONDON.

Entomological Society, October 4.—Mr. G. H. Verrall, President, in the chair.—The President announced the death, at the advanced age of eighty-six years, of M. Hippolyte Lucas, an Honorary Fellow of the Society. He also announced the death of Mr. Samuel Stevens, and in reference thereto said the Society had to deplore the loss of one of its oldest and most highly esteemed Fellows.—Mr. J. J. Walker exhibited a specimen of *Galerita bicolor*, Drury, a North American beetle of the family Carabidæ, said to have been taken many years ago at Doncaster. He also exhibited a remarkable variety of *Vanessa urticae*, L. (*ichnusoides*, De Selys), which was captured in the Isle of Sheppey on August 28.—Mr. B. A. Bower showed dark aberrations of *Boarmia rhomboidaria*, Hb., in which the normal colour of the fore wings is replaced by dark brown, causing the fuscous markings to stand out very prominently.—Mr. C. J. Wainwright exhibited a number of Dipterous insects, including a long series of *Anthrax paniscus*, Rossi, taken in Cornwall at the end of July and beginning of August; a series of *Eumerus ornatus*, Mg., from Herefordshire, and *Eumerus lunulatus*, Mg., from Cornwall; and a specimen of *Mallota eristaloides*, Lœw, taken near Hereford last July.—Mr. H. J. Donisthorpe exhibited specimens of *Dytiscus dimidiatus*, Berg., and *D. circumcinctus*, Ahr., taken last August in Wicken Fen. He also showed eight specimens of *Athous rhombeus*, Oliv., taken last June in the New Forest.—The Rev. F. D. Morice exhibited three female specimens of *Exoneura libanensis*, Friese, taken at Brumana on Mount Lebanon, near Beirut. He commented upon the remarkable distribution of the genus *Exoneura*, Smith, this genus having been hitherto recorded only from Australia.—Mr. G. J. Arrow read a paper on sexual dimorphism in the Rutelid genus *Parastasia*.—Mr. W. L. Distant contributed descriptions of four new species of Cicadidæ, and Mr. Claude Fuller a paper on some species of Western Australian Coccidæ.

Royal Microscopical Society, October 18.—Mr. E. M. Nelson, President, in the chair.—The President called attention to an old microscope by Cary, presented to the Society by Mr. Gleadow. An instrument of the same design was figured in the *Journal* for 1898, p. 474.—Messrs. Watson and Sons exhibited their new school microscope, which was provided with a diagonal rack and pinion coarse adjustment, but no fine adjustment, their idea being to produce a strong well-made instrument at a low price. Dr. Dallinger had seen this instrument, and thought it would admirably answer the purpose for which it was intended; the coarse adjustment was so well made that he had no difficulty in focussing a $\frac{1}{8}''$ objective with it. The President thought the microscope was strongly made and well fitted, and would be found to be a very useful instrument. Messrs. Watson also exhibited a new form of eye-piece, named the "Holoscopic," which was fitted with an adjustment to render it either over- or under-corrected and suitable for use with either achromatic or apochromatic objectives.—Dr. Measures exhibited a microscope for photo-micrography, made by Zeiss, having a new form of fine adjustment which admitted of the arm being made of any length without throwing extra weight upon the fine adjustment screw. Dr. Dallinger considered the way in which the speed of the fine adjustment had been reduced was most ingenious; the motion was extremely slow, being only $\frac{1}{615}''$ for every revolution of the screw. A protest had always been made in the Society against the fine adjustment having to carry much weight, and it was therefore satisfactory to find that this one had to lift only one-fifth of the weight usually put upon the fine adjustment. The President said the application of an endless screw was a novel way of slowing down the fine adjustment; the reduction of weight upon the thread was an important improvement, and the increased length of arm was another good feature.—The President then described a new form of fine adjustment by Reichert, which was shown applied to his Austrian model, exhibited by Mr.

C. Baker; the indicator to this fine adjustment was movable, so that it could be set to zero when required, thus greatly facilitating the reading of the divisions on the head of the screw. The instrument was fitted with the English standard substage, and the axis of the trunnions was placed above the stage to ensure a better balance. Two other microscopes by Reichert were also exhibited, one being a student's without fine adjustment, but fitted with a dissecting loupe as a substage condenser. The President next showed a microscope fitted with his new stepped rackwork coarse adjustment by Messrs. Watson and Sons; there was no "loss of time," though the pinion was pressed but lightly into the rack. The President also exhibited a dissecting stand by Andrew Ross, which was about forty or fifty years old, and was still a thoroughly good working instrument; and though the lenses were not achromatic, they gave very good images.—Mr. C. Lees Curties exhibited some stereoscopic photo-micrographs taken on the Ives principle by Mr. E. R. Turner, who briefly described the method of taking them.—Dr. Hebb said they had received part vi. of Mr. Millett's "Report on the Foraminifera of the Malay Archipelago," which would be taken as read and published in the *Journal*.—Mr. F. Enock gave an extremely interesting account of his observations on the life-history and habits of British trap-door spiders, illustrating the subject with most excellent original lantern views.

MANCHESTER.

Literary and Philosophical Society, October 17.—Prof. Horace Lamb, F.R.S., President, in the chair.—The Secretary read the draft of the address which was recently presented by the Society to Sir G. G. Stokes, Bart., on the occasion of the jubilee of his tenure of the Lucasian Professorship of Mathematics at Cambridge University, and also the reply received thereto.—Prof. Dixon stated that the restoration of Dalton's tomb had been effected under the direction of the committee appointed, and that there remained a balance in hand of about 27*l*. It was hoped to raise this sum to 50*l*., and to form a vested fund which would provide for any future repairs that might be necessary.—The President announced that the Society had had presented to it another relic of Dalton, in the shape of his diploma of honorary membership of the Edinburgh Medical Society, to which he was elected in 1818.—Mr. Thomas Thorp read a paper on diffraction grating films and their application to colour photography, and exhibited an apparatus which showed photographs of objects in their natural colours by the aid of gratings, and without the use of pigments or dyes.—A paper entitled "On the electrical resistance between opposite sides of a quadrilateral, one diameter of which bisects the other at right angles," was read by Dr. Charles H. Lees.

NEW SOUTH WALES.

Royal Society, July 5.—Mr. W. M. Hamlet, President, in the chair.—Suggestions for depicting diagrammatically the character of seasons as regards rainfall, and especially that of drought, by H. Deane. The author called attention to the inadequacy of the ordinary methods of judging of the dryness or otherwise of seasons by using the totals of the rainfall and comparing them with the average. He explained that the proper way of exhibiting the character of any period is by showing diagrammatically the progressive dryness that takes place in the soil after rainfall ceases. This is marked by a descending line, and being from time to time more or less compensated for by falls of rain, these are indicated by rises. The only useful rain to the soil itself is what soaks in and tends to saturate it; all beyond this, although it may be useful for conservation and for keeping up the flow of rivers, is waste so far as the particular ground on which the rain has fallen is concerned. The diagrams exhibited show the effect of this "loss and compensation" system, and the dryness of the years and parts of years given in the series 1883 to 1898, inclusive, are rendered visible and measurable.—The initiation ceremonies of the aborigines of Port Stephens, New South Wales, by W. J. Enright.

August 2.—Mr. W. M. Hamlet, President, in the chair.—On the crystalline camphor of eucalyptus oil (eudesmol) and the natural formation of eucalyptol, by Mr. Henry G. Smith. In August 1897, the author, with Mr. R. T. Baker, announced the discovery of a crystalline camphor or stearoptene in eucalyptus oil. This substance was named *eudesmol*. The present paper deals with the chemistry of this camphor and its relation to eucalyptol. Eudesmol has been found in the oil of many species of eucalyptus, and should be present at certain times of the year in all those eucalyptus oils that are eventually rich in eucalyptol. Eudesmol has a formula $C_{10}H_{16}O$, is isomeric with ordinary camphor, but has the oxygen atom combined in a different manner. It does not appear to be ketonic, and it cannot be reduced by sodium in alcohol or by other methods. It is optically inactive. It forms a dinitro-compound and a dibromide, but does not form a nitrosochloride. It melts at 79–80° when perfectly pure, but has a tendency to form products having a lower melting point. On oxidation with dilute nitric acid, camphoronic acid is formed, but no camphoric acid. A large amount of evidence is brought forward to show eudesmol to be intermediate in the formation of eucalyptol, and that eucalyptol is derived directly from the fraction containing eudesmol if the oil be kept in the crude condition for some time under ascertained conditions. Oxygen is necessary to this alteration. It is shown that the oxygen atom enters the eucalyptol molecule during the formation of eudesmol, and that by the natural alteration of the high boiling fraction of oils containing eudesmol (*E. macrorhyncha*, for instance) eucalyptol is formed. The synthesis by Perkin and Thorpe (*Journ. Chem. Soc.*, 1897, 1169) shows camphoronic acid to be trimethyl tricarballylic acid, as was first suggested by Bredt, and as eucalyptol is derived from eudesmol, and eudesmol forms camphoronic acid, the question is raised whether Brühl's formula for eucalyptol is correct. It is suggested that the oxygen atom in eudesmol is quadrivalent, and that the peculiarity of eucalyptol may be thus accounted for. From the formula suggested for eudesmol camphoronic acid, as trimethyl tricarballylic acid, can be constructed.—Observations on the determination of the intensity of drought, by Mr. G. H. Knibbs. The paper was really a continuation of the subject of Mr. H. Deane's paper, read at a previous meeting. It was shown that if the degree of saturation of ground was taken as the reciprocal of the measure of drought intensity, as suggested by Mr. Deane, then, theoretically, it was determinable. The essential features of Mr. Deane's solution and of the nature of the problem were discussed.—Divisions of some aboriginal tribes, Queensland, by Mr. R. H. Matthews. A short paper dealing with the social organisation of some native tribes of Queensland.

PARIS.

Academy of Sciences, October 30.—M. van Tieghem in the chair.—Remarks on the volume, "Connaissance des Temps pour l'année 1902," by M. Poincaré. This work contains an important improvement as the result of a conference of directors of observatories in England, Germany, America and France. This year the work contains the mean positions of all the stars in Prof. Newcomb's catalogue, the apparent positions of which do not already appear in one of the four official publications.—On the intervention of plants in the formation of calcareous tufa, by M. de Lapparent. The author points out that the results published by M. Stanislas Meunier in the last number of the *Comptes rendus*, concerning the function of mosses and microscopic algæ in the formation of calcareous tufa, were discovered as far back as 1862 by M. Cohn.—On the Giacobini comet, by M. Perrotin. The elements of the comet have been calculated by M. Giacobini, from the observations made in various observatories. The form of the orbit is at present sensibly parabolic. At the time of its discovery the nebula surrounding the nucleus amounted to 1·5 minutes of arc; at the present time this is reduced to 1·0 minute. The nucleus appears to have increased in lustre, being now of about the eleventh magnitude.—Remarks by M. Fouqué on the alterations introduced by M. de Lapparent in the new edition of his "Treatise on Geology."—On the hyperabelian functions, by M. Georges Humbert.—On congruences of normals, by M. E. Goursat.—On the propagation of electric oscillations in dielectric media, by M. Albert Turpain. The author quotes the expressions of Maxwell and of Helmholtz and Duhem for the relations existing between the velocity of light, the velocities of propagation of the Hertzian waves in different media, and the dielectric constants of those media, and shows that the experiments of Arons and Rubens, Cohn and Zeeman, and of Blondlot do not clearly distinguish between the Maxwell and Helmholtz-Duhem hypotheses. The author describes an experiment which he believes to be free from ambiguity, the results of which are in accord with the views of Helmholtz and Duhem.—Transmission of Hertzian waves through liquids, by M. Édouard Branly. The receiver was placed in the centre of a large glass vessel containing the liquid under examination, and measurements were made of the distance to which the exciter had to be removed to produce no effect upon the receiver. Distilled water or spring water possesses a much greater absorptive power for the rays than oil or air, and the effect of sea water was so great that any thickness over 20 cm. was sufficient to completely absorb the radiations, its power of arresting the rays being greater, in fact, than the same thickness of cement.—On Wehnelt's electrolytic interrupter, by M. E. Rothé. The author describes a curious phenomenon produced by varying the resistance of the circuit. For any given interrupter with a fixed potential difference, there appears to be a limiting resistance, such that for all lower resistances a condition of rapidly varying current strength only is possible. For all higher resistances there may be either the same state of affairs, or a steady current, according to the manner in which the current is established.—On the atomic weight of boron, by M. Henri Gautier. Analyses of boron chloride and bromide lead to values for the atomic weight of boron of 11·01 and 11·02 respectively, single determinations varying between 10·98 and 11·04. The chloride and bromide were prepared from the halogen and boron, the latter being prepared by Moissan's method. The author considers that his products were free from dissolved hydrobromic or hydrochloric acids, and that the lower figures obtained by Abrahall (10·84) by the analysis of boron bromide, were due to traces of hydrobromic acid dissolved in the halogen compound.—On the mixed oxyhydrides of fatty and aromatic acids, by H. A. Béhal. The existence of the mixed anhydrides discovered by Gerhardt has been called in question by Rousset, but comparative experiments carried out by the author upon a mixture of benzoic anhydride and acetic anhydride and the mixed acetobenzoic anhydride prepared by Gerhardt's method show that the mixed anhydride really exists, although always containing a little benzoic anhydride as an impurity.—Naphthopurpurin, an oxidation product of naphthazarin, by M. Georges F. Joubert. The analogy between the behaviour of alizarin and naphthazarin is further shown by the ready oxidation of the latter by sulphuric acid and manganese peroxide to naphthopurpurin, or tri-oxy-naphthoquinone.

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 9.

MATHEMATICAL SOCIETY, at 8.—Certain Correspondences between Spaces of *n* Dimensions: Dr. E. O Lovett.—On the Form of Lines of Force near a Point of Equilibrium; The Reduction of Conics and Quadrics to their Principal Axes by the Weierstrassian Method of reducing Quadratic Forms; and on the Reduction of a Linear Substitution to a Canonical Form; with some Applications to Linear Differential Equations and Quadratic Forms: T. J. I. Bromwich.—On Ampère's Equation $Rr+2Ss+Tt+U(rt-S^2)=V$: Prof. A. C. Dixon.—The Abstract Group isomorphic with the Symmetric Group on *k* Letters: Dr. L. E. Dickson.—The Fundamental Solutions of the Indeterminate Relation $\lambda x \geqq \mu y$: Major MacMahon, R.A., F.R.S.—Note on Clebsch's Second Method for the Integration of a Pfaffian Equation: J. Brill.

FRIDAY, NOVEMBER 10.

ROYAL ASTRONOMICAL SOCIETY, at 8.—*Papers received*: Observations of Mars, 1898–99: Rev. T. E. R. Phillips.—Observations of Jupiter and his Satellites at Mr. Crossley's Observatory, Bermerside, Halifax, 1898–99: J. Gledhill.—Observations of Nebulæ made at the Chamberlin Observatory, Denver: H. A. Howe.—(1) On the Probable Proper Motion of the Annular Nebula in Lyra; (2) The Exterior Nebulosities of the Pleiades; (3) Diameters of Ceres and Vesta: Prof. E. E. Barnard.—*Papers promised*: Theory of the Figure of the Earth carried to the Second Order of Small Quantities: Prof. G. H. Darwin.—Distribution of Stars Photographed at Oxford for the Astrographic Catalogue: F. A. Bellamy. Variation of Personal Equation with Stellar Magnitude: Prof. H. H. Turner.—Photographic Magnitudes: a Comparison of the Greenwich Astrographic Plates with the Magnitudes of the Bonn Durchmusterung: F. W. Dyson and H. P. Hollis.—Ephemeris for Physical Observations of Jupiter, 1899–1900: A. C. D. Crommelin.

PHYSICAL SOCIETY (Central Technical College, Exhibition Road, South Kensington), at 5.—Contact Electricity: F. S. Spiers.—On the Heat of Formation of Alloys: J. B. Tayler.

MALACOLOGICAL SOCIETY, at 8.—Additions to the List of Marine Shells of South Africa published in 1897, with Descriptions of Seventeen New Species: G. B. Sowerby.—Remarks on a Collection of Helicoid Hand-Shells from Japan and the Loo-Choo Islands: G. K. Gude.—*Metastracon*, a New Slug-like Genus of Dart-bearing Helicidæ: Henry A. Pilsbry.

MONDAY, NOVEMBER 13.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Opening Address: The President.—Travels in Bokhara: Willy Rickmer Rickmers

TUESDAY, NOVEMBER 14.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Waterloo and City Railway: H. H. Dalrymple-Hay.—The Electrical Equipment of the Waterloo and City Railway: B. M. Jenkin.

MINERALOGICAL SOCIETY, at 8.—Florencite, a New Hydrated Phosphate of Aluminium and Cerium Earths from Brazil: Dr. Hussak and Mr. Prior.—On a New Mineral from Cornwall: Mr. Hutchinson.—Mineralogical Notes: Prof. Miers.—On Various Sulpharsenites of Lead from the Binnenthal: Mr. Solly; with Analyses by Mr. Jackson.—Crystallised Stannite from Bolivia: Mr. Prior and Mr. Spencer.—On the Constitution of the Mineral Arsenates and Phosphates. Part IV. Beudantite: Mr. Hartley.—Petrographical Notes on some Rock Specimens from the Little Island of Trinidad, South Atlantic: Mr. Prior.

WEDNESDAY, NOVEMBER 15.

SOCIETY OF ARTS, at 8.—Opening Address: Sir John Wolfe Barry, K.C.B., F.R.S.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—The Diurnal Variation of the Barometer in the British Isles: Richard H. Curtis.—Note on Earth Temperature Observations: G. J. Symons.

ROYAL MICROSCOPICAL SOCIETY, at 7.30.—Exhibition of Foraminifera: A. Earland.

ENTOMOLOGICAL SOCIETY, at 8.

THURSDAY, NOVEMBER 16.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: Note on the E.M.F. of the Organ Shock, and on the Electrical Resistance of the Organ in *Malapterurus electricus*: Prof. F. Gotch and G. J. Burch.—On the Formation of the Pelvic Plexus, with especial reference to the Nervus Collector in the genus Mustelus: R. C. Punnett.—On the Least Potential Difference required to produce Discharge through various Gases: Hon. R. J. Strutt.—On the Propagation of Earthquake Motion to Great Distances: R. D. Oldham.—An Experimental Research on some Standards of Light: J. E. Petavel.

LINNEAN SOCIETY, at 8.—The Comparative Anatomy of certain Species of *Encephalartos*, a Genus of the *Cycadaceae*: W. C. Worsdell.—On a Collection of *Brachyura* from Torres Straits: W. T. Calman.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.

CHEMICAL SOCIETY, at 8.—The Chlorine Derivatives of Pyridine. Part IV. Constitution of the Tetrachloropyridines: W. J. Sell and F. W. Dootson.—Contributions to our Knowledge of the Aconite Alkaloids. Part IV. On Japaconite and the Alkaloids of Japanese Aconite: Wyndham R. Dunstan, F.R.S., and H. M. Read.—On the Determination of Transition Temperatures: H. M. Dawson and P. Williams.

FRIDAY, NOVEMBER 17.

ANATOMICAL SOCIETY, at 4.—A Persistent Left Inferior Vena Cava: Stanley Boyd.—Specimen of Sacculated Œsophagus: Miss Stoney.—Child's Skull, showing Parietal Perforations: Prof. A. M. Paterson.—Note on the Morphology of the Biceps Flexor Cruris: Prof. B. C. Windle, F.R.S., and F. G. Parsons.—Lantern Demonstration of certain Points in the Lymphatic System of the Appendix: C. B. Lockwood.

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THURSDAY, NOVEMBER 16, 1899.

THE CAMBRIDGE NATURAL HISTORY.

The Cambridge Natural History. "Insects. Part II." By David Sharp. Pp. xii + 626. (London: Macmillan and Co., Ltd., 1899.)

THE appearance of the concluding part of Dr. Sharp's treatise on Insects, after an interval of nearly four years since that of its predecessor, is most welcome to all readers who were led by the first part of this work to recognise what a step in advance had been taken in the treatment of the subject.

The present volume has confirmed the opinions we then expressed in these columns on Part i., and again we must record our admiration for the knowledge and industry of the author, and for the attractive manner in which he has set forth his results; for wherever the subject-matter allows, the whole work is most fascinating reading.

As was pointed out in 1896, the chief feature of this work is the extensive use made of modern researches, of a kind not hitherto found in text-books. So far as insect morphology is concerned, one or two other recent works may challenge comparison with the present one, but we know of none that attempts to bring forward so large a bulk of unfamiliar particulars, which in a "natural history" are appropriately of the first importance, about the habits and life-histories of insects. But such topics take space, and a complete history of insects on this large scale can only be condensed, even into the 1100 or more pages of this treatise, either by general compression or by the selection of topics for detailed treatment, to the exclusion, so far as practicable, of others. Dr. Sharp has preferred the latter plan, and has been remarkably concise in dealing with such parts of his subject as are familiar from other accessible text-books, which this work may be said rather to supplement than to supersede.

The treatment of certain portions, particularly of Coleoptera and Lepidoptera, will perhaps come as a disappointment to those students who do not bear in mind the limitations of space that have hampered the author. Preconceived notions of the relative importance of insect-families are not easily got rid of, and it is something of a shock to find, *e.g.*, the Cerambycidæ dismissed with less than four, or the Tineidæ with three pages. It would have been an advantage if the editors could have seen their way to devote still more space to the subject, perhaps by restricting Vol. v. to the insects alone. The association with the Prototracheata and Myriapods, if zoologically orthodox, is not of much practical value.

We think, too, that the omission of certain obscure families, except for a bare mention of their existence, would have been a gain. However much symmetry may require a notice of each of the many families of insects (Dr. Sharp enumerates eighty-five in the Coleoptera alone), such notice is not worth giving unless it can be adequately done, and the accounts, for example, of the Rutelinæ, Ægialitidæ, or Apioceridæ, to select at random, serve no clearly useful purpose.

The present volume deals with the Tubuliferous and Aculeate Hymenoptera, the Coleoptera, Lepidoptera, Diptera, Thysanoptera and Hemiptera. The Aphaniptera are treated as a sub-order of Diptera, and the Strepsiptera and Anoplura are included provisionally with Coleoptera and Hemiptera respectively.

Of these orders, the Hymenoptera, which lend themselves admirably to treatment from a bionomical standpoint, are dealt with in great fulness, the observations of M. Fabre on habits being in particular constantly referred to at length. No less than fifty-three pages are devoted to the ants alone, and, among much that is interesting, attention may be called to the accounts of the Dorylides, of the associations of ants with other insects (chiefly based on Father Wasmann's work, and again dealt with under Coleoptera), and to Mr. Green's drawing, on p. 147, of a worker of *Oecophylla smaragdina* using a larva of the species as a kind of animated gum-bottle for joining together the edges of leaves.

In proportion to their numbers, Coleoptera are the least interesting of insects. Their life-histories are very little known, and with the exception of the singular parasitism and hypermetamorphosis found in the Cantharidæ and their allies, are singularly devoid of noticeable peculiarities. It is not surprising, therefore, that even Dr. Sharp's intimate knowledge of the Order has not prevented him from being "gravelled for lack of matter,' and that this chapter, overweighted as it is with many families, is among the least readable in the work. With the removal of Gyrinidæ from the Hydradephaga, few entomologists will be disposed to disagree; but the grouping of the Clavicorn and Serricorn series of Coleoptera into a single aggregate, to be called Polymorpha, is of questionable value. The new series is admittedly incapable of definition, except by the fact that its components do not belong elsewhere; and to associate into a single congeries of forms such widely different families as, for example, the Staphylinidæ and Buprestidæ, is to abandon classification, so far as a fourth of the Order is concerned.

Dr. Sharp pays a good deal of attention to stridulating organs throughout his work, and describes and figures (we imagine, for the first time) a remarkable modification of the hind legs of Passalid larvæ into paws which scratch a stridulating plate on the middle coxæ. It is hard to imagine why a larva that lives in rotten wood should desire to stridulate, but the practice appears to be common among the Lamellicorns. He does not refer to, and perhaps is not acquainted with, the remarkable asymmetrical structure, probably a sound-producing organ, which Ribaga has described in the abdomen of the bed-bug.

Great advances have been made in recent years in the study of Lepidoptera, chiefly with a view to obtaining sound classificatory points; and the chapter on these insects is noteworthy for the completeness with which it deals with lepidopterous structure and development, especially of the mouth parts (in connection with which attention may be called to the figure illustrating the pupal mandibles of *Micropteryx*, first described by Dr. Chapman in 1883) and of the wings, wing-scales, and coloration. An interesting sense organ of unknown function in the abdomen of *Chrysiridia* is here described for the first time. More might have been said with advantage on Dr. Chapman's researches on lepidopterous pupæ, for, though several times alluded to in the text, no description of them is given. Although incomplete, they have given a great impetus to the study of lepidopterous relationships, and it is not every reader that has time or opportunity for turning them up in the *Transactions* where they appeared.

The system followed in the Heterocera is that given in Sir George Hampson's "Fauna of British India—Moths," but it has the manifest disadvantage that it does not include two or three of the families referred to. On p. 432 the Prodoxidæ are called a family, though they are clearly intended to be included in the family Tineidæ. The use of the same term and ending for an aggregate and its subdivision tends to confusion.

Mention of the Lepidoptera leads naturally to the subject of mimicry. So far as facts are concerned, Dr. Sharp brings forward many interesting examples, among them an unrecorded case of the larva of a British bug, *Nabis lativentris*, which mimics an ant, the resemblance being absent in the imago. On the other hand, no reference is made to some of the astounding and comparatively little known resemblances found among Membracidæ. In a species allied to one, *Heteronotus trinodosus*, which is figured, the prothoracic prolongation takes on the form of the entire body of a Hymenopterous insect, so that the Membracid walks about under a mask, or rather, a false body, of the most deceptive kind.

Dr. Sharp is, however, averse from countenancing any theory of the subject, and his brief account of existing hypotheses is scarcely impartial. In a singular criticism he writes:

"In endeavouring to realise the steps of the process of the development of the resemblance we meet with the difficulty that the amount of resemblance to the model that is assumed to be efficient at one step of the development, and to bring safety, is at the next step supposed to be inefficient and to involve destruction."

This appears either to involve a non-comprehension or to imply a complete negation of the principles of natural selection; we do not know whether the latter is intended.

Of the remaining chapters, that on Diptera is of especial value, on account, not so much of their intrinsic interest, great as that is when once the repugnance to their study has been overcome, as of the help it gives towards obtaining a fair general knowledge of an Order which does not form as a whole the subject of popular monographs, and of which the study is particularly difficult.

In view of the economic importance of Diptera, it is greatly to be regretted that they do not absorb more of the entomological energy that is wasted in investigating trifles that lead to nothing. With Dr. Sharp's account, it is possible at least to make a start.

Economic questions, which would have led the author outside the scope of this work, are seldom referred to. With this necessary exception, it is difficult to find a subject of any importance in entomology that is not, in some place or other, touched on more or less fully, and often in the light of independent observation and research. Very few forms of real interest are omitted; but among them is that of *Dyscritina*, on the life-history of which Mr. E. E. Green has lately thrown light. Though his paper was published since the appearance of Vol. v. of this series, reference might have been made in the short appendix to the present volume to his account of this Forficulid larva, which so singularly modifies our knowledge of the earwigs.

We do not recollect to have before met with the word "exstulpate," which Dr. Sharp is rather fond of using to denote the extruding of an eversible papilla. If it is a latinised form of the German "ausstülpen," it can hardly be considered as an ornament to the English language!

It remains to allude to the illustrations; these are as good as, though relatively fewer than, those in the preceding volume. The figures of *Ornithoptera paradisea*, one of the few butterflies selected for figuring, are not successful. Exquisite as this insect, at least the male, is, it does not look well in a woodcut, and these large blocks look coarse and inappropriate on so small a page.

W. F. H. BLANDFORD.

A COMPREHENSIVE GEOGRAPHY.

The International Geography. By Seventy Authors. Edited by Hugh Robert Mill, D.Sc. Pp. xx + 1098. With 488 illustrations. (London: George Newnes, Ltd., 1899.)

SOME forty years ago geography was the most dreary of subjects in school lessons. Its text-books were as arid as the Sahara, lists of names and compilations of statistics; mere cram, without a single statement or principle which could help the learner to understand the history either of the earth or its inhabitants; useful as exercise for the memory, but baneful in every other respect. All that has been changed. Geography is now taught as illustrative of principles. Like geology, it is an application of a group of the natural sciences to explain a particular problem, the history of the earth; differing however, from that in dwelling more on the superficial aspect—the physiography—of our globe, and less on underlying causes or on the remote past. The volume before us is an example of the new method. Though too large for direct use as a text-book in schools, for it consists in all of over 1100 pages of rather closely-printed type (which ageing eyes will wish thicker), it will filter down to the classes through the teachers. The first part of the work deals with the principles of geography, the more distinctly scientific aspect of the subject, in a series of excellent essays, which treat of the principles and progress of geography, its relation to mathematics, the making of maps, the plan of the earth and the features of its surface, the ocean, atmosphere and climate, the distribution of life, including the races of man, and the political aspect of geography; all these subjects being discussed by very high authorities. Each of the following parts is devoted to one of the great divisions of the earth, treating it first as a whole, and then under its minor natural or political divisions, in a series of separate articles, each of which is contributed by "a specialist or recognised authority of high standing."

To review critically such a book as this demands something like geographical omniscience, to which I have no pretensions; probably the editor himself is about the only really competent person, and he might be not unnaturally suspected of a certain prejudice. So I have tried to look at a few sections from the point of view of personal knowledge, and others from that of ignorance; for in the one case I might test the information, in the other regard the book as a learner. For the former purpose I have read in a carping spirit. Not that I hold it right to do this with a really good book. Horace lays down the true rule, "Ubi plura nitent in carmine non ego paucis offendar maculis"; but I did it, and now give the results to show that the book will stand a test which is almost unjust. A short glossary of rock names and some other geological terms would be a useful addition for the sake of the unlearned. In the course of my reading I have found one misprint, "Apls" for Alps, which is very likely due to that familiar of the printer who should be out of place in a chapel. Editors are not always responsible for press errors. However, here they must be few indeed. In mentioning Suess' idea that sometimes it is rather the ocean which has sunk than the land which has risen, a writer says that the 100-foot beach-line in Western Scotland

"maintains its level, lying on rocks of different ages and hardness, and crosses undisturbed great faults and dislocations."

But if the antiquity of the faults, as is the case here, is much greater than that of the beaches, the last reason is not conclusive, for the mass might be so far welded together as to move as a whole But is the fact itself certain? If it be so, it does away with an objection commonly urged against the marine origin of the parallel roads of Glenroy. At any rate it should have been added that in Norway, not to mention other parts of the northern hemisphere, a beach level often varies in height. Perhaps, also, a little too much prominence is given to the theory of the earth's tetrahedral figure, for it is still on its trial, and apparently fails, as the author admits, to explain every fact. On p. 57 boulder clay is said to be an accumulation left by ice-sheets or in extra-glacial lakes. As not a few persons who have carefully studied the subject maintain that some boulder clay has been deposited in the sea, and have added proofs which have been met only by hypotheses, that view also should have been mentioned as a third possibility. In another aspect of ice-work, one author (p. 258) boldly abandons glacial excavation to account for the origin of the Alpine lakes, and attributes them, rightly as I believe, to crust movements; yet we are told on p. 272 that the lakes of the Alpine foreland are clearly related to the great ice-sheet which once overspread it. We presume this signifies glacial excavation; but, if so, what about the "hinter land"? Again, has it yet been *proved* (see p. 269) that the Scandinavian ice-sheet extended over northern Germany? It is, no doubt, an article of faith with a large school; but as difficulties suggest themselves to a sceptical mind after examining the ground, a less positive statement would have been better. As regards the Alps, it is not a happy phrase to speak of the Finster Aarhorn, Jungfrau, Möneh, Wetterhorn, &c., as

"grouped in one compact mass of snows and rugged peaks *round* the valleys of Lautebrunnen and Grindelwald";

for nothing can be more striking than the apparent ending, of those valleys at the foot of that great mountain wall. We find no mention of the Viso among the Italian Alps, yet no peak is more conspicuous than it from the Piedmontese plain; and the fact that the south-eastern Alps near the Austro-Italian frontier—so remarkable in their scenery—are magnesian limestone is not clearly stated.

The Pelvoux (p. 237) is not over 13,000 feet high, for only two peaks in the Dauphine group, the Ecrins and the Meije, exceed that elevation. To say that "since historic times not the slightest eruption has taken place in Auvergne" assumes a controverted point. In Italy the remarkable group of the Carrara mountains is not distinguished so clearly as it should be from the rest of the Appennines, and to say that Pozzuoli "stands in the midst of vast ruins of the Roman period" is not quite the most accurate of phrases.

Enough however of such criticisms, for they are so trivial as to be hardly worth mention. We only write them down to show how difficult, even if one tries to carp, it is to find any fault. When we come to excellencies their name is legion. With seventy contributors, all of whom have done their work well, it is almost invidious to select, but we may mention Prof. De Lapparent's article on the physical geography of France as no less lucid in statement than powerful in grasp, and those on Natal, the Transvaal and the Orange Free State, by the Right Hon. J. Bryce (which we naturally selected to look at from the standpoint of general ignorance), as singularly clear and informing. The book must have cost Dr. Mill no little toil as editor. Organisation and correspondence in a work like this must have been heavy tasks; and besides these he has himself contributed some excellent articles, and translated wholly or partially those of seventeen contributors. We heartily congratulate him on the final result. He deserves our gratitude for giving us a geography which is at once good in literary form and invaluable for reference, far in advance of any similar work which has been produced in this country. No teacher, indeed no advanced student, can afford to be without it; more than this, it must be on the shelves of every important library, and will be of the greatest use to literary as well as to scientific men, indeed to all who read for the love of culture. T. G. BONNEY.

CHEMISTRY FOR THE PEOPLE.

Einführung in die Chimie in leichtfasslicher Form. Von Prof. Dr. Lassar-Cohn. Pp. xi + 299. (Hamburg and Liepzig: Leopold Voss, 1899.)

THIS book begins with an interesting *apologia.* When the author first took up the work of teaching in Volkshochschulen he lectured to the pupils very much in the same way that he himself had been lectured to in the University during his first semester. He soon came to think, however, that this was a mistake, and that a class of people, meeting in the evening hours for the improvement of their general knowledge, should not be treated like students taking up a professional study. He therefore altered the form of his lectures, and endeavoured to present a more general and expansive view of chemistry, and to impart, as it were, the spirit and stimulus of the science. In like manner he came to the conclusion that ordinary chemical text-books are unsuitable for the pupils of Volkshochschulen, and the present work has been written to fill the void. The case which Prof. Lassar-Cohn endeavours to meet is a somewhat special one. Given an evening class of young men desirous of improving their general education, which is the best way of giving them some notion of chemistry? Prof. Lassar-Cohn answers this question by saying that as a laboratory is a luxury which a Volkshochschule cannot afford, you must content yourself with experimental lectures and present the subject in its broadest and most interesting aspect.

Here again, it would seem, the prejudice of University training makes itself felt, in the notion that a laboratory suitable for teaching the elements of chemistry is necessarily the large and expensively furnished apartment set apart in universities for the professional study of chemistry. This is indeed a common enough belief, one that has led in this country to great extravagance and much futile teaching. It is impossible to believe that Germany would make difficulties about providing the Volkshochschulen with all that is really requisite for teaching, by practical work, the amount of elementary physics and chemistry which should be there attempted. Until this is done, until a properly coordinated course of work in the laboratory and class-room can be arranged, really profitable *teaching* will, in the opinion of the present writer, be impossible.

Whether or not we accept the author's standpoint that lectures are inevitable, we must admit they may be made to open out new vistas of knowledge and supply a stimulus to study, and we cannot hesitate to praise the book before us. Dr. Lassar-Cohn possesses in a high degree the faculty of exposition; he writes in a style which, for force, clearness, and above all, freedom from prolixity, is uncommon enough in German text-books. The matter of the book, too, fully corresponds with the author's intention. It is comprehensive without being encyclopædic, and is supplied with a good deal of human interest. The historical element is not introduced to any great extent, not as much, in fact, as it might well be in such a book. Hardly a great name in the roll of chemists is mentioned, except that of Kekulé. The book begins much in the orthodox way, with an attempt to delimit the frontier between chemistry and physics, and quickly and discreetly passes on to water and hydrogen. After this come the halogens and the hydracids, followed by lucid explanation of the laws of chemical combination and the atomic and molecular theories. The other chief non-metals and their compounds are passed in review, and then half a dozen of the metals are dealt with. Here and there chapters appear dealing with special topics, such as the building up of plants from inorganic substances, the preparation of metals by electrolysis, the classification of the elements. The treatment of these topics is excellent. The author has a lightness of touch which is very agreeable, and very different from the heavy hand of the compiler. This is particularly evident in the treatment of organic chemistry, which is admirably reviewed in some forty pages, and throughout the work there is indeed a pleasant sense of freshness. To those who wish to gain a general idea of the scope of modern chemistry, and who cannot obtain class instruction, this book may be strongly recommended. It has not the popular interest of the author's "Chemistry in Daily Life"; but it has a different object, the aim being to show the philosophy rather than the practical usefulness of the science. It is probable that there is a considerable public to whom the book will be a really valuable acquisition, and with whom it will fulfil its aim of being an introduction to chemistry "in leichtfasslicher Form."

The illustrations, which are fairly numerous, call for a word of criticism. They are exceedingly crude, over-shaded, and often purposeless. The first figure in the book, for example, is an ill-drawn dinner-bell, which is to illustrate the statement that a bell when sounded remains unchanged in substance, and that therefore the science of sound belongs to physics!

In a brief postscript Dr. Lassar-Cohn enters a vigorous protest against the recent decision of the German Chemical Society to tabulate the atomic weights on the basis of $O=16$. He maintains that, to the beginner, it will be quite unintelligible why the lightest atom should have a weight of 1·01—chemical teaching, in fact, will sink back to a half-alchemistic stage if the system of atomic weights, which lies at the foundation of the whole science, is to be a matter for belief rather than for logical reasoning. There seems to be some exaggeration here. Whatever may be said in favour of oxygen being taken as 16 or 15·88, it is surely not a very difficult matter to explain, even to beginners, the practical reasons why *for the time being* 16 has been selected. It may indeed be an advantage if pupils are thereby forced to realise a little more fully than has been usual how atomic weights actually are determined. It must be admitted, however, that the question of $O=16$ *versus* $H=1$ is well worth consideration from the point of view of the chemical teacher.

A. S.

OUR BOOK SHELF.

Laboratory Manual. Experiments to illustrate the Principles of Chemistry. By H. W. Hillyer, Ph.D. Pp. 200. (New York: The Macmillan Company. London: Macmillan and Co., Ltd.)

THIS book is intended as an introduction to chemistry for college students, and is written on the newer (or, as we have heard it termed, the new-fangled) plan. In other words, the student is asked to record what he finds in his experiments, and not told what he should find. The success of this newer method, as of the older one, must depend on much besides the text-book; but if it be assumed that the student is anxious to learn and willing to take trouble, there can be little doubt where the advantage lies.

In addressing the student, the author remarks that "the mere bringing of chemical substances into conditions under which they will react has less utility as a means of culture than most of the manual occupations"—a just if a somewhat "superior" observation—and he proceeds to give general directions which, if only observed, will leave nothing to be desired in the student's attitude of mind. Experience shows, alas! how very difficult it is to get these injunctions observed.

To illustrate the author's method, the following may be cited. "Heat a few pieces of zinc with a strong solution of sodium hydroxide. What gas escapes? What is there in the solution? From your previous experience, what acids will dissolve zinc?" Or again, "To 1 c.c. of silver nitrate solution add a little ammonium chloride solution, and then a solution of some of the salt made above [sodium thiosulphate]. Describe the phenomena, and explain, using equations."

It is obvious that each of these experiments opens up a large subject, and will necessitate reference to a descriptive text-book, and probably to a demonstrator as well. This is, of course, eminently desirable, and there can be little doubt that Dr. Hillyer's book, if properly used, will prove a helpful laboratory manual. It ranges over inorganic chemistry, and the selection of experiments has been carefully directed to bring out the most important facts and principles.

L'Industrie des Matières Colorantes Azoïques. Par George F. Jaubert. Pp. 167. (Paris: Gauthier-Villars.)

IT is over forty years since the late Dr. Peter Griess placed at the disposal of chemists a reaction which has since proved of such importance, both scientifically and technically, that a large literature is now in existence dealing with the class of compounds known as azo- and diazo-compounds. From the industrial side, the most important development has been the manufacture of a group of colouring-matters which are now turned out on a colossal scale, and which are so numerous in individual members, that in the last edition of the "Tabellarische Übersicht" of Schultz and Julius (1897) no less than two hundred and seventy-three distinct technical products of this class were catalogued. The present little work is one of the useful "Aide-Mémoire" series from the "Encyclopédie Scientifique," published under the direction of M. Léauté of the Institute. It is fairly brought down to date, and contains in a handy and portable form a tabular list of the colouring-matters in question, including also the nitro- and azoxy-compounds which find place in technology. The little volume will be found valuable by all engaged in this department of chemical industry.

R. M.

Elementary Practical Mathematics. By Frank Castle, M.I.M.E. Pp. x + 401. (London: Macmillan and Co., Ltd., 1899.)

IN this book the student is carried rapidly through a course of arithmetic, algebra, geometry and trigonometry to some of the simpler problems of mensuration and dynamics. The idea is to bring the desk and paper work of the pupil into closer touch than heretofore with the work of the shop or factory—in other words, to indicate from the very beginning the practical value of mathematical methods.

The purely academic theorem or problem is to be "taboo," or, in the words of the preface, "abstract reasoning is to be relegated to the background, and concrete facts are to form the basis of the student's work." The principle is probably a sound one, but it may be carried too far; and experience alone will decide as to the efficiency of the system embodied in Mr. Castle's book. The student, if not otherwise instructed, will find certain parts very hard to follow. Thus on p. 341, in the discussion on maxima and minima, a differential coefficient is suddenly introduced without a word of explanation or apology. The great brevity, which the limits of the book impose on many of the sections, will also be a serious barrier to their ready intelligibility. As a general rule, the explanations and descriptions are clear and accurate; but we have noticed two statements which, if not absolutely incorrect, are, at any rate, misleading. On p. 23 we read that "the invariable interval of time between two consecutive southings of a star is divided into 24 equal parts, each called an hour." True, but this is not the hour as usually understood and *practically* used; yet there is nothing in the context to indicate the distinction between the sidereal and mean solar hour. The other doubtful statement is on p. 290, where we read: "Any change in the direction or speed of a moving body is produced by force. When a force acts in either of these ways it is said to do work." The "direction of a moving body" is a curious truncated phrase; but the implication that a force always does work when it alters the direction of motion of a moving body is still more curious. Here truly are sinks of waste of solar energy that were never dreamed of in the philosophy of Helmholtz and Kelvin! These blemishes apart, however, there is much to commend in the book. Contracted arithmetical operations are strongly insisted upon. The chapters on logarithms, the slide-rule, orthographic projection and graphical methods, are particularly deserving of praise. The book is beautifully printed, the illustrations are clear and well conceived, and the examples —both in the text and in the exercises—are all of a distinctly practical character.

The New Education. Manual Training: Woodwork. By Richard Wake. Pp. viii + 360. (London: Chapman and Hall, Ltd., 1899.)

MANUAL training, or instruction in the use of tools, may be made of great educational value if care is taken to develop the rational and constructive faculties rather than to produce dexterity in tool manipulation. The author of this volume deals with the subject upon the right lines, and the course described by him will encourage pupils to measure accurately, observe minutely, and work with close attention to details—all of which are desirable attributes to cultivate. A special feature of the course is the effort made to develop the creative faculty in children by inducing them to design for themselves the simple models to be constructed in wood. No attempt is made to describe woodwork of the ornamental character which is often seen in school workshops; each exercise has a purpose, and that purpose is to educate.

The book covers the requirements in manual training for Standards V., VI. and VII. of public elementary schools. It is well illustrated with working drawings and reproductions from photographs showing pupils performing the various operations of woodwork. Teachers of the subject will find the volume helpful and suggestive.

The Naval Pioneers of Australia. By Louis Becke and Walter Jeffery. With illustrations. Pp. xii + 314. (London: John Murray, 1899.)

THIS is a pleasant and accurate compilation for popular reading, based largely on the authoritative documents now being published by the Government of New South Wales. It is, in fact, a short history of the connection of the British navy with Australia. The standpoint is that of political rather than natural history; but many references are made to the large interest taken by Sir Joseph Banks in the beginnings of Australian colonisation. The problems of the first discovery of Australia are scarcely touched on, and the book is in no sense concerned with controversial questions.

Arithmetical Exercises in Chemistry. By Leonard Dobbin, Ph.D. Third Edition. Pp. vi + 52. (Edinburgh: James Thin, 1899.)

PROF. CRUM BROWN, who contributes a preface to this book, points out that it contains clear descriptions of "the principles involved in the calculations required in dealing with chemical changes, and such physical changes as are of special importance to junior students of chemistry." The exercises should be of value in fixing ideas in the minds of students and illustrating the operations of arithmetical chemistry. The ability to make such simple calculations as are here given is essential to a clear understanding of the laws of chemistry.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Coccospheres and Rhabdospheres.

I RECENTLY learned with much surprise from Sir John Murray that the German *Valdivia* expedition failed to discover anywhere in the ocean either Coccospheres or Rhabdospheres. Since the earlier Plankton expedition under Prof. Hensen had also failed to find any of these organisms, a certain amount of doubt has been privately expressed in Germany and elsewhere as to the validity of the results obtained by Mr. V. H. Blackman and myself.

In addition to our Atlantic work (published in *Phil. Trans.*, 1898) on this subject, I may state that, through the agency of Captains Cowie, Leigh and Wright, of the P. and O. Company, we have obtained these organisms from the Indian Ocean.

I have, however, received most welcome confirmation from Mrs. Weber van Bosse, who is with her distinguished husband on board H.M. *Siboga* engaged in the Dutch expedition in Malayan waters. She writes :—"Will you kindly insert a little note in a paper to state that the *Siboga* expedition found *Coccosphaera pelagica* and *C. leptopora* both in the Ceram and Banda Seas? We get them floating in the water with the horizontal cylinder of Hensen. . . . I found also Rhabdoliths, but as yet no Rhabdospheres. I am looking out for them," &c.

November 10. GEORGE MURRAY.

The Stockholm Fisheries Conference.

As the British Government was represented by official delegates at the recent International Fisheries Conference at Stockholm, and took part in its proceedings presumably with the view of undertaking fishery investigations upon a more extended scale in the future than it has previously done, the resolutions of the Conference (see p. 34) are of more than usual interest and importance to marine biologists in this country. For this reason I would ask you to allow me space for some remarks upon them.

The general plan of the investigations proposed by the Conference, both as regards hydrographical and biological work, will, I believe, meet with the approval of all competent judges, though doubtless minor differences of opinion as to details will be found. The researches suggested are a continuation, upon a more extended scale, of those which the various bodies undertaking fishery investigations in this country have been endeavouring to carry out in so far as the limited means at their disposal have permitted, and there can be no doubt that only by the prosecution of such investigations can that accurate knowledge be acquired upon which a rational treatment of fishery questions may be based.

Two points only relating to the schemes of investigation proposed by the Conference call for comment. In the first place, with regard to the value of international co-operation in such investigations it may be pointed out that, in case the scheme should not be carried out in its entirety, such co-operation is of greater importance in the hydrographical than in the biological work, since in the former simultaneous observations made by identical methods over great areas are of primary importance, a condition which does not apply to an equal extent to the latter. This, however, does not affect what is, perhaps, the chief argument in favour of international co-operation, and one which is given a prominent place in the preamble to the resolutions of the Conference, namely, that any attempt to regulate the fisheries of the high seas can only be carried out by international agreement. Whether or not any such international agreement can be regarded as reasonably probable, or whether, if attained, the regulation could be made effective, are certainly questions open to doubt.

In the second place, from the point of view of British fisheries as a whole, the area proposed by the Conference to be covered by the hydrographical investigations should be extended to include the English Channel, the Irish Sea and the western coasts of the British Isles. Even in considering the North Sea fisheries alone such an extension is of importance, since it has been clearly demonstrated that water from the Channel enters the southern part of the North Sea from time to time, and the fauna of this region is known to contain a considerable number of southern forms, which show it to be in reality an extension of the Channel fauna.

In attempting to give effect to the recommendations of the Stockholm Conference, what appears to be the most satisfactory course for the British Government to pursue is to develop and as far as possible coordinate the work of the various organisations already in existence, namely, the Marine Biological Association (either as at present constituted, or with a more intimate connection with the Fisheries Department of the Board of Trade), the Scientific Department of the Scottish Fishery Board, and the Fishery Department of the Royal Dublin Society, at the same time encouraging the formation of local laboratories established by County Councils and other bodies at various points around the coast, such as those of Liverpool (at Port Erin), Piel, Cullercoats and Millport.

For the actual carrying out of the proposed investigations the two essential requirements are (1) a sufficient number of capable naturalists devoting their whole energies to the work, and (2) sea-going steamships efficiently equipped. The various laboratories around the coast would form valuable ports of call or depôts for the vessels engaged in the investigations. The elaborate and expensive organisation of a central bureau and of a central laboratory proposed by the Stockholm Conference appears to me to be a matter of only secondary importance, against which some objections may be made. To coordinate the investigations of the different countries, and to insure such uniformity of method as will make the results of the different observers comparable, an international Council, composed chiefly of the experts actually responsible for carrying out the investigations, and meeting once a year, seems an adequate arrangement.

With an elaborate organisation such as that suggested by the Conference there is a danger that the work of the biological stations would degenerate into the mere taking and recording of routine observations, whilst original work and the development of new methods of research, which are in reality of far greater importance, would receive a check. Good men would certainly not be attracted to work which consisted merely in recording observations taken according to a stereotyped plan dictated by a central bureau. A large amount of individual freedom to the workers is absolutely essential in order to secure the best results from scientific research. For these reasons a more elastic organisation than that of the international central bureau proposed by the Stockholm Conference would seem to be preferable.

The Laboratory, Plymouth. E. J. ALLEN.

Sextant-Telescopes.

I RECENTLY made the attempt to attach one of the prism forms of binocular to a sextant in place of the ordinary telescope, and it seemed that such an adaptation would materially increase the usefulness of the instrument and add to the accuracy of its records. In the sextant which I used there was no provision for rigorous attachment. and only a device of a temporary character could be adopted; but a very slight modification in the construction of the instrument or of the so-called "up and down piece" would overcome this drawback.

I am inclined to believe that very frequently only a plain sight is used in observations at sea, and that in many cases, where some optical power is employed, an ordinary Galilean opera-glass, with a power of about three, is preferred. The telescope usually supplied, which will give a power of from ten to fourteen, has so many drawbacks that its use is not popular, at least in the Mercantile Marine. The field is small, the telescope inverts, and the sextant is obliged to be held at a considerable distance from the body, so that if the framework be not made of aluminium it becomes heavy and burdensome.

The prism opera-glass which I used was made by Messrs. Goerz, of Holborn Circus, and among other advantages over the ordinary form, it gave more light in the field of view, of obvious importance in judging of the position of a dimly illuminated horizon. Also there was a direct view, so that the ordinary methods of observing needed no modification, and the field was sufficiently large to enable the object to be followed with ease. The power was about nine, quite as high probably as could be used on the deck of a ship with advantage; but I imagine it would be preferable in surveying work to use the highest power constructed, which gives a magnification of twelve. Possibly fifteen might be reached with advantage.

Liverpool Observatory. W. E. PLUMMER.

Solution of the Quartic.

PERHAPS the following semi-graphic solution of a quartic equation may be of some interest to your readers.

Suppose the parabola $x^2 - y = 0$ is drawn, once for all, on a sheet of squared paper. Take an equal parabola, and place it with its vertex at the point (a, b) and axis parallel to OX so that its equation, in this position, is

$$(y - a)^2 = x - b.$$

Then the abscissæ of the intersections of the parabolas are the real roots of

$$x^4 - 2ax^2 - x + (a^2 + b) = 0 \quad . \ . \ . \ . \ . \ (1)$$

Now the general quartic is at once reducible to the form

$$x^4 + px^2 + qx + r = 0,$$

and if we put

$$x = -z\sqrt[3]{q},$$

this becomes

$$z^4 + \frac{p}{q^{\frac{2}{3}}}z^2 - z + \frac{r}{q^{\frac{4}{3}}} = 0.$$

This is identical with (1) if

$$a = -\frac{p}{2q^{\frac{2}{3}}},\ b = \frac{4r - p^2}{4q^{\frac{4}{3}}};$$

so we can calculate a, b, then place the movable parabola in position, read off the real values of z, and finally take

$$x = -z\sqrt[3]{q}.$$

G. B. MATHEWS.

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Rural Education.

I AM very glad to learn from my friend, Prof. Meldola, that the school of which I previously wrote is so well known. The frequent reference to Bigods as an experiment, and as the first attempt to give a systematic training in science in a purely rural district, led me to imagine that people were not generally aware of Sexey's Trade School. It seemed therefore that some mention of its success might act as an encouragement to others, but obviously the fact that this work has been successfully carried on for some years in Somersetshire in no way detracts from the value of what is now being done in Essex. I may observe too that, while the latter has had to depend mainly upon the generosity of Lady Warwick and the enthusiasm of Prof. Meldola, the former enjoyed certain advantages in the way of endowment.

At Bruton the outlay in capital has amounted to 5140*l.* (cost of site 640*l.*, buildings and equipment 4500*l.*). This sum is made up of grants from the County Council amounting altogether to 1100*l.*, and of 4040*l.* derived from endowment, income account and donations. The County Council Building grants were thus distributed: in 1891 250*l.* for building and equipment, in 1892 450*l.* for a similar purpose, in 1894 250*l.* for new class-rooms and metal work, in 1897 150*l.* for a new physical laboratory, &c.; in all 1100*l.* Nothing under this head has been contributed by the Science and Art Department. Since 1893 a capitation grant of 2*l.* for day scholars and 3*l.* for boarders has been paid by the County Council to all approved schools in Somersetshire. At Sexey's Trade School this amounts to about 225*l.* a year. These grants go towards the salaries of science and technical teachers, and the school is open to inspection by the County Director of Technical Education. The total annual income of the school is about 1200*l.* Since 1894, pupils from the school have obtained 21 out of 36 County Intermediate Scholarships, and 5 out of 11 Senior Scholarships.

The school was opened with fifty pupils in temporary premises in April 1891. At Easter 1892 the new buildings were opened with sixty pupils. The cost of the buildings so far was nearly 3000*l.*, towards which, as stated above, the County Council contributed 700*l.* and the Governors subscribed 120*l.* Some of the classes were registered in connection with the Science and Art Department in the autumn of 1892, and the first examinations were held in May 1893. The school buildings were enlarged in 1897, when two new class-rooms, a metal workshop and gymnasium were erected. In 1895 the new regulations of the Science and Art Department for organised science schools were issued. The school appears to have been working for three years on similar lines to those laid down by the Department, and I am told that the conversion of the school into an "organised science school" was accomplished with practically no change of curriculum or method. The first grant of 260*l.* under the new regulations was received in 1896. Since then the grant has been very high, almost maximum grants for chemistry and physics having been awarded. The grant this year was 385*l.* and the number of pupils presented was fifty-seven. The grants from the Department have been as follows:—1893, 57*l.*; 1894, 104*l.*; 1895, 96*l.*; 1896, 260*l.*; 1897, 384*l.*; 1898, 355*l.*; 1899, 385*l.* To comply with the requirements of the Department, a new physical laboratory and other buildings were provided in 1897, and this year a new museum and additions to the master's residence are being undertaken at a cost of nearly 400*l.*

I regret that I can furnish no information as to the constitution of the Technical Instruction Committee of the Somersetshire County Council, but doubtless these particulars can be ascertained from its annual report. JOHN C. MEDD.

Stratton, near Cirencester, October 29.

I SHOULD like to add to the above interesting statement by Mr. Medd that a rural school of science, which is even more akin to Bigods' than Sexey's Trade School, has been at work for some years at Bakewell in Derbyshire. I referred to this in my address at Bigods in 1898. The resemblance in constitution and function is due to the co-education of boys and girls, and it would add to the value of the present discussion if some information could be given as to the working of the Bakewell school.

R. MELDOLA.

IN addition to Sexey's Trade School, Bruton, the visitors of Sexey's Hospital recently (and in this case also at the instance of Mr. Hobhouse) have established a dual school of the same general type as the Bruton school in the village of Blackford, five or six miles from the nearest railway station, and in the midst of a purely agricultural district. New buildings have been erected at a cost of about 4000*l.*, towards which the County Education Committee has contributed 1000*l.*, in addition to 250*l.* in aid of the equipment of the laboratory and workshop. The Blackford school has been carried on for about one year in unsuitable temporary premises, but nevertheless attracted more than fifty pupils. The new buildings were opened at the end of September by Sir Henry Roscoe. The school has now between seventy and eighty pupils, a considerable proportion being boarders. The school will receive from the County Education Committee an annual grant of at least 120*l.*

C. H. BOTHAMLEY.

County Education Office, Weston-super-Mare, November 2.

Birds Capturing Butterflies.

WITH reference to Mr. O. H. Latter's note in NATURE (September 28, p. 520) on the capture of butterflies by the sedge warbler, it may be of interest to note that Sweet, whose work on keeping warblers in captivity is incorporated with Bechstein's "Cage-birds" in Bohn's edition of that work, recommends a living butterfly as a bait for this very species, and for several other warblers, when it is desired to trap adult birds.

I may mention that not long ago I saw here in Calcutta a common Mynah (*Acridotheres tristis*) with a white butterfly in its bill, which it had no doubt obtained in repose, as the day was dull, and the Mynah is not very expert at catching insects on the wing. I remember also once seeing at Dehra Dun a Dhyal or Magpie-robin (*Copsychus saularis*) take a disabled *Catopsilia* I threw out for it, though I have seen the same bird disregard a specimen flying at no great distance. Evidently the birds wait their opportunity, and, though too wise to waste their energies in the pursuit of these evasive insects on the wing, are always ready to snap them up when they can take them at a disadvantage. In this way it can hardly be expected that attacks by birds on butterflies will be often noticed, unless a naturalist will undertake to watch individual insectivorous birds for whole days at a time.

Similarly, one does not in India see kites and crows pursuing sparrows, though a dead one flung out will be greedily snapped up by either species, and no doubt fledglings perish in numbers by these ever-watchful enemies. F. FINN.

Indian Museum, Calcutta, October 19.

MR. FINN'S letter is interesting as giving support to the opinion that it is when at rest that butterflies are chiefly attacked by birds. The injurics to be noticed on the wings of the insects very frequently are symmetrical on the right and left sides, and can only have been inflicted when the wings were folded in repose. I can only recall one occasion on which I have witnessed a bird attack a butterfly in flight, and then the attempt was unsuccessful. OSWALD H. LATTER.

Charterhouse, Godalming, November 7.

THE EFFECT OF WEATHER ON EVERY-DAY LIFE.[1]

SOME time since, a distinguished member of the Cotton Exchange asked my assistance to solve a problem connected with the variation of prices in "futures." He remarked that these prices varied almost from hour to hour without any apparent cause, such as a knowledge of the state of the crop or of the condition of the American market, which would explain these fluctuations. He was tempted to look for a subjective cause, and thought it might be found in the state of the weather exercising a powerful but unrecognised influence on the dispositions of purchasers and speculators, inducing them to buy or sell as they were alternately swayed by hopefulness or despondency. I was therefore invited to compare the movement of the cotton market with the variations in the weather, with the view of detecting the hidden relation, and was further stimulated to exertion by the assurance that if the origin of the fluctuation could be discovered "wealth beyond the dreams of avarice" would be at my command. Unhappily I failed to trace in the fickle weather the hidden springs that underlie the motives of speculators; and that fortune is still to be made by some one, possessed it may be of greater ingenuity or greater application, and to such an one I present the idea without hope of reward or acknowledgment.

Mr. Dexter's book reminded me of this experience, for he, too, has apparently embarked on an inquiry as difficult, but with a motive more noble, and let us hope with a reward more certain. Mr. Dexter wishes to trace the influence of weather on human conduct in general, and to see how far man's emotional state is affected by meteorological conditions. His reward is the attainment of a degree of Doctor of Philosophy, and the inquiry which he has instituted has apparently been undertaken with a view to meet the requirements of the authorities of Columbia University. One may sincerely hope that Mr. Dexter will have his ambition gratified, for to say that he has not spared himself in the labour of the inquiry is to say little. What is much more to the purpose he has not spared others. Teachers and superintendents of schools, wardens of prisons, superintendents of asylums for the insane, officials of the Weather Bureau and many others have been laid under contribution, by having submitted to them a "questionnaire" to completely satisfy whose interrogations involved not a little labour. Apart from the inconvenience which such a process might cause individuals, we doubt whether the plan adopted is the most trustworthy that could be found. Personal influence rather than climatic conditions is likely to introduce a systematic error into the final result. It is open to question whether the authorities consulted have satisfactorily eliminated the effect of weather from their own systems and mental states. The power of punishment rests with the authorities who have been consulted, and it may happen that those under their care are the victims of an irritability, engendered in the supervisors from causes with which the weather has absolutely no concern. To judge therefore mainly by the infliction of punishments seems of rather doubtful wisdom. This obvious objection has, of course, not escaped the author, and in one place he certainly recognises that the emotional state of the teacher is a not unimportant factor in the result. Indeed, he says, it may be the teacher we are studying more largely even than the pupil. The frankness with which this admission is made is more to be approved than is the reasoning by which it is set aside.

And now we are tempted to record a fact of which Mr. Dexter is entitled to make the fullest use. The temperature is 78°, the sky is cloudy, the wind is east, the velocity about three miles an hour, and under these conditions we find it much easier to present the facts at which Mr. Dexter has arrived than to criticise his results or carp at his methods. We notice that the author has studied, grouped, and commented on no less than fourteen classes of empirical data, embracing more than a quarter of a million separate facts. These fortunately can be grouped under fewer heads than the elaborate method pursued by the author admitted, and we hope we shall do him no injustice by the curtailment. First we have the registration and the behaviour of children in public schools (which we should probably call Board Schools in England) in New York City and at Denver, Colorado, two very widely different climates it will be remarked. Then we have a large amount of information drawn from police reports, which include assault and battery, discipline in penitentiaries, arrests for insanity and reported suicides. To these are added a few more or less fancy matters, in which the numbers involved are necessarily small, such as the clerical errors discovered in the records of certain of the national banks in New York City, maximum strength tests in gymnasia, and lastly "a study in discrimination carried on in the Psychological Laboratory of Columbia University." The discussion, it will be seen, is very wide, and one fact that will strike the reader prominently when he considers the variety of occupations into which the author has thought it judicious to push his investigations is the length to which this kind of inquiry can be carried when once we are bound hand and foot by the demon of statistics. Possibly the weather has no more to do with a clerk's mistakes than has the quantity or the quality of his supper the night before, but given a nicely ruled sheet of paper, and a system of rectangular coordinates, it is impossible to forgo the delight of plotting results to a scale. This is a harmless amusement; but when we begin to draw conclusions and to build theories, we may go as hopelessly astray as did the famous witness who connected the high tides with the building of a steeple. The author endeavours to meet any criticism of this nature in a passage which we may quote at length, to serve both as an example of his style of writing and his method of argument.

"The meteorological conditions are the essential causes of certain general physiological or mental states, some of which seem to be fertile fields for the action of immediate causes which are, from the standpoint of this problem, accidental. To be concrête, on a certain morning Johnny could not have what he wanted for breakfast, and went to school with the sulks, with a consequent disastrous effect upon his deportment. Most certainly the disappointment at home had a causal relation to his demerit, and no excuse from the weather is sought. But if we take the record of 200 Johnnies for 600 different days, and find that on certain days more of them are out of sorts than on other days, we look for a constant con-

[1] "Conduct and the Weather: an inductive study of the mental effects of definite meteorological conditions." By Edwin Grant Dexter, A.M. (New York and London: The Macmillan Co. *Psychological Review* Memoir.)

dition which might be considered in some way the cause. We cannot suppose that bad breakfasts or whippings or the disappointments common to child life would bear this constant relation, so look for it elsewhere. Wherever found it must be considered valid. But it must be some factor which would be a part of the environment of all the children similarly affected. We have sought it in the varying conditions of weather, with what success is shown by the curves which form the basis of our discussion."

These curves or diagrams are not so conclusive as the author seems to think. We have no proof that a legitimate application of the calculus of probabilities has been attempted. We cannot estimate the amount of variation exhibited by particular instances from the general interpolatory curve. In a word we cannot understand how the numerous observations have been combined, so that the unavoidable irregular errors have the least possible effect on the result. Further, these diagrams, or at least some of them, present another difficulty. To take the first figure which exhibits the effect of weather on the deportment, the class and mechanical work of boys and of girls in schools of various towns, and of boys and girls combined, in Colorado. The abscissa line is divided into eight sections of equal length defined by the weather conditions—hot, cold, wind, calm, storm, muggy, cloud and clear. Evidently there is no connection between the several parts—no regular progression in such an abscissa line. We cannot see, therefore, any reason for joining the several points, of which five out of eight are practically zero. But taking the author's interpretation as it stands, which for reasons already given we are quite prepared to do, this is what we learn.

In climates similar to those of New York, deportment and work are considered to be at their best on cold, calm, clear days, irrespective of sex, and at their worst on "muggy" days. In Colorado, calmness of the atmosphere produces a desirable effect on the condition of the pupils, wind exercises the most deplorable influence. Deportment, which apparently plays a great part in these schools, a fact which should rejoice the shade of the late Mr. Turveydrop, is affected by weather conditions, more in the case of boys than girls. This fact is explained by one teacher on the ground that boys are under less disciplinary control than girls. Another adds that girls "are greater adepts, not only at restraining impulses to do mischief, but also in concealing all evidences of it when it is in progress. This may be due to a greater horror on their part of an open reprimand." The cogency of this argument is not manifest, because the consequences of detection are likely to be visited on the boys with greater asperity than is covered by the term "open reprimand." The knowledge that acute punishment can and will follow conviction, should act as a deterrent and suggest methods of concealment that defy the penetration of the teacher.

When we come to discuss the behaviour of children of older growth, we still find the weather capable of exercising a baneful influence on their conduct and self-control, as illustrated by the number of suicides, assaults, and the perpetration of grave crimes. With regard to the morbid tendency disclosed in the mental state that produces the first of these misdemeanours, the author confirms the remark of Morselli and of others, who have considered the statistics of suicide, that an undue proportion take place in May and the spring and summer months of the year. This fact, which is contrary to the commonly received opinion, Mr. Dexter explains as arising not merely from a depleted vitality, produced by the exhausting influence of the cold of winter, but also by the "conscious or unconscious contrast of the recognised low condition of vitality with the exuberance of energy and life in the rejuvenated nature about, making one that is weak feel that the struggle against the resistance to life and progress, in competition with a world so virile, is hopeless." This remark is perhaps more ingenious than convincing, but if any considerable space of time is supposed to elapse between the contemplation and the completion of the act, it seems useless to tabulate the number of suicides with the height of the barometer and the humidity of the atmosphere, quantities that are continually varying.

It is of interest to notice that the number of assaults increases pretty uniformly with the temperature, or it would be more correct to say with an excess of temperature. Given a hot day in the spring or autumn, and our pugnacity rises in an alarming manner, though in the hot days of summer this quarrelsome mood is not so aggressive. The author concludes from the arrangement of his facts that the effects of heat up to a certain limit are vitalising in their tendency, while at the same time irritating; but above that limit, heat is so devitalising in its effects as to leave hardly energy enough to carry on a fight. Sad to relate, the effect of heat upon ladies is greater than on men; and this is shown not only by an increased desire to fight, but also by evident mental unbalancing. Whether one is the consequence of the other, or whether both are to be traced to the greater sensitiveness of women to weather conditions, is too thorny a subject for masculine debate. But the tales that come from penitentiaries and from those who have charge of the insane, alike testify to the irritating effects of increased temperature. In this connection the author thinks that a study of the record of profanity might yield interesting results, but unfortunately he adds "inclination alone will at least get no one into the police court," so that numerical data are wanting to discuss this phase of the weakness of human nature. It would probably be found that the curve would not greatly differ from that of assault, and it would certainly be comforting if we could shift the responsibility of our deviations from rectitude to such an impersonal agent as the weather. In our own ignorance we were rather tempted to attribute these lapses from good conduct to too free an indulgence in alcoholic beverages in the warm weather, but the author with far greater familiarity with the subject traces them to a much deeper source to be found possibly "in the depletion of the cell structure," or "in acceleration of the oxidising processes of life," expressions which we can only hope are as accurate as they are sonorous.

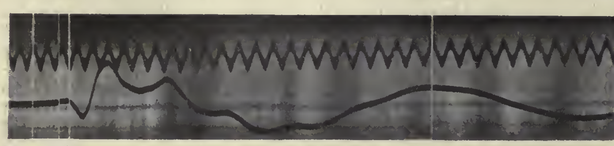
It is no new question to seek the effect of weather upon the moods and impulses of the population, but Mr. Dexter has tapped a new source of inquiry when he asks what are the meteorological conditions which induce clerks in banks, and we presume computers in general, to make mistakes in their work, and to offer up incorrect answers. When the barometer is low, let us forswear computations, but if the humidity be at the same time small, it would be positively immoral to attempt to add up a column of figures. The author explains this by the fact "that the intellectual balance is more disturbed by the increased electrical potential than is the emotional." We are afraid to discuss this proposition, more especially as we have overstepped the limits of space, but we must find room to say that we respect the evident trouble and care which the author has taken in compiling his results, and to ask his pardon if our remarks have appeared too flippant, when applied to a work which he has taken very seriously. Some of his inquiries are not yet complete, but we hope that he will continue them to the end, and leave his results in such a form that a more rigorous discussion may be possible. By "rigorous" is merely meant on recognised mathematical principles, in which one can see easily the relative "weight" which is to be attached to the separate deductions, and the "probable error" that accompanies each.

W. E. P.

VIBRATIONS OF GUN BARRELS.[1]

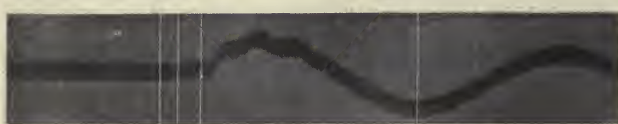
THE authors of this research on the vibrations of gun barrels were induced to make an experimental investigation of the behaviour of rifle barrels, in order to clear up certain difficulties connected with that which is known in ballistics as the *error of departure*. It had been noticed that in shooting with a rifle (whether held loosely, or firmly fixed), that the initial tangent to the trajectory —"die Anfangstangente der Flugbahn"—does not coincide, as would be expected, with the axis of the bore of the barrel, when produced, but is more or less inclined to it at a small angle; this is called *the angle of error of departure*. The authors, working with photo-chronographic methods, determined the movements of the muzzle end of a rifle in a vertical plane, and a vibrational movement of the barrel was detected, and recorded on a moving photographic plate, on the same plate; a trace from a tuning-fork of known period was also formed, so that the position of the muzzle was known at any instant. The rifle used was of the Mauser type M 71.

The collection of photo-chronographic records, twenty-eight in number, show the manner in which a rifle barrel



γ

Fig. 1.



γ

Fig. 2.

Curves showing the vibrations of different parts of a gun barrel after firing. The spot on the bright line marked γ indicates the moment at which the shot left the barrel. Fig. 1 is the vibration curve of a point 1·5 cm. from the mouth, and Fig. 2 of a point 18·5 cm. from the mouth.

vibrates when subjected to the concussion due to an explosive. Figures 6, Plate I., and 7, Plate II., indicate a rapid initial vibration, apparently due to the beginning of the explosion. The records, as a whole, show how an error of departure may be produced. The photographs in some cases are not so clear and defined as those usually produced in physiological research; this is probably due to the beam of light having been cut off by an object of circular section, such as the wire used by the experimentalists. A thin metallic lamina, such as blackened aluminium foil, would have given sharper details. The authors show that the experimental results agree well with figures calculated on the assumption that the rifle barrel is a cylindrical tube.

There is much in the work of Messrs. Cranz and Koch which will be of value to the student of ballistics and to those who design military and other rifles. F. J. J-S.

[1] "Untersuchungen über die Vibration des Gewehrlaufs." Von C. Cranz und K. R. Koch. Pp. 31. Six plates; 13 figures in letterpress. (München: 1899.)

NOTES.

THE Council of the Royal Society has adjudicated the medals for the current year as follows:—The Copley Medal to Lord Rayleigh, F.R.S., for his contributions to physical science; a Royal Medal to Prof. George Francis Fitzgerald, F.R.S., for his contributions to the advancement of physical science, especially in the domains of optics and electricity; a Royal Medal to Prof. William Carmichael McIntosh, F.R.S., for his important monograph on British marine zoology and on the fisheries industries, and on account of his work in establishing a Marine Biological Laboratory at St. Andrews; the Davy Medal to Mr. Edward Schunck, F.R.S., for his investigations on madder, indigo and chlorophyll. Her Majesty the Queen has graciously signified her approval of the award of the Royal Medals.

THE first congress of Russian electricians, organised by the Société Impériale Technique de Russie with the authority of the Ministers of the Interior and Finance, will be held at St. Petersburg on December 27, 1899 (January 8, 1900). The objects of the congress are the promotion of friendly intercourse between electricians, the exhibition of the most recent inventions in electricity and its applications to industry, the discussion of instruction in technical electricity, and other subjects which are concerned with the advancement of electrical science in Russia. The apparatus and machinery, plant, models and inventions, sent by electricians of any nationality, will be exhibited in the rooms of the Imperial Technical Society, Panteleimonskaja 2, St. Petersburg, to which address all communications should be forwarded. Objects intended for the exhibition will be admitted into Russia free of duty, under the condition that they are removed within a month of the close of the exhibition.

PROF. TYLOR writes to call attention to the remarkable activity of anthropological research of late years throughout Austria-Hungary. Students interested in such work may profit much by visiting several districts now of easy access, whether in quest of remains of the Hungarian Copper Age, the caves and burial-places of the Trieste district, the dug-out canoes of the Bosnian fishermen, or the dwindling survivals of ancient patriarchal-communal life in the zadrugas of Croatia. As an example of the activity of the anthropological museums may be mentioned the descriptive catalogue, by Dr. Jankó, of the Biró Ethnographic Collection from New Guinea in the Hungarian National Museum at Buda-Pesth. The first part has been lately published, and is of so excellent quality that it is to be hoped that funds will be forthcoming to complete the work on the same scale.

MR. R. F. MUIRHEAD has been elected president o. the Edinburgh Mathematical Society for the ensuing year.

THE American Geographical Society receives 1000*l.* under the will of the late Mr. C. P. Daly, for the foundation of a medal to be awarded for distinguished services to geography.

THE *Chemist and Druggist* announces that Prof. Moissan has been appointed director of the Laboratory of Practical Chemistry at the Paris Faculty of Sciences.

THOUGH the distance is not less than thirty miles, the sound of the firing at Ladysmith is said to be so plainly heard at Estcourt that the reports of heavy guns (supposed to be the two naval 4·7-inch guns, followed by the bursting of Lyddite shells) can be easily distinguished above those of the Boer 40-pounders and the smaller guns on both sides.

WE learn from *Science* that Mr. R. E. Snodgrass and Mr. A. H. Heller have 'ust returned from a ten months' collecting trip to the Galapagos Islands. The collections are large; birds, fish, and insects and spiders being represented by especially large numbers of specimens. The collections belong to Stanford University, under whose auspices the expedition was made.

As the gravels in the neighbourhood of Chelsea are very rich in rude flint-flakes and the like, many students of archæology and geology may be glad to know that a large vacant space at the corner of Cheyne Walk and Beaufort Street, Chelsea, is shortly to be built upon, and the excavations will probably go down into hitherto undisturbed soil. Mr. W. F. Sinclair calls our attention to the opportunity which the excavations will afford for collecting flint specimens.

BY the death of Mr. William Pamplin, in the ninety-third year of his age, on August 9, English botanists have lost their *doyen*. Mr. Pamplin was an authority on British plants, and especially on their geographical distribution, in the first half of the present century. The "London Catalogue of British Plants" owed much to him. In the year 1827 he published a list of the rarer plants of Battersea and Clapham; and he was elected an Associate of the Linnean Society in 1830. Mr. Pamplin at one time carried on the business of a second-hand bookseller in London, but had lived for many years in great retirement near Bala in North Wales.

THE annual course of Christmas lectures, specially adapted for young people, at the Royal Institution, will this year be delivered by Mr. C. V. Boys, F.R.S. The subject will be "Fluids in Motion and at Rest." The lectures (which will be six in number) will commence on Thursday, December 28, at three o'clock. The remaining lectures will be delivered on December 30, and on January 2, 4, 6, and 9, 1900.

Science announces that Mr. O. F. Cook, of the Division of Botany, U.S. Department of Agriculture, left New York a few days ago for Puerto Rico to make a preliminary examination of the plant products of that island with reference to the introduction of new and useful tropical plants. Mr. Cook is accompanied by Mr. G. N. Collins, of the Department of Agriculture, as photographer, and by Mr. George P. Gall, who is sent by the Smithsonian Institution to collect material for the National Herbarium.

WE learn from the *Cape Times* that Mr. P. L. Sclater, F.R.S., who has lately returned from a visit to South Africa, attended a meeting of the South African Philosophical Society on September 17, and gave an address on the desirability of establishing a Zoological Garden in Capetown. Mr. Sclater showed that the important centres all over the world were taking measures to establish such institutions for instruction and recreation, and urged that Capetown, being the port and capital of what would shortly be an enormous empire, should not be behindhand in the matter. Mr. Sclater's proposals were discussed and well received, and a committee of the Society was appointed to consider the subject and report to a future meeting.

REFERRING to the death of Dr. Edward Orton, professor of geology in the Ohio State University, in the seventieth year of his age, the *American Journal of Science* remarks that while his labours have extended to all branches of geological science, his close watch of the exploitation of petroleum and natural gas, in Ohio and the neighbouring States of Pennsylvania and Indiana, has given him a place of pre-eminence as interpreter of these important geological products. In 1897 Dr. Orton was elected president of the Geological Society of America, and, as president of the American Association for the Advancement of Science, presided at the recent meeting of the Association, in Columbus, in August last. Prof. Orton was a man of broad culture and of influence outside his chosen science. He was for a time president of Antioch College, Yellow Springs, Ohio, and them became president of the Ohio Agricultural and Mechanical College, which has now become the State University. He resigned the presidency and became State geologist in 1882, which position he held up to the present year. Dr. Orton received the degree of Ph.D. from Hamilton College in 1848, and LL.D. from Ohio State University in 1881.

AT the opening meeting of the new session of the Royal Geographical Society on Monday, the president announced that, including the Government grant, the funds at the disposal of the joint committee on Antarctic exploration amounted to 90,000*l.*, but he recalled the fact that the grant which had been promised was made dependent upon another 5000*l.* being raised from other sources. A valuable paper, illustrated by many striking photographs, was read by Mr. W. Rickmer Rickmers, on a journey in the Eastern provinces of Bokhara, with his wife and Dr. von Krafft, now of the Geological Survey of India. Mr. Rickmers established a permanent camp on a tributary of the Yakh-su river, with the object of studying the wonderful mountain system of the "conglomerates" of East Bokhara. The "conglomerates" cover an area of 800 square miles, disposed in a long strip between the rivers Vaksh and Panj, with a strike from north-east to south-west. They show distinct stratification, and Dr. von Krafft ascribes them to the Tertiary period. The stones composing them are chiefly crystalline. The greatest thickness of the formation may be said to be at least 4000 feet. The population of the region is mainly dependent for its livelihood on the gold-washing industry. The yearly gold output of East Bokhara is variously estimated from 20,000*l.* to 30,000*l.*, but this is a mere trifle considering the potentialities of the alluvial deposits. The quantities extracted by the natives in the course of centuries have hardly encroached upon the store, and are as nothing compared with what Europeans could produce in a few years.

As appears from the Report of the Select Committee on the Destruction of Vermin, lately presented to the House of Assembly of the Cape, no less a sum than 27,084*l.* was spent in the various districts of the Colony in the year ending June 30, 1899, in rewards paid for the "destruction of vermin." This large expenditure not unnaturally excited the attention of the Legislative Assembly, who appointed a Select Committee to consider it. The Committee, after taking the evidence of many farmers, land-owners and other persons interested in the subject, have come to the conclusion that it is expedient for the agricultural interest (a predominant factor, it may be remarked, in Cape politics) that the system of giving rewards for the "destruction of vermin" should be continued, but that more care should be exercised in ascertaining that those who claim the rewards are properly entitled to them. The "vermin" in question appear from the evidence to be the Black-backed Jackal (*Canis mesomelas*), the Aard Wolf (*Proteles cristatus*), the Cape Baboon (*Papio porcarius*), and the so called "Lynx" or Roode Cat (*Felis caracal*), all of which are accused of ravaging the farmers' flocks, especially during the lambing season. The Aard Wolf, it is admitted, is not usually carnivorous, but is said to have developed of late years a noxious habit of tearing open the breeding ewes in order to get at the milk in their breasts.

A POSSIBLE substitute for india-rubber and gutta-percha was exhibited and described by Mr. W. F. Reid at the last meeting of the Society of Chemical Industry, under the name of "Velvril." The material appears to be suitable for machine-belting—made by coating cotton canvas with it—waterproofing cloth or canvas, and as a varnish for paint, wood or metal; and so far as its mechanical and protective properties are concerned, it compares favourably with gutta-percha. *The Electrician* is of the opinion that the material at present lacks the flexibility necessary to the core of a submarine cable, and also the strength and elasticity required for a golf ball. Perhaps with improved methods of manufacture these qualities can be given to "Velvril," but until then gutta-percha will hold its own as the most suitable substance for these two purposes.

A FEW years ago the phenomena of "Barisâl Guns," and other similar noises, were discussed at some length in the columns of NATURE. A valuable contribution has recently been made to this interesting subject by Prof. A. Issel, in a paper published in the *Bollettino* of the Italian Seismological Society. The author's chief object is to describe the detonations which were heard at about the time of the Umbria-Marches earthquake of December 18, 1897. These detonations are quite distinct from the sound which generally accompanies an earthquake-shock. They are rather crashes, more or less prolonged, and resemble the boom of thunder or the report of heavy guns at a distance. Sometimes they are isolated; at other times they occur in series, following one another at brief intervals. Generally they begin with a strong blow, which has very often a slightly metallic sound, and then gradually diminish in number and intensity until they cease, but there may be one or more renewals of activity. To many persons the crashes seemed to come from Monte Nerone, where the epicentre of the earthquake was situated. They are frequently heard at other times by the inhabitants of the middle Appennine region, and are known to them by the name of Bomblo. Very often they occur in close connection with earthquakes, and they may be followed immediately by a slight shock or tremor; they are also stronger and more numerous during epochs of maximum seismic activity. Prof. Issel correlates these crashes with those known in other places as Marinas, Mist-Poeffers, &c.; and, as these phenomena are especially characteristic of seismic districts, he regards them for the most part as due to endogenous causes.

ELECTRICITY is rapidly gaining ground as a motive power for harbour and dock works and for traction on canals. In France haulage by electricity has been in use on some of the canals for several years, and, besides being found economical, has been of special value for working the boats through tunnels. The system is now to have a trial in this country, a portion of the Leeds and Liverpool Canal near Wigan being fitted for electric traction; and it is anticipated that, besides other advantages, a saving in the cost of traction of 50 per cent. as compared with horse haulage will be effected. On the Dortmund and Ems Canal in Germany, recently opened for traffic, the cranes and other machinery at the terminal stations, and all the work at the locks connected with the opening and closing of the gates and sluices are to be operated from a central station, where electricity is to be provided by steam power. The haulage along the canal is to be effected by a small electric locomotive running along the tow-path, and obtaining its supply from trolly wires. On the Erie Canal one or more systems have already been tried with partial success. It is now reported that the storage battery system is to be introduced; an electric traction engine will run along the tow-path and haul a canal boat filled with storage batteries of sufficient capacity to furnish current for the traction engine and the boats towed by it. The locks of the North Sea and Baltic Canal, and also the new lock of the Amsterdam Canal at Ymuiden, are both worked by electricity, which is found to have great advantages over hydraulic power in winter when sharp frosts prevail. In this country, at Southampton Docks and other places, cranes are in use worked by electricity.

A THESIS on "The Memory Image and its Qualitative Fidelity," reprinted from the *American Journal of Psychology*, has been received from Dr. I. Madison Bentley. The results of experiments carried on for the special investigation of the visual memory image and its fidelity to an original presentation have led to several conclusions of psychological interest. It appears that discs—grey and coloured—shown and remembered in daylight, tend to grow light in the visual memory, while grey discs shown in a dark chamber display a tendency in the visual image to grow dark during an unilluminated interval. These results indicate that the condition of the retina in respect to stimulation during the memory interval is important for the memory image. Illuminated and unilluminated intervals, where all other conditions are constant, are followed by different judgments with the same memory stimuli. It is therefore concluded that in all experiments with brightness and colour, where a time interval is involved, care should be taken to control the state of the visual organ. It is not improbable that a similar caution would apply to other sense memories. The results also show that memory is not to be regarded as a storehouse of perfectly conserved images, but that the most simple memories are continually exposed to change, and that it is, at times, only by the combination of various memorial resources that retention is made definite and exact.

THE intermittent treatment o. sewage in bacteria coke-beds forms the subject of a second report presented to the London County Council by their chemist. Various investigations were carried out and are here recorded with the object of ascertaining the most effective method of constructing and working the coke-beds, and the data obtained form an interesting contribution to the literature, now considerable, daily accumulating on this method of sewage treatment.

THE reports of the malaria expedition in Italy under the direction of Prof. Koch receive adverse criticism at the hands of Dr. Grassi, writing in the *Atti dei Lincei*, viii. (2), 8. Among the points at issue it would appear that Koch, in the reports referred to, still admitted the possibility of malaria being propagated by *Culex pipiens*, a view long since abandoned by Grassi on circumstantial evidence, which he now summarises in detail. Much of the evidence which led Grassi to attribute the propagation of malaria to Anopheles and not to Culex has been given in previous papers in the same journal.

THE well-known experiment of the early popular text-books on "freezing and boiling water simultaneously" under the exhausted receiver of an air-pump being difficult to perform in practice, Mr. R. W. Quick describes in the *Physical Review* another mode of achieving a similar result. This is a continuation of the experiment commonly described under the heading "water boiled by cold," in which the tightly-corked flask containing the water and steam is cooled, first with iced water, and then with a mixture of solid carbon dioxide and ether, until ice forms as the water boils—or the flask bursts. As Mr. Quick remarks, there must not be sufficient residuum of air in the flask to keep the pressure above 0·46 cm. (the vapour pressure of ice at 0° C.), otherwise no amount of cooling would be effectual in causing boiling and freezing simultaneously.

A PAPER by Prof. Archibald Barr, on "Similar structures and machines," read before the Institution of Engineers and Shipbuilders in Scotland, is appearing in the form of a series of illustrated articles in *Engineering*. The disproportionality between large and small structures required to ensure corresponding strength in supporting weight is illustrated by figures showing the difference in structure between the skeletons of large and small animals, and also by diagrams showing the Britannia and Forth Bridges reduced to the same span.

THE *Proceedings* of the annual meeting of the Indiana Academy of Science, held at Indianapolis at the end of December last, contains quite a number of mathematical papers, foremost among which are Mr. D. A. Rothrock's papers on point invariants for the Lie groups of the plane, and on differential invariants derived from point invariants. To those interested in the geometry of the triangle, Mr. Robert Judson Aley's list of concurrent sets of three lines connected with the triangle will prove a most useful synopsis for purposes of reference; it enumerates eighty-four different concurrences. The same writer communicates a note on a new triangle and some of its properties; while Mr. C. E. Smith, of Indiana University, discusses the geometry of Simson's line. A linear relation between certain of Klein's X-functions and sigma functions of lower division value is given in a note by Mr. John A. Miller.

A FEW years ago Lussana discovered that the electric resistance of aqueous solutions presented certain anomalies in the neighbourhood of the temperature of maximum density, these anomalies being represented by a point of inflection in the curve expressing the relation between the resistance and the temperature. In view of the objections raised against Lussana's work and the intimate relation known to exist between the electric resistance of a fluid and its viscosity, it occurred to Dr. G. Pacher to examine whether any variations analogous to those found by Lussana existed in the coefficient of viscosity of water near the temperature of 4° C. The results of Dr. Pacher's experiments are described in a paper in the *Atti del R. Istituto Veneto*, lviii. (2), pp. 785–814. The coefficient of viscosity was found by observing the efflux of the liquid through a capillary tube, Poiseuille's law being assumed, and the temperature was maintained constant by immersing the tube in a water bath. From the viscosity its temperature-coefficient was calculated and represented graphically by a curve. The conclusions arrived at are as follows: (1) In the neighbourhood of 4° the viscosity of distilled water presents an anomaly indicated by a point of inflection in the curve connecting he viscosity with the temperature; (2) the temperature-coefficient of the viscosity presents a maximum followed by a minimum between the temperatures of 3° and 6°; (3) given the relation between the temperature-coefficient of viscosity and that of electrical resistance, a similar anomaly may be expected to exist in the electrical resistance of distilled water; (4) Lussana's results thus receive indirect confirmation from the present investigation.

A POPULAR account of the possibilities and difficulties of aërial navigation, based upon the scientific experiments made by Langley, Lilienthal, Pilcher, Maxim and others, appears in the current number of the *Fortnightly Review*.

SIR JOHN EVANS's presidential address, on "The Antiquity of Man, with especial reference to the Stone Age in Egypt," delivered at the Birmingham and Midland Institute, has recently been published. It is a brightly written sketch of a vast subject; the more important approximate dates are given, which is a useful feature.

THOSE who are interested in Indian folk-lore must always keep an eye upon the *Journal* of the Asiatic Society of Bengal. The first part of the new volume of the Anthropological Section for this year contains a variety of interesting papers, amongst which may be noted one, by Mr. C. C. Mitra, on folk-lore about birds, and one, by Mr. C. A. Silberrad, on a rain-compelling ceremony which is performed by women.

A COPY of the Report and Transactions of the South-Eastern Union of Scientific Societies, containing an account of the proceedings at the fourth annual Congress held at Rochester in May last, has been received. The Union systematises scientific work among the different societies composing it, and in various ways promotes the interests of science. Next year's Congress will be held at Brighton early in June.

FROM Messrs. Williams and Norgate's very useful "Book Circular" (Scientific Series, No. 72), containing descriptive notes on the contents of recent foreign publications, we obtain the following announcements as to forthcoming scientific works:—"Die Elemente der Entwicklungslehre des Menschen und der Wirbeltiere" is the title of a work by Prof. O. Hertwig, of Berlin, which will shortly be published.—M. Le Dantec, lecturer on embryology at the University of Paris, has written a work entitled "Lamarckiens et Darwiniens," which will be issued very shortly.—"Ueber Reduktionstheilung, Spindelbildung Centrosomen und Cilienbildung im Pflanzenreiche" will be the subject of the sixth part of Prof. E. Strasburger's "Histologische Untersuchungen."—The first part of "Nouveaux éléments de botanique," by Prof. Louis Crié, of Rennes, will soon appear, and the second part will be published in the course of next year. —The fourth edition of Prof. Lapparent's "Traité de Géologie" will be issued in three parts. Of these, the first two will appear almost immediately, and the third will appear in January.

THE difficulty of preparing metallic cæsium is well known. The metal has hitherto been obtained chiefly by the electrolysis of the cyanide mixed with barium cyanide, but the unsatisfactory character of this process is sufficiently shown by the price of the product, which is about twenty-eight shillings a gramme. It has been shown quite recently by Herren Graeffe and Eckhardt that cæsium can be prepared easily and with an almost theoretical yield by the reduction of cæsium carbonate by means of magnesium powder. The mixture is heated in an iron tube through which a slow current of hydrogen passes. The metal distils over, and is collected under melted paraffin. It has a silvery lustre with a slight yellow tint, and remains bright under paraffin. On exposure to air it oxidises rapidly, melts, and finally inflames. In its action on water it resembles potassium. A previous attempt by Winkler to prepare cæsium by reducing the carbonate with magnesium failed, and led that chemist to doubt the statement of Beketoff that the reducibility of the alkaline carbonates increased with increasing atomic weight of the metal. Herren Graeffe and Eckhardt, however, confirm Beketoff's conclusion, and show that cæsium is more easily reducible than rubidium, and rubidium than potassium.

THE additions to the Zoological Society's Gardens during the past week include a Sykes's Monkey (*Cercopithecus albigularis*) from East Africa, presented by Lord Alexander Thynne; a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mr. W. J. Beard; a Vervet Monkey (*Cercopithecus lalandii*) from South Africa, a Viverrine Phalanger (*Pseudochirus cooki*) from Tasmania, an Agile Wallaby (*Macropus agilis*) from Australia, a Brown Capuchin (*Cebus fatuellus*) from Guiana, a Rufous-necked Wallaby (*Macropus ruficollis*) from New South Wales, three Cardinal Eclectus (*Eclectus cardinalis*) from Amboyna, four Serrated Terrapins (*Chrysemys scripta*), three Prickly Trionyx (*Trionyx spinifer*), four Menobranchs (*Necturus maculatus*), an Amphiuma (*Amphiuma means*) from North America, three Mute Swans (*Cygnus olor*), European, deposited; a Black-backed Jackal (*Canis mesomelas*) from South Africa, two Brazilian Caracaras (*Polyborus brasiliensis*), an Anaconda (*Eunectes murinus*) from South America, purchased; a Spring-Bok (*Gazella euchore*) from South Africa, received in exchange; a Hog Deer (*Cervus porcinus*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE ANDROMEDES.—In respect to the reported observation of Biela's comet, no confirmation of which, however, is yet to hand, it will be well to keep careful watch on the character of the second November display. The maximum is timed to occur from the 23rd to the 27th, the approximate coordinates of the radiant being

R.A. = 1h. 40m.
Decl. = +44°;

that is, a little north-west of γ Andromedæ. The usual characteristic of these meteors is their slow flight, in contrast to the swift Leonids, and this should facilitate photographic impressions of them being obtained.

HOLMES' COMET (1899 *d*).

Ephemeris for 12h. Greenwich Mean Time.

1899.	R.A. h. m. s.	Decl. ° ′ ″
Nov. 16	2 20 25·87	+48 25 43·7
17	19 24·98	19 55·4
18	18 25·68	13 51·5
19	17 28·03	7 32·5
20	16 32·09	48 0 59·3
21	15 37·93	47 54 12·3
22	14 45·60	47 12·4
23	2 13 55·17	+47 40 0·2

OCCULTATION OF NEPTUNE.—On Sunday evening next, November 19, there will be an occultation of Neptune, visible throughout the whole of northern Europe, for the observation of which the following particulars will be useful :—

	Sidereal time. h. m.	Mean time. h. m.	Angle from North point. °	Angle from Vertex. °
Disappearance...	22 4	6 10	95	129
Reappearance...	22 56	7 1	261	299

The angles given will facilitate the adjustment of the moon's image so as to bring the points of "immersion" and "emersion" into the positions of best definition. The "angle from the north point" is the angle subtended at the centre of the moon's disc by the arc extending from the star when in contact to the point of intersection of the moon's limb by a great circle passing through the North Pole; the "angle from the vertex" is the angle subtended by the arc extending from the star to the point of intersection of the limb by a vertical great circle passing through the zenith.

For the convenience of observers south of London it may be mentioned that the limits of latitude for this occultation are 90° N. to 25° N.

"THE HEAVENS AT A GLANCE" (1900).—Mr. Arthur Mee, of Cardiff, has published his annual astronomical calendar, upon which is given a concise tabulation of the more important astronomical constants and events for the coming year. One half of the card constitutes a celestial diary, indicating the favourable dispositions of the various constellations for each month, the sun's declination, phases of the moon, and configuration of the planets, with detailed enumeration of occultations and variable star phenomena. Following this, descriptive notes are given of the prominent features visible on the moon at various stages throughout the lunation; times of elongation, opposition, &c., of the planets throughout the year; a list of the more prominent meteor showers, the eclipses of the year, and several facts concerning variable stars. The whole is printed on a single card, facilitating its being kept within reach for instant reference by the observer's side, and thus specially recommends itself to the amateur who may be unable to spare the time necessary for obtaining the information from the more complete reference works of the observatory. Astronomical time is used throughout, and all the data are for Greenwich, but are applicable with slight corrections to the whole of the British Isles. Not the least important feature is the clear style of arrangement and printing, which will render its use more pleasant under actual working conditions.

THE CONFERENCE OF GERMAN MEN OF SCIENCE AT MUNICH.

THE seventy-first meeting of the Society of German Naturalists and Physicians opened at Munich on September 17, and continued until the 23rd.

A great disaster had just visited the city; the floods which had wrought such havoc throughout the Salzkammergut and South Bavaria culminated their work of destruction in Munich, where the Isar, rising many metres in a few hours, destroyed two of the finest bridges in the capital, inundated the low-lying parts of the town, and threw out of gear the Electric Works and many factories along the banks; many lives were lost.

The Prince Regent bridge, which was entirely destroyed, was the gift of the ruler whose name it bears; the original cost was 1,500,000 marks, and the munificent Prince has undertaken to bear the cost of rebuilding the same.

In spite of the dislocation of all routes of communications, the congress was attended by about 3500 members. The proceedings opened with a gala meeting in the Royal Theatre on Monday, September 18, when the congress was inaugurated by Councillor von Winckel, and the members were welcomed, on behalf of the Prince Regent, by Prince Ludwig Ferdinand, who evinced his interest by attending all subsequent general meetings.

After several other speeches had been delivered, Dr. Fridtjof Nansen ascended the tribune and summarised the scientific results of his Polar Expedition.

Parenthetically, it is interesting to note that three of the most remarkable addresses were delivered by foreigners—Nansen, van t' Hoff and Ramsay—in fluent German.

Nansen showed the typical glacial appearance of the Siberian coast, then described Franz Josef's Land, which is far less extensive than appears on the maps; the land is almost entirely covered with ice, relieved here and there with masses of black basalt rocks, which rest on a seam of clay some 500 feet in thickness.

The Arctic Ocean may be considered as a kind of lagoon separated from the Atlantic by a submarine range of mountains, stretching from Spitsbergen to Greenland; this range is responsible for a curious condition of things. The Arctic Ocean is covered with a layer of brackish water containing a low percentage of salt, and collected from the Siberian rivers and the Bering Strait; below this is Gulf Stream water, containing a normal quantity of salt.

If these two layers of water were mixed, the average temperature would fall, but this average would not be so cold as that of the surface layer of Arctic water; this condition accounts for the enormous formation of ice in the polar region.

The points were all illustrated by photographs, tables and diagrams, and drawings of the diatoms found in the fresh-water lakes, formed by the sun melting the surface of the ice, were shown.

The lecturer was followed by Prof. von Bergmann, who demonstrated the value of radiography in the diagnosis of surgical diseases; and by Prof. Förster, who described the alteration in the face of the heavens from the remotest periods down to the present time.

After these addresses many members adjourned to the Technical College, the whole of which magnificent building had been placed at the disposal of the congress, and where reading and writing rooms, reception and inquiry offices, a restaurant, &c., were to be found.

Here the daily programme was to be obtained, and each member of the congress was presented by the city with an admirable album of views and a "Festschrift."

The Festschrift was a magnificent quarto volume describing the development of Munich under the influence of the natural sciences during the last decades. The first part of the work was devoted to vital statistics and general municipal organisation. A few facts are, however, of general interest and formed the subject of addresses during the congress.

The Electrical Works on the Isar are a most remarkable example of a municipal undertaking; besides the current used for the electric cars, lighting, telegraph and telephone purposes, they supply current to work 172 motors (1329 H.P.), 13,500 incandescent and 329 arc-lights in 91 factories. Besides the Corporation works, there are 317 private installations, of which 69 use gas, 39 water, and 179 steam to supply the motive power.

The population of Munich is 450,000. The cost of lighting the streets (incandescent gas and arc-lights) represented last year, per head of the population, a yearly cost of 1·925 marks; in 1881 the cost was less than half this sum, 0·81 mark per head.

Of the two most prominent industries in Munich, the second, the industrial production of cold, originated in the demands and necessities of the first, the brewing industry.

In 1898 there were 24 breweries, producing 1,540,000 hectolitres of beer. Munich has always been celebrated for its beer, and in the year 1500 possessed 38, in 1618 no less than 69 breweries.

The industry of the production of low temperatures is due to the energy of, and was initiated by, Dr. Carl Linde, who in 1881, with the help of the Polytechnic Society, started the famous works, where successful experiments were carried out with the "high pressure and low temperature system," and with the happy combination of Siemens' alternating principle with the Joule-Thompson "cooling effect," produced by the streaming of gases from high to low pressures. The following are the chief industrial and scientific uses of low temperatures: manufacture of ice in the brewing industry; preservation of meat and alimentary products generally; preservation of anatomical specimens; in the morgues; the arrestation of the development of the silk cocoon; arrestation of the growth of bulbs (making the same independent of their accustomary flowering season); in the testing of meteorological instruments; and in scientific research generally; the preparation of explosives, the fractionation of liquid air, and consequent preparation of mixtures rich in oxygen; the manufacture of ozone.

The Cold Air Storage Installation at Munich is the most complete building of the kind at present erected; the cells are kept constant at 3° C., and the air contains 60–70 per cent. of moisture.

The second general meeting was also held in the Royal Theatre, and the addresses on this occasion were delivered by Prof. Boltzmann (Vienna) on the course of the development of modern physical methods; by Prof. Birch-Hirschfeld on science and therapeutics; and by Prof. Klemperer (Berlin) on Justus von Liebig and medical science.

The last-named speaker showed that Liebig initiated the use of chemical preparations of known composition in the place of those plant infusions of doubtful consistency, which formed the staple drugs of the older physicians. Prof. Klemperer declared that the days were drawing near when such extracts would disappear from pharmacology, and chemistry would be entirely substituted for botany.

In another, less direct, way Liebig was the means of enriching our pharmacopœia, for it is by the method of organic analysis he perfected that the composition of the numerous synthetic remedies of to-day is determined. Chloroform and chloral were discovered by him, and, working in a somewhat different region of thought, Liebig exploded the theory that the warmth of the animal organism was in part due to electricity and the action of the nerves, showing that all animal warmth was produced by the chemical processes continually taking place within the organism.

THE CHEMICAL SECTION.

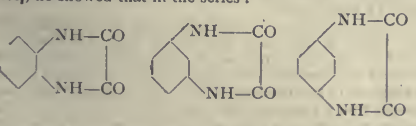
This Section was presided over by Prof. Adolf von Baeyer, Professor of Chemistry at the University of Munich, who welcomed the members of the section, and spoke a few words in memory of Bunsen; the following passage deserves to be quoted:—

"Bunsen's value as a teacher and master lay not so much in the lectures he delivered as in the example he set. He was always working himself, and worked in the presence of his pupils."[1]

Prof. Wislicenus, sen., was elected president for the first day, and won general approval by keeping the speakers strictly to the twenty-minute time limit.

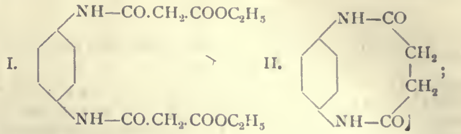
The proceedings were opened by Prof. van t' Hoff (Berlin), who showed that the formation of the Stassfurt salt beds by the evaporation, at 25° C., of a solution of common salt, borates, and calcium and magnesium sulphate and chloride, could be graphically represented on a diagram.

Richard Meyer gave an account of his experiments on the condensation of aromatic diamines with dibasic acids of the oxalic series; he showed that in the series:



the ortho-derivative alone was stable; further, that with malonic ether an amino acid ether (I.) was obtained, but with succinic ether a ring (II.)

[1] This seems an important pronouncement in view of the disputed question of the efficacy of private-research rooms as compared with large laboratories.



the difference being possibly due to the greater length of the succinic acid chain lessening the tension.

Dr. H. Stobbe (Leipsig) described the condensation products of benzaldehyde with succinic ether, and showed that such a body as dibenzal succinic acid

$$\begin{array}{l} C_6H_5.CH=C—COOH \\ \qquad\qquad\quad | \\ C_6H_5.CH=C—COOH \end{array}$$

which yields a colourless anhydride is converted by means of iodine into a stereoisomeric acid giving a bright yellow anhydride.

Dr. Krämer (Berlin) advanced certain views as to the formation of petroleum by the decomposition of diatoms; he found that the wax contained in diatomaceous mud consisted largely of decane.

In the subsequent discussion a geologist pertinently remarked that though it was possible that petroleum was formed to a certain extent in this way, yet much larger quantities must be formed by the decomposition of fish and marine animals generally; in confirmation of the animal origin of petroleum he mentioned the fact that many fossil bivalves contained, on opening, drops of oil; he also suggested that the oil in the Caucasus was formed to some extent by the large number of fish that were killed yearly by passing from the fresh water into the strong brine of the lagoons.

The animal origin of petroleum was acknowledged by all speakers.

J. Tafel followed with a paper on the course of electrolytic reduction. The experiments were carried out with a solution of caffeine, and the rapidity of the reaction measured by the evolution of hydrogen at the kathode as compared with the evolution of hydrogen in a similar cell containing dilute sulphuric acid.

In order to effect reduction Tafel showed that the kathode must be of lead, and, moreover, must be coated by spongy lead, the use of a polished lead pole giving a bad result, immediately rectified by the introduction of a little lead acetate solution. The introduction of copper and the noble metals stopped the reaction, which, in the case of these metals, recovered its normal course; if platinum had been introduced, there was no recovery.

In the discussion Drs. Bodländer, Nernst and Arendt took part, the latter remarking that the anode also should be of lead.

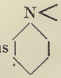
Richard Meyer read a second paper on the thio-derivatives of the di- and tri-phenylmethane series, and the influence on the fluorescence of the substitution of sulphur for oxygen in such bodies as

$$CO\left\langle {C_6H_4 \atop C_6H_4} \right\rangle O \quad CS\left\langle {C_6H_4 \atop C_6H_4} \right\rangle O \quad CO\left\langle {C_6H_4 \atop C_6H_4} \right\rangle S\,;$$

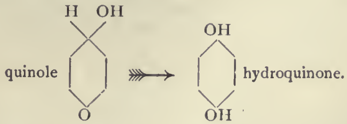
the results were, however, conflicting.

R. Schenck read a paper on the two kinds of dimorphism and their mutual relationship, describing the course of the change (in the case of para-azoanisole) from enantiomorphism to monotropism.

Dr. Bachhold (Frankfort) gave a short account of the work done by bacteria in the disposal of sewage—in one experiment he took mud from the filter-beds in July and found it to contain 14·60 per cent. of fats; on preserving this, moist, in a corked flask till November, he found it contained only 5·82 per cent. of fats; if the mud was previously dried, the percentage, naturally, did not alter.

Prof. Bamberger's (Zürich) address was of especial interest to organic chemists, and was also remarkable in introducing a new expression, which should be welcomed by chemical philologists. He used the expression "torso" to describe the molecular aggregate or residue which had been bereft, so to speak, of its limbs; thus  represents the torso of diethyl-aniline, &c.

In his paper on the mechanism of the passage of hydroxylamines into amidophenoles, he described a new class of bodies, quinoles, which only exist at a low temperature, and pass on warming into more stable isomers; thus he obtained a quinole isomeric with hydroquinone:



Prof. Lieben (Vienna) gave a general review of the properties and formation of the aldoles, introducing a new classification of these bodies, according to the ease with which they lose water—the three classes being thus graphically represented:

$$\overset{\text{I.}}{CH_3\text{—}CH(OH)\text{—}} \qquad \overset{\text{II.}}{R.CH_2.CH(OH)\text{—}} \qquad \overset{\text{III.}}{R_2.CH\text{—}CH(OH)\text{—}}.$$

Aldoles belonging to the first class split off water with difficulty, those belonging to the third class with ease.

Prof. Ramsay's address on "The Newly-discovered Gases" was delivered at a combined meeting of the Chemical and Physical Sections, and, despite the early hour at which it was given, attracted a large audience.

As full accounts of these researches have appeared from time to time in NATURE, it will suffice to state that the lecture was illustrated by Crookes' tubes, containing the gases, and to recall the analogy in the periodic system between the group formed by the new gases and the group formed by the halogens

H = 1	F = 19	Cl = 35·5	Br = 80	I = 127
Helium = 4	Neon = 20	Argon = 40	Krypton = 82	Xenon = 128

The periodic system, indeed, furnished the subject-matter for several papers in the Chemical Section, and, passing over a paper on this subject, which caused much amusement, it is interesting to note the conclusions arrived at by Prof. Brauner in his investigation of the position of the elements of the rarer earths in this system.

He considers that the position indicated by the fourth group and the eighth series must be assigned to a group of three elements.

Cerium 140, Praseodidymium 140·8, Neodidymium 143·6.[1]

This conclusion is based in great measure on the study of the higher oxides. Prof. Brauner considers that the oxides Pr_2O_4 and Nd_2O_4 belong to the oxides of the PbO_2 or ozonic type—that is to say that the metals in these oxides are tetravalent, and the oxides correspond to Ce_2O_4.

At first sight the oxides obtained by precipitation with hydrogen peroxide should belong to the second, H_2O_2, or antozonic type of oxide; Prof. Brauner found that on repeating this experiment at low temperatures the hydrates of true superoxides were formed, possessing the formula Pr_2O_5 and Nd_2O_5, and loosing oxygen with great ease.

Dr. Otto Bleier followed with a paper on "The Vapour Density of Sulphur."

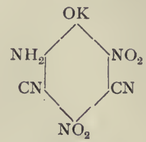
The present methods for the determination of vapour densities cannot be applied with exactitude in experiments performed in order to determine the density of sulphur vapour before the molecules have begun to dissociate.

By a new method, which combines low pressures and low temperatures, Dr. Bleier showed that, though it was impossible to reach a combination of pressure and temperature at which no dissociation of the sulphur molecule had taken place, yet at 214° and at a pressure of 4 m.m. the density of the vapour was 7·88, which corresponds to a molecule containing $7\frac{1}{2}$ atoms; it may therefore be reasonably concluded that the molecule of undissociated sulphur vapour may be represented by S_8, and not by S_6, as given in the text-books.

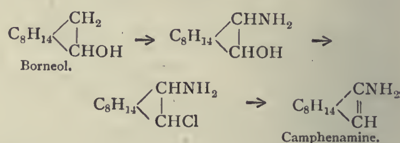
[1] The German expressions Praseodym and Neodym are less cumbersome!

Papers were also read by Dr. Staudenmeier on graphitic acid, and by Prof. S. Ruhemann on the acetylene carboxylic acids.

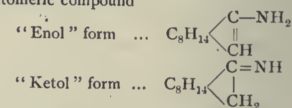
Dr. Nietzki gave the results of investigations undertaken with his pupils on isopurpuric acid, and detailed the grounds on which he assigned to the potassium salt of this acid the formula:



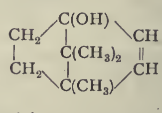
Dr. Dulden gave an account of certain researches in the camphor series. Starting with borneol, he obtained amidoborneol, and converted this body by means of phosphorus pentachloride into a substance which, with potash, split off hydrochloric acid to yield camphenamine:



This body shows a considerable analogy with vinylamine, and is a tautomeric compound



The investigator hopes to convert this base into an isomer of camphor by replacing the NH_2 group by hydroxyl; experiments in this direction have led to the isolation of a substance which appears to possess the formula:



Dr. Brauns (Giessen), in a paper on the different modifications of sulphur, described no less than seven distinct varieties. A paper of considerable interest to English chemists described the researches on colloid metals, conducted by Prof. E. von Meyer and Dr. Lattermann, the first example of a metal in this condition having been discovered by Carey Lea.

Mercury, bismuth, copper and silver were obtained in a colloidal condition by reduction of dilute solutions of their salts by means of sub-salts of tin, and subsequent precipitation of the colloid metals by ammonium citrate. Such solutions contained invariably stannic acid in a colloidal condition, and it seems probable that mercury, copper and bismuth can only exist in this state when combined with stannic acid. Colloidal silver when treated with a halogen yields a colloidal solution of the silver halide; true colloids, such as gelatine, increase greatly the stability of the above solutions, which, on the other hand, are immediately precipitated by electrolytes.

The papers in this section were given in the original lecture theatre which Liebig built and which bears his name, and attracted an audience of 100 to 120 daily; at the British Association the morning devoted to organic chemistry did not attract a tenth of this number. The papers began at 9 a.m. and continued, with a pause of fifteen minutes, up to nearly 1 p.m.; the section resumed at 3 p.m. and sat again till 5.30 p.m.; two and a half days were occupied by the sessions of this section.

Among the chemists attending the meeting were von Baeyer, van 't Hoff, E. Fischer, Curtius, Kahlbaum, Bernsthen, Ramsay, W. H. Perkin, jun., R. Meyer, H. Stobbe, Bamberger, Brauner (Prague), Hantzsch, Lieben, Einhorn, Ostwald, Werner, J. and W. Wislicenus, Soxhlet, Staudenmeier.

OTHER SECTIONS.

In the Physiological Section Prof. Rudolf Cohn (Königsberg) described a new series of his investigations of the nature of the base obtained by the action of hydrochloric acid on albumen.

He obtained a body possessing the formula $(C_6H_{13}N)_2$, and isomeric with and similar to leucinimide, and probably possessing the constitution of dioxydibutyldiethylendiamine. The ease of the formation of such bodies may explain the occurrence of certain bases, such as spermine in the animal organism.

In the Section for Hygiene and Bacteriology an important discussion was inaugurated by Dr. Czaplewski on the method of using formaldehyde (formal, formaline) as a disinfectant.

A remarkable paper was contributed to this section by Dr. Weyl (Berlin) on the sterilisation of water by means of ozone. Water to be sterilised is pumped to the top of a tower and allowed to flow slowly over stones, meeting as it falls a current of air charged with ozone.

In one experiment with Spree water containing 80,000–90,000 micro-organisms per cc., 3000 litres of water were obtained in an hour, containing less than 100 organisms per cc.

This process appears to be also effectual in purifying peat and bog water, the solution of the iron salts of humic acid being decomposed and oxidised, and the brown colour disappearing in consequence.

The method can be advantageously used in connection with filter-beds, by which the floating organic matter is removed from the water before it is treated with ozonised air.

The cost of sterilising an average river water works out at $\frac{1}{4}$*d.* to $\frac{1}{2}$*d.* per 1000 litres; no ozone remains in solution.

In the Physical Section an interesting paper was read by Dr. Carl Linde, on the industrial uses of liquid air.

Prof. Adami's discourse, in the same section, was remarkable for demonstrating the possibility of constructing dynamos and galvanometers at the cost of a few pence, and the power of performing electrical experiments with the simplest materials. It is impossible in an abstract to give any idea of the charm of Prof. Adami's manipulations.

Prof. C. Kahlbaum's (Basle) experiments on the distillation of metals showed that most metals can be distilled in vacuo, vessels of glass or porcelain being used. Very remarkable is the fact that alloys can be fractionated by this method; in one experiment the copper was quantitatively separated from the nickel in a German coin, the nickel remaining in the flask as a silvery regulus, and the copper crystallising in the receiver; such newly-distilled metals resist to a greater degree the action of atmospheric oxygen.

Prof. Ostwald's paper on periodic changes in the rate of reaction was received with some scepticism, and produced a lively discussion. It appeared that pieces of a certain block of metallic chromium, 5 kilograms in weight, and prepared by Dr. Goldschmidt, showed a remarkable property.

When such pieces were placed in dilute hydrochloric acid, the numbers of the bubbles of hydrogen evolved in equal times, and measured in a capillary tube, exhibited a constant variation; thus in equal periods of time two, four, six and eight bubbles appeared respectively, and then the series recommenced with two bubbles. This truly remarkable phenomenon was confirmed by observations reaching over many months.

Unfortunately, this was the only specimen of metallic chromium which could be obtained possessing this curious property.

All the scientific sections were invited to a meeting in the Kailnsaal, where Prof. Chun explained the exhibition of the results of the German Deep Sea Expedition.

These results confirmed in many cases the results obtained on the *Challenger* expedition, especially as to the existence of life at the greatest depth of the Antarctic Ocean.

When the explorers landed at Kerguelen they were immediately surrounded by great flocks of birds, showing no fear, and perching on the shoulder or pecking at the boots of the astonished members of the expedition.

Some of the fish found at depths of 3000 metres, to which depth naturally but little light penetrates, resembled those found in the Lias, representing a period when the atmosphere of the earth was dense, and charged with carbon; these fish were in some cases provided with special means of collecting light, being in possession of enormous eyes occupying nearly the whole side of the head, or supplied with telescopic organs; in other cases they carried their light with them on their heads, in a somewhat similar fashion to the glow-worm.

On Wednesday afternoon and on Saturday no meetings were held, and a large number of excursions were arranged, comprising visits to the lakes and watering-places near Munich, and excursion to the royal palaces and to Ratisbon.

On Thursday a gala-performance of "Lohengrin" was given at the Opera by royal command, for which every member of the Congress received a ticket.

During the whole week the picture galleries and exhibitions were open to the members at a reduced charge, and opportunities of visiting the breweries, ice-works, &c., were afforded.

The accommodation of the guests was in the hands of a special committee, who performed their difficult task to the satisfaction of every one, the prices of the rooms being especially moderate.

The next meeting of the Society will be held in September 1900, at Aachen (Aix-la-Chapelle), and, being easy of access, should attract English men of science. W. T. L.

BOTANY AT THE BRITISH ASSOCIATION.

THE President of the Section (Sir George King) delivered an address in which he gave a comprehensive sketch of the history of Indian botany. Reports were presented by the committees on assimilation in plants and on fertilisation in the Phæophyceæ. In the former investigations—conducted by Dr. F. F. Blackman (Cambridge)—the experimental work dealt with the sources of the carbon dioxide of leaf assimilation, with the respiration of the stem as distinguished from the leaf, with the magnitude of the absorption of carbon dioxide from the soil, and with kindred problems, of which a preliminary account was given by Dr. Blackman at the Bristol meeting. Mr. Lloyd Williams (Bangor) had been engaged during the past year in researches into the cytology and life-history of various members of the Phæophyceæ, including *Dictyota dichotoma*, *Halidrys siliquosa*, *Himanthalia lorea*, *Laminaria saccharina*, *Alaria esculenta* and several species of Fucaceæ.

Mr. Williams contributed a preliminary note on the life-history and cytology of *Halidrys siliquosa*, in which he dealt with the formation and liberation of the sexual cells, the striking phenomena accompanying the act of fertilisation, the segmentation of the spore, together with the cytology of the various processes. In the process of fertilisation the most important points observed were (1) the gyrating, clockwise movement of the antherozoids; (2) the long time taken to effect fertilisation—30–50 minutes as against 3–10 minutes in *Fucus*; (3) the peculiar behaviour of the egg at the moment of fertilisation, its distension and sharp rugged conical projections with beady threads emitted from their apices; (4) the subsequent restoration of the egg to its normal shape and size.

In accordance with the usual custom, Friday afternoon was devoted to a semi-popular lecture, which was this year delivered by Mr. Harold Wager, on the sexuality of the fungi. The lecturer gave an interesting and clear account, illustrated by lantern slides, of the phenomena of sexuality in the various groups of fungi.

An additional value was given to the lecture by the number of new facts dealt with by Mr. Wager; these included some new observations on fertilisation in *Peronospora parasitica* and *Polyphagus Euglenae*.

Miss Ethel Sargant gave a demonstration of vermiform nuclei in the fertilised embryo-sac of *Lilium Martagon* (*vide Proc. Roy. Soc.*, vol. lxv. p. 163, 1899).

Mr. J. C. Willis, Director of the Royal Botanic Garden, Peradeniya, Ceylon, gave an account of the research laboratory and of the facilities afforded to botanists conducting investigations in the Ceylon Gardens.

On Saturday, September 16, Mr. G. Dowker, the local secretary of Section K, whose intimate knowledge of the Kent flora made him an admirable leader, conducted a botanical excursion to Sandwich. Those who were present at the meetings of Section K will learn with sincere regret that Mr. Dowker died suddenly on Friday, September 22. The botanists present at Dover had learned in their short acquaintance with Mr. Dowker to appreciate his kindly nature and the keen interest he took in botanical work.

THALLOPHYTA.

Prof. Marshall Ward gave an account of his recent work on *Onygena equina*, a horn-destroying fungus (*Proc. Roy. Soc.*

vol. lxv., 1899, p. 158). The genus *Onygena* comprises six species, all very imperfectly known, remarkable for their growth on feathers, hair, horn, hoofs, &c., on which their sporocarps appear as drumstick-shaped bodies 5–10 mm. high. A cow's horn thoroughly infested with the mycelium of *O. equina* yielded material for the investigation; the author not only verified what little was known, but was able to cultivate the fungus, to trace its life-history, and to supply some details as to its action on horn. The development of the sporocarps, the structure, germination and biology of the chlamydospores were dealt with; also the details and development of the asci and the germination of the ascospores. Prof. Ward expressed the view that no trace of any morphological structure comparable to sexual organs could be discovered, though many points suggest the alliance of this fungus with Erysipheæ and the Truffles.

Mr. R. H. Biffen (Cambridge) presented an account of *Bulgaria polymorpha* (Wettstein) as a wood-destroying fungus. *Bulgaria polymorpha* is stated by Ludwig to be parasitic on oak. The author has examined its anatomy, and studied it in pure cultures on wood and in food-material. The white early growth soon becomes bright orange; small rounded elevations are afterwards formed, which are incipient reproductive bodies. The action on wood was examined in some detail. The fungus grows better on oak than on pine. The lignified wood-elements are de-lignified. Details as to the reactions in various stages of its destructive action are dealt with in the paper. The author does not regard the fungus as of great importance as a wood-destroying organism in this country.

Mr. A. Howard (Cambridge) described some recent work on a disease of *Tradescantia*.

During the summer it was found that two species of *Tradescantia*, growing in greenhouses, were being attacked by a fungus. Diseased leaves and stems were in many cases found to be covered with long white conidiophores. Pure cultures were made of the parasite, which proved to be a species of *Botryosporium*. Some difficulty was experienced in obtaining this form free from another fungus, a species of *Cladosporium*. It was found in the case of the naturally growing host plants that infection started either on the upper side of the leaf or from the margin. Tangential sections of the upper epidermis of the leaf, when grown in hanging drops, showed in all cases hyphæ on the epidermis, which gave rise to the same species of *Cladosporium* as that mentioned above, occurring as a weed in the *Botryosporium* cultures. The development of this *Cladosporium* was then followed out from a single spore by the hanging-drop method, and infection experiments were made which proved successful.

Prof. Potter (Newcastle) read a paper on a bacterial disease—white rot—of the turnip.

The author found in the early autumn numerous turnips, whose roots, when fully grown, became completely rotten. The rotten portion presents a white glazy appearance, and the tissues are reduced to a soft pulpy condition; the cell-walls are much swollen, faintly stratified, and separate from each other along the middle lamella. The decaying mass is infested with bacteria, but the most careful microscopic search has failed to detect any fungoid hyphæ. The rottenness can be readily introduced into a sound root by inoculation at a wounded surface; from this point the decay spreads rapidly through the root, the leaves gradually turn yellow, and in about fourteen days the entire plant has succumbed. Among the bacteria found in the rotten mass one has been isolated, which, when sown from a pure culture on turnips, under sterile conditions, induces all the characteristic effects of the "white-rot."

The bacterium, which has a single polar flagellum, was described by the author under the name *Pseudomonas destructans*. It occurs in the form of short rods about 3μ long by $\cdot 8\mu$ broad, with one polar flagellum; it rapidly liquefies gelatine, forming circular whitish colonies. The organism is parasitic on turnips, potatoes, carrots, but not on beetroot, forming a cytase.

Mr. Harold Wager gave an account of the phosphorus-containing elements in yeast. By using the method of Macallum for the determination of phosphorus in cells, which consists in the formation of a precipitate by means of a nitric acid solution of ammonium molybdate and subsequent coloration by means of the reducing agent phenylhydrazine hydrochloride, the author has been able to demonstrate that the phosphorus resides in a definite organ of the cell, which has been described as a nucleus by various observers. This affords, therefore, additional evidence in favour of the nuclear nature of the body.

¶ Prof. Ward contributed some notes on methods for use in the culture of algæ. The notes were of the nature of suggestions, the experiments being still in progress; but the author gave an account of the work in hand with a view to interest those engaged in investigations involving the cultivation of algæ.

If agar is swollen in dilute acetic acid, and then washed very thoroughly, it can be used, mixed with the necessary culture fluids, as a convenient medium for the growth of some algæ, as Beyerinck had already observed.

The author has succeeded in separating algæ by the following methods:—

The algæ are shaken up in a sterilised nutritive mineral solution, mixed rapidly with silica jelly, also sterilised, and poured into glass dishes. With species of *Oscillaria* and of *Palmella* the author has observed growth in hanging drops of this silica-jelly medium under high powers.

Another device is as follows:—Shake the algæ up in the nutritive solution and rapidly mix with sterilised plaster of paris and pour into dishes. The fixed algæ grow *in situ* in some cases, but others appear to be too sensitive for such treatment.

Experiments have also been made as follows, with some promise of success:—The algæ are shaken up in the culture medium, and a large quantity of lime-water quickly added. Carbon dioxide gas is then passed rapidly through, and the algæ are thrown down with the precipitate of calcium carbonate; this is poured into dishes as if it were plaster of paris. Perhaps this method could be utilised in the study of calcareous algæ, but with some forms it appears too drastic. One drawback is the difficulty of obviating the use of unsterilised materials.

In illustration of the application of the methods, Prof. Ward described some observations of the growth of *Oscillaria tenerrima* in hanging drops of silica-jelly. The growth of a single filament was followed for more than a week, and the curve showed that growth ceased during the hours of darkness, and was coincident with assimilation during the day. The author also obtained "light-figures" by exposing plates of green algæ, covered with stencil letters, to various intensities of daylight reflected from mirrors. When the light was not too strong, a green letter on a colourless ground was formed, but with intense illumination the exposed algæ were killed, while those in the covered area, illuminated only by diffuse light, were able to grow; the result was a colourless letter on a green ground.

Mr. W. G. Freeman (Royal College of Science) contributed a note on the *Anabaena*-containing roots of some Cycads. The author drew attention to the manner in which the roots occur on various species of Cycads growing in very poor soil in the Royal Botanic Garden, Peradeniya. In most cases a dense coralloid mass of specialised fleshy roots was found encircling the stem; in others—*e.g. Macrozamia Peroffskiana*—normal-looking lateral roots ran horizontally beneath the ground, giving off the special algæ-containing roots at intervals. These primary lateral roots may be apogeotropic for a time, but after bearing the *Anabaena*-containing masses they resume a normal habit and grow downwards.

Mr. E. J. Butler (Queen's College, Cork) communicated a note on a mixed infection in *Abutilon* roots. The roots of seedlings of *Abutilon* hybrids in the plant-houses of Queen's College, Cork, presented tuberoid enlargements due to, at least, two parasites—a Nematode and an Ascomycete. (1) The Nematode is a *Heterodera*, apparently not identical with *H. Schachtii*. All stages of the life-history were worked out by the author. (2) The Ascomycete is a new *Thielavia*, which the author named *T. Hartogii*, differing from *T. basicola* in its more abundant sporidia in each pseudo-sporangium and dark green chlamydospores. (3) A fungus, coexisting with (1) and (2), whose unseptate hyphæ, "cellulose" wall and reproductive bodies recall Peronosporeæ, has been partially studied.

PTERIDOPHYTA.

Prof. Bower read a paper on fern sporangia and spores, in which he gave an account of the results of his recent investigations described at a meeting of the Royal Society on April 20 (*Proc. Roy. Soc.*, vol. lxv. p. 96, 1899). Prof. Bower suggested the following classification of the ferns based on (1) the relative time of appearance of sporangia of the same sorus, (2) certain details of structure of the sporangium and its stalk, (3) the orientation of the sporangia relating to the whole sorus, (4) the potential productiveness of the sporangium as estimated by its spore-mother cells, and the actual spore-output.

Simplices	Marattiaceæ	Eusporangiatæ.
	Osmundaceæ	Leptosporangiatæ.
	Schizæaceæ	
	Gleicheniaceæ	
	Matonineæ	
Gradatæ	Loxsomaceæ	
	Hymenophyllaceæ	
	Cyatheaceæ	
	Dicksonieæ	
	Dennstædtineæ	
Mixtæ ...	The bulk of the Polypodiaceæ	

Mr. L. A. Boodle (Jodrell Laboratory, Royal Gardens, Kew) gave an account, illustrated by numerous microphotographs, of his researches into the stem-structure in *Schizaeaceae*, *Gleicheniaceae*, and *Hymenophyllaceae*.

There is a wide difference between the types of stem-structure shown by the different members of the *Schizaeaceae*. *Lygodium* has a stele in which the xylem forms a central solid mass and is surrounded by a continuous ring of phloem, pericycle and endodermis. *Aneimia Phyllitidis* has a ring of separate bundles (or steles); *Mohria* resembles *Aneimia Phyllitidis* in type. Certain species of *Aneimia*, *e.g. A. mexicana*, have in the internodes a complete ring of xylem bounded on the inner and outer side by a ring of phloem, pericycle and endodermis, with a central pith. *Schizaea* has a ring of xylem surrounding a central pith, but no internal phloem or endodermis.

The above four genera, which make up the *Schizaeaceae*, agree in having a stem protoxylem, which is not well marked. *Lygodium*, *Aneimia*, and *Mohria* are exarch; in *Schizaea*, however, the relative position of the protoxylem has not been made out with certainty.

The *Aneimia* type (which corresponds with that of a mature *Polypodium*) may be regarded as the more specialised type among the *Schizaeaceae*, and *Lygodium* (which corresponds in structure with the base of the stem of *Polypodium*) as the more primitive type.

The *Gleicheniaceae* and *Hymenophyllaceae* also include forms with a solid central mass of xylem, but differing in some details from *Lygodium*. *Gleichenia* is mesarch and closely resembles the fossil genus *Heterangium*. In the *Gleicheniaceae* the only advance on the *Lygodium* type is found in *Platyzoma*, in which there is a ring of xylem surrounding a central pith, as in *Schizaea*, but differing from the latter plant in having an inner endodermis.

In the larger species of *Trichomanes* there is a solid xylem-mass, but with a group of parenchyma in connection with the one or two more or less centrally placed protoxylems. In *Hymenophyllum* the corresponding parenchymatous mass is large in proportion to the amount of xylem. In the smallest species of *Trichomanes* the stele of the rhizome takes the form of a collateral bundle. The protoxylem of *Trichomanes spicatum*, unlike the other species examined, resembles that of the *Schizaeaceae*.

The solid stele may be regarded as primitive, the *Aneimia* type being derived from it by the following steps:—

(1) Solid central xylem-mass surrounded by phloem, &c.

(2) Ring of xylem surrounding a central pith.

(3) Ring of xylem with internal phloem, endodermis, and pith.

(4) Ring of separate bundles formed by the breaking up of the above vascular ring, owing to large leaf-gaps.

PHYSIOLOGY.

Sir William Thiselton-Dyer described some experiments of far-reaching importance, made by Prof. Dewar, on the influence of the temperature of liquid hydrogen on the germinative power of seeds. The most important was one in which five kinds of seeds, varying in size and composition, were immersed for six hours in liquid hydrogen. The temperature to which they were cooled was $-453°$ F. below melting ice. They were subsequently sown at Kew, and germinated readily without exception (*vide Proc. Roy. Soc.*, vol. lxv. p. 361, 1899).

The bearing of the experiment on the accepted conception of protoplasm gave rise to some discussion. Protoplasm is conceived to consist of physiological molecules, the properties of which cannot be explained with our present knowledge of either physics or chemistry. They are in a state of constant kinetic energy based upon equally continual metabolic change. But if it is admitted that the latter is impossible at very low temperatures, the former must cease and the evidence of life disappears. The physiological molecule becomes purely static; its energy is wholly potential, and in fact it becomes, as Prof. Casimir De Candolle has pointed out, analogous to an explosive.

Mr. Francis Darwin described some exceedingly interesting investigations on the localisation of the irritability in geotropic organs. The seedlings of *Setaria*, *Sorghum* and some other grasses are remarkable for possessing a hypotcotyl or stalk-like part intercalated between the grain and the cotyledon. Rothert has shown that while the hypocotyl is the motor apparatus, the sensitiveness to light resides in the cotyledon, which transmits a stimulus to the hypocotyl, and this results in curvature. The author showed that the cotyledon is also a sense-organ for gravitation, the stimulus which leads to geotropic curvature being in like manner transmitted to the hypocotyl. If a seedling of *Sorghum* or *Setaria* is fixed by its grain to a support so that the hypocotyl is horizontal, it bends upwards apogeotropically till the cotyledon is vertical; it then ceases to be geotropically stimulated, and no longer transmits an influence to the region of curvature. But if the conditions are reversed, if the seedling is supported by its cotyledon (which is fixed in a horizontal position) while the hypocotyl projects freely, the result is otherwise. The hypocotyl begins to curve upwards just as in the first experiment, but it does not cease to curve when the free end points vertically upwards; the curvature continues indefinitely, so that the hypocotyl curls into a spiral of three or four rings. This can only be explained by the assumption that the geotropic sensitiveness resides in the cotyledon, and that since the cotyledon remains horizontal it continues to be stimulated and transmits a continuous influence to the motor part of the seedling.

On Saturday morning some of the members of the Botanical Section took part in a joint discussion with the Chemical Section on symbiosis. Prof. Marshall Ward introduced the subject by an able account of the meaning and significance of symbiosis, as illustrated by numerous instances of symbiosis and symbiotic fermentations afforded by various vegetable organisms. After describing particular cases of symbiosis, more particularly of symbiotic fermentations, Prof. Ward dealt with the physiology of symbiosis.

Mr. J. Parkin (Cambridge) communicated some isolated observations bearing on the function of latex.

The author has lately returned from a year's sojourn in Ceylon, where he has been acting as scientific assistant to Mr. Willis, the Director of the Royal Botanic Gardens. During his time there he has been principally engaged in investigations on caoutchouc-yielding trees, chiefly *Hevea brasiliensis* (Para Rubber) and *Castilloa elastica*, var. (a Central American rubber-tree). The results of this research are contained in a recently-published circular of the Royal Botanic Gardens, Ceylon, entitled "Caoutchouc or India-rubber," intended primarily for those interested in rubber cultivation.

The author drew attention to some of the observations and experiments recorded in the circular, which, besides their practical value, have a general botanical interest; he also recorded other observations which may throw light on the functions of laticiferous tissue.

The points treated of in the paper were grouped under six sections:—

Section I. dealt with the coagulation of the latex of *Hevea*.

Section II. contained observations and remarks relating to the carbohydrates of latex.

In Section III. reasons were given for thinking that in some caoutchouc trees the latex of the young stems and leaves differs in composition from that of the trunk and main branches. While the latter yield rubber free of stickiness, the former give a somewhat viscous substance with feeble elasticity. Such is the case with *Hevea*, *Castilloa*, *Landolphia Kirkii*, &c.

Section IV. treats of an important fact connected with the tapping of *Hevea* trees—namely, that wounding the bark causes a greater flow of latex from subsequent injuries.

In Section V. a peculiarity in the exudation of latex from the severed base of the petiole of *Hevea brasiliensis* and *Plumiera acutifolia* was described and discussed.

And in Section VI. a special laticiferous system in the immature seed of *Hevea brasiliensis* was described.

The paper concluded with general remarks and suggestions on the origin and functions of laticiferous tissue.

Mr. R. H. Biffen (Cambridge) contributed some notes on india-rubber. Caoutchouc is a constituent of the latex of many plants belonging chiefly to the Euphorbiaceæ, Apocynaceæ and Urticaceæ, that is, of plants characterised by the possession of laticiferous cells as distinct from vessels. Caoutchouc occurs as small particles in latex; if a reagent is added which will cause coagulation, the particles run together in strings and form a moss-like mass of rubber with the watery portions of the latex entangled within it. Two physical processes are now being used. (1) The latex, mixed with water, is strained and churned; the thick cream which rises to the surface is pressed through rollers and converted into rubber. (2) The author's process consists in separating the rubber with a centrifugal apparatus. Details are given in the paper regarding the chemical properties of the different kinds of rubber obtained from *Hevea*, *Castilloa*, *Manihot*, *Ficus*, *Hancornia*, *Kickxia*, *Artocarpus* and *Clusia*. The author also raises some questions of theoretical interest with regard to possible relations between caoutchouc, starch and resin-bodies, and indicates lines for further inquiry.

Flowering Plants, &c.

Mr. J. C. Willis, of Peradeniya, Ceylon, read a paper of exceptional merit, illustrated by numerous lantern slides, on the morphology and life-history of the Indo-Ceylonese Podostemaceæ.

The paper read was an abstract of a forthcoming monograph of the Indian and Ceylon species of this very remarkable order of water plants, in which the various species will be described in detail both morphologically and ecologically. A few typical species were described and their life-history explained, showing the extraordinary modifications which the vegetative system has undergone to suit the needs of life in rising and falling water and in rapid currents. The vegetative organs consist largely of modified roots forming thallus-like bodies, and bearing leafy or floral endogenous shoots, and branching themselves in an exo- or endo-genous manner. The conclusion was drawn that the endo- or exo-genous origin of an organ or a branch is a phenomenon of an adaptive nature in these plants, and to a large extent in others also. The adaptive modifications of the structure, such as the gradual reduction, through a series of forms, of the shoots and leaves, the increased multiplication of the shoots by vegetative budding, the reduction of the number of flowers per shoot, and the change to anemophily, the increased dorsiventrality and other characters, were shown to be rather correlated with the rise and fall of the water than with the velocity of the stream. In conclusion, some of the more general questions of morphology were discussed in the light of the observations made on these plants.

Prof. Douglas Campbell (California) gave a short account of work in progress on the development of the flowers and embryos of various species of Araceæ.

The materials for the author's investigations were collected mostly in Jamaica, and include species of *Dieffenbachia*, *Aglaonema*, *Philodendron* and *Anthurium*. A study was also made of *Lysichiton* of Pacific North America.

A study of the development of the ovule indicates that the primitive form is axial, as in other low monocotyledons; the early development of the embryo-sac follows the ordinary type. Later there is a multiplication of the antipodal cells, and the sac becomes filled with endosperm at an early stage. The ovule is often massive, and there is a marked development of mucilage-secreting hairs upon the funiculus and the base of the nucellus. In all forms so far examined the embryo is destitute of a suspensor, and the cotyledon is very large, sometimes suggesting the scutellum of the grass-embryo.

The forms with a single carpel are probably most primitive and most nearly related to the other low monocotyledons.

Mr. G. Dowker gave a description of the sand dunes between Deal and Sandwich, with remarks on the flora of the district.

The author in this paper gave an account of the formation of the dunes and mud-banks, claiming for them the reclamation of the large tract of sand from the sea, mostly since the Roman occupation of Britain. He referred to the Acts of Parliament passed prohibiting the destruction of the mat grass, which contributed so largely to the preservation of the hills, and lamented that nothing was done to prevent the wholesale gathering of Sea holly by men who ruthlessly destroyed it by taking it away to sell. He recounted his long experience and knowledge of the district, dating back to his schoolboy days with the Rev. J. Layton, a distinguished botanist of Sandwich. He particularised the following rare or characteristic plants as denizens of the hills: *Allium vineale*, *A. compactum*, *Poa bulbosa*, *Hippophae rhamnoides*, *Silene conica*, *Orobanche caryophyllacea*, *Lepidium latifolium*, and on the salt marshes, *Atriplex pedunculata*, *Frankenia levis*, *Aster Tripolium*, and *Polypogon monspeliensis*. The author added a list of over 300 species of flowering plants to be met with in the district.

Miss Dale (Cambridge) presented a paper on intumescences of *Hibiscus vitifolius*.

The plants on which the observations were made were grown, directly or indirectly, from seed from Somaliland. The intumescences, which vary in size and shape, occur on the leaves, stems, green parts of the flower, and on the young fruit. Some are entirely colourless; others are green at the base. On the leaf the intumescences are either purely epidermal or partly subepidermal; and on the stem the outgrowths are more complex and usually larger.

A number of seedlings were planted in separate pots, and allowed to grow under identical conditions. They all developed intumescences, and were all very much alike. When each had about nine or ten leaves, and was beginning to flower, the plants were placed under different conditions, and examined at the end of six weeks.

The experimental evidence points to the conclusion that the intumescences are pathological, and are due neither to insects nor to fungi, but to the direct effects of environment. The formation of outgrowths appears to be caused by excessive moisture combined with a high temperature. If the temperature is low the plants do not appear to have strength to form them. The production of outgrowths seems to be a response on the part of the plant to insufficient transpiration.

Fossil Plants, &c.

Prof. Bertrand (Lille) described the structure of a stem of a ribbed *Sigillaria*. The specimens of *Sigillaria* hitherto described anatomically are species with a smooth bark, but no account has so far been published of the structure of an undoubted *Sigillaria* belonging to the *Rhytidolepis* section. The species described by Prof. Bertrand exhibits external characters recalling those of *Sigillaria elongata*. The primary wood, which forms a continuous ring, agrees with that of the stems previously described as *Diploxylon*; it is enclosed externally by a zone of secondary wood. The primary xylem is characterised by the prominent ridges or points on its external face, the projecting points corresponding with the grooves on the surface of the stem. In the immediate neighbourhood of the origin of a leaf-trace, the small tracheal elements form a median band in the middle of a sinus on the face of the corona. Each leaf-trace passes outwards through a medullary ray of the secondary wood; it consists solely of primary elements. The author compared his specimen with *Sigillaria spinulosa* and with *Diploxylon* stems from Halifax, Oldham and Burntisland. The central cylinder of the ribbed *Sigillaria* differs from that of a Phanerogam in the manner of origin of the leaf-traces, and in the structure and centripetal development of the primary wood.

Prof. F. E. Weiss (Manchester) communicated a paper on a biserial *Halonia* belonging to the genus *Lepidophloios*.

At the Bristol meeting of the British Association, Dr. D. H. Scott exhibited photographs of this *Halonia* from the Hough Hill Colliery, Stalybridge, and pointed out the agreement of its structure with that of *Lepidodendron fuliginosum* of Williamson. Dr. Scott had generously allowed the author to undertake the further examination of the specimen, and this confirmed the identity of the internal structure of the *Halonia* with that of Williamson's *Lepidodendron fuliginosum*.

The same structure is shown also by stems of the ordinary multiseriate Halonias, which, as Kidston and Potonié have shown, belong undoubtedly to the genus *Lepidophloios*. Stems, therefore, showing the structure of *Lepidodendron fuliginosum*, Williamson, should be referred to the genus *Lepidophloios*.

The fruiting branches of this genus, however, termed *Halonia*, or halonial branches, have usually a number of rows of spirally arranged tubercles. The Hough Hill *Halonia* has only two rows of tubercles; hence it would by some palæobotanists be classed as Ulodendroid, but it seems better to call it a "biserial *Halonia*," since the name of Halonia has been reserved by Kidston and others for the fruiting branches of *Lepidophloios*, and also because its elevated tubercles distinguish it from the usually depressed Ulodendroid scars.

The author described two specimens of biserial Halonias showing on the surface *Lepidophloios* leaf-scars, in support of the view that the Hough Hill specimen may be regarded as a fruiting branch of *Lepidophloios*.

Mr. A. C. Seward showed some microphotographs, and gave a brief account of a new genus of Palæozoic plants.

The description of this genus, which represents a new type of Cycadofilices, was founded on a single specimen in the Binney Collection of Coal-measure Plants. The specimen consists of a small piece of stem, unfortunately without the cortical tissues, with the structure of the primary and secondary wood very clearly preserved. A strand of primary xylem, 1·9 cm. in diameter, occupies the axial region; this consists of large iso-diametric or slightly elongated tracheids with multiseriate bordered pits, associated with parenchymatous tissue; the narrow protoxylem elements occur at the margin of the primary stele, which is, therefore, of exarch structure. Surrounding the primary stele there is a broad cylinder of secondary wood exhibiting anatomical features characteristic of Cycadean stems. Leaf-traces, consisting of long tracheids intermixed with parenchyma, are given off from the periphery of the primary strand.

The features of most interest in the anatomy of this stem are (1) the manner of origin and behaviour of the leaf-traces; (2) the exarch structure of the primary xylem; and (3) the structure of the large primary tracheids. The author placed the genus among the Cycadofilices, and compared it with *Heterangium* and other Palæozoic genera, also with *Lygodium* and other recent plants.

Mr. A. C. Seward also gave a *résumé* of his recent work on the Jurassic flora of Britain. The Lower Oolite rocks exposed in the cliff-section between Whitby and a few miles south of Scarborough have long been famous as affording rich collections of fossil plants, which enable us to form a fairly accurate idea of the chief characteristics of the Jurassic flora. Plants from the Yorkshire coast are abundantly represented in most of the English museums as well as in continental collections. The Ferns and Cycadean genera constituted a large proportion of the vegetation, with an abundance of one or two species of *Equisetites* and a few conifers; no trace of undoubted Angiosperms has so far been discovered. The account of the flora includes a description of the more important types, a general comparison of the English species with recent plants, and remarks on the characteristics and distribution of the Lower Oolite floras.

The same author, in conjunction with Miss J. Gowan, gave an account of the morphology and geological history of the maiden-hair tree (*Ginkgo biloba*). The chief points dealt with in the paper may be summarised as follows:—

(1) *Ginkgo bilboa.*—The history of our knowledge of *Ginkgo;* its external features and peculiarities; the variability in form and structure of the leaves; the structure and morphology of the male and female flowers; pollination and fertilisation of the ovule; the development and structure of the embryo; the anatomy of the seedling and adult plant; comparison of *Ginkgo* with other genera, and its place in the plant-kingdom.

(2) *Fossil Ginkgoaceae.*—A general consideration of the evidence available towards an account of the past history of *Ginkgo* and closely allied plants; a comparison of *Ginkgo* with various fossil types from Palæozoic, Mesozoic and Tertiary horizons; the geographical distribution of *Ginkgo* during the Mesozoic and Tertiary epochs.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The following is the speech delivered on November 9 by the Public Orator, Dr. Sandys, in presenting Prof. Somerville for the complete degree of Master of Arts *honoris causa*.

Agri culturae professorem nostrum primum, auspiciis optimis nuper electum, Universitatis totius nomine libenter salutamus. Salutamus virum, primum per sex annos rei rusticae experientia probatum, deinde per quinquennium scientiae studiis et domi et peregre excultum; virum non modo nomismate non uno honorifice donatum, sed etiam doctoris titulo inter Monacenses summa cum laude ornatum; virum denique et Societati Regiae Edinensi et Societati Linnaeanae Londinensi in perpetuum adscriptum. Olim inter Edinenses primus rei silvestris praeceptor, deinde in Universitate Dunelmensi agri culturae professor primus constitutus, nuper eodem cum titulo e Boreali Britanniae regione ad nos feliciter devectus est. Viri talis auxilio rei rusticae scientia, olim ab ipso Tullio senectutis inter voluptates numerata nunc demum etiam iuventutis nostrae inter studia locum diu sibi debitum sine dubio vindicabit.

Duco ad vos WILLELMUM SOMERVILLE.

Mr. Shelford Bidwell, F.R.S., has been approved for the degree of Doctor of Science.

An Isaac Newton Student in Astronomy and Physical Optics will be elected next term. The studentship is worth 200*l.* a year for three years. Candidates must be Bachelors of Arts who are under the age of twenty-five. Applications are to be sent to the Vice-Chancellor between January 16 and 26, 1900.

Prof. Somerville will give an inaugural lecture on "Some aspects of the bearings of Science and Education on Practical Agriculture" on Friday, November 24, at noon, in the Chemical Theatre.

A report proposing a new scheme for the Mathematical Tripos has been issued to the Senate. Among other changes, it suggests the abolition of the time-honoured "order of merit" in the Tripos list.

BY the will of the late Mr. Cornelius Vanderbilt, of New York, Yale University receives 100,000 dollars, and Vanderbilt University 50,000 dollars.

SIR MICHAEL HICKS BEACH, Chancellor of the Exchequer, spoke on the subject of commercial education at the Mansion House on Friday last. In the course of his remarks he referred to the University of London, and said that the reorganisation offered an opportunity to a "pious founder" to graft upon the University a faculty of commerce in which the study of all subjects belonging to commercial education shall be encouraged. He pointed out that there is no part of the world in which there are greater chances at the present time of pushing our trade and commerce than in the empire of China, and yet there is no civilised part of the world the language and history and customs of which are so absolutely unknown to the vast majority of our people. If it were possible to expend a comparatively small sum in extending a knowledge of these things in connection with a faculty of commerce in the University, more might be done to promote British trade and commerce in China than will ever be done by extracting concessions from the Government of China, many of which, the speaker added, will confer benefit upon nobody except the promoters who try to float them into companies.

THE ninth annual report of the Technical Instruction Committee of the City of Manchester shows that steady progress was made during the year ending last month. The large scale of the operations of the committee may be judged by the fact that the payments made in connection with the Municipal Technical School amounted to 16,796*l.* The expenditure on capital account to meet various charges in respect of the new building was 26,531*l.*, making a total sum of 97,061*l.* expended for this purpose up to last March. The receipts from the Exchequer Contribution Account (Customs and Excise) were 15,567*l.* and the amount raised from the rates was 7585*l.* The new estimates provide a sum of 33,000*l.* for building purposes during the current year in connection with the technical school in course of construction. The total sum now borrowed upon capital account for providing technical schools in Manchester is 140,000*l.* When the new municipal technical school is completed, Manchester will possess one of the finest buildings in the country for carrying on the work of technical education. For the equipment of the building alone a loan of 59,025*l.* has been sanctioned by the Local Government Board. Referring to the subject of secondary education, the committee remark:—"The enactment during the past session of Parliament of a measure establishing a Board of Education cannot but be satisfactory, however much it may fall short of finality, to all those who are sincerely interested in the advance on sound lines of secondary and technical education, since it creates for the first time a real and responsible Minister of Education, and unifies the various branches of education—elementary, secondary and technical—under one controlling authority. It will unquestionably promote the efficient working of the technical schools by the measures which it will take to place the secondary education of the country, now so lamentably deficient, upon a sound and satisfactory basis, without which no technical education worthy of the name can be carried on."

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, November 10.—Ordinary meeting held in the Physical Laboratory of the Central Technical College (by invitation of Prof. Ayrton).—Prof. Lodge, F.R.S., President, in the chair.—Mr. F. S. Spiers read a paper on contact electricity. The object of the paper was to determine, in a more satisfactory manner than has hitherto been attempted, the part played by the medium in the potential difference which arises when two dissimilar metals are put in contact. The first experiments were made with a piece of apparatus used by Profs. Ayrton and Perry about twenty years ago. This apparatus, in which the metals in contact are capable of a rotation of 180° about a vertical axis, and are placed between two vertical inductors connected to a quadrant electrometer, was afterwards considerably improved, and the compensation arrangement of Lord Kelvin was introduced so as to measure the potential differences by a null method. The metals first used were platinum and zinc, but on account of the low melting point of the latter metal it was replaced by aluminium. In order to try and remove the air sheets which cling to the surfaces of the metals, the tube was repeatedly heated and exhausted. The potential difference between the plates was found to gradually fall as this was done. It was proved that this was due to the oxidation of the aluminium, for on cleaning its surface the original effect was again obtained. Attempts were then made to remove the oxygen by displacing it with hydrogen; but after four washings with pure dry gas and at low pressures there was still enough oxygen left to completely oxidise the aluminium. The oxide of aluminium is not decomposed by hydrogen at a bright red heat. It was therefore decided to substitute iron and burn out the oxygen with hydrogen by encasing the lower part of the apparatus in a copper tube, and heating to bright redness with a blowpipe flame. By this means the value of the Volta effect between iron and platinum in an atmosphere of hydrogen was found to be 0·6 of a volt, the platinum being positive to the iron. This result is different both in magnitude and sign to that obtained when air is the medium. The Chairman said he had given the subject of contact electricity some attention during the last fifteen years, and the author had performed a valuable series of experiments which he should have liked to have seen done several years ago. He had always felt that a vacuum would never get rid of the condensed air films. The burning-out process used had provided the most trustworthy results upon the subject. Dr. Lehfeldt pointed out that the action of hydrogen upon ferric oxide was a limited one, and that it was impossible to bring about complete deoxidisation in that manner. At a dull red heat the ratio between the water vapour and oxygen present is about 20 to 1. Prof. Perry expressed his interest in the experiments, but said that they had not affected his opinion upon the nature of the Volta effect. Prof. Armstrong said he was not wholly satisfied with the results, although a substantial approach to a solution had been made. The author had fully realised the difficulties of the experiments, but he had treated the matter as a surface gas effect, and had not guarded against moisture. Gases must be both dirty and moist before chemical action can take place, and we cannot expect to arrive at a solution of the problem until we have removed not only oxygen but dirt and moisture. It is impossible to completely exhaust the apparatus, and a number of molecules must always be left which is more than necessary to produce the Volta effect. Moisture can never be got rid of by exhaustion. The method of Dewar of using liquid oxygen or liquid hydrogen would get rid of gases and water vapour, and in this manner it would be possible to perform experiments which could be regarded as final. If the effect disappeared at low temperatures it might be urged that the temperature was too low for it to be produced. The author must have been dealing with combination effects, for it had been proved that hydrogen alloyed both with platinum and iron at a dull red heat. Mr. Cooper said he would like to see the experiments repeated after precautions had been taken to remove nitrogen from the apparatus. Prof. S. P. Thompson said he had recently taken part in a discussion upon the subject with some earnest followers of the old contact theory. They uphold that the property of metals which determines the potential difference when two are put in contact is as fixed and definite as other physical properties, such as density, and that the potential difference observed in air is approximately the same as the true potential difference. It has been agreed to call the former the apparent potential difference. Prof. Thompson said that according to Pellat the real Volta effect was near to the effect observed in air. In circuits formed of metals there are other electromotive forces of the order of a millionth of a volt. The chemical electromotive forces in a circuit are of the order of a volt. The value of the Volta effect derived from thermodynamical considerations concerning the Peltier effect is much smaller than observed chemical potential differences. If, however, we take into account not only the Peltier effect but also the Thomson effect, we will have other terms entering into the equations which may tend to give a value more nearly equal to a volt. Prof. Thompson said that in observing chemical E.M.F.s the Peltier effects did not come into the question because of their smallness compared with the value of the chemical effect. Prof. Perry pointed out that the Peltier effect was not distinct from the Volta effect, but was simply the differential coefficient of it. The Chairman said that if a circuit containing Peltier effects were treated thermodynamically as if it were a reversible heat engine, we could arrive at an equation connecting the value of the Peltier effects with the rate of change of the whole electromotive force in the circuit with temperature. The electromotive force which changed was not necessarily the Volta effect. Prof. Perry said he thought it was. Prof. Ayrton suggested that an advance might be made in the theoretical side of the question if the Chairman were to put in writing his objections to the statement that the E.M.F. concerned was the true Volta effect. The extent of the Peltier effect proves the variation of the Volta effect with temperature; but because it is small it does not necessarily follow that the Volta effect is small. Where the Volta effect is a maximum or a minimum the Peltier effect vanishes. The experimental work of the paper did not go far enough to convince him of the nature of contact electricity. Before we can hope to prove anything with respect to the two theories, we must be able to get a cyclic change of events; that is to say, we must be able to change our surfaces and media in a perfectly definite manner so as to be able at any time to return to the particular state from which we started. Prof. Everett said that as the variation in the potential difference between two metals in a medium was probably due to slow chemical action which caused the metals to become less and less susceptible, he should expect that changing backwards and forwards from one medium to another would give to the potential difference an oscillatory variation gradually becoming smaller and smaller. The Chairman said he would like to see experiments showing a cyclic effect similar to that mentioned by Prof. Ayrton. The difficulty in these experiments is to avoid chemical action. Chemical action is not necessary to get the Volta effect. The effect would be greatest in dry gas. Moisture tends to reduce the effect, and that is why its presence is unimportant. Prof. Callendar expressed his interest in the surface character of the effect and its independence of the manner in which the plates were touched. Dr. Stansfield suggested gold as a suitable metal to be experimented on because of its non-oxidisability. Mr. Spiers, in replying, referred to Dr. Lehfeldt's assertion that the whole of the oxygen cannot be removed by hydrogen. In his experiments, however, there was very little ferric oxide and a large quantity of hydrogen, and although it was possible that all the oxide was not reduced, still a large portion of it was. The experiments were to be carried on, and attempts would be made to get a cyclic effect.—A paper on the heat of formation of alloys was postponed until the next meeting.

MANCHESTER.

Literary and Philosophical Society, October 31.—Prof. Horace Lamb, F.R.S., President, in the chair.—Dr. Broadbent introduced the subject of the well at Giggleswick, known for the ebb and flow of its water, and asked whether an explanation of what is known locally as the "silver thread" could be offered by any member. The well consists of a stone cistern, at the top and back of which the water enters from the Giggleswick Scars, there being two small outlets about half-way down each side of the tank and opposite each other. Under certain conditions there appears extending through the water, from one outlet to the other, a thread apparently formed of air. Prof. O. Reynolds suggested that the phenomenon might be explained by the inflow producing a circulation of the water having its vortex parallel between the two outlets, the reduction of pressure thus permitting a passage of air from one orifice to the other.—Mr. J. Cosmo Melvill communicated a paper by Mr. Peter

Cameron, entitled "Hymenoptera Orientalia; or, contributions to a knowledge of the Hymenoptera of the Oriental zoological region. Part ix. The Hymenoptera of the Khasia Hills. Second paper."—A paper "On the question of Irish influence on early Icelandic literature, as illustrated by the Irish MSS. in the Bodleian Library," was read by Miss Winifred Faraday (communicated by Mr. F. J. Faraday).

PARIS.

Academy of Sciences, November 6.—M. van Tieghem in the chair.—Researches on the diamines: piperazine, by M. Berthelot. The heats of solution of anhydrous diethylenediamine and its hydrate are given; and also the heats of combustion and formation, and of neutralisation with hydrochloric acid.—On some characters of the diamines deduced from their neutralisation, by M. Berthelot.—Preparation and estimation of glycogen, by M. Armand Gautier. The author had observed that when a slight excess of mercuric acetate is added to an animal or vegetable extract, dilute potassium carbonate solution being added at the same time to keep the liquid neutral, the nitrogenous bodies are nearly wholly precipitated. Liver or muscle is treated with boiling water, and the liquid pressed out on cloth. The neutralised liquid is concentrated by rapid boiling to half its bulk. The exact quantity of mercury solution is then added, the precipitate separated by a centrifugal machine. The clear liquid is acidified with acetic acid and poured into alcohol, when crude glycogen is precipitated. The method is a quantitative one, 1000 grams of fresh human liver giving 20·5 grams of glycogen, and of rabbit's liver 14·0 grams. Glycogen is apparently dissolved by water, but filtration through porcelain shows that the glycogen is not really dissolved, as the whole of the sugar is found on the outside of the filter, pure water only passing through. Its copper reducing power is slightly less than that of anhydrous glucose (97·8 : 100).—On the theory of the hydraulic brake in guns, by M. Vallier.—On the mass of the cubic decimetre of water, by MM. Ch. Fabry, J. Macé de Lepinay and A. Pérot. The authors have shown in previous papers how to measure the dimensions of a quartz cube in terms of a wave-length of light as a unit of length, and now give a method for obtaining, by a photograph of the fringes, the exact deviations of opposite faces from parallelism. These curves, together with the absolute thickness at one point, give the mean thickness corresponding to the pair of faces considered. The results of measurement of the mass of water at 4° C. displaced by this cube show that the mass of 1000 c.c. at 4° is 21·4 mgr. less than 1 kilogram, showing a remarkable agreement with an unpublished result of M. Chappuis (1 kgr. − 24 mgr.) obtained by a different method.—Microphonic registration of the beat of chronometers, by M. Alphonse Berget. The apparatus described, consisting of a small Hughes microphone working a relay, gave clear curves very easily read. The method has the advantage of suppressing the personal error in reading the chronometer, and also renders it possible to apply the method of coincidences with great accuracy to the comparison of a chronometer and a pendulum. It is also possible in this way to make one chronometer govern several pendulum clocks.—On the radio-activity induced by the Becquerel rays, by M. P. Curie and Mme. M. P. Curie. A disc of an inactive substance, placed immediately over a radio-active substance (polonium or radium), acquires the property of emitting Becquerel rays, and rendering air capable of conducting. The activity so induced increases with the time of exposure to the radium, but tends to a limit. Discs of various substances were tried—zinc, aluminium, brass, lead, platinum, bismuth, nickel, paper, barium carbonate, bismuth sulphide—but the effects produced were all of the same magnitude. Experiments were made showing that these results cannot be explained by the assumption of an actual transference of the radio-active material, either as powder or vapour, but that there really exists an induced radio-activity.—Remarks by M. Becquerel on the preceding paper.—On the spectrum of radium, by M. Eug. Demarçay. As the barium chloride gained in radio-activity new rays appeared in the spectrum, which it would appear reasonable to attribute to the radiating element. In the latest specimens prepared by M. and Mme. Curie, besides the spectra of barium, platinum, lead and calcium, were fifteen new lines, the most marked being one $\lambda = 3814·7$, $4683·0$, and a nebulous band having $\lambda = 4627·4$ as a centre.—Electrical reproduction of Savart's figures, obtained by the aid of liquid layers, by M. P. de Heen.—Transformation of styrolene into metastyrolene under the influence of light, by M. Georges Lemoine. A quantitative study of this isomeric change, including the effect of the thickness of liquid layer, nature of the radiations, temperature.—On molybdenum dioxide, by M. Marcel Guichard. Pure MoO_2 can be prepared in several ways, by the action of molybdic anhydride upon ammonium molybdate, by heating ammonium molybdate alone, or by the electrolysis of fused molybdic anhydride, in all cases the final purification from unchanged molybdic anhydride being effected by washing with 10 per cent. soda solution, which gives much better results than the ammonia solution used by previous workers.—On rhamninose, by MM. Charles and Georges Tanret. Xanthorhamninose, which on hydrolysis gives ultimately rhametine, rhamnose and galactose, by careful treatment with very dilute sulphuric acid gives an intermediate sugar, rhamninose, besides galactose and rhamnose. The ferment rhamnose gives better yields of the new sugar, whose composition is $C_{18}H_{32}O_{14}$, its hydrolysis being represented by the equation

$$C_{18}H_{32}O_{114} + 2H_2O = 2C_6H_{12}O_5(\text{rhamnose}) + C_6H_{12}O_6(\text{galactose}).$$

Rhamninose is lævorotatory, $[\alpha]_D = -41°$, and melts with some decomposition at 140°. Its reducing power is one third that of glucose, and it is not fermentable by yeast. With sodium amalgam it gives rhamninite, $C_{18}H_{34}.O_{14}$, from which dulcite and rhamnose are obtained by hydrolysis. Galactonic and mucic acids are produced on oxidation by nitric acid.—Researches on the progressive development of essence of bergamot, by M. Eugène Charabot.—On a new disease of carnations, by M. Louis Mangin.—On the actual state of the volcanoes of Southern Europe, by M. Matteucci.—On the innervation of the pancreas, by MM. E. Wertheimer and L. Lepage.

AMSTERDAM.

Royal Academy of Sciences, September 30.—Prof. Van de Sande Bakhuyzen in the chair.—Prof. Beyerinck, on the production of indigo from woad (*Isatis tinctoria*). The generally accepted opinion that woad contains the glucoside indican is erroneous. The chromogene, present in all growing parts of this plant, is indoxyl C_8H_7NO in the free state. *Polygonum tinctorium* and *Indigofera leptostachya* on the other hand contain indican, which can be split up into indoxyl and sugar by a peculiar enzyme, present in the species, but absent in the woad, by certain bacteria and yeasts and by boiling with acids. The woad, as an "indoxyl plant," when exposed to the vapour of ammonia in a confined atmosphere, at once produces indigo blue, whereas *Indigofera leptost.* and *Polyg. tinct.* as "indican plants" do not become blue by the action of ammonia, the indigo enzyme being destroyed by it. "Indican plants" can, however, be converted into dead "indoxyl plants" when slowly killed by the exclusion of air, which is best performed by complete submersion in mercury. If then exposed to alkaline vapour and extracted with alcohol, which dissolves the chlorophyll pigment, they become dark blue. Indigo plants do not contain a peculiar oxydase, but produce some alkali when slowly dying in the air.—Prof. Bakhuis Roozeboom communicated the results of an inquiry, made by Dr. W. Reinders, concerning the mixture crystals of HgI_2 with $HgBr_2$. The melted mixtures of these substances solidfy into a continuous series of rhombic mixture crystals. No chemical combination takes place. The temperatures of solidification show a minimum at 59 per cent. Mol. $Hg.Br_2$. Below 127° the mixture crystals change from rhombic yellow ones into tetragonal red ones. Moreover, the transition temperature varies within a transition interval, which has been studied down to 0° partly in the optical way, partly through crystallisation of the mixture crystals out of solutions. With due allowance for the composition of the two kinds of coexisting mixture crystals, the fall of the conversion temperature is in accordance with the laws of diluted solutions. Prof. Bakhuis Roozeboom also presented, on behalf of Dr. Ernst Cohen and Dr. C. van Eyk, a paper entitled "The enantiotropy of tin (II.)."—Prof. Lobry de Bruyn presented, on behalf of Mr. H. Bijl and himself, a paper on isodialdane, a substance analogous with cane sugar. (These communications will be inserted in the *Proceedings*.)—The following were further presented for publication in the *Proceedings*: (*a*) by Prof. Bakhuis Roozeboom, on behalf of Dr. Ernst Cohen, a paper entitled, "On a new kind of transition elements (sixth kind)"; (*b*) by Prof. Kamerlingh Onnes, on methods and apparatus employed in the cryogen laboratory," and (1) on behalf of Mr. Fritz Hasenoehrl, "Die Dielektricitäts constante von verflüssigtem

Stickoxydul und Sauerstoff"; (2) on behalf of Dr. W. van Bemmelen, a paper on spasms in the earth's magnetic force. Dr. Van der Stok, correspondent of the Section, showed some seismograms and magnetograms illustrating Mr. Van Bemmelen's paper. Magnetical curves, obtained by means of a self-registering instrument, exhibit oscillations of the same kind as those observed on photographic lines produced by seismographs of various patterns, which oscillations are known as earthquake motions, pulsations and tremors. Seismographs have been in actual use for a few years only, while magnetical curves have been known for a period of about twenty years; the latter may, therefore, be considered more sufficient data for an investigation into these oscillations by statistical methods than the former. Dr. Van Bemmelen has investigated those movements of short duration, which he calls "spasms," and also the oscillations of a well-defined zigzaggy description and longer duration, viz. pulsations. In both phenomena the author has found well-marked diurnal and annual variations, but no connection between their frequency and cosmical causes can be traced. Dr. Van Bemmelen has also tried to investigate these movements by means of a very sensitive bifilar, which inquiry takes a great deal of time and trouble, because it is not possible to make this instrument self-registering, owing to the enlarged time scale and the lack of sensitiveness of the photographic paper. This inquiry by ocular observation has hitherto not yielded any definite results.—(*c*) By Prof Hubrecht, on behalf of Dr. J. F. van Bemmelen, a paper entitled "Results of a comparative inquiry into the palatine orbital and the temporal region of the skull of the monotremata."—(*d*) By Prof. V. A. Julius, on behalf of Dr. A. Smits, a paper entitled "On decreases in the tension of solution vapours at 0°." The previous experiments with the micromanometer on solutions of NaCl, KOH and sugar were repeated, and it was again found that the molecular decrease of vapour tension increased with the concentration. The inquiry was then extended to H_2SO_4, $CuSO_4$ and KNO_3. In the case of H_2SO_4 and $CuSO_4$ the molecular decrease of vapour tension increased with the concentration; while, on the contrary, in the case of KNO_3 the decrease of vapour tension became smaller on the concentration becoming greater.—(*e*) By Prof. Cardinaal, on behalf of Mr. K. Bes, a communication concerning the formation of the ultimate equation.—(*f*) By Prof. Zaayer, on behalf of Prof. W. Einthoven, a paper on the theory of the capillary electrometer. The mechanical friction in the capillary tube and the resistance of the circuit influence both time relations of the capillary electrometer. The amount of either of these influences has been measured. The experiments show that in many capillary electrometers the influence of the resistance of the circuit is far surpassed by that of the mechanical friction. Hermann's theory of the capillary electrometer is rejected.—(*g*) By Prof. Van der Waals, on behalf of Mr. E. H. J. Cunaeus, a paper entitled "Refractivity determination as a method of inquiry into the composition of the coexisting phases in the case of mixtures of acetone and ether." The inquiry comprises, besides the determination, by Lord Rayleigh's method, of the refractivity of some mixtures of H_2 and CO_2, also the determination of the refractivity of the vapour above various mixtures of acetone and ether, in order to derive therefrom the composition of the coexisting liquid and vapour phases with the appertaining pressure.—Prof. Haga showed a negative, obtained by means of Uran-rays, yielded by the "A" preparation from de Haën's manufactory (*Wied. Ann.*, August 1899).

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 16.

ROYAL SOCIETY, at 4.30.—Note on the E.M.F. of the Organ Shock, and on the Electrical Resistance of the Organ in *Malapterurus electricus*: Prof. F. Gotch, F.R.S., and G. J. Burch.—On the Formation of the Pelvic Plexus, with especial reference to the Nervus Collector in the Genus Mustelus: R. C. Punnett.—On the Least Potential Difference required to produce Discharge through various Gases: Hon. R. J. Strutt.—Mathematical Contributions to the Theory of Evolution. VII. On certain Formulæ in the Theory of Correlation, and their Application to the Inheritance of Characters not capable of Quantitative Measurement: Prof. Karl Pearson, F.R.S.—On the Propagation of Earthquake Motion to Great Distances: R. D. Oldham.—An Experimental Research on some Standards of Light: J. E. Petavel.

LINNEAN SOCIETY, at 8.—The Comparative Anatomy of certain Species of *Encephalartos*, a Genus of the *Cycadaceae*: W. C. Worsdell.—On a Collection of *Brachyura* from Torres Straits: W. T. Calman.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.

CHEMICAL SOCIETY, at 8.—The Chlorine Derivatives of Pyridine. Part IV. Constitution of the Tetrachloropyridines: W. J. Sell and F. W. Dootson.—Contributions to our Knowledge of the Aconite Alkaloids. Part IV. On Japaconite and the Alkaloids of Japanese Aconite: Wyndham R. Dunstan, F.R.S., and H. M. Read.—On the Determination of Transition Temperatures: H. M. Dawson and P. Williams.

FRIDAY, NOVEMBER 17.

ANATOMICAL SOCIETY, at 4.—A Persistent Left Inferior Vena Cava: Stanley Boyd.—Specimen of Sacculated Œsophagus: Miss Stoney.—Child's Skull, showing Parietal Perforations: Prof. A. M. Paterson.—Note on the Morphology of the Biceps Flexor Cruris: Prof. B. C. Windle, F.R.S., and F. G. Parsons.—Lantern Demonstration of certain Points in the Lymphatic System of the Appendix: C. B. Lockwood.

EPIDEMIOLOGICAL SOCIETY, at 8.30.—Presidential Address on the Comparative Mortality of English Districts: Dr. Franklin Parsons.

MONDAY, NOVEMBER 20.

SOCIETY OF ARTS, at 8.—Enamelling upon Metals: H. H. Cunynghame.

TUESDAY, NOVEMBER 21.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Papers to be further discussed*: The Waterloo and City Railway: H. H. Dalrymple-Hay.—The Electrical Equipment of the Waterloo and City Railway: Bernard M. Jenkin.

ANTHROPOLOGICAL INSTITUTE, at 8.30.—The Nature of the Arab Jinn illustrated by the Present Beliefs of the People of Marocco: Dr. E. Westermarck.

ROYAL STATISTICAL SOCIETY, at 5.—Notes on the Food Supply of the United Kingdom, Belgium, France and Germany: R. F. Crawford.

WEDNESDAY, NOVEMBER 22.

SOCIETY OF ARTS, at 8.—National Forestry: D. E. Hutchins.

GEOLOGICAL SOCIETY, at 8.—On some Remarkable Calcisponges from the Eocene Tertiary Strata of Victoria (Australia): Dr. G. J. Hinde, F.R.S.—The Silurian Sequence of Rhayader: H. Lapworth.

THURSDAY, NOVEMBER 23.

ROYAL SOCIETY, at 4.30.

SOCIETY OF ARTS, at 4.30.—Old and New Colombo: John Ferguson.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Cost of Steam Raising: John Holliday.—Influence of Cheap Fuels on the Cost of Electrical Energy: R. E. Crompton.

FRIDAY, NOVEMBER 24.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Openings for Mechanical Engineers in China: The Right Hon. Rear-Admiral Lord Charles Beresford, C.B.

CONTENTS.

THURSDAY, NOVEMBER 23, 1899.

THE APPLICATIONS OF THERMODYNAMICS TO CHEMISTRY.

Traité élémentaire de Mécanique chimique, fondée sur la Thermodynamique. Par P. Duhem. 4 vols. Vol. i. pp. viii + 299; vol. ii. pp. 378; vol. iii. pp. 380; vol. iv. pp. 381. (Paris: Librairie scientifique, A. Hermann, 1897–1899.)

PROF. DUHEM'S treatise on the thermodynamic potential is so well known that little or nothing need be said in introducing another work from the pen of the same writer dealing with thermodynamical considerations.

The study of the laws of combination and dissociation is intimately connected with that of such physical processes as evaporation, liquefaction and solution. To this subject the not over-appropriate title of "chemical mechanics" (*mécanique chimique*) has been given in France. While Berthollet sought an explanation of the fundamental phenomena in the laws of motion combined with the Newtonian hypothesis of molecular attractions and repulsions, Sainte-Claire Deville referred the principles of "chemical mechanics" to thermodynamical considerations, and thanks to the labours of Hortsmann, Moutier, Gibbs, Helmholtz and a large number of other physicists, there has sprung up that wide field of investigation which has given the present book its title of "chemical mechanics founded on thermodynamics," or more briefly, chemical thermodynamics.

It is not with special applications alone that Duhem deals. The greater portion of the first volume and part of the second are occupied with thermodynamics proper, and constitute, to our mind, the best treatise on thermodynamics that we have seen. An introductory section contains a summary of the more important mathematical and dynamical theorems and principles required at the outset, and this should be helpful to students.

In his preface the author calls attention to the great difficulty of giving a perfectly rigorous and logical exposition of the laws of thermodynamics, and claims only to have attained the degree of precision usually adopted in treatises on physics. A comparison of Duhem's work with the heterogeneous mixtures of experimental results, mathematical formulæ and veiled assumptions which commonly have to do duty as text-books on thermodynamics, will show that the author has really advanced a long way in making the subject clear and intelligible. No better illustration of this can be cited than the careful precautions taken to avoid premature assumptions with regard to thermometric scales in the treatment of perfect gases. In these days of widespread education in "general elementary science" such terms as "a perfect gas" and "absolute temperature" bid fair to become by-words; but how many B.Sc.'s either of London or of our provincial universities can give correct definitions of them? If this point were tested, we venture to predict that in the vast majority of cases the first term would be defined by reference to the second, and the second by reference to the first, and if the circular nature of this reasoning were pointed out, the graduate under examination would have to take refuge in considerations respecting molecules, about whose nature and mode of motion he knew nothing. Moreover, apart from Charles's law and the difficulties connected with it, comes the question as to whether or not the definition of a perfect gas is to include Clausius's hypothesis as to the constancy of one (and therefore both) of the specific heats. Here again the question is considered most explicitly.

Another feature of Duhem's treatment is that while the old familiar p, v, t trio receives full consideration, generalised coordinates are introduced from the very outset, and the significance of such coordinates is explained by illustrative examples as far as possible. To one feature, however, we must take exception, and that is the retention in Duhem's equations of the useless E (synonymous with the English J) standing for the "mechanical equivalent of heat," as it was once, and unfortunately often still is, called. This quantity is nothing more or less than the work measure of the specific heat of water at a certain temperature, and the equations of thermodynamics in no way depend on the specific heat of water. The absolute unit of heat is the unit of work, and with this unit E must be replaced by unity. As Prof. Poynting remarked in his address to Section A at Dover, "the real superiority of the work measure of specific heat lies in the fact that it is independent of any particular substance, and there is nothing whatever hypothetical about it."

In this respect the work unit of heat stands on a much more rational footing than the universally adopted dual systems of so-called "absolute units" of electricity and magnetism, which are not independent of the medium, and whose dimensions moreover are incompatible.

As regards Duhem's two chapters on stability, we can only wish they had been before us when first learning thermodynamics, as we should have been saved the trouble of thinking out for ourselves conclusions similar to those here expounded, after vainly attempting to follow the arguments of the text-books and to apply them to a Tripos rider; now the whole matter appears before us in a clearer light than it ever did previously.

The last part (Book ii.) of volume i. deals with false equilibria and explosions. By "false equilibria" (*faux équilibres*) are meant states of equilibrium which can be realised experimentally, although the conditions of equilibrium of conventional—or, as Duhem calls it, "classical"—thermodynamics are not satisfied. They are analogous to the equilibrium of rough bodies in statics, in configurations which, in the absence of friction, would have been impossible. This analogy has led, in Duhem's hands, to the development of an extremely elegant mathematical theory of false equilibria and explosions based on the introduction of a function which the author calls the "friction" (*le frottement*) of the system. This function is entirely distinct from that which represents viscosity, but when it is introduced into the equations of the system, along with the thermodynamic potentials, Clausius's inequality for irreversible cycles $\int dQ/T > O$ is satisfied. In a diagrammatic representation, the line of true equilibrium is bordered on either side by a region of false equilibrium. When the

E

representative point just falls outside this region the conditions required for the occurrence of an explosion admit of a simple geometric interpretation.

In the second volume, Book iii. deals with change of state, dissociation, and the triple point; much of the latter matter will be familiar to those who have read the author's "Thermodynamic Potential." Book iv. deals with the critical point, the principle of James Thomson, Van der Waals's and allied formulæ, and the principle of corresponding states, specific heats of fluids, and adiabatic expansion of vapours. Book v. treats of dissociation in mixtures of perfect gases. In the third volume, Book vi. deals with the thermodynamic potentials of a homogeneous mixture, solution, osmotic pressure, the hypotheses of Van 't Hoff and Arrhenius, and the law of Guldberg and Waage. Book vii. contains a full investigation of the general problem of solution, the chapter dealing with double salts being of much interest, especially the graphical representations. In the fourth volume Book viii. is devoted to the consideration of double mixtures, including the thermodynamic theory of distillation, while an account of Willard Gibbs's theory of the statics of heterogeneous systems in Book ix. concludes the treatise. In this last book the law of phases is established, and the different degrees of variance of a system are considered separately, actual instances of the systems in question being cited. A separate chapter is devoted to the properties of univariant and bivariant systems. As Duhem points out, the whole of this theory is based on "classical" thermodynamics where "friction" is left out of account, as is also capillary action.

The treatise, taken as a whole, shows what vast progress has been made in expressing the laws of mixture, combination, dissociation, and chemical transformation generally, in terms of a single potential function of generalised coordinates, and thus placing chemistry and chemical physics on a similar footing to dynamics. The essentially mathematical treatment is not the least valuable feature of Duhem's work. Thermodynamics is quite as capable of being regarded from a purely mathematical standpoint as dynamics or hydrodynamics, but hitherto its mathematical aspect has not been exhibited so prominently as it ought to be. The inclusion of descriptions of details of experiments would have broken the continuity of the theory, and such details can be far better studied in the original papers to which abundant references are given in footnotes. Indeed, the present work appears to be in many respects a model of what such a treatise ought to be. In any special problem certain hypotheses are first made; these should be clearly pointed out, and attention specially drawn to them. From these hypotheses certain conclusions are drawn by mathematical reasoning, and lastly we have references to the evidence derived from experiment as to the accordance of these conclusions with observed facts. So long as a substance is regarded as a purely mathematical abstraction, it may be defined by any hypotheses whatever as to the form of its thermodynamic functions, and a Thermodynamics based on hypotheses convenient for purposes of calculation would possess the same interest to mathematicians as a Hydrodynamics which ignores viscosity and capillarity or a Geometry of any particular non-Euclidian space. But it would appear that the conclusions *do* largely represent, either exactly or as approximations, the results of experiment; and the subject thus assumes a physical reality.

It is difficult in writing on such a subject as the present to avoid, quite unintentionally, "smuggling" doubtful assumptions into the midst of an argument without declaring their nature. As we all know the late Clerk Maxwell was much addicted to this practice, the gaps in his reasoning having afforded fruitful material for later investigators. When we consider the variety of sources from which the subject-matter of the present treatise has been compiled, we can only congratulate the author on the measure of success he has achieved in admitting only perfectly rigorous deductions based on explicitly stated hypotheses.

We cannot close this work without some reflections as to the relative progress that has been accomplished by the two schools in explaining the properties of matter, the one by means of the thermodynamical potential, and the other by the application of dynamical principles to the individual molecules of bodies. Molecular dynamics has given us equations representing, under certain conditions, the fact that dQ/T is a perfect differential; but there is still a something we have not got to the bottom of in every kinetic theory of matter, as applied to thermodynamics. We have as yet discovered no dynamical theorem of sufficient generality corresponding to the uniqueness of temperature, or establishing the fact that under the most general possible conditions the entropy of a system tends to a maximum. The question—Can the irreversible phenomena of thermodynamics of a body of finite size be accounted for by applying the equations of a conservative and reversible dynamical system to its individual molecules without making *some* special assumptions?—has never been completely answered. To deduce the second law from the equations of the kinetic theory imposes restrictions on the systems to which the conclusion applies where no such restrictions exist in the law itself. Even the very question of applying statistical methods at all to systems of molecules endowed with the property of perpetual motion requires careful consideration, since our statistical theories are so largely based on our experience of every-day phenomena—events by their very nature irreversible. One may thus be led to wonder whether Prof. Duhem's "friction" may possibly involve the existence of some molecular property which prevents molecular motions from being represented by the equations of what in the author's own nomenclature may be styled "classical" dynamics, and which introduces irreversibility into the motions even of individual molecules.

From a mathematical point of view the theory of the thermodynamic potential has attained far greater perfection than any theories based on molecular hypotheses that have been suggested up to the present; whatever the future may bring forth is another question. While thermodynamics originated in this country from the discoveries of Joule, it now hardly receives so much attention from Englishmen as it deserves. Prof. Duhem's treatise, by showing the wide range of phenomena which come under its scope, even omitting (as he does) thermo-electric phenomena and thermo-elasticity, cannot fail to attract students to this fascinating branch of mathematical physics. G. H. BRYAN.

THE CONTINUITY OF THE ERYTHREAN RIFT VALLEY.

Seconda Spedizione Bottego. L'Omo. Viaggio d'Esplorazione nell' Africa Orientale. By L. Vannutelli and C. Citerni. Pp. xvi + 650; 11 plates, 9 maps, and numerous illustrations. (Milano: Hoepli, 1899.)

THE Erythrean Rift Valley has been proved continuous across forty degrees of latitude from the Jordan to the south of Kilima Njaro, except for a possible break of about 250 miles between Lake Rudolf and the basin of the Hawash. Whether the valley is broken in that district depends on the course of the Omo and its relations to the river known as the Nianam, which flows into the northern end of Lake Rudolf. The name Omo was introduced into geography by Léon des Avanchers in 1858, for a river which drains part of the southern slope of Abyssinia, a little to the west of Menelik's capital at Addis Abeba. The river had been known long before, for it is the Zebé of the seventeenth-century Jesuit missionaries. The upper part of its course was described by Ludolf in his "New History of Ethiopia" (1681) from information supplied by the Abba Gregorius. But the lower course of the river was quite unknown. Ludolf believed that it flowed eastward and entered the Indian Ocean near Mombasa.

Bruce in the following century accepted this hypothesis and called the river the "Zebé or Quilimancy," the latter being an old name for the Ozi, a river which is a parasite of the Tana.[1]

But in the present century Frederick Ayrton and Antoine d'Abbadie claimed the Zebé as one of the head-streams of the Nile. This view was supported by Petermann, who held the Zebé to be a tributary of the Sobat, and by Bonala, who believed that it flowed into the Victoria Nyanza, and was therefore the remotest source of the Nile. Harris, McQueen, Schweinfurth and Cecchi on the contrary supported the theory that the Zebé belonged to the Indian ocean drainage, and rendered this view more plausible by identifying the Omo as one of the sources of the Juba. In 1889 and 1890 a fresh explanation was introduced by Teleki and von Höhnel's discovery of Lake Rudolf, and Borelli's descent of the Omo towards that lake, into which native rumour asserted that the river flowed. The work of these travellers seemed to disprove both the old theories; but Dr. Donaldson Smith, after his important journey to Lake Rudolf in 1895-6 again advocated the connection of the Omo and the Juba. What was known of the levels of the three rivers seemed fatal to this idea, and in a review of Donaldson Smith's book in NATURE (July 1, 1897) it was maintained that the Omo and the Juba could not be connected, and that "the Omo must continue as the Nianam and flow into Lake Rudolf."

[1] Bruce is quoted on p. 4 of the present work as having regarded the Zebé as one of the head-streams of the Nile; but that was only the view of some of his editors. Bruce himself did not reach the Zebé; he does not appear to mention it in his narrative, and his map marks it as separated from the Nile tributaries.

In order to settle this long controversy Vittorio Bottego, an explorer well known from his work in the Juba basin in 1891–2, proposed an expedition which was fitted out under the auspices of the Italian Geographical Society. Thanks to the energy of this Society, Bottego started in October 1895 from Barawa on the Somali coast at the head of a powerful caravan of four European officers, 250 natives, 120 camels, and 300 mules.

The expedition left Barawa in October 1895, and marched across Italian Somaliland, along a route parallel to the river known to geographers as the Juba. The authors, however, speak of it as the Fiume Ganana, which being interpreted is the "River River."

The first long halt was at Logh, the principal commercial centre in the Juba valley. After building a fort and a trading station at that town the expedition crossed the "Fiume Ueb" (which also means "River River"), and marched north-westward up the course of the principal tributary of the Juba. The explorers found that this river dwindled rapidly, and long before they reached its head found that it could have no connection with the Omo. Leaving the Juba basin, the expedition carefully explored Lake Abbaia, which it is proposed to call Lagho Regina Margherita, and then proceeded to its main objective the Omo. The river was reached near the point to which Borelli had tracked it from the north. Bottego, after his former expedition, inclined to the view that the Omo was one of the Nile tributaries; but after following the river for some distance westward it suddenly bent southward, became the Nianam of von Höhnel, and entered Lake Rudolf. The Omo problem was settled.

While resting in the food country at the northern end of Lake Rudolf, the expedition mapped its western shores, and collected much fresh information regarding the Reshiat, who are described under the name of the Gheleba. This interesting tribe was first described by von Höhnel. From the facts and figures given by Vannutelli and Citerni it appears probable that the people are Nilotic negroes, allied to the Njempsians, and altered by Galla intermixture.

After mapping the western shores of Lake Rudolf the expedition proceeded up the second river, which von Höhnel had described as entering the northern end of the lake. The existence of this river has, however, been denied. Bottego's party followed the river, which it is proposed to rename the Fiume Maurizio Sacchi, to the north-west; but its course is short, and the expedition climbed the water-shed into one of the tributaries of the Sobat. For this tributary the authors propose to restrict the name of Juba. They followed this river to the north-west until it left the Ethiopian highlands near its junction with the group of rivers that unite to form the Sobat. They traversed the swamps of this region to a point some forty miles from the old Egyptian station of Nassur. Having thus settled the relations of the Sobat-Juba, the expedition returned to the Abyssinian highlands on the home trail. They entered the Sajo country, which is ruled by one of Menelik's governors. Bottego sent a polite request for permission to return to Massowah either across the Amhara province around Lake Tsana, or through Shoa, or by any route which might be suggested. The expedition was invited to visit the

Abyssinian chief at Jellem, where it was received with great state; but two days later Bottego's Abyssinians were invited to desert, and in the night twelve men escaped, taking away two cases of cartridges. At daybreak the Italians found their camp surrounded; they attempted to cut their way to open country, and were attacked. They fought with desperate courage against overwhelming odds. Bottego was killed, Citerni was wounded and captured, and Vannutelli compelled to surrender. Fortunately Major Nerrazzini was then in Addis-Abeba arranging the final details of the peace which had been concluded between Italy and Abyssinia. At his intervention the two officers were promptly released, and they returned to Europe through Addis-Abeba, where they were courteously and sympathetically received by Menelik.

Meanwhile the second part of the expedition had fared as disastrously. Dr. Sacchi had left the main party at Lake Stefanie, and crossed the Borana country, intending to reach Lake Abbaia by a new route. But his party had a fight with a force of Abyssinians a little to the south of that lake. Sacchi was killed, apparently on February 7, 1897. Part of his diaries have been recovered, and they contain many interesting notes on the geology of the country traversed.

In spite, however, of these disasters, the results of the journey were of great importance, and they are admirably summarised in the present volume, which has been written by the two survivors Vannutelli and Citerni. The book is interestingly written; the incidents are graphically related; and the details are sufficiently full to be of great scientific interest. Geographically the main achievement of the expedition was the final solution of the Omo problem, and proof of the unity of the northern and southern parts of the Erythrean Rift Valley. The basins of lakes Stefanie, Abbaia and Zuai connect the well-marked depressions of Lake Rudolf and the Hawash. The atlas that accompanies the volume is not only a complete revision of the geography of the region, but contains extensive new surveys. Ethnographically, the expedition has collected much new information regarding the little-known Somali and Galla clans of the Juba country and of the mixed Nilotic-Hamitic races around the northern part of Lake Rudolf. The zoological collections, in spite of losses, were very large, and have been previously described in a series of reports by specialists, and in the present volume there is a general summary of results by Prof. Gestro.

The geological collections made by the expedition are described by d'Ossat and Millosevich, who from Dr. Sacchi's notes have been able to prepare a geological map of the Omo and Upper Juba. The meteorological records, which seem to have been very carefully taken, are edited and discussed by Dr. Peyra. The present volume is therefore not only a narrative of an adventurous expedition, but a most important contribution to the geography and natural history of Eastern Africa. It not only confirms Bottego's reputation as one of the most daring and successful of Italian African explorers, but shows him to be a man of wide scientific sympathies and attainments. His friends have at least the consolation of knowing that his life has not been laid down in vain. J. W. G.

MODERN SURGERY.

Surgery: a Treatise for Students and Practitioners. By Thos. Pickering Pick, Consulting Surgeon to St. George's Hospital. Pp. xix + 1176. (London: Longmans, Green, and Co., 1899.)

IT is always a matter of satisfaction when a senior member in any profession writes a text-book, for the seniors who have attained to a high position have had unrivalled opportunities of practice which renders their opinions of the greatest value. Mr. Pick is therefore to be highly commended for the completion of his self-imposed task. The book contains, he tells us, the substance of the lectures which he has delivered at St. George's Hospital for fifteen years, and is the outcome of his experience as a hospital surgeon and teacher of surgery for nearly thirty years. It is worthy of comparison with the world-renowned text-book of surgery written by Erichsen, which has hitherto been the most satisfactory of all the English surgical works, and it bears the comparison well, for it is written on very similar lines. Mr. Pick's treatise has the advantage of being an original work, whilst Sir John Erichsen's has been adapted repeatedly to present needs, and however skilfully such adaptations are made they lack somewhat of the savour which first gives a successful book its vogue. Mr. Pick's work, too, is contained in a single volume, whilst Sir John Erichsen's, by a process of incorporation and the requirements of successive editions, has become two bulky volumes.

Mr. Pick has brought his book to a most successful issue. It contains a clear and concise account of modern surgery, not overweighted by detail, and yet sufficiently full to be an accurate guide both to the student and to the medical practitioner who can only afford a single work in each department of his profession. Mr. Pick is old enough to have been educated in the days of suppurative surgery, but his actual practice has been carried out in the modern operating theatre and wards where antiseptic surgery reigns supreme. He is able, therefore, to contrast the old with the new systems, and one of the charms of his book is the skilful manner in which he selects the good points in the practice of the older surgeons and adapts them to the present *régime*.

Where all is good it is difficult to select one article more than another for praise, but the influence of the great surgical school attached to St. George's Hospital is perhaps best marked in the chapter on diseases and injuries of the head; whilst Mr. Pick's acknowledged eminence in connection with the surgical diseases of children, and in fractures and dislocations renders his remarks on these subjects of especial value.

The surgical pathology throughout the work is quite consonant with modern teaching, and such errors as may be present are rather errors of omission than of commission. The recent summer has shown how large a part gnat bites may play in the production of cellulitis amongst the poorer and less healthy inhabitants of towns. There is no mention of ossifying sarcoma of bone, or of Pirrie's fracture; whilst in describing the diatheses or "complexions" it would be more accurate to speak of them as being characteristic of persons predisposed to tubercle rather than of the tuberculous individual.

The sections on actinomycosis and syphilitic disease of joints might be advantageously recast and made somewhat fuller, whilst "tensing" as a synonym for "tighten," and "sorbefacient" for "causing resolution" are certainly as ugly as they are unwarranted.

The book is illustrated by 440 drawings, of which the majority have been executed by Dr. Harvey Goldsmith, some from preparations or drawings in the museum of St. George's Hospital, others from rough sketches made by Mr. Pick himself. The drawings for the most part fulfil their purpose of illustrating the text, but in Fig. 6 the veins appear to be situated external to the skin; whilst the drawings of the mocmain and lever trusses in Fig. 338 are too diagrammatic to be useful.

The book has a good index, and concludes with an appendix containing a description of the various methods of amputation. This appendix might have been rendered additionally serviceable by the introduction of a section upon prothetic appliances. D'A. P.

OUR BOOK SHELF.

Elements of Precise Surveying and Geodesy. By Mansfield Merriman, Professor of Civil Engineering in Lehigh University. Pp. 261. (London: Chapman and Hall, Ltd. New York: Wiley and Sons, 1899.)

THIS book will be useful not only to undergraduates attending Prof. Merriman's classes at the well-known Lehigh University, but to all who may be engaged in carrying out accurate or geodetic surveys. It is clearly written, methodically arranged, and well illustrated; and the problem at the end of each section seems well designed to test the student's knowledge.

In Chapter i. the laborious method of least squares is explained, and the most important processes for the comparison of observations are described. Chapter ii. deals with precise plane triangulation, the measurement of horizontal angles, the adjustment of the angles of a triangle and the computations. Chapter iii. is devoted to base lines, their measurement and reduction to sea-level. A steel tape, from 300 to 500 feet long, is recommended as a convenient apparatus for the measurement of base lines, and instances are given of the excellent results that have been obtained with it in the United States. In its favour are its portability and the moderate cost at which accuracy of measurement can be secured by its use. Chapter iv. contains useful sections on accurate levelling and the adjustment of "a level net." In Chapter v. the field operations necessary for the determination of azimuth, latitude and longitude are well described, and it may be noted that a good sextant is held to be preferable to a transit theodolite for taking altitudes of a star. In Chapter vi. there is a slight sketch of the attempts to determine the form and size of the earth from that of Eratosthenes to the measurement of the Lapland and Peruvian arcs by the French Academy. This is followed by sections on the solution of geodetic problems on the supposition, first, that the earth is a sphere, and then, Chapter vii., that it is an oblate spheroid. In the latter case Clarke's elements of the spheroid are used for the calculations. Chapter viii. deals with projections, including the polyconic projection adopted in the United States; and Chapter ix. is a brief but clear account of the various operations connected with the practical work of geodetic triangulation. In Chapter x. there are short discussions on the figure of the earth considered as a spheroid, an ellipsoid, an ovaloid and a geoid; and in Chapter xi. there are tables sufficient for the solution of the problems given in the volume.

Prof. Merriman's book contains frequent references to the valuable publications of the United States Coast Survey, which are not always easily accessible, and the American meter is used in the tables and calculations. But this does not lessen its value as a treatise on the elements of precise surveying and geodesy that may be profitably used for instructional purposes in this country. C. W. WILSON.

Experimental Science (Physiography: Section I.). By R. A. Gregory and A. T. Simmons, B.Sc. Pp. viii + 332. (London: Macmillan and Co., Ltd., 1899.)

THIS is one of the school books called into existence by the alterations which have been made by the Department of Science and Art in the syllabus for elementary physiography. A clear perception of the needs of both pupils and teachers is evident throughout, and the high standard which the authors have set themselves in previous works of a similar character is thoroughly maintained. The book is so planned that it is well adapted for the new arrangement whereby the subject may be taken in three stages, by candidates for engagement as pupil teachers, and pupil teachers in their first and second years; and it also includes most of the subjects of the Oxford and Cambridge Junior Local examinations in experimental science. Though treating a considerable range of subjects, and keeping examination requirements well in view, the book is by no means sketchy, but indicates very clearly the significance of the progressive series of experiments described. Many of the experiments are suitable for performance by the pupils themselves. The illustrations are both numerous and good.

Tito Nenci. I. Bachi da Seta. 3a edizione con note e aggiunte di Francesco Nenci. Con 47 incisioni e 2 Tavole. Pp. xii+300. (Milano: Hoepli, 1900.)

THIS is a compact little manual which seems to have first appeared in 1883, and has now arrived at its third edition. The portrait of Prof. T. Nenci forms the frontispiece, and the other plate illustrates the ventilation of a silkworm establishment. The text illustrations are good, some of them occupying a whole page. The book is divided into seven parts, dealing with the natural history of the silkworm; the "bacheria," or silkworm-breeding establishment; races and rearing; diseases of the silkworm; degeneracy and regeneration; outlay; properties of silk, &c.; and other silk-producing Lepidoptera. But the book is chiefly intended as a practical manual; and the last chapter gives little more than the names of a few of the best-known silk-producing Saturniidæ, though the cocoons of two of these are illustrated. W. F. K.

Types of British Animals. By F. G. Aflalo. Pp. xx + 290. (London: Sands and Co., 1899.)

THIS well-illustrated and very readable addition to the "Library for Young Naturalists" is likely to become a favourite with boys. Technical terms are reduced to a minimum, though room has been found for necessary explanatory paragraphs. The first eight chapters describe types of British quadrupeds and whales, and are followed by eight chapters on birds. After single chapters on British reptiles and amphibians, with six on British fishes, invertebrate life is considered in the concluding six chapters. Spiders and insects are described by Mr. C. S. Colman. The familiar and chatty style which is adopted throughout will be sure to capture a boy's attention, and eventually set him observing for himself. We hope the author's appeal to his readers to burn their catapults may prove successful, but we have our doubts. The eight full-page plates and thirty-one illustrations by Mr. Caldwell not only add to the attractiveness of the volume, but will prove useful in enabling the reader to recognise living specimens.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Stockholm International Conference on the Exploration of the Sea.

THE publication of a portion of the report of the Stockholm Conference in NATURE of November 9 (p 34) shows, I suppose, that the matter is now open for discussion by scientific men; and it is certainly desirable in that case that marine biologists and others interested in Fisheries investigation should express their opinions on the resolutions, and especially the recommendation, of the delegates. I feel sure that those gentlemen who attended the Conference and took part in drawing up the report will not consider such discussion ungracious, or that we who criticise are in any way wanting in appreciation of their labours. It is because we recognise the great importance which this report, with its series of resolutions, ought to have that we think it worth while to urge that some parts of it should receive careful re-consideration.

Although one may cordially approve of many of the resolutions passed by the delegates, still the report is certainly in some respects a disappointing document; and there is internal evidence to show that this is the result of compromises which were perhaps inevitable, but which have probably led to the omission of what might have been a valuable programme of work.

Last summer, when the arrangements for the Conference were announced, hopes ran high, and it was very naturally and confidently anticipated that the report, when issued, would contain strong recommendations to the Governments concerned involving the use of sufficient boats and men to carry out a definite scheme of biological investigation during a definite period. For surely what we need most at the present time in the interests of more exact fisheries knowledge is the nearest possible approximation to a census of our seas—beginning with the territorial waters. Most fisheries disputes and differences of opinion are due to the absence of such exact knowledge.

If anything approaching a census or a record of trustworthy fisheries statistics had been taken fifty years ago, it would now be invaluable to fisheries inspectors, superintendents and local authorities, as well as to biologists. Our successors will justly reproach us if with our increased knowledge and opportunity we let the twentieth century commence without inaugurating a scheme of practical work which will give us the desired statistics.

The Stockholm report unfortunately says nothing to the point in regard to all this. In place of asking for boats and men, it urges—in the only recommendation of the Conference (" Résolutions textuelles," p. 12, C)—the establishment of a "central bureau," in which the work will apparently in large part be that of a physico-chemical laboratory.

I hope I shall not be misunderstood in this. I do not undervalue the importance of hydrographic work in its connection with the fisheries (and I am only considering it in that connection at present) as carried on of late years, chiefly by the Scandinavians; but it is curious how in this report the obvious, primary, biological investigations are passed lightly over and the secondary physico-chemical work in the central bureau is strongly recommended. Part of the report is called a programme of work, but it contains no definite programme of biological work. I suppose it may be said, all that will be arranged in time at the central bureau, but in the meantime an opportunity is lost. If nothing but an International Committee and a central bureau is asked for, probably that (at most) is all that will be obtained, and *it is not all that is necessary.* In my opinion, what we want at the present time is not conferences, or committees, or a central bureau, so much as boats and men, *and work at sea.*

W. A. HERDMAN.

Croxteth Lodge, Liverpool, November 16.

P.S.—I see Mr. Allen's letter in to-day's NATURE. On the whole he seems to regard the report with more favour than I do; but on most points we are in agreement. It is certainly curious to omit the English Channel and the Irish Sea from an investigation in the interests of the British fisheries.

The Meteors of Biela's Comet.

WITH your permission I should like to call attention to the possibility of a return of the Andromedes meteors on or about November 23. A consideration of the period of the shower, as deduced from all its known returns, had some time back led me to the conclusion that this year was more likely to be favoured with it than last. The fact that it was not seen last year is, as far as it goes, in support of my contention. But, of course, the stream may take less than a year to pass the point of the intersection of the orbits, in which case the earth may very possibly not pass through it at this return of the meteors.

E. C. WILLIS.

South Radwello, Norwich Lodge, Ipswich.

MR. WILLIS's inference that some Bielan meteors may be visible this year seems quite in accordance with the historical facts of the stream. The parent comet was observed between 1772 and 1852, and its mean period from twelve revolutions was 6·71 years. If this also represents its mean orbital time since 1852, perihelion would occur in September 1899. But the last four observed returns from 1826 to 1852 averaged 6·62 years, which would indicate perihelion at the end of January 1899. On the whole it seems highly probable that when the earth crossed the comet's orbit in November 1898 it was too far in advance of the cometary nucleus for any meteoric shower to result. It also appears likely that at the meeting, now imminent, of the earth and cometary orbit, the former will encounter a section of the stream too far in the wake of the comet for it to be very thickly strewn with its material. However, this remains to be seen. The apparition of a fine shower of these meteors on November 23, 1892, sufficiently proves that the period of thirteen years intervening between the rich displays of 1872 and 1885 did not exactly represent two returns of the same part of the meteoric group. In 1872 the earth passed through a section of the stream following the comet, while in 1885 it encountered a part preceding the comet. Intervals of twenty years (equivalent to about three periodical revolutions of the comet) seem favourable to recurrences of the meteoric shower as it was observed in 1798 and 1838 (including two periods of twenty years) and in 1872 and 1892. I think the next brilliant return of the meteors will certainly occur in 1905, and that a minor display is very likely to be visible in 1899. If so, the meteors will appear in the early evening of November 24 next, the longitude of the node being 242°·2.

According to the investigations of Schulhof and Abelmann, the planet Jupiter will greatly disturb this meteoritic stream in about March 1901 and cause a minus displacement of the node to the extent of 6°·2. This means that in 1905 the shower will make its apparition on about November 18.

November 15.

W. F. DENNING.

RECENT DEVELOPMENTS OF WIRELESS TELEGRAPHY.

THE efficiency of the system of wireless telegraphy developed by Mr. Marconi has recently been put to some striking tests, with results which are in every respect satisfactory. During the yacht races for the America Cup, descriptive reports of progress were sent by wireless telegraphy from the *Grande Duchesse*, on which Mr. Marconi had his apparatus installed; and as many as four thousand words were transmitted by this means over distances up to thirty miles in the course of a single afternoon.

The method of sending the reports of the yacht races is described by the *Scientific American* to have been as follows:—"The foremast of the *Grande Duchesse* carried an auxiliary mast of sufficient length to give the desired vertical height of 120 feet to a wire, which reached from a short yard on the mast to the table of the operating room below, on which the sending and receiving apparatus was placed. A similar wire was suspended from the foremast of the Bennett-Mackay cable steamer, which was anchored near the Sandy Hook lightship, the starting and finishing point of the races, and also from a mast at the Navesink Highlands. The cable ship and the Highlands had temporary cable connections with New York.

The *Grande Duchesse* accompanied the yachts over the course, and the momentary details of the race, as observed from her decks, were flashed to the cable ship, from which they were sent over the cable to New York, and thence telegraphed throughout the world."

Before leaving the United States Mr. Marconi gave some demonstrations of his system to naval officers and technical experts appointed to report upon its value in naval warfare. With the instruments he had available, perfect communication was kept up between the cruiser *New York* and the battleship *Massachusetts* when the vessels were thirty-five miles apart; and messages were exchanged over a distance of ten miles with a torpedo boat travelling at full speed.

An even more striking demonstration of the utility of wireless telegraphy was given as we went to press last week. It appears from a letter communicated by Major Flood Page to the *Times*, that when Mr. Marconi left New York he cabled to the office of his company in London that he would speak to the Needles from the steamship *St. Paul* on their arrival in English waters. The vessel was expected to pass the Needles about 10 or 11 o'clock on Wednesday morning, and Major Flood Page arrived there on the previous evening, when all arrangements for communication were made. On Wednesday morning, he writes:

"We sent out our signals over and over again, when, in the most natural and ordinary way, our bell rang. It was 2.45 p.m. 'Is that you, *St. Paul?*' 'Yes.' 'Where are you?' 'Sixty-six nautical miles away.' Need I confess that delight, joy, satisfaction swept away all nervous tension, and in a few minutes we were transcribing, as if it were our daily occupation, four cablegrams for New York, and many telegrams for many parts of England and France, which had been sent fifty, forty-five, forty miles 'wireless,' to be despatched from the Totland Bay Post Office."

Upon the vessel itself a *Transatlantic Times* was printed by the ship's compositor, and the subjoined extract from this novel newspaper is of interest in connection with that given above:

"Through the courtesy of Mr. G. Marconi, the passengers on board the *St. Paul* are accorded a rare privilege—that of receiving news several hours before landing. Mr. Marconi and his assistants have arranged for working the apparatus used in reporting the yacht race in New York, and are now receiving despatches from their station at the Needles. War news from South Africa and home messages from London and Paris are being received. The most important despatches are published on the opposite page. As all know, this is the first time that such a venture as this has been undertaken. A newspaper published at sea with wireless telegraph messages received and printed on a ship going 20 knots an hour! This is the 52nd voyage eastward of the *St. Paul*. There are 375 passengers on board, counting the distinguished and extinguished. The days' runs have been as follows:—November 9, 435; November 10, 436; November 11, 425; November 12, 424; November 13, 431; November 14, 414; November 15, 412; 97 miles to Needles at 12 o'clock, November 15. Bulletins:—1.50 p.m. . . .—. First signal received, 66 miles from Needles. 2.40.—'Was that you, *St. Paul'?* 50 miles from Needles. 2.50.—Hurrah! Welcome home! Where are you? 3.30.—40 miles. Ladysmith, Kimberley, and Mafeking holding out well. No big battle. 15,000 men recently landed. 3.40.—At Ladysmith no more killed. Bombardment at Kimberley effected the destruction of one tin pot. It is felt that period of anxiety and strain is over, and that our turn has come. 4.0.—Sorry to say the U.S.A. cruiser *Charleston* is lost. All hands saved."

In addition to the messages above-mentioned, the *Times* states that passengers availed themselves of the instruments to send greetings to friends in England and America, and when the *St. Paul* was forty miles from shore in one case arrangements were completed by a passenger for a supper party in town upon the night of the arrival of the American Line express at Waterloo Station.

This interesting development of wireless telegraphy solves the problem of the communication of a ship with the shore, so far as ocean-liners are concerned; for there should be no difficulty in installing the necessary apparatus, or in training officers to work it. Now that such results have been obtained, advantage should be taken of the system as a means of communication whenever opportunity affords.

SOME RECENT WORK OF THE MARINE BIOLOGICAL ASSOCIATION.

ONE of the most important tasks which can be undertaken by the staff of a sea-side laboratory is the exact description of the relations between the fauna of the neighbourhood and the external conditions. Excellent anatomical work can be performed, as it is habitually performed in all the various marine stations which now exist, by naturalists who are unable to live continuously at the sea-side. In many cases a short visit to a suitable locality will enable an anatomist, aided by the knowledge and experience of skilled residents, to collect in a short time material for the most complete study of a species from the anatomical point of view. But many complicated problems connected with the breeding of marine animals, and others, equally complex, which arise from even the most superficial study of their distribution, can only be solved by continued observation extending in many cases over years; and such observations can only be conducted by resident naturalists, with the resources of a properly equipped laboratory at their command.

It is well known that officers of the Marine Biological Association have for years been engaged in the study of questions connected with the breeding of fishes and other marine animals. The last number of the Association's *Journal* contains a report of some 180 pages, illustrated by sixteen charts, which shows that Mr. Allen, the Director of the Plymouth Laboratory, is fully alive to the need for continuous and careful study of the way in which the fauna of the neighbourhood is distributed.

The report deals with the strip of sea-bottom which runs from a point just west of the Eddystone Lighthouse to the Start, at a depth of from about 28 to about 35 fathoms.

A careful description of the nature of the sea-bottom throughout this area is given, and a useful suggestion is made as to the possibility of a uniform nomenclature, by which descriptions of the character of a sea-bottom may be made more clearly intelligible than they are at present.

The bottom deposit is washed through a series of sieves, with apertures varying from 15 millimetres to 0·5 mm.; and a distinct name is given to the material which rests upon each of these sieves, if the deposit is washed through them in order. Six kinds of material are thus recognised, from "stones," which will not pass through a sieve with perforations of 15 mm. diameter, to "medium sand" which remains on a sieve with a mesh of 0·5 mm. The material which passes through apertures of 0·5 mm. diameter is separated into two portions by being shaken up in sea-water. Anything which settles in one minute is spoken of as "fine sand," anything which remains in suspension after one minute is spoken of as "silt."

When a deposit has been separated in this way into constituents of different degrees of fineness, the various constituents are dried and weighed, and the weight of each, expressed as a percentage of the total weight of the sample of deposit, is given for each locality.

This method of describing the texture of a sample of the sea-bottom is simple, and not very laborious. The general adoption of such a method would certainly make it easier than it is at present to compare descriptions by various writers.

A short geological account of the various sands and gravels obtained is given by Mr. R. H. Worth, together with a determination of the $CaCO_3$ (which in these deposits is nearly all of organic origin) in deposits of varying degrees of fineness. Several partial analyses of silts are also given.

Mr. Allen clearly appreciates the great importance of the character of the silt, which forms so large a part of the food of many creatures living on the sea-bottom, and it is to be hoped that in course of time he may be able to attempt a systematic survey of the silts in the neighbourhood of Plymouth, so as to tell us not only more about their chemical composition, but more about their physical character, and about the organisms they contain. He has already made an important advance in our knowledge by showing that "coccoliths" occur in shallow water deposits very much more frequently than has hitherto been believed; but many other organisms, such for example as the the various bacteria which exist in these deposits, are likely to be of considerable importance as part of the biological environment; and of these we know practically nothing.

Having given a detailed description of the nature of the sea-bottom at eighteen selected places in the small area dealt with, Mr. Allen gives a complete list of the species obtained at each locality as the result of a number of dredgings, together with an estimate of the relative abundance of the various species. This complicated information has been admirably digested, and it is so tabulated that the reader can see with very little trouble the relation between the abundance of any species and the character of the bottom deposits or of the fauna of adjacent localities.

The work is deliberately limited to a small area, where the conditions of life are tolerably uniform throughout, and statements are made which lead one to hope that this is only a first instalment of a more extended survey.

Every one who cares about the problems of marine zoology will hope that Mr. Allen may be able before very long to publish his promised account of the region between the thirty-fathom line and the shore, so that the relation between the littoral fauna and the fauna he has now described may be determined. As it stands, however, his work is a solid and valuable contribution to a kind of knowledge which must be largely increased before we can hope to understand the bionomics of the sea.

THE OLD RED SANDSTONE OF SHETLAND.

THOUGH abounding in ill-preserved plant remains, the Old Red Sandstone rocks of Shetland have hitherto yielded none of those characteristic fossil fishes which would enable us to compare them with rocks of similar age elsewhere in Scotland. On the general evidence of lithological features and the supposed identity of their respective floras, they have been regarded usually as a northward extension of the "Orcadian" beds of Caithness and the Orkneys. Two years ago Mr. John S. Flett, M.B., B.Sc., of Edinburgh University, was able to report that he had found certain obscure fish remains in Shetland, and, this summer, assisted by a grant from the Royal Society of London to defray the expenses of quarrying, he has succeeded in obtaining a number of undoubted fish-remains from the flag-stones of Brissay, near Lerwick. In this collection, which consists mostly of broken and detached plates, Dr. R. H. Traquair, F.R.S., has recognised fragments of an *Asterolepis* (probably a new species) and of *Holonema*, a fish new to Britain, but occurring in the Chemung (Upper Devonian) of North America. A full description of these will, no doubt, shortly be forthcoming. In the meantime, it seems certain that the fauna of these beds is distinct from any fauna of Old Red age at present known in Britain, and, until more fully investigated, its horizon remains open to question; but Mr. Flett inclines to believe that its real position will turn out to be intermediate between the John-o'-Groat's beds (the highest of the Orcadian series of the Orkneys) and the true Upper Old Red of Moray and Elgin. The genus *Asterolepis*, so characteristic of the Upper Old Red, was shown by him two years ago to occur also in the Thurso beds of the Orkneys, and the general forms of the Shetland flora would indicate a connection with the Orcadian. Nevertheless, the whole aspect of the fauna is Upper Old Red; not one of the commoner Orcadian fishes has been obtained in Shetland. An interesting problem is opened up by these discoveries, to which it is to be hoped further investigations will furnish a definite solution.

SIR J. WILLIAM DAWSON, C.M.G., LL.D., F.R.S., &c.

NEWS has been received of the death of Sir William Dawson, Emeritus Principal and Chancellor of McGill University, Montreal, and the most distinguished of Canadian geologists. He was the son of James Dawson, of Picton, a town on the northern shores of Nova Scotia, where he was born in October 1820.

Coming to this country in early youth he studied at the University of Edinburgh, and gained a knowledge of geology and allied sciences from Robert Jameson, then Regius Professor of Natural History. Returning to his native land, Dawson became Superintendent of Education in Nova Scotia from 1850 to 1853; and later on Professor of Geology and Principal of McGill College and University 1855 to 1893.

On his return to Nova Scotia he directed his attention with the greatest enthusiasm to the study of geology, for as early as 1845 we find him communicating to the Geological Society of London papers on the Coal-formation of the country. To this formation for many years he gave especial study. In company with Sir Charles Lyell he made in 1852 a detailed examination of the fine succession of "fossil forests" of the Coal-period in the cliffs of South Joggins. Together they obtained also the first remains in the Coal-measures of an "air-breathing reptile," named *Dendrerpeton*, which was found in the interior of one of the erect Sigillariæ; a single species of land-shell, *Pupa vetusta*, was found in the same situation.

Zealously pursuing his observations, Dawson was enabled to issue in 1855 his well-known work entitled "Acadian Geology: an account of the Geological Structure and Mineral Resources of Nova Scotia." A third edition of this work was published in 1878.

In 1854 he became a Fellow of the Geological Society of London, and it is noteworthy that all his leading discoveries, before and afterwards, were brought before this Society. His contributions to geological science were many, and though dealing largely with fossil plants, with footprints and impressions of various animals, he also wrote concerning the higher forms of life, and devoted much attention to the phenomena of the Glacial period.

In 1862 Dawson was elected a Fellow of the Royal Society. Two years later his name was rendered familiar to every student of geology by the announcement of the discovery of an organism in the oldest known rocks, the Laurentian of Canada. As early as 1859 Sir William Logan had expressed his opinion that traces of organic structure were to be found in Laurentian limestone; but it was not until 1864 that Dr. Dawson determined by the aid of the microscope that the structure was that of a Foraminifer. He then gave to the "fossil" the name *Eozoon Canadense*, and his opinion was strongly supported by Dr. W. B. Carpenter and Prof. T. Rupert Jones. It is needless here to refer more particularly to the controversy that took place regarding this supposed organism; suffice it to say that for many years the fossil was figured as an organism in most text-books, and was considered to be the oldest evidence of life on the earth. If we turn to Prof. Lapworth's "Intermediate Text-book of Geology, 1899," p. 182, we still find a figure of "Eozoon"; but the author remarks: "the organic nature of *Eozoön* is discredited by most geologists, and the preponderance of scientific opinion has long been in favour of regarding it as a peculiar mineral structure, imitative of the organic." Dawson himself, however, in the *Geological Magazine* for 1895, still boldly upheld the animal nature of Eozoon.

In 1881 the Council of the Geological Society awarded to Dr. Dawson the Lyell Medal, the President (Mr. Etheridge) remarking on the value of his researches on the fossil flora of the Carboniferous and older rocks of Canada. In 1884 Dr. Dawson published a series of articles, and afterwards a small volume, on the geology of Egypt and Syria, but for the most part his original contributions relate to Canadian geology.

In addition to his Acadian Geology, he was author of several other more or less popular volumes, including "Archaia; or Studies of the Cosmogony and Natural History of the Hebrew Scriptures" (1860); "The Story of the Earth and Man" (1873, and many later editions); "The Dawn of Life" (1875); "Fossil Men and their modern Representatives" (1880); "Geological History of Plants" (1888); "Relics of Primeval Life" (1897).

Dr. Dawson was appointed C.M.G. in 1881, and he was knighted in 1884 on the first occasion when the British Association paid a visit to Canada. He was elected President of the Association for the Birmingham meeting in 1886.

He died November 19, in his eightieth year. His son, Dr. G. M. Dawson, C.M.G., F.R.S., is the distinguished and energetic Director of the Geological Survey of Canada.

H. B. W.

THE LEONIDS.

THE following communications have reached us with reference to the Leonid meteors observed last week:—

MR. DENNING'S REPORT.

It may be safely said that no meteoric display was ever so generally looked for and awaited with so much interest as the one which has just occurred. That the character of it should have proved disappointing is to be regretted, and especially so after the previous failures in 1897 and 1898. The astronomical world had been eagerly anticipating the event for many months, and the curiosity of the general public had been excited by articles in the newspapers pointing out, perhaps too confidently, that the meteors would appear in such amazing numbers that the event would form one of the most striking spectacles of a lifetime. Every one therefore sat up to see the shooting stars, but all more or less failed to realise the expectations they had formed. Some people saw nothing, for clouds or fog hid the moon, stars and meteors on the nights of November 14 and 15. Others had a clearer sky and a dazzling moon, but the grand display of meteors was entirely wanting. The constellation of Leo could be distinctly seen as it rose higher in the east, but meteoric stars only shot at intervals from the familiar "sickle." We had expected that the whole firmament would be furrowed with these "Leonids," as it was in 1799, 1833 and 1866; but instead of a heavy bombardment, there was only weak, desultory firing, and when, in the grey dawn of November 16 observers discontinued their vigils, it was with a feeling of regret; moderated, however, by the knowledge that better success might attend similar efforts in 1900 and 1901.

A large number of reports have been received from observers in different parts of the country. Observations were commenced on November 6 by Prof. A. S. Herschel, at Slough, and in three hours he counted twenty-eight meteors after 14h. on that night, but there was no sign of the Leonids. On November 8 he watched for two hours after 13h. 45m., and saw seventeen meteors, but still no indication of radiation from Leo. On the same night Mr. Besley, at Clapham, watched between 10h. 55m. and 13h. 10m., and counted twenty-two meteors, including seven Taurids and possibly two Leonids.

On November 10 further observations were secured by Prof. Herschel and Mr. Besley, as well as by Mr. T. H. Astbury, at Wallingford, and by the writer at Bristol. An aggregate of seventy-two meteors was seen, including perhaps two Leonids; but it is often very difficult to identify true Leonids from the same swift, streak-leaving meteors directed from other radiants in the neighbouring region of sky.

On November 11, in two hours between 14h. 30m. and 16h. 30m., the writer at Bristol noted ten meteors, including two certain Leonids. One of these at 14h. 52m. was a well-observed foreshortened path from $158°+15°$ to $160°+12°$, and would, in combination with the other Leonid, indicate the radiant at $152°+23°$. If this position is correct the radiant would appear to be a stationary one like that of the October Orionids.

On November 12 the sky was much clouded, but on November 13, between 17h. 8m. and 17h. 50m., Mr. J. E. Clark, at South Croydon, saw nine meteors (seven Leonids). At Bristol the S.W. sky was partly clear from 17h. 15m. to 18h., and five meteors (one Leonid) were counted. At Marlborough between 17h. 20m. and 18h. 30m. twenty-one meteors (eighteen Leonids) were seen by Mr. H. Savory. At Cambridge between 17h. and 18h. 25m. twenty-three meteors were counted by Mr. Hinks.

On November 14, Mr. T. H. Astbury, at Wallingford, registered twenty-five Leonids, and saw about a dozen more between 16h. 3m. and 17h. 53m. Sir W. J. Herschel, at Littlemore, Oxford, saw ninety-eight meteors (sixty-six Leonids) during the night. At Yeovil the sky was generally cloudy, but between 17h. and 18h. 30m. six meteors were seen crossing breaks in the clouds. Both at Littlemore and Yeovil a very fine non-Leonid was seen at 17h. 40m. At Worthing, Sussex, between 15h. and 18h. more than 200 Leonids were counted by Mr. A. R. Schulz. At Cambridge four observers watching from 12h. 5m. to 16h. 35m. observed forty-five meteors. At Brighton between 14h. 30m. and 18h. twenty-eight meteors (twenty-four Leonids) were noted by Dr. R. J. Ryle.

On November 15, 16 and 17, further observations were made, but meteors fell in very moderate numbers. They appear, in fact, to have been no more numerous than on mid-November nights in ordinary years when the comet is not far from aphelion.

Reports from foreign stations may possibly modify our present views and show that a fairly bright shower was observed elsewhere and during the daytime in England. But from a few descriptions already to hand from America and various parts of Europe it appears that the meagreness of the display formed a common experience even among observers situated in widely different longitudes.

There is every reason to suppose that though the shower has managed to elude us this year it must confront us next year, and possibly in 1901. It will be remembered that there were rich displays in 1866, 1867 and 1868. The one in 1866 occurred ten months after the parent comet of Tempel had passed through its perihelion (January 11), while the shower of 1868 appeared nearly three years after the return of the comet. The latter object probably reached perihelion last spring (though it was not observed anywhere), and we are clearly entitled to expect from the great extension of the meteor stream visibly encountered from 1866 to 1868 that exhibitions of the finest kind will be presented in the two ensuing years. Whether or not the phenomenon will be favourably perceptible in England is uncertain, but it ought to be seen in one of the two years.

In 1833 there was a magnificent display. In 1866 the earth passed through a section of the orbit three months in advance of the part we encountered in 1833. There was a very rich shower in 1866, but it was nothing like the preceding one. In 1899 the earth intersected a region of the stream six months in advance of that of 1833, and where the meteors are thinly distributed. Everything supports the view that observers will not watch in vain for these meteors in 1900 and 1901.

When we consider the circumstances affecting the visibility of the Leonids, we must readily concede that it will often evade notice at a given place. In England, November nights are rarely clear and clouds may hide the meteors, or the earth may traverse the swarm at some time during the 15 hours in a day when it possibly could be seen, for from 7 a.m. to after 10 p.m. either daylight or an invisible radiant places it beyond reach. But many of us will hope to find compensation for the disappointments of recent years in observing a brilliant return of the meteors in one of the two ensuing years, and certainly before the denser region of the stream gets too far on its outward journey to aphelion.

W. F. Denning.

Cause of the Non-appearance of the Shower.

None of the Leonid meteors are visible until and unless some out of their vast number chance to plunge into our atmosphere and are extinguished after a second or two of intense brilliance. We cannot accordingly follow their motions by observations in the open sky, and can only tell where they are when we can compute where they must be. This has become possible with reference to station A in the stream, that portion through which the earth passed in 1866, and of which Adams determined the osculating ellipse as it existed in that year. Any change either in form or position which it has since undergone has been due to perturbations. The meteors occupying that portion of the stream have nearly completed another revolution since 1866, November 13. The perturbations they have suffered in the latter part of their course have been computed in Germany by Dr. Berberich, and the perturbations over the whole of the revolution have been computed in this country by Dr. Downing and the present writer, with the aid of the skilled computers of the Nautical Almanac, and at the expense of the Royal Society. These more full computations enable us to follow all the motions of this portion of the stream. It will reach its descending node, where it comes nearest to the earth's orbit, on the 27th of next January, and is accordingly at present advancing towards the earth, along an osculating ellipse of which the present form and position can be determined. This has been done, and it has been thus ascertained that the earth passed the descending node of this orbit last Thursday morning at about 6 a.m. In 1866 this orbit intersected the earth's orbit, but unusually intense perturbations have since acted on it, and have so shifted its position that the point when it pierced the plane of the earth's orbit last Thursday, and which we may call point P, lay at a disrance from the earth towards the sun which was 0·0141 of the mean distance of the sun, that is, it lay about five times farther from the earth than the moon is. A subsidiary investigation, which will shortly be published, makes it almost certain that the point P indicated above is situated within the stream which was passing the earth last Thursday. This is the only point in the stream which was passing us last Thursday of which we actually know the position; and it was at the great distance from us which is above stated.

Now comes in another consideration. A separate dynamical investigation into the conditions under which the Leonids were drawn into the solar system by Uranus, has shown that when that planet advanced along his orbit and left them behind, they found themselves moving nearly with the same speed and nearly in the same direction, but not quite. They were in fact scattered over a very small cone of dispersion. This occasioned small differences to exist between the vast elliptic orbits round the sun, upon which they then entered. Some of the meteors found themselves in planes slightly more inclined to the ecliptic than others, some started along ellipses of slightly greater ellipticity, and so on; but all when they had travelled along the inward part of their new elliptic journeys would cross the plane of Uranus's orbit (which is nearly the plane of the earth's orbit) at points which lay along the line of nodes, measured in the plane of Uranus's orbit, a line which nearly coincided with the radius of the earth's orbit, which lay along the line of nodes in the plane of the ecliptic. Hence the stream became a ribbon-shaped stream at its descending node, where the earth encounters it, the width of the ribbon lying very nearly along one of the radii of the earth's orbit. The position of this ribbon has been somewhat altered by the perturbations to which it has been exposed during the seventeen centuries and threequarters which have since elapsed. Its width accordingly no longer lies quite perpendicular to the earth's orbit. We know that the stream has this ribbon shape, but we do not know its width further than that it is considerable, nor do we know where in the width of the ribbon the point P lies whose position we have been able to determine. That we have not had one of the great Leonid showers this year conclusively proves that the part of the width of the ribbon which lies outside the point P has not been able to reach the whole way out to the earth's orbit—a distance of about 1,300,000 miles.

G. Johnstone Stoney.

Greenwich Observations.

The Astronomer Royal reported to the *Times* on the 16th inst., that the preparations made at Greenwich for observing the Leonid meteors were rendered abortive by cloud and fog on the nights of November 14–15 and 15–16. During a short break in the clouds on the morning of the 16th only 16 Leonids were noted (by four observers) in 42 min. from 5h. 34min. to 6h. 16min. A.M. November 16. No photographs could be obtained.

Report from the Solar Physics Observatory.

To take advantage of the meteor shower that was expected at the earlier part of last week, the whole staff of the Solar Physics Observatory took part in a carefully-prepared programme. The observers were divided up as follows: The six-inch Dallmeyer camera for photographing the radiant point, and a siderostat with three small cameras mounted on its polar axis for obtaining spectra were worked by Dr. Lockyer and Mr. Howard Payn, who was a volunteer. Mr. Fowler took charge of an integrating spectroscope and a small visual spectroscope mounted equatorially to examine bright trails. The large 6-inch prismatic camera was used by Mr. Baxandall and Mr. Shackleton on alternate nights, while a 9-inch prismatic reflector and another battery of small cameras was worked by Mr. Butler and Mr. James.

On all the four nights (9 p.m. to 6 a.m.) during which a watch was kept, the weather was very unfavourable, and it was only for short periods of time on Wednesday and Thursday that a glimpse of the sky was at all possible. In fact, fog and cloud seemed to alternate or combine at the expense of a clear sky. To take advantage of a clear sky at some distance from the observatory, such as at Hampstead, several volunteers took up their positions there with advantage. At the observatory itself no photograph of any meteor trail or spectrum was obtained, and it was practically only for a short period on Thursday morning that plates were actually exposed with any prospect of success. Eye observations indicated, however, that if the shower had arrived on Wednesday or Thursday, at least some trace of its presence would have been seen during the period of observation, in spite of the fog, if the display had attained anything like its grandeur of 1866.

Tuesday night was apparently very clear at Hampstead, and one of our keen amateurs reported that between 10 p.m. and 4 a.m. the next morning, there was an absolute dearth of meteors. Another observer on Banstead Downs also saw no signs of the shower, for between 2.28 a.m. and 3 a.m. on the Wednesday morning, he counted only ten meteors, and these might not all have been Leonids. Brighton had a clear sky on the morning of Wednesday, and an observer there who watched between midnight and 4 a.m. saw no evidence of a display but sixteen Leonids and a few sporadic meteors. Several other observers who observed from Hampstead Heath on the Thursday morning early also reported no shower, but simply a meteor or two.

It must be concluded therefore that the expected shower did not arrive, or rather that the earth has not passed through any very dense portion of the swarm. It may be recollected that in the two preceding Novembers the Leonids were conspicuous by their absence, and this may practically be said of the recent display.

In addition to the above reports, the communications printed below have been received :—

Mr. E. C. Willis, of Ipswich, reports as follows :

November 14 :—

Time.	Meteors seen. Leonids.	Others.	Remarks on weather.	
12 5 – 12 45	1	0	Thick mist	Moonlight.
13 0 – 13 20	0	0	Very thick mist	
14 0 – 14 25	1	0	Thick mist	
16 45 – 17 0	10	4	Fine	No moon.
17 0 – 17 15	4	1	Fine, with some cloud	
17 15 – 17 30	8	3	Fine	
17 30 – 17 45	12	6	Fine	
17 50 – 18 5	2	2	Fine, sky much lighter	

November 15.—Observed occasionally from 11h. to 18h. The clouds at times covered the entire sky, while at times they were much broken up. No meteors were seen. The conditions were such that a brilliant shower could not have passed unobserved.

November 16.—Observed from 11.40 till 12.10. The sky was mostly covered with cloud. No meteors were seen.

The following notes by the Rev. Martin Wall, Fort Augustus, N.B., have been received from the Meteorological Office :—

"Great meteor" seen at 8.20 p.m., November 15. Flying with tremendous velocity south-east to north-west. Described, by an engineer, as a mass of flame of between 2 and 3 feet square ; in brilliancy like the arc-light ; leaving a trail of flame in its course, and lighting up the sky with a white light. It was seen by a second person to explode, over hill to north-west.

[N.B.—Indoors, where the electric light was burning, the diffused light of the meteor was distinctly noticeable.]

Two or three Leonid meteors were seen on the night of November 14 (one or two at 2 a.m., and one at 5.45) ; but the 15th and 16th were totally clouded over ; hence photographic preparations were of no avail.

[N.B.—Numerous ordinary meteors were also seen on the 14th.]

NOTES.

THE scientific lessons of the war are crowding upon us. We have already referred to the blunder made by our military authorities, in not sending Marconi apparatus to South Africa among the first equipments. We now learn indeed, after the investment of Ladysmith is drawing to a close, that Marconi apparatus is being sent out. The silence of Ladysmith during the last eventful weeks will point the moral, which is not likely to be forgotten in the future ; and it may well be that in the movements about to take place, in which the Ladysmith and the relieving force should be able to work in concert, the absence of a sure and rapid method of signalling, the absence of the Marconi apparatus, may render this difficult if not impossible. We have been informed on good authority that some time ago the importance of a locomotive search-light in operations of war was strongly represented to the military authorities ; but they would have none of it. Fortunately, however, the naval force in Natal has now provided the army with one. It is certain to do good service.

THERE can be little doubt that the presence of another scientific instrument, the balloon at Ladysmith, has saved the situation. A moment's consideration of what this touch of science can do for us will indicate that the above expression is well grounded. Imagine two identical maps of Ladysmith and its surroundings, including the region dominated by our guns, carefully marked with squares, so that the position of any patch can be exactly defined by the rectangular coordinates shown at the side. A1, A20, &c., X6, Z30, Z40, &c. Imagine one of these in the hands of an officer who knows the ground thoroughly well, in the car of the captive balloon. He telephones the position of the enemy to the officer commanding the artillery down below, who is possessed of an identical map. From this he can at once determine the azimuth and range, and in a few minutes the shell may be fired in the required direction. The telephone of the balloon will inform the gunners how the shell has been dropped, and any directions regarding range can be given. It will therefore be impossible for the rebels, thanks to the balloon, to form in daylight in any large numbers for an attack on the camp, without rendering themselves liable to the searching fire of the guns. May we hope therefore that the balloon will also be used along the chief line of advance? During a calm day it is possible that this scientific instrument may be far more valuable than an army of scouts, though the difficulties attending its working are fully recognised. Seeing then how important scientific instruments are in this struggle, in which millions are freely spent, we return to our question, how is it that there is no scientific committee to advise the Government in such matters, even if only to anticipate scientific applications? and how is it that from the Grand Council of the nation, the Privy Council, men of science are rigorously excluded?

A CONFERENCE of representatives of electric railway and electric tramway enterprises on the one hand, and representatives of the Government interested in the Greenwich and Kew Observatories on the other, was held at the Board of Trade on Wednesday in last week. The object of the conference was to ascertain the best means of dealing with the interference with the delicate instruments in the observatories by the leakage which there is reason to believe will follow from the introduction of large systems of electric traction. After Sir Courtenay Boyle had opened the proceedings, Prof. Rucker and the Astronomer Royal showed that magnetic instruments are seriously affected by the proximity of systems of electric traction ; but Sir Douglas Fox and Major Cardew would not admit that any interference with observatory instruments had at present been proved. As a result, a committee was appointed "to investigate the amount of magnetic disturbance produced in the neighbourhood of electric tramways and railways constructed and worked under the Board of Trade regulations ; and to report as early as possible." The committee consists of Profs. Rucker, Ayrton and Perry, representing the laboratories ; Prof. Kennedy, Mr. H. F. Parshall, Major Cardew and Mr. Brousson, for the electric traction companies ; and Mr. A. P. Trotter for the Board of Trade.

THE Paris correspondent of the *Chemist and Druggist* makes the following announcement :—The Professorship of Inorganic Chemistry at the Paris School of Pharmacy, vacant by the retirement of Prof. Riche, has been given to M. Henri Moissan. The latter's appointment as professor of toxicology at the School, which he already held, was perhaps due more to a very natural desire to attach the brilliant professor to the teaching staff than to poisons being his *forte*. He will now lecture on the subject that has practically been his life study. His first lesson on

Thursday afternoon of last week produced quite a little ovation, M. Moissan being loudly cheered by the large number of students present. He gave a short address on the career of Prof. Riche, and touched on the subject of electro-chemistry.

THE *Cecil Rhodes*—the first iron steamer designed for service on Lake Tanganyika—was launched at Wyvenhoe on Saturday. The steamer is to be employed primarily in laying the wires of the Cape to Cairo telegraph line along the shores of the lake. After the trial trip the boat will be dismantled and taken to pieces for shipment to Chinde, on the East Africa coast, whence she will be taken up the Zambesi and Shiré rivers by the Sharrers Zambesi Traffic Company, thence by native porters through Blantyre to Mpimbo, where she will be again shipped and carried across Lake Nyassa to Karonga, and finally taken overland along the Stephenson road to the south end of Lake Tanganyika, at which point she will be reconstructed and launched for the second time.

PROF. FERDINAND TIEMANN, honorary professor of chemistry in Berlin University, died on November 7.

DR. HENRY HICKS, F.R.S., the distinguished geologist, died on Saturday last, at the age of sixty-two.

THE death is announced, at Southport, of Mr. Alexander McDougall, who was widely known about sixty years ago in connection with the invention of the atmospheric railway, and has been associated since then with a long succession of mechanical and chemical appliances of public utility.

WE regret to see the announcement of the death of Dr. Camara Pestana, chief of the Bacteriological Institute at Lisbon. It was his verdict on specimens sent to him from Oporto for examination that conclusively established the existence of the plague there in August last. Dr. Pestana caught the plague while studying it at Oporto, and his death was due to that disease.

FROM the *Cape Times* we learn with regret that Prof. Francis Guthrie, until the end of last year professor of mathematics in the South African College, died on October 19. Prof. Guthrie was a brother of the late professor of physics at the Royal College of Science, South Kensington. He was born in 1831, and went out to Cape Colony in 1861 as professor of mathematics in the then newly-established Graaff-Reinet College. In 1875 he resigned his appointment at this college, and went to Cape Town. After a brief visit to England in 1876, he was appointed to the chair of mathematics in the South African College, then vacant by the retirement of the Rev. Prof. Childe. This appointment he held for twenty-one years, retiring from it in 1898. The Council of the college marked their appreciation of his long and honourable term of service by according a pension of double the amount to which he was legally entitled. Prof. Guthrie was deeply interested in botany; and he had the advantage of attending the lectures of John Lindley, an English botanist of high reputation. In Graaff-Reinet he gave, outside the college course, a series of public lectures; and on his removal to Cape Town, took up again more assiduously his botanical pursuits. Finally, he undertook, in conjunction with his life-long friend, Mr. Harry Bolus, the enormous task of a revision of the Order of the Heaths, for the next volume of the "Flora Capensis," now in course of preparation at Kew. Into this work he threw himself with all the ardour and enthusiasm of youth, and was engaged upon it up to a short period before his death.

FELLOWS of the Physical Society, and their guests, dined together at the Hotel Cecil on Friday evening, November 17. The president of the society, Prof. O. J. Lodge, took the chair, and the guests included many distinguished men of science.

MR. STEWART CULIN, of the University of Pennsylvania, is preparing a memoir on the late Dr. D. G. Brinton, at the request of the family of the deceased anthropologist. He will be glad to receive letters and other literary materials bearing upon the subject of his memoir.

THE *British Medical Journal* states that Mr. J. W. Stephens and Dr. R. S. Christophers, members of the Royal Society expedition on malaria, have returned home, but they may possibly at a subsequent date proceed to the West Coast of Africa.

As a proof of his cordial sympathy with the cause of bird protection, the Poet Laureate, Mr. Alfred Austin, has written a special poem for the Christmas card which the Society for the Protection of Birds is issuing this year. It is entitled "Peace and Goodwill to the Birds," and is illustrated by a coloured picture of that much persecuted bird the tern, designed for the purpose by Mr. A. Thorburn.

A MONUMENT erected, by public subscription, to the memory of the lamented astronomer, M. Felix Tisserand, late director of the Paris Observatory, was unveiled at Nuits-Saint-Georges on

October 15, in the presence of a distinguished company of men of science. The accompanying illustration of the monument is given in *La Nature* with an account of the inauguration ceremony. Général Bassot, speaking on behalf of the Academy of Sciences, referred to Tisserand's scientific work. M. Poincaré spoke as the representative of the Bureau des Longitudes; M. Baillaud reminded the company of Tisserand's work at Toulouse; M. Callandreau spoke on behalf of the Société Astronomique;

M. Tannery in the name of the École Normale; M. Bigourdan for old pupils; and M. Lœwy, the director of the Paris Observatory, as the representative of the Government and the Observatory. The French delight to honour their men of intellect; but it is not often that a memorial of the kind erected to Tisserand is unveiled in honour of a man who has devoted his life to science in England.

FOUR years ago a scheme was drawn up by the late Dr. E. von Rebeur-Paschwitz for the organisation of the study of earthquakes over the whole globe. He obtained for it the support of all the leading seismologists, but his early death unfortunately delayed its execution. Prof. Gerland, on whom Von Rebeur's mantle has fallen in Germany, continues to support the scheme, and, having secured the approval of the Geographical Congress at Berlin, has issued a pamphlet in which he suggests the foundation of an international seismological society. The objects of the society would be to diffuse as far as possible the study of earthquakes in all countries, and especially in those which do not yet possess seismological stations; to create a methodical organisation of microseismic observations; and to centralise the publication of reports, which would appear in the form of supplements to the *Beiträge zur Geophysik*. It is also proposed that the Society should hold its general meeting conjointly with the International Congress of Geography.

MAJOR S. J. RENNIE describes in the *British Medical Journal* a grave case of snake-bite treated successfully with Calmette's antivenene serum. In concluding his account, he remarks: "That we have in Calmette's antivenene serum a most powerful remedy against the bites of venomous reptiles has been fully proved both in the laboratory, and also, in a few instances, in actual practice. In the year 1896 it fell to my lot to treat the first case in which this serum was used in India, and since then other successful cases have been reported. The case under consideration is, however, of especial interest, in that it proves, first, that no matter how acute the symptoms, or how far advanced the effects of the poison, it is never too late to use the antidote; for, as will have been noted, the boy, in this instance, was, to all intents and purposes, dead at one time; and, secondly, that the "antivenene" will keep for an almost indefinite period, and exposed to all vicissitudes of climate, as I had the serum used in this case in my possession in the plains of India for nearly four years."

THE annual report by the Board of Trade on their proceedings under the Weights and Measures Acts has just been issued as a Parliamentary paper. The report refers to the biennial meeting of the International Committee of Weights and Measures, which was held in Paris in April last, to consider the work undertaken at the bureau of the committee since the year 1897, and also to arrange the future proceedings at the bureau for the years 1899–1901. The committee was attended by representatives from various countries, including Great Britain, and was presided over by the president, Prof. W. Förster, director of the observatory at Berlin. The discussions at the numerous meetings of the committee, and the results of the inquiries by the committee into the administration of the bureau and the scientific investigations undertaken there by the director of the bureau, Dr. J. René-Benoît, have been published under the directions of the committee in the "Procès-Verbaux des Séances de 1899," and also in the "Travaux et Mémoires du Bureau International des Poids et Mesures." The report states that the Board of Trade are in communication with some Government departments with the view of ascertaining how far the metric system of weights and measures might be officially adopted in contracts. The Standards Department have in course of preparation, for the purpose of explaining the principles of the metric system in schools, a set of education models of metric weights, measures, and weighing and measuring instruments similar to those used in trade.

TWO papers, dealing with the construction and equipment of the Waterloo and City Railway, were read at last week's meeting of the Institution of Civil Engineers. The first paper, by Mr. H. H. Dalrymple-Hay, was devoted to a description of the general features of the line, and the methods used in its construction. The new line is one and a half miles long, and, with the exception of a short length at Waterloo, consists of two iron tunnels with a station at each end, approached by stairs and inclines. The method of tunnelling in the London clay and in water-bearing strata was the well-known Greathead system, except in the case of a short length of tunnel which was driven by a new method not requiring the employment of a heading or timbers outside the shield. The average rate of working in the small tunnels was ten feet every twenty-four hours where the tunnels were in the clay. In the larger tunnels at the City Station, which were also in the clay, six feet was completed regularly in the same time. In water-bearing strata, however, the speed varied greatly, depending upon the character of the ground and the depth of ballast and head of water at the face.

THE second paper, referred to above, by Mr. Bernard M. Jenkin, gave an account of the electrical equipment of the line, which is the second underground railway that has been built to be worked electrically. The electric energy is generated at the Power Station, at the Waterloo end of the line, by high-speed engines coupled direct to two-pole dynamos. The energy is transmitted to the trains by feeders connected to an insulated rail, or conductor, placed between the two running rails of the permanent way. Experiments and tests were made on completion of the line to ascertain the time and power taken to drive a train from one station to the other under different conditions and with different limits of speed on the sharp curves. The time in which a train could traverse the whole of the distance from one station to the other depends mainly upon the maximum speed which could be allowed on the sharpest curves. There are some very sharp curves at the bottom of the dip in the line where it passes under the river, and it was originally intended that the speed on these curves should be limited to twenty-four miles an hour. Before the line could be opened it was inspected by the Board of Trade, and Sir Francis Marindin decided to limit the speed round the sharpest curves to fifteen miles an hour instead of twenty-four miles an hour, for which the whole of the electrical equipment of the line was designed. This alteration has had naturally a very great effect on the whole working of the traffic on the line, the brakes having to be applied to the train on the down gradients, as the speed which would be attained by gravity alone would very much exceed the limit of fifteen miles an hour by the time the curves were reached. The switchback principle of working the line cannot, therefore, be adopted as it might otherwise have been with the particular arrangements of gradients and the absence of intermediate stations which is the peculiarity of the line described.

IN the few years that have intervened since the water of Niagara was first turned into the wheel-pit of the Niagara Falls Power Plant, a large number of entirely new industries have sprung up around, or within easy touch of, the power station. That the tendency is for the industries to gravitate to the power rather than the power to be transmitted to the industries is shown in an account given in the *Scientific American*, from which it appears that out of a total of 35,000 horse-power delivered from the station, over three-fourths are consumed in its vicinity, as against less than one-fourth that is transmitted to a distance—the principal long distance transmission being that of 8000 horse-power to Buffalo, for the use of the Cataract Power and Conduit Company. It must not, however, be concluded that long distance transmission will not enter largely into the ultimate utilisation of the energy of Niagara. The remarkable installation recently opened in Southern California, where a transmission of eighty-three miles has been successfully accomplished, suggests that a large part of the 7½ millions of hydraulic horse-power available at Niagara Falls may yet be transformed and transmitted to the large cities of the eastern States. The present indications are, however, that for some time to come transmissions are not likely to be attempted for distances of over 100 miles.

THE success of the Naples Zoological Station in preserving marine animals for the purposes of both exhibition and study is so well known to all interested in museum work, that they will be prepared to welcome the translation by Mr. E. O. Hovey, which has recently appeared in the *Bulletin of the U. S. Museum* (No. 39), of Dr. Salvatore Lo Bianco's memoir on the methods employed in such preservation. It is to Dr. Lo Bianco himself that the exquisite results obtained are chiefly due; and the translator appends the following remarks on the secret of this success. "One reason for the beautiful appearance of the material sent out by the station is that it is properly caught in the first place; another is that, for the most part, the animals are alive when the process of preservation begins. With many forms it is indispensable that they be alive at the beginning of operations; with some it is not so necessary, but with all it is highly desirable. . . . The best methods have been determined for each species by itself, different species of the same genus often requiring different handling. . . . When new species are encountered, the best method of procedure must be determined by experiment." It is interesting to note that the author assigns to alcohol the first place as a preservative medium; adding that although formalin is a very useful liquid for keeping animals temporarily, it is less well suited for their permanent preservation.

LOCAL scientific societies often have a tendency to develop into societies for the promotion of penny readings and popular lectures; but the committees should always bear in mind that though interesting accounts of the scientific work of others may create a desire to know more of the facts of nature, the real value of a local scientific society must be judged by the facilities afforded for original observations, and the use the members make of them. The Preston Scientific Society, to judge by the annual report presented last week, not only encourages interest in science by means of lectures, but in each of its sections systematic studies and individual investigations are organised. A scheme for identifying and recording the flora of Preston and the neighbourhood was drawn up three years ago, and has been actively carried out during the past summer. Much new information has thus been gained, and in regard to the flowering plants it appears that the flora of the district was never so completely known as it is now. Mr. E. Dickson, who has been elected president for the ensuing year, pointed out in his address that this is the kind of work that can usefully be done by a local society, namely the investigation of local facts and phenomena. There is much to be done in the way of working out details of the natural history in every district, and the societies which stimulate activity in the required directions will assist in the advancement of scientific knowledge.

THE *Bulletin* of the Cracow Academy for July contains an important note of a mathematical character by Dr. Ladislaus Natanson on the thermokinetic properties of solutions. The present investigation appears to furnish a thermodynamical interpretation of Van 't Hoff's molecular theories of osmotic pressure.

WE have received the fourth report of the International Commission of Glaciers. The report is entirely devoted to records of glacier measurements made in various parts of the world during 1898; it forms a substantial addition to our knowledge of glacier movements and their periodic variations.

THE new *Bulletin de la Société de Géographie* contains a number of papers of more than average interest. Mr. F. J. Clozel contributes a historical paper on the Ivory Coast; Captain Chanoine writes on the Voulet-Chanoine Mission; Dr. Huguet describes the physical geography of Southern Algeria in a paper illustrated by some rough but suggestive sketches of sand-dunes. There is an account by Dmitri Klementz of travels in Western Mongolia in 1885 and 1897, and the first part of an important paper on the Meteorology of Palestine and Syria, by Father R. P. Zumoffen, S.J.

WE have received parts 1-3 of vol. xxi of the *Transactions and Proceedings* of the Botanical Society of Edinburgh (1897-1899), which contain several interesting articles, especially on the structure and microscopical examination of woods, recent and fossil, viz.:—On the histological structure of fossil woods, by Mr. R. A. Robertson; on a method of injection-staining plant vascular systems; on contact negatives for the comparative study of woods; and on the histology of some fossil woods, by the same writer. Mr. R. Stewart McDougall has a paper on the bacteria of the soil, with special reference to soil inoculation; Mr. R. Turnbull, one on *Apodya lactea*, a fungus belonging to the Saprolegniaceæ; Mr. Percy Groom, one on the fusion of nuclei among plants, and Mr. R. A. Robertson, one on abnormal conjugation in *Spirogyra*.

OUR German contemporary *Globus* is always interesting, and it is a great pity that there is no journal on similar lines in the English language. The following articles in recent numbers are well worth reading: "The Philipponens of Ostpreussen" (vol. lxxvi. No, 12) gives an account of the houses, mode of life, and religious beliefs of a strange Christian sect that was established about 1700 by Philip Pustoswiät. "The Onondaga Indians of New York State, and the Sagas of the foundation of the confederation of the five nations by Hiawatha" (Nos. 13, 14). "Indian and Singhalese Children and their Games" is a welcome addition to a neglected subject; there are several illustrations (Nos. 14, 15). R. Schumacher gives (No. 15) an illustrated ethnographical account of a recent travel among the uncivilised Tschin-huan who live in the high and hard-to-reach mountains of Formosa; the author does not believe that they are an aboriginal population (No. 14). "Folk-lore among the Huzulen" (Nos. 15, 16, 17). Dr. H. Jansen gives (No. 17) a valuable illustrated *résumé* of recent ethnographical, anthropological, and archæological work in Portugal. We would call attention to the illustrations of existing pile dwellings.

MESSRS. WILLIAM WESLEY AND SON have sent us a catalogue of books and pamphlets on modern astronomy, which is a model of clear and orderly arrangement. The catalogue is limited to astronomical literature of the nineteenth century, and includes 2240 titles, arranged under thirty-three heads and subheads. The classification adopted is particularly convenient, and it enables an astronomer to find at once the works in the list bearing upon the branch of celestial science in which he takes special interest.

THE additions to the Zoological Society's Gardens during the past week include a Diana Monkey (*Cercopithecus diana*, ♂) from West Africa, presented by Mr. E. F. Martin; a Spotted Ichneumon (*Herpestes auro-punctatus*) from Busreh, presented by Mr. B. F. Ffinch; two Dusty Ichneumons (*Herpestes pulverulentus*), a Cape Crowned Crane (*Balearica regulorum*) from

South Africa, presented by the Trustees of the South African Museum; two Schalow's Touracous (*Turacus schalowi*), four Cape Turtle Doves (*Turtur capicola*) from South Africa, presented by Mr. W. L. Sclater; a Vulturine Eagle (*Aquila verreauxi*) from South Africa, presented by the Rev. D. Kolbe; a Tawny Eagle (*Aquila noevioides*) from South Africa, presented by Mr. Claude Southey; a White-tailed Gnu (*Connochaetus gnu*, ♂) from South Africa, presented by Mr. C. D. Rudd; two Mandrills (*Cynocephalus mormon*, ♂ ♂), two White-collared Mangabeys (*Cercocebus collaris*, ♂ ♀), a Tantalus Monkey (*Cercopithecus tantalus*, ♂), a Lucan's Crested Eagle (*Lophotriorchis lucani*) from West Africa, a Spring-Bok (*Gazella euchore*, ♂) from South Africa, a White-tailed Ichneumon (*Herpestes albicauda*) from the Atbara River, a Yellow-headed Conure (*Conurus jendaya*) from South-east Brazil, four Lesser Pin-tailed Sand-Grouse (*Pterocles exustus*), a Black-headed Partridge (*Caccabis melanocephala*) from Arabia, deposited; a Roi Rhe-Bok (*Cervicapra fulvo-rufula*, ♂) from Maryland, Schombie Station, Cape Colony, a Gannet (*Sula bassana*), British, purchased.

OUR ASTRONOMICAL COLUMN.

HOLMES' COMET (1899 *d*).

Ephemeris for 12h. Greenwich Mean Time.

1899.	R.A. h. m. s.	Decl. ° ′ ″
Nov. 23	... 2 13 55·17	... +47 40 0·2
24	... 13 6·67	... 32 36·4
25	... 12 20·16	... 25 1·7
26	... 11 35·67	... 17 16·9
27	... 10 53·25	... 9 22·5
28	... 10 12·94	... 47 1 19·5
29	... 9 34·75	... 46 53 8·4
30	... 2 8 58·72	... +46 44 50·0

COMET GIACOBINI (1899 *e*).—Several observations of this comet having been obtained, Herr S. K. Winther continues his ephemeris in the *Astronomische Nachrichten* (Bd. 150, No. 3600):—

Ephemeris for 12h. Berlin Mean Time.

1899.	R.A. h. m. s.	Decl. ° ′	Br.
Nov. 23	... 17 52 33	... +10 17·6	
24	... 54 12	... 10 34·0	... 0·50
25	... 55 52	... 10 50·5	
26	... 57 32	... 11 7·0	
27	... 17 59 12	... 11 23 6	
28	... 18 0 52	... 11 40·2	... 0·48
29	... 2 33	... 11 56·9	
30	... 18 4 13	... +12 13·7	

During the week the comet passes from the northern part of Ophinchus into Hercules, about 6° east of α Ophinchi.

REFRACTION EFFECT OF COMET SWIFT (1899 I).—Prof. C. D. Perrine, during May and June 1899, made several attempts to determine if any appreciable refraction was caused by the body of Swift's comet on a ray of light passing through it, and contributes his conclusions to the *Astronomische Nachrichten* (Bd. 150, No. 3602). The observations were made with the 36-inch Lick refractor, and consisted of determining accurately the position angle and distance of two stars, (1) when one or both of them were seen enveloped in the mass of the comet; (2) when quite free from the cometary matter. The diameter of the head of the comet was computed to be about 174,000 miles, and the extent of matter traversed by the light from the stars about 163,000 miles. The greatest range of variation in the measured distance of the stars was 0″·26, which the author thinks in all probability accidental, as no systematic variation was detected; so that from these experiments the conclusion is that the mass of a comet causes no appreciable effect of refraction on light passing through it.

PREDOMINANCE OF SPIRAL NEBULÆ.—In the *Astronomische Nachrichten* (Bd. 150, No. 3601), Prof. J. E. Keeler describes the preliminary results of his inquiry into the structure of nebulæ. The discussion is based on photographs obtained with the Crossley reflector of the Lick Observatory, and the author finds that in addition to confirming the spiral structure of the nebulæ catalogued by the Earl of Rosse, so many others possess the same characteristic form that their being put in a special category loses its significance; in fact, any small compact nebula not showing evidence of spiral structure, appears exceptional. He finds gradations leading to the belief that the elongated spindle-shaped nebulæ of Herschel also really belong to this class. The author concludes by stating that if numerous exceptions prove that spirality in nebulæ is not an universal law, it may perhaps be regarded as the usual or normal accompaniment of contraction in cosmical masses, and any departure from it may be explained as the result of special conditions, tending to suspend or weaken causes which are generally in operation.

BULLETIN ASTRONOMIQUE.—The *Bulletin Astronomique* for November 1899 contains an illustrated article by M. Camille Flammarion on the "Eclipses of the Twentieth Century visible at Paris." Forty-three eclipses of the sun will be visible, two of them being total, and thirty-three presented in good positions for observation. The particulars of each are given, with a diagram showing maximum phase. The same author describes the observations of 339 Perseids made at Juvisy from 10–13 August 1899, with illustrations showing the plotted paths. The mean position of the radiant was RA = 3h. 3m.; Decl. +56°.—M. Souleyre concludes his article on the "Distribution of rain on the earth's surface."—M. A. Benoit contributes a very interesting article on "Transneptunian planets," giving particulars respecting a proposed instrumental equipment for a systematic search for such bodies.

THE FITTING OF THE CYCLE TO ITS RIDER.[1]

THE present time is opportune to notice some points in cycle riding which have received our attention during the last three years. Every intelligent rider of a cycle must have at some time compared his powers as a human motor with the motors that drive the motor-cars which he now so frequently meets in the streets. He naturally wishes to study the question of most efficient propulsion, including that of his own mechanical efficiency as a motor driving his cycle. The design of the modern cycle was so far developed by 1896 that a standard type then became the rule, most cycles having a 45-inch wheel base, two wheels of equal diameter 28 inches, cranks 6½ inches long, and a ratio of gear varying between 59 to 80 inches, the sole difference made between cycles intended for tall riders and those for short ones consisting in varying the height of the frame. In 1896 the writers, being urged thereto by Mr. Otto Blathy, the well-known engineer of Budapesth, had their attention called to the necessity of varying the crank length to suit the varying length of leg of the rider. A series of experiments was carried out for cranks up to 9½ inches long, and the results obtained were very remarkable. It may now be taken as admitted that a very large proportion of the riders who have tried cranks of increased length have found great benefit from their use, but although they feel strongly how tangible these advantages are, some difficulty has been felt in satisfactorily explaining them.

All that has been written on cycle riding in the past has been confined to the style of riding which has been gradually elaborated on cycles fitted with the standard 6¼-inch to 6½-inch cranks, but this is little or no assistance to us when we attempt to investigate the subject through wider limits of muscular movement.

When mechanical engineers measure the efficiency of any form of mechanical motor they confine themselves generally to the consideration of the fuel that it consumes, but do not, as a rule, when considering its efficiency, take into consideration the cost of keeping it in repair, or include with it the cost of feeding and maintaining the driver; but the food which is the fuel of the cycle rider has not only to perform the same duties as the fuel of the mechanical motor, but has in addition to supply the nerve waste and repair the muscle waste which answers to the repairs to the mechanical motor, and from the same supply to maintain the brain power of the driver. The food energy of the cyclist has, therefore, to be distributed through three distinct channels: the first in importance is that which is required

[1] Abstract of paper read before the Cycle Engineers Institute at Birmingham, by R. E. Crompton and C. Crompton.

to repair brain waste, and which we hereafter call "Brain Waste"; second, that required to supply the nerve action, which energises the muscles when ordered to do so by the brain, and which we hereafter call "Nerve Waste"; and third, that for the upkeep of the muscles themselves, and which we hereafter call "Muscular Waste." Hitherto writers have, we believe, given too much prominence to the last-named of these. We think that, instead of being the most important of all and taking the largest share of food, it is probably the least important of the three. Dr. E. Turner has shown a method of estimating, with considerable scientific accuracy, the proportions of the food supply required by the above three sources of waste. He has noticed that the proportions of uric and phosphoric acids present in the human urine after exertion give the measure of the brain and nerve wastes relatively to the urea present, which is a measure of the muscle waste. A long series of experiments have made us feel reasonably certain that the nerve waste is practically proportional to the number of times that the nerve centres energise the muscle in order that it may make a stroke; in other words that the nerve waste is proportional to the number of revolutions of the crank shaft of the cycle, and it is doubtless this fact that has led to the craving for high gears, which allow of a reduced number of crank revolutions, as riders have found that by reducing the number of crank revolutions they can economise their nerve waste so as to leave a greater reserve of food energy to supply brain and muscular waste. Our attention was directed to this at a very early stage in our experiments; but we found that a limit was soon reached to the raising of the gear, as if the crank length is kept constant the crank pressure necessary to drive the cycle increases just as the gear is increased, so that a strain is brought on the muscles at times of facing high winds or climbing steep hills, which is greater than the muscles can stand without muscular soreness setting in; in fact, the limit of strain is surpassed, which it will be convenient to call the "elastic limit" of the muscles, and whenever this "elastic limit" is passed for more than a few minutes the muscle is temporarily weakened for the remainder of the day's run; in fact, the repair of that muscle cannot be made until the rider rests and sleeps as well.

We have adopted this term "Elastic Limit" of the muscles because it corresponds very closely to a term well known to mechanical engineers when used to express the extent to which metals may be strained or stretched without taking permanent set; so long as they are subjected to strains within this limit no permanent injury is done to the metal, whereas if it is passed the structure of the metal is altered and becomes weaker and liable to fracture. This process of being strained, even to a small extent above the elastic limit, has been sometimes called the fatigue of metals, and is somewhat analogous to the fatigue of muscles strained above their elastic limit.

We use the term "Pedal Pressure" and symbol "F" to express the pressure in lbs. which the rider must apply at the pedal during the entire revolution of the crank shaft in order to drive his cycle at the required speed. We measure the total resistance or pull of the cycle on the road in lbs., and call it total resistance expressed by our symbol "R," the power exerted by the cyclist, that is, the rate of doing work in foot pounds per minute by the symbol "P," and the work done in foot pounds per hour by the symbol "W." So long as the crank lengths are kept constant, or nearly so, the term geared to 60 or 70, as the case may be, give a sufficiently accurate idea of how far the pedal pressure "F" is influenced by the ratio of revolutions of the crank shaft to that of the driving wheel, but immediately the crank length is varied this term gear leads to confusion. We think a better term is multiple, which we denote by the symbol "M." "M" is the figure by which the angular speed of the feet or pedal is to be multiplied in order to get the lineal speed of the cycle moving along the road, consequently R multiplied by M gives F. We have prepared several tables which give the value of "R" for speeds varying from 5 to 20 miles an hour. It will be seen that "R" consists of three parts, $r1$, $r2$, and $r3$. $r1$ is the mechanical friction of the cycle, $r2$ is the road rolling and tyre resistance; these two first are functions of the weight of the machine and its rider, $r3$, the most important of all, is that due to air resistance. In a second table we have the value of F worked out for various multiples, and in a third table we give the value of F under maximum conditions of hill climbing at a speed of 8 miles an hour. From

TABLE I.—*Giving Values of R for a Rider and Cycle weighing* 190 *lbs. at Speeds from* 5 *to* 20 *miles an hour.*

V = miles per hour	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Wind pressure in lbs. per sq. ft. = ·00241 V^2	·0602	·0867	·118	·154	·195	·241	·291	·347	·407	·472	·542	·616	·696	·780	·870	·964
R^3 = ·00241 $V^2 \times$ 5·5 sq. ft. when area is 5·5 sq. ft.	·353	·48	·653	·85	1·[illegible]8	1·33	1·64	1·92	2·25	2·61	3·00	3·41	3·85	4·32	4·81	5·33
$R^1 + R^2$ = ·0008 $WV^{\frac{2}{3}}$ when W = 190 ...	·94	1·07	1·2	1·3	1·4	1·52	1·61	1·72	1·82	1·9	1·98	2·10	2·16	2·25	2·3	2·4
R_1 R_2 R_3 = R ...	1·293	1·55	1·853	2·15	2·48	2·85	3·25	3·64	4·07	4·51	4·98	5·51	6·01	6·57	7·11	7·73

TABLE II.—*Giving Values of F for a Rider and Cycle weighing* 190 *lbs. at Speeds from* 5 *to* 20 *miles an hour.*

Miles per hour = V	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
M = 4½	5·82	6·95	8·32	9·65	11·18	12·8	14·6	16·4	18·3	20·3	22·4	24·8	27 0	29·5	31·9	34·8
M = 5	6·45	7·75	9·25	10·7	12·4	14·25	16·23	18·2	20·3	22·5	24·8	27·5	30·0	32·7	35·5	38·6
M = 5½	7·1	8·5	10·2	11·8	13·6	15 65	17·85	10·0	22·4	24·75	27·3	30·3	33·1	36·1	39·2	42·5
M = 6	7·75	9·3	11·1	12·9	14·9	17·05	19·5	21·8	24·5	27·0	29·8	33·1	36·2	39·4	42·9	46·4

TABLE III.—*Values of F in lbs. on Various Hills with Different Values of M at* 8 *miles an hour.*

Hill of	1 in 30	1 in 25	1 in 20	1 in 15	1 in 10
M = 4½	38·160	43·875	52·425	66·645	95·175
M = 5	42·40	48·75	58·25	74·05	105·75
M = 5½	46·640	53·625	64·075	81·455	116·325
M = 6	50·88	58·50	69·90	88·86	126·90

these tables we are able to show that we have to deal with values of F varying from 18 lbs. to 130 lbs. It will be seen that the F required by an average rider using a multiple of 5 when he is maintaining a speed of 12 miles an hour on a calm day will vary between 18 lbs. and a maximum of 106 lbs. when he is climbing hills of 1 in 10 at a reduced speed of 8 miles an hour. These figures are representative as average conditions of the forces which have to be exerted by riders, although it is needless to say that far greater values of F are reached by riders when racing or in hill-climbing competitions.

We have endeavoured to give some approximate value of the elastic limit of muscles, and have made extended experiments to settle this point. In the case of one of the writers, the elastic limit of the quadriceps cruris at the point where soreness is usually felt, *i.e.* just above the knee, appears to be that corresponding to an F of 120 lbs., so that in this case with a multiple of 5, whether the arrangement be 6½-inch cranks, 65 gear, or 9½-inch cranks, 95 gear, a gradient of 1 in 10 can be ridden, and it is probable that this limit can be reached for three or four minutes without causing the muscular soreness. This of course varies greatly with the physical condition of the rider, but it is probable that this elastic limit is a function of the cross section of the muscle, and that the above value may be taken as an average one for men of average physique; with women it is probably somewhat less. It appears certain that the value of the elastic limit is a most important determining factor in designing a cycle to enable a rider to develop his physical powers when cycle riding in the most efficient manner. Once we determine it we can fix on the multiple M, and then, as we desire to keep down the nerve waste by reducing the crank revolutions for a given road speed, we can only do this, as M is a fixed quantity, by increasing the crank length. To what extent can this be done to give the best possible efficiency? The rider's thigh bones and the muscles that work them up and down may be looked upon as levers working on the hip joint as a fixed point, the outer ends being connected to the pedal by the shank bones, ankle joint and foot acting as a rather complicated connecting rod. The effective length of the thigh bone of riders varies between 15 inches for short men and 23 inches for tall men. The length of the standard 6½-inch cranks is therefore 43 per cent. of the length of the thigh bone on short riders, but only 28 per cent. of its length in tall men. In the case of the writers it is about 35 per cent. It was necessary to determine this proportion of the crank length to the thigh-bone length.

Our experiments, extending over three years, show that although we have gradually increased the crank length from 6½ inches to 9½ inches, in other words, from 35 per cent. up to 53 per cent. of the effective length of the thigh bone, we have not yet passed the point of greatest efficiency. Our proposals have of course been severely criticised, mainly by those who have not tried the system, and the following objections have been urged against increased crank length.

(1) Causing loss of power when hill climbing, or when riding against the wind, in fact at any time when the F required is considerable, and that this loss of power is caused by the excessive bending of the knee joint, which in its turn causes knee soreness.

(2) Militates against proper ankle action.

(3) Causing saddle soreness, bad steering, and other troubles.

(4) Causing extra strains on the parts and frame of the cycle.

Dealing with these questions in the above order, we have shown that the main object of increasing the crank length is to reduce the number of revolutions at a given road speed without increasing the value of F, and as it is practically certain that the knee soreness complained of entirely depends on this value of F not being exceeded, the only other way in which knee soreness could be produced is by excessive knee flexure. There are two ways in which this question of knee flexure may be considered. It has been said that when the knee is bent beyond a certain angle the muscles act at a disadvantage, and again that the extra flexure of the joints is the cause of the soreness which riders complain of, and that a rider having an 18-inch thigh bone can actually exert a greater pedal force at the half-stroke of 6½-inch cranks with its corresponding knee angle, than he can with 9 inch cranks and the correspondingly increased angle. We have, however, settled this question by careful experiments made in a testing machine, and we have shown that the knee angle at which the maximum pushing strain can be exerted is that which corresponds to a crank length of 18¾ inches; in other words, that the maximum force of the leg is obtained with a knee flexure far in excess of that required for any possible crank length that could be used on a cycle, so that this question of loss of power from excessive knee flexure is completely disposed of. Fig. 1 shows these results plotted on a curve.

TABLE IV.

Distance between hip-joint and ball of foot in inches	Angle at knee between shank and thigh	Maximum push in lbs.
22	75° 30′	325
23	79 36	370
24	83 31	390
24½	86 0	412
25	87 44	408
26	92 46	385
27	97 32	362
28	102 32	325

What writers mistake for knee soreness caused by excessive flexure is really due to the following cause. Any muscle which is constantly used throughout only a part of its stroke becomes developed and hardened into a condition which Sandow calls "a muscle-bound condition." It becomes shorter as it is never properly stretched out, the tendons which secure it also become shortened, and if this condition is not speedily remedied it becomes permanent. In the hard riding short crank cyclist, this applies to the quadriceps cruris, it being only called upon to work through a part of its stroke. When such a cyclist uses long cranks for the first time, he finds himself unable to properly flex his knee joints on account of this shortening of the quadriceps. The effort of stretching the muscle out to its full stroke causes the knee soreness complained of. There can be no question, however, that long crank riders benefit greatly by the extra knee flexure, compelled by the long cranks, and that this greatly increases their bodily activity and enables them to excel in exercises, such as running, walking, hill climbing and jumping, all of which require flexibility of the knee joint. Sandow points out that the best way to prevent the muscle-bound condition is to work the muscles in pairs throughout their full stroke; consequently, if we desire to develop the quadriceps cruris in a perfect manner to the full length of its stroke, we must also develop the muscles which form the pair to it on the underside of the thigh, *i.e.* the biceps cruris. It occurred to us, therefore, at an early period, that we ought to train these muscles to do their share of the work of propelling the cycle, hence arose what we call the pull stroke. Cyclists who use toe clips, or those who notch the soles of their cycling shoes, so as to get a better grip of their pedals, can use this pull stroke to a small extent; that is to say, they can claw or pull the pedal round

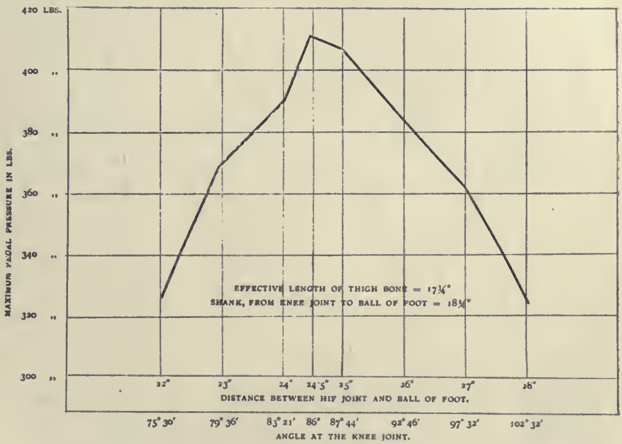


FIG. 1.—Curve showing relation between knee angle and maximum thrust on pedal.

during the lower portion of its circular path; but unless special devices are provided to enable them to draw the pedal upwards throughout a much larger arc, they cannot make use of the pulling muscles in a satisfactory manner. In order to do this we have bent our pedal plates slightly forward, as shown on Fig. 2, and we have prepared shoe plates of a form which enable them to hook into the back plate of the pedal.

It will be seen that our pulling device differs essentially from toe clips, which do not enable the upward pull being made unless the toe is pointing downwards. We find that this militates against good ankling action, and has a tendency to induce cramp in the calf muscles; on the contrary with our pulling device, the calf muscles may be quite inert during the upward stroke, the shank acting merely as a connecting rod in tension. It will be seen that the pull stroke enables us to reduce

FIG. 2.

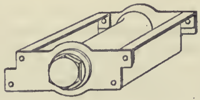


FIG. 3.—Crompton patent pedal.

the minimum pressure on the downward stroke, which is necessary to produce the average pressure F. Our experience of this subject is that it takes a long time to teach these muscles, which are seldom used except by running men, to take up their share of the work of cycle propulsion, and those who begin to use the pull stroke will find that, although it does greatly reduce the pushing strain made by the upper thigh muscles in hill climbing, yet that the thought and attention required to apply it under ordinary conditions of riding is so considerable that they do not persevere in practising it. It is our opinion that it is well worth while for a rider to cultivate the pull stroke. The pulling muscles are large and powerful, their elastic limit is high, it is not easy to overstrain them, and the extra brain waste that is required during the process of teaching these muscles is soon found to be reduced, as by practice these muscles automatically take up their share of the work.

It has been said that increased crank length militates against proper ankle action. The use of ankle action is not generally understood. The moving portion of a man's leg has considerable weight, when it is at the top of the stroke it possesses potential energy which is changed into kinetic energy as the leg descends, when it gets at the bottom of the stroke it stops going downwards and commences to rise, and the kinetic energy due to the downward movement of the leg has to be given up. What becomes of it? If the stopping of the leg is done by the same muscles which lift the leg there is a considerable waste of power, but if towards the lower end of the downward stroke the man begins to flex his calf muscles the velocity of his leg is gradually decreased, the force required to do this not coming from the muscles which move his leg, but from the calf muscles, which take a purchase, not against the saddle, as would be the case if he did not use ankle action, but against the pedal itself, so that the kinetic energy which is taken out of the leg in stopping its descending weight is usefully employed in propelling the cycle, and thus there is a great saving of energy by good ankle action.

If we take curve Fig. 4, the vertical lines of which represent velocity, the velocity downwards being represented by the vertical lines below the base line A B, and the velocities upward by the vertical line above it; if also we take the horizontal line to represent time when travelling with 60 gear and 6-inch cranks at 10·71 miles an hour, M being 5, a complete revolution is made in one second, and the upward and downward velocity of the leg at any moment is shown by the curve. Now rate of acceleration is change of velocity at a given time, and therefore the acceleration at any point is represented by change of velocity in a given time at that point. Suppose the acceleration to remain the same throughout that time as it is at the point P, the curve would describe a tangent to that curve at the point P and the acceleration—that is, the change of velocity divided by the time—would equal the tangent of the angle formed by the tangent of the curve with the base line.

You will notice that up to 90 degrees the tangent increases as the angle increases, therefore the steeper the curve at any point the greater is the acceleration at that point, and the greater the acceleration the greater the rate at which kinetic energy has to be taken out of the leg, and therefore the greater necessity for ankling. If, however, when riding at the same speed we use 9-inch cranks with 90 gear M is still 5, but the curve takes the form of the black line. You will see that the curve is obviously of the same relative shape as the red curve, but it is drawn out lengthways in the proportion of 6 to 9, and therefore the angles which the curve makes with the base line at any point is less than the angle which the red curve makes at a corresponding point. The tangents of the angle of steepness vary as 6 to 9, and the rate at which acceleration is reduced is also as 9 to 6, so that the necessity for careful ankling is in this case reduced in the same proportion, in other words, for equal efficiency long cranks do not require such careful ankling as short ones; although as more time is given in which to carry out such ankling, it is easier for the average rider to acquire it to a sufficient extent.

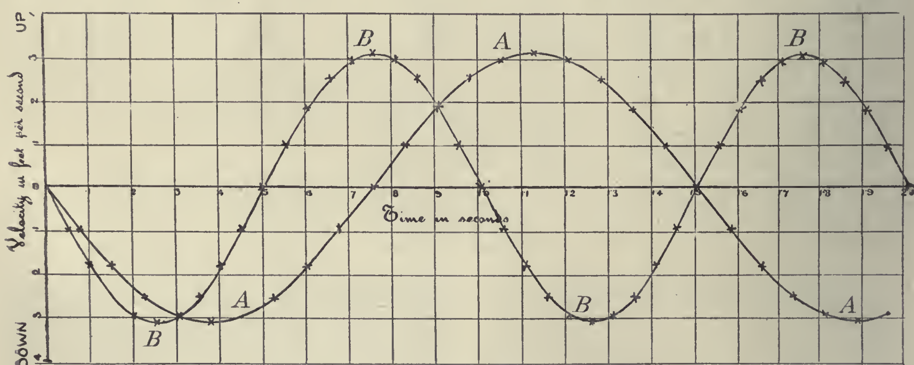


FIG. 4.—Curve B shows vertical velocity of pedal of 6 inch crank, 60 gear } Both at speeds of 10·71 miles per hour.
" A " " " 9 " " 90 "

It is unnecessary to deal at any length with the question of saddle soreness. We cannot find that lengthened cranks have made any notable difference in this respect. Those who were liable to soreness with short cranks have not had this liability increased, but rather decreased by the new system. The position of the saddle has of course to be carefully attended to in riding with the lengthened cranks. As to the bad steering, this is an imaginary fault. We find that a well-designed machine will steer just as well, hands off, with long cranks as with short ones. It is true that the long cranks do introduce some extra strains into the cycle. The cranks themselves have to be carefully designed and made of special material. The use of nickel steel has enabled us to make the long cranks of ample strength, although they weigh very little more than short ones. The strains introduced into the frame are mainly those due to chain pressure, and are not influenced by crank length but entirely by the speed of the chain. The speed of the chain can be increased by enlarging both the sprocket and back pinion wheels. Summarising our results it appears—

(1) That when we talk of designing the cycle to suit any individual rider, so as to develop his powers as a motor to the greatest extent, we have first to consider how we can best economise his nerve waste by enabling him to reduce the number of revolutions and increase the stroke through which his legs can travel. Our experiments have shown us that these conditions are best fulfilled in the great majority of cases by giving to the rider a length of crank equal to half the length of his thigh bone.

(2) That the value of M the multiple, in other words the gear, is then to be determined by the maximum strains which his muscles will stand, and we believe in most cases this corresponds to a pedal pressure F not exceeding 100 lbs. for weak individuals up to 140 lbs. for strong ones.

(3) That the crank length determines the shape of the frame and the length of the wheel base, and that the extra long wheel base necessitated by the long cranks renders the cycle pleasanter to ride and does not materially increase its weight.

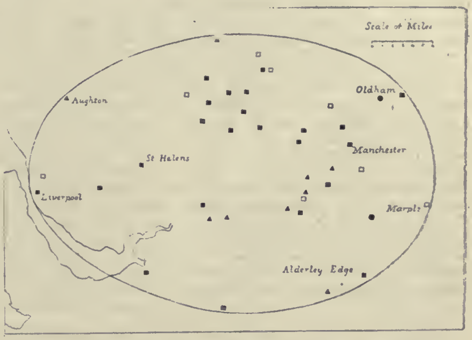
(4) That considering how important it is to reduce the number of crank revolutions in order to economise nerve waste, the cultivation of the pull stroke enables a greater average F to be obtained without straining the muscles beyond their elastic limit, and, consequently, allows of a higher multiple M and a correspondingly reduced number of revolutions. Out of a number of carefully made test runs we have selected the following as representative of the increased efficiency which we have obtained from the use of the lengthened cranks. The elder of us, aged 54, height 5 feet 10 inches, thigh bone 18-inch shank, from knee to ball of foot 21 inches, made a trial in the summer of 1896 with a cycle having $6\frac{1}{2}$-inch cranks, geared to $99\frac{1}{2}$. The total weight of rider and cycle was then 195 lbs., and the surface exposed to the air, including cycle, was $5\frac{1}{2}$ square feet. The maximum distance that could be travelled on a good road with an average wind was 78 miles in ten hours, including rests, or in an actual riding time of $7\frac{1}{4}$ hours. The average foot pounds per minute in this case was 2917. In September 1898 R. E. Crompton made a test on a cycle having cranks 9·1 inches long, geared to 102. The weight of the cycle and rider was, as in the former trial, made up to 195 lbs. The test run was from Kensington Court, London, to Romsey in the New Forest and back; total distance 156 miles, total time 13 hours 28 minutes, riding time 10 hours 54 minutes. The bodily fatigue on this day was no greater than on the 78-mile run in 1896. In this ride the average foot pounds per minute throughout the day was 6650, so that whereas with the old system of short cranks in 1896, R. E. Crompton was able to maintain P at 2917 for $7\frac{1}{4}$ hours, with the new system in 1898 he was able to maintain 6650 for 10 hours 54 minutes; in other words, from a given amount of food or, what is the same thing, a given amount of bodily fatigue, R. E. Crompton was in 1898, on the long-crank machine, able to do three times as much work as he did on the short-crank machine in 1896. Many other similar runs have been made, and other long-crank riders can produce equally satisfactory results.

The theory we have formed as to the nature of bodily fatigue induced by cycle riding, in which we have endeavoured to show the extreme importance of the part played by the brain and nerve systems, and that probably the major portion of the energy of the human body considered as a motor passes through the brain and nerve tissues to energise the muscles, is a matter which merits the careful attention of physiologists. Writers on this subject have hitherto considered the human or animal motor as a heat engine, all the useful energy being obtained by corresponding chemical work done on the muscles. We believe that the greater part of the energy-yielding processes goes on within the brain itself or in the nervous system directly connected with the brain. Many facts observed by cyclists and other athletes when carrying out feats of endurance show that brain and nerve nourishment is to be aimed at rather than the repair of muscle waste, and that certain foods and drinks have to be avoided on account of their action in producing temporary slackness; in fact, on account of their preventing the brain from effectively energising the muscles.

NOTE ON THE DISTANCES TO WHICH EXPLOSIONS ARE FELT AND HEARD.

ST. HELENS being situated in a thickly populated district, the disaster at Messrs. Kurtz's works (belonging to the United Alkali Company) seemed to offer a good opportunity for determining how far a great explosion may be felt and heard. Isolated observations, as will be seen below, have been made on other occasions; but, to feel confidence in the results, we require a fairly continuous series of records extending from near the centre of disturbance to the boundary of the affected area. I therefore wrote letters to all the more important newspapers in the south of Lancashire and north of Cheshire, in request of observations either of the sound or of the movement of windows by the air-waves. In reply to them, I received more than fifty accounts, which, in addition to several which appeared in the local press, gave a total of 61 records from 47 different places.

The immediate cause of the explosion was the firing of one of the vessels used in crystallising the chlorate of potash, the vessels being made of wood lined with lead. It is computed that eighty tons of chlorate exploded. The whole of Messrs. Kurtz's buildings were razed to the ground, and nine out of ten great vitriol chambers on the other side of an adjoining road were destroyed. Within a few hundred yards of the chemical works there are many streets of workmen's cottages; the doors, windows, chimney-stacks of whole rows were dismantled, and, in some cases, the roofs fell in. Within a radius of a mile or so, hardly a window seems to have escaped;[1] but according



to one of my correspondents, who was in the north-west of the town, the damage to windows around him was comparatively slight.

On the accompanying map are shown all the places from which records of the explosion were obtained. A small square denotes a place where the air-wave was strong enough to make windows and doors rattle; if the square is filled in, the sound was also heard. Places where the observation of the sound only is recorded are represented by a circle if the observer was out of doors at the time, and by a triangle if he was inside, or probably inside, a house. A perceptible tremor of the ground, strong enough to be mistaken for an earthquake, was felt at some distance from St. Helens, but how far cannot be definitely ascertained.

It will be seen that the area over which the sound was heard is practically the same as that in which the air-wave was strong enough to make windows rattle. The bounding curve is elliptical in form, $39\frac{1}{2}$ miles in length from east to west, $27\frac{1}{2}$ miles in breadth, and includes an area of about 850 square miles. St. Helens lies close to the longer axis of the curve and nine miles to the west of the centre. Towards the east, the sound was heard at Alderley Edge ($24\frac{1}{2}$ miles from St. Helens) and at Oldham (27 miles). Windows were observed to rattle at Alderley Edge and also at Marple (28 miles). To the west of St. Helens the sound was heard at Liverpool (10 miles) and Aughton (10 miles). I have tried in vain to ascertain the direction of the wind at the time of the explosion at different places

[1] The above particulars are obtained from the account given in the *Manchester Guardian* for May 13.

within the sound-area, but the observation above recorded from the north-west quarter of St. Helens is worthy of notice in connection with the easterly elongation of the area of disturbance.

For the sake of comparison it may be worth while to refer briefly to the results obtained from previous explosions. At the conclusion of Sir John Moore's retreat, a great Spanish powder magazine, containing, it is said, 1500 barrels, was blown up near Corunna. The ground rocked sensibly for miles, and at a distance the shock was felt before the sound was heard (R. Mallet, *Irish Acad. Trans.*, vol. xxi., 1848, pp. 63-64). In the great Erith explosion (October 1, 1864) two barges, a large magazine and a small one blew up in succession. They contained respectively about 9, 33, and 4 tons of gunpowder. Everything within a distance of half a mile—trees, houses, barns—was utterly destroyed, except two haystacks on the south side of the river. Windows were shattered within a radius of at least five miles. The explosion was heard and felt at Teddington (21 miles), Uxbridge (27 miles), and Windsor (32 miles), and the concussion is said to have been felt near Ashford, which is distant about 40 miles (*Times*, October 3-6, 8, 1864). The catastrophe in the Regent's Canal (October 2, 1874) was caused by the explosion of about five tons of gunpowder. The shock and sound were observed as far as Chiselhurst (13 miles), and the vibrations were felt at Aveley (18 miles) and Gravesend (23 miles) (*Times*, October 3, 5, 1874). To effect the removal of the Flood Rock in Hell Gate, New York Harbour, about 130 tons of dynamite, &c., were exploded; and the vibrations were perceived, with the aid of a mercury bath and telescope, at a distance of 183 miles (*Times*, October 12, 1885; Milne's "Seismology," pp. 98-99). Mr. Fox Strangways states that the blasting operations in the Charnwood Forest quarries can be heard at a distance of 18 miles or more (NATURE, vol. liii., 1895, p. 130). The shock caused by the explosion of nearly 50 tons of dynamite at Johannesburg on February 19, 1896, was felt at Krugersdorp (19 miles) and Pretoria (33 miles) (*Standard*, February 21, 22, 1896). The Lagouban naval magazine (near Toulon), which blew up on March 5, 1899, is said to have contained 50,000 kg. of black powder. The country for a radius of nearly two miles was swept almost bare. Houses were razed to the ground, and trees were overturned or bent into the most extraordinary shapes. It is affirmed that the report of the explosion was heard at Nice (84 miles), and even beyond the frontier at Ventimiglia (100 miles); but it is obvious that, in the absence of intermediate records, we cannot place much reliance on these accounts (*Times*, *Daily Chronicle*, *Daily Mail*, *Daily Telegraph*, March 6, 1899).

CHARLES DAVISON.

THE HURTER MEMORIAL LECTURE.

THE memorial lecture established by the Liverpool Section of the Society of Chemical Industry in memory of Dr. Ferdinand Hurter, and which will be given every alternate year, was inaugurated by Prof. G. Lunge, of Zürich, on October 4, before a large and representative gathering at University College, Liverpool. Prof. Lunge's subject was "Impending changes in the general development of industry, and particularly in the alkali industries." After an appreciative review of Hurter's contributions to technical chemistry, in which special reference was made to his remarkable mathematical power and to the manner in which he employed it side by side with the highest branches of chemical science for the investigation and elucidation of technical problems, Prof. Lunge turned to the more immediate subject of his address. In contemplating the general features of chemical industries as carried on to-day, the question of the supply of fuel and of other sources of power was first considered; it was pointed out that the superiority which many countries, notably Great Britain, enjoy in many industries on account of their wealth of coal is limited in time, and that the increasing consumption of coal with a decreased source of supply as the result, must lead to the employment of other sources of energy. The economical use of coal in the blast-furnace, the adoption of closed coke ovens which, in addition to allowing the recovery of by-products, also increase the yield of coke, and recent improvements in the production of gaseous fuel are likely to postpone the time and force of the competition of those other sources of energy of which water-power stands foremost, but such postponement is restricted essentially to certain industries. From a general standpoint the total energy of the fossil fuel of the world is an infinitesimal fraction of the energy which the sun expends daily on the evaporation of water, and which is transformed to a great extent into the kinetic energy of falling water. The transformation of water-power into electrical energy, with its easy and cheap power of transmission, is likely to lead to revolutionary changes in chemical industries, not only in respect to the conditions of manufacture, but also in regard to the centres of production. Countries possessing great water-power will in the future carry on all those manufacturing processes in which electricity is either essential or an advantage, subject to certain limitations regulated by the cost of carriage of both raw materials and products. Prof. Lunge detailed the present position of electrical processes applied to chemical industries, dealing especially with the alkali trade and the manufacture of bleach and chlorate; the next generation will in all probability, in his opinion, obtain its chlorine by electrolytic methods, but the accompanying alkali will not form more than one-eighth or one-tenth of the world's demands. The bulk of the latter must therefore be derived from other sources—these, in Dr. Lunge's opinion, will be the ammonia-soda process and naturally occurring soda. In regarding the future of these industries the modern developments of the manufacture of sulphuric acid by the catalytic process, in which sulphur dioxide and oxygen are passed over platinised asbestos, were discussed; the success of this method, especially for the manufacture of strong acid, is thoroughly established, and the lead chamber is threatened with extinction in consequence. Prof. Lunge pointed out, however, that this old apparatus has still certain claims of efficiency in the manufacture of weak sulphuric acid. Incidentally, in considering the economical use of fuel, Prof. Lunge gave a most interesting description of the Dellwik-Fleischer water-gas process, the efficiency of which he had himself examined with the result that he found that it gave no less than 82 per cent. of the fuel value of the coke against the 45 per cent. of the older processes. The characteristic of the process is the formation of carbon dioxide during the "blow" instead of carbon monoxide, a fact which reduces the time of the blow from 10 minutes to $1\frac{3}{4}$ minutes.

In looking back upon the industry with which Hurter's life-work was associated, Prof. Lunge dwelt upon the fact that the very processes Hurter had helped so ably and successfully were without doubt doomed, if not to complete extinction, still to a most serious crippling. Like other earnest workers, Hurter had but tilled the soil from which others will reap a harvest; and although there is a feeling of sorrow in the thought that so much genius, inventive talent and honest labour had been expended in what seemed now a transient aim, still

Der wer den Besten seiner Zeit genug gethan
Der hat gelebt für alle Zeiten.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Mr A. Hutchinson, of Pembroke College, has been reappointed Demonstrator in Mineralogy and Assistant-Curator of the Museum of Mineralogy for a term of five years.

Sir Walter Gilbey and Mr. Austin Keen have been appointed additional members of the Board of Agricultural Studies.

Mr. H. Woods, of St. John's College, is to be appointed a University lecturer in Palæozoology. He has hitherto held the post of demonstrator in this subject at the Woodwardian Museum.

The awards of entrance scholarships have been made at the two groups of Colleges, the first comprising Trinity, Clare and Trinity Hall, the second Pembroke, Caius, King's, Jesus, Christ's, St. John's and Emmanuel. One hundred and seventeen scholarships and exhibitions have been given; of these 23 are for mathematics, 28 for natural science, and 49 for classics. The value of these scholarships varies from 80*l*. to 40*l*. a year, that of the exhibitions from 50*l*. to 20*l*. a year.

NEGOTIATIONS have been proceeding with the authorities of Mason College and King Edward's Foundation relative to the provision of a remodelled system of commercial education in Birmingham. It is expected that the charter of the new University for Birmingham will be granted early next year, and that there will be a faculty of commerce in connection therewith.

Speaking at the Birmingham Chamber of Commerce last week, Mr. Neville Chamberlain said they were on the eve of a new departure in the educational life of Birmingham. They were looking forward to the rise of a University which would take up new and special lines, including commercial education. That was a great experiment, and it seemed to him to be the duty of that chamber, as representing the commercial life of Birmingham, to do what it could to ensure the success of the experiment.

SCIENTIFIC SERIALS.

Bulletin of the American Mathematical Society, October.—The number opens with a partial analysis of the papers communicated at the sixth summer meeting of the Society, held at Columbus, Ohio, in August last, by Prof. Holgate.—The President, Prof. Woodward, congratulated the Society on the manifest interest in mathematical study and investigation as evidenced by the large number (twenty-three) of communications presented.—A report on the recent progress in the theory of linear groups is an interesting and thorough report by Dr. L. E. Dickson, which was made before Section A of the American Association for the Advancement of Science at its meeting at Columbus, previous to the above gathering of the Society. It is a supplement to the previous report, drawn up by Dr. G. A. Miller, which appeared in the February (1899) number of the *Bulletin*. The author restricts himself to finite linear groups, and of these he considers first the finite collineation groups and afterwards the linear congruence groups and the more general groups in Galois fields. These reports are very useful to students of the subject.—A few shorter notices (small reviews) follow.—The "Notes" contain many items of interest, but two of them are not quite accurate. For instance, the London Mathematical Society has *not* decided to issue its *Proceedings* in two volumes per annum. The resolution, as stated in the appendix to Volume xxx, says "in future the volumes of *Proceedings* shall contain as nearly four hundred pages as may be found convenient, provided that each volume shall begin with the report of proceedings at a meeting, not necessarily an annual general meeting." This may sometimes result as in the "Notes," but not necessarily so. A statement on p. 40 would lead one to infer that Dr. Graves was professor at Trinity College, Dublin, at the time of his death, and had been so ever since 1843.

American Journal of Science, November.—March weather in the United States, by O. L. Fassig. If the earth's surface were uniform, the normal circulation of air would produce two belts of high pressure at a latitude of about 30° north and south. The presence of continents breaks up these areas. The author shows that the "permanent" high pressure areas have a great determining influence upon weather in its general aspects, and that a considerable advance in forecasting work may be expected to result from their study. The March weather of the United States is determined by the relative extent of three such areas, and the course of the March storms lies along the gap between them.—Some new minerals from the zinc mines at Franklin, N.J., by S. L. Penfield and C. H. Warren. The minerals include "hancockite," which has the general formula of epidote, but having lead and strontium isomorphous with calcium; "glaucochroite," $CaMnSiO_4$, closely allied to monticellite, $CaMgSiO_4$; and its matrix "nasonite," the empirical formula of which is $Pb_6Ca_4Cl_2(Si_2O_7)_3$. The authors also investigate the chemical composition of ganomalite, and show that the acid, $H_6Si_2O_7$, of which nasonite and ganomalite are salts, is intermediate between orthosilicic acid, H_4SiO_4, and metasilicic acid, H_2SiO_3, and may be regarded as their algebraic sum, or as derived from two molecules of the former by abstraction of water.—Action of acetylene on the oxides of copper, by F. A. Gooch and D. Baldwin. While metallic copper may at comparatively high temperatures induce the polymerisation of acetylene, it is an oxidising action which starts at moderately low temperatures the formation of the peculiar "acetylides." Thus it is found that ferric oxide heated in acetylene at temperatures varying from 150° to 360°, according to circumstances, darkens, glows, and gathers with evolution of heat a dark carbonaceous deposit. In the products of such action the content of iron varies from 2·8 to 5·8 per cent. Silver oxide also acts upon acetylene.—A new mode of occurrence of ruby in North Carolina, by J. W. Judd and W. E. Hidden. Corundum occurs in North Carolina in three different forms. In the ordinary schists of the district, long prismatic crystals, usually of grey, pink and blue tints, occur. In the peridotites, crystals are found, some of very great size and of great variety of colour, but seldom or never clear and translucent. In certain garnet-bearing basic rocks at Cowee Creek, small tabular and short prismatic crystals are abundant, and these very frequently exhibit the transparency and colour of true ruby.

Wiedemann's Annalen der Physik und Chemie, No. 10.—Explosions in air, by W. Wolff. The effect of an explosion in air is propagated by a process analogous to the propagation of sound, except in the immediate neighbourhood of the source, where a bodily translation of the air is superadded. But that translation does not extend further than about 25 m. Up to that point the propagation of the wave is more rapid than the propagation of sound.—Glow-light phenomena with high-frequency alternate currents, by H. Ebert. There is a residual effect of the positive charge in the glow-light, which persists for a short time after the glow has ceased. This produces a repulsion between the two electrodes.—Influence of impurities upon a gaseous spectrum, by P. Lewis. The addition of very small quantities of mercury vapour to hydrogen gives rise to the green mercury line, which only disappears at −20 degrees. When oxygen is added to hydrogen in increasing quantities, the maximum of emission is shifted towards lower pressures.—Resistance to projectiles in air, by R. Emden. The resistance offered by air is jointly proportioned to the square of the velocity, v^2, and to another function of the velocity, $f(v)$. The latter quantity is constant up to the point where v becomes the velocity of sound. Then it abruptly increases to about three times its former value, remaining constant at high velocities. The increase is due to the energy expended in producing and maintaining the head wave.—Electric pictures, by L. Fomm. The author produces pictures of sections of different kinds of wood by covering them on one side with tinfoil and on the other with bromide paper, with the film in contact with the wood. A metallic point negatively charged by an influence machine, mounted at 5 cm. from the paper surface, produces a good impression in about half a minute.—The Macfarlane-Moore vacuum vibrator, by J. Elster and H. Geitel. To avoid the sticking of the vacuum interrupter the authors keep it vibrating by a separate interrupter outside the vacuum tube, in unison with the one inside.—A fault in Lippmann's photography, by O. Wiener. There is always a difference of phase between the wave reflected by the gelatine surface and that reflected by the first elementary stratum. The remedy consists either in eliminating the surface reflection altogether, as by immersing the plate in benzol, or in producing a large difference of path, by coating the gelatine with a film of collodion. With a suitable thickness of the latter, very brilliant and true effects are obtained.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 15.—"On the Resistance to Torsion of certain forms of Shafting, with special reference to the Effect of Keyways," by L. N. G. Filon, M.A., King's College, Cambridge, Fellow of University College, London.

In this paper solutions of the torsion problem are obtained for cylinders whose cross-sections are bounded by confocal ellipses and hyperbolas. The method employed is that of conjugate functions, suggested by Saint-Venant, Thomson and Tait, Clebsch, Boussinesq and MacDonald, and applied by them to other cases.

The strains and stresses are obtained in the form of infinite series of circular and hyperbolic functions. There are two types of sections specially studied.

The first is bounded by an ellipse and by the two branches of a confocal hyperbola. The solution is worked out numerically for various values of the eccentricity of the ellipse and of the angle between the asymptotes of the hyperbola.

The position of the fail-points, or points of maximum strain and stress, is investigated at length.

It is shown that the maximum stress does not always occur, as is usually assumed, at the point of the boundary nearest to the centre of the section, but that in some cases there are four fail-points symmetrically distributed round the contour, on the broad sides of the section.

An example of this kind has already occurred in Saint-Venant's edition of Navier's "Leçons de Mécanique." This is compared with the present results. The paper also investigates the critical sections when the two cases of four and two fail-points pass into one another. It is shown in particular that when the angle between the asymptotes is less than 73° the greatest stress always occurs at the neck of the section.

The second type of section is bounded by one ellipse and one branch of a confocal hyperbola.

The case in which the confocal hyperbola reduces to a straight slit or thin keyway is specially studied.

For the first type of section this case gives two thin keyways; for the second only one.

The manner in which the reduction of the torsional rigidity, due to cutting such slits into the material, varies with the depth, is very striking. This reduction, which is as great as 23 per cent. when the depth of the keyway is 0·6 (semi-major axis) falls to about 1 per cent. when this depth is 0·12 (semi-major axis). This would account for such keyways not always giving in practice the reduction in torsional rigidity which we should expect from Saint-Venant's results for the circle. Keyways of only moderate depth will affect the torsional rigidity very little.

Finally, the effect on the torsional rigidity of two such equal and opposite slits is shown to be about twice the effect of a single slit.

Chemical Society, November 2.—Dr. W. H. Perkin, Vice-President, in the chair.—The following papers were read: On methods for determining the relative proportions of gaseous chloroform and air in a mixture of the two, and on a method for producing a mixture of air and chloroform in any desired proportion, by A. Vernon Harcourt.—The theory of saponification, by J. Lewkowitsch. It is demonstrated that partially hydrolysed fats contain di- and mono-glycerides, and that the hydrolysis of triglycerides constitutes a bimolecular reaction.—Note on the action of dilute nitric acid upon oleic and elaidic acids, by F. G. Edmed. Dilute nitric acid converts oleic acid quantitatively into elaidic acid.—Formation of tetrazoline, by S. Ruhemann and H. E. Stapleton. A good yield of tetrazoline, $CH\langle{}^{NH.N}_{N.NH}\rangle CH$, is obtained by heating monoformylhydrazide.—Asymmetric optically active nitrogen compounds. Dextro- and lævo-benzylphenylallylmethylammonium iodides and bromides, by W. J. Pope and S. J. Peachey. On heating α-benzylphenylallylmethylammonium iodide with silver dextrocamphorsulphonate and acetone, a mixture of the camphorsulphonates of the dextro- and lævo-quaternary ammonium derivates is obtained. From these salts the corresponding and optically active iodides and bromides may be prepared. It is thus proved that dissolved substances may owe their optical activity to asymmetric nitrogen.—Camphoroxime. Part III. Behaviour of camphoroxime towards potassium hypobromite, by M. O. Forster. Camphoroxime yields, when treated with potassium hypobromite, a nitroso-derivative, $C_{10}H_{16}BrN_2O$, which is converted into a compound of the composition $C_{10}H_{14}BrNO$ by sulphuric acid; on treating either substance with soda, a nitrite, $C_9H_{13}N$, and an amide, $C_9H_{15}NO$, are produced. The latter seems to be campholytic amide.—Optical influence of an unsaturated linkage on certain derivatives of bornylamine, by M. O. Forster.—The interaction of sodium hydroxide and benzaldehyde, by C. A. Kohn and W. Trantom. Electrolytic preparation of induline dyes, by E. C. Szarvasy. On electrolysing a fused mixture of aniline and its hydrochloride, the following substances are formed: induline, anilidoinduline, induline 6 B, and azophenine.—The heat of combination of copper with zinc, by T. J. Baker.—The action of sulphuric acid on fenchone, by J. E. Marsh. 1:2:4-Acetorthoxylene is produced by the action of sulphuric acid upon fenchone.—On glucosides, by H. Ryan.—Note on polyazo-compounds, by R. Meldola and W. A. Williams.—On ethyl dibromobutanetetracarboxylate and the synthesis of tetrahydrofurfuran-αα'-dicarboxylic acid, by B. Lean.—The application of powerful optically active acids to the resolution of externally compensated basic substances. Resolution of tetrahydroquinaldine, by W. J. Pope and S. J. Peachey.—The application of powerful optically active acids to the resolution of feebly basic substances. Resolution of camphoroxime, by W. J. Pope.—The application of powerful optically active acids to the resolution of externally compensated basic substances. Resolution of tetrahydroparatoluquinaldine, by W. J. Pope and E. M. Rich.—Homogeneity of dextrolævo-α-phenethylamine dextrocamphorsulphonate, by W. J. Pope and A. W. Harvey.—The characterisation of racemic liquids, by F. S. Kipping and W. J. Pope.—A method for discriminating between "non-racemic" and "racemic" liquids, by W. J. Pope and S. J. Peachey.—On two hydrated cobalt oxides, green- and buff-coloured, by W. N. Hartley.—A method of separating isomeric xylidines from the commercial product, by W. R. Hodgkinson and L. Limpach.—Action of hydrolytic agents on α-dibromocamphor and the constitution of bromocamphorenic acid, by A. Lapworth.

Entomological Society, November 1.—Mr. G. H. Verrall, President, in the chair.—Mr. J. J. Walker exhibited two living specimens of *Bostrychus cornutus*, Fab., obtained from a wooden stool which was brought from Zanzibar.—On behalf of Mr. W. Purley, of Folkestone, Mr. C. G. Barrett exhibited the following species of Lepidoptera:—*Stigmonota trauniana*, *Lozopera beatricella*, *Peronea cristana*, *Cledeobia angustalis*, *Crambus inquinatellus*, var., *Eudorea dubitalis*, var. *ingratella*, and *Endotricha flammealis*.—Mr. McLachlan showed four examples of *Deilephila lineata*, taken by Mr. E. W. Hainworth at Victor, Colorado, at an elevation of 9000 feet, on July 23, 1899; also an ash-twig which had been girdled by hornets, the observation of this curious fact having been made by Mr. W. C. Boyd, of Cheshunt, from whom he received the twig.—Dr. T. A. Chapman exhibited specimens of *Erebia flavofasciata* taken at Campolungo at an elevation of 7000 feet. He stated that the species occurred only in those places where there was an outcrop of dolomitic strata belonging to the crystalline schists, and was not met with elsewhere at that elevation, nor was it to be found in association with the same strata at lower levels.—Mr. H. J. Elwes exhibited and gave a brief account of a collection of Lepidoptera made by Mrs. Nicholl and himself in a part of Bulgaria which had not previously been visited by entomologists. *Lycaena eroides*, *L. anteros*, *L. zephyrus*, *Melitaea cynthia*, *Erebia gorge*, and *Coenonympha typhon* were a few of several interesting forms to which he directed attention.

Linnean Society, November 2.—Dr. A. Günther, F.R.S., President, in the chair.—Prof. Stewart, F.R.S., exhibited and made remarks on a preparation of the leaves of *Mimosa pudica* showing the diurnal and nocturnal positions. He also exhibited the embryo and egg-cases of *Cestracion Philippi*.—Rev. G. Henslow read a paper on the proliferous state of the awn of Nepal barley. After describing the two varieties *Hordeum coeleste*, vars. *Aegiceras* and *trifurcatum*, he showed that the inverted flower-buds (which constitute the peculiarity of the monstrosity) were different in the two varieties.—Dr. W. G. Ridewood read a paper on the hyobranchial skeleton of the new aglossal toad, *Hymenochirus Boettgeri*. The hyoidean cornua of this animal was shown to be ossified, a fact unique among tailless amphibians.—Mr. Harold Wager read a paper on the eye-spot and flagellum in *Euglena viridis*.

Mathematical Society, November 9.—Lord Kelvin, G.C.V.O., President, in the chair.—The President stated that the Council, as announced at the June meeting, had awarded the De Morgan medal to Prof. W. Burnside, F.R.S. After Major MacMahon, R.A., F.R.S., on behalf of the Council, had stated the grounds of the award, the President presented the medal to Prof. Burnside, who suitably thanked the Council for the honour they had conferred upon him.—The following gentlemen were elected the Council for the ensuing session: President, Lord Kelvin; Vice-Presidents, Prof. Elliott, F.R.S., Lieut.-Colonel Cunningham, R.E., Prof. Lamb, F.R.S.; Treasurer, Dr. J. Larmor, F.R.S.; Secretaries, R. Tucker and Prof. Love, F.R.S.; other members, Prof. Burnside, Dr. Glaisher, F.R.S., Prof. Hill, F.R.S., Dr. Hobson, F.R.S., A. B. Kempe, F.R.S., Dr. F. S. Macaulay, H. M. Macdonald, Major MacMahon and E. T. Whittaker.—Prof. Burnside communicated a short note by Dr. L. E. Dickson on the abstract groups isomorphic with the symmetric group on k letters.—Major MacMahon spoke on the fundamental solutions of the indeterminate relation $\lambda x \geqq \mu y$.—The following papers were read in abstract. Certain correspondences between spaces of n dimensions, by Dr. E. O. Lovett. (1) On the form of lines of force near a point of equilibrium; (2) the reduction of conics and quadrics to their principal axes by the Weierstrassian method of reducing quadratic forms; and (3) on the reduction of a linear substitution to a canonical form; with some applications to linear differential equations and quadratic forms, by T. J. I. Bromwich: (1) on Ampère's equation $Rr + 2Ss + Tt + U(rt - S^2) = V$, and (2) the theory of automorphic functions, by Prof. A. C. Dixon.—Note on Clebsch's second method for the integration of a Pfaffian equation, by J. Brill.

Zoological Society, November 14.—Dr. A. Günther, F.R.S., Vice-President, in the chair.—Mr. Sclater gave an account of his recent journey to the Cape, and made remarks on the animals he had obtained there for the Society's collection. He also called attention to the desirability of the establishment of a Zoological Garden at Capetown.—Mr. A. Smith Woodward read a communication from Señ. F. Ameghino containing some further notes on *Neomylodon listai* (*Grypotherium*). Mr. A. Smith Woodward also exhibited, on behalf of Dr. Moreno, the skull and other specimens of this animal lately discovered in the cave in Southern Patagonia where the original pieces of skin had been obtained, and made remarks on them.—Mr. Lydekker exhibited and made remarks on a remarkably fine head of the swamp-deer (*Cervus duvauceli*), obtained by Major C. B. Wood in the Central Provinces of India.—The Secretary exhibited, on behalf of Mr. C. Pole Carew, some malformed horns of the Sambur Deer (*Cervus aristotelis*), obtained by him in the southern province of Ceylon, and read some notes on them sent by Mrs. Carew.—A communication was read from Mr. F. Vaughan Kirby, containing field-notes on the blue-buck of the Cape Colony (*Cephalophus monticola*).—A communication was read from Mr. R. I. Pocock, containing an account of the collections of Arachnids made by Mr. G. L. Bates in French Congo. To this was added a complete list of the species of the same group represented in the British Museum, and descriptions of the new genera and species.—A communication was read from Mr. Stanley S. Flower containing notes on a second collection of Batrachians made in the Malay Peninsula and Siam from November 1896 to September 1898. Forty-nine species, of which fifteen had not been previously recorded from these countries, were enumerated, and the tadpoles of several of them were described for the first time.—Mr. R. Lydekker read three papers dealing with (1) the specific characters of the Chilian Guemal (*Cariacus chilensis*), which previously, from the absence of good specimens of the animal, had been inaccurately given; (2) the skull of a Shark-toothed Dolphin (*Prosqualodon australis*) from Patagonia, in which he pointed out the characters of distinction between that species and the genus *Squalodon*; (3) the results of recent investigations on the dentition of the Marsupial and Placental Carnivores.—A communication was read from Mr. Ernest Gibson, containing field-notes on the Wood-Cat of Argentina (*Felis geoffroyi*), two specimens of which animal had recently been presented to the Society by Mr. William Brown, of Buenos Aires.

CAMBRIDGE.

Philosophical Society, October 30.—Mr. J. Larmor, President, in the chair.—The following were elected officers for the ensuing year: President, Mr. J. Larmor; vice-presidents, Mr. F. Darwin, Prof. A. R. Forsyth, Dr. W. H. Gaskell; treasurer, Mr. Newall; secretaries, Mr. Baker, Mr. Shipley, Mr. Wilberforce; members of Council, Mr. Harker, Mr. Hutchinson, Prof. Liveing, Mr. Skinner, Mr. Gadow, Mr. Sharp, Prof. J. J. Thomson, Mr. Berry, Sir G. G. Stokes, Mr. Bateson, Mr. Seward, Mr. G. T. Walker.—The following communications were made to the Society: On semi-convergent series, by Mr. W. McF. Orr.—An experiment on the condensation of clouds, by Mr. C. T. R. Wilson. The author gave an experimental demonstration of the production of cloud by the contact of layers of moist air of different temperatures.—On the conductivity of gases from arcs and from incandescent wires, by Mr. J. A. M'Clelland. The first part of this paper contains an account of experiments on the conductivity of gas through which an arc discharge has passed; the second part deals with the conductivity of gas near an incandescent wire. Experiments have been made with an arc between platinum terminals and with an incandescent platinum wire in air, oxygen and carbonic acid gas. The conductivity is shown to be produced by ionisation, and the nature of the carriers, their velocity under an electric force, and other points are investigated. With the arc in air, or oxygen, there is a small excess of positive electricity in the gas taken from the neighbourhood of the arc, and this excess is very great in CO_2; the greater velocity of the negative carriers under electric force causes more of them to be discharged to the terminals of the arc. The velocity of the carriers under electric force is not a constant quantity, but varies with the nature of the arc and the temperature of the incandescent wire. The velocity diminishes as the temperature is raised; this may be caused by the carriers coming from the wire itself or the arc terminals at these higher temperatures, or by the disintegration of the wire or terminals affording material to condense on the carriers already formed in the gas.—On the secondary Röntgen rays, by Mr. J. S. Townsend. This paper contained an account of experiments made with the rays given out when Röntgen rays fall on metals and other bodies. These rays are of two kinds. The first are rapidly absorbed by the air, and at a distance of one centimetre from the radiating body their power of ionising the air is reduced to one-thousandth of its value at the surface. The rays of the second kind are more penetrating, and extend to a distance of several centimetres from the radiating body. They cannot be considered part of the first kind of rays, as these would only have an effect of $\frac{1}{10^{18}}$ of their initial value at a distance of 6 centimetres, which would be too small to detect.

MANCHESTER.

Literary and Philosophical Society, November 14.—Prof. Horace Lamb, F.R.S., President, in the chair.—Mr. W. E. Hoyle exhibited a series of flint implements, &c., from Egypt, forming part of a large collection obtained by Prof. Flinders Petrie during the past winter in excavating about twenty miles of cemetery in the western desert between Hu and Dendereh, and since presented to the Manchester Museum. These belonged to various periods, from prehistoric to Roman. Certain types of knives with very finely notched edges and forked lance-heads are very characteristic of the prehistoric age. One cemetery dates from the Libyan settlements in Egypt at the close of the Middle kingdom, about 2400 B.C. Here the graves were all shallow pits of the form known as "pan graves," in which the bodies were laid in a contracted position, but not all in the same direction. From this were obtained several of the strings of beads exhibited. The shell bracelets are very characteristic of this period. Another large cemetery at Hu began in the sixth dynasty, and contained, besides pottery, a large quantity of beads. One large necklace of five strings was of amethyst, others were of cornelian and garnet, whilst in the other sets were metal beads, which, from their not having corroded, were presumed to have contained a considerable proportion of gold. The collection included a large number of pieces of engraved bone, apparently prepared for inlaying, as well as two beautiful diorite saucers, one circular and the other in the shape of a large *Unio* shell. A block of stone about six inches square, with a circle and two cross-lines on the top, once formed the upper part of a short stone pillar, and is believed to have been a surveyor's mark.

PARIS.

Academy of Sciences, November 13.—M. van Tieghem in the chair.—Observation relating to researches on the diamines, by M. Berthelot. A correction to the paper published on this subject in the last number of the *Comptes rendus*.—The disease attacking carnations at Antibes, by MM. Prillieux and Delacroix. The primary cause of the disease is a fungus, a detailed description of which is given. Artificial cultures could be carried out either on potato or in a drop of nutrient fluid. The species appears to be new, and the provisional name of *Fusarium Dianthi* is given to it.—Researches on acute alcoholism; estimation of alcohol in the blood and tissues, by M. N. Gréhant. The alcohol was introduced into the stomach in measured amounts through a tube, and samples of blood taken at half-hourly intervals were submitted to distillation in vacuo, and the alcohol in the distillaters estimated by the bichromate method of Nicloux. In another experiment the animal was killed, and separate analyses made of the brain, muscles, liver, kidneys and blood. The amounts per 100 grams of material were nearly the same, varying between 0·325 and 0·41 c.c. of alcohol.—On congruences of circles and spheres which intervene in the study of cyclic and orthogonal systems, by M. C. Guichard.—On equations of the second order with fixed critical points, by M. Paul Painlevé.—On the generalisation of expansions in continued fractions given by Gauss and Euler, of the function $(1 \times x)^m$, by M. H. Padé.—A new mode of considering the propagation of luminous vibrations through matter, by M. G. Sagnac.—On the spectrophotometry of the electric light, by M. Fernand Gaud. A comparison between the intensities of different portions of the spectrum of incandescent and arc lights with sunlight was made by decomposing each light by screens of homogeneous colour, and measuring the intensity of the transmitted light with a simple Foucault or Bunsen photometer. The screens were previously carefully examined by Frauenhofer's method, and the wave-length of the light transmitted by the screen exactly determined.—On the atomic weight of the metal in radio-active barium chloride, by Mme. Sklodowska Curie. Fractional crystallisation of barium chloride obtained from uranium minerals gave a salt which concentrated the radio-activity in the least soluble portions. The atomic weight was found to increase with the radio-activity, the maximum value obtained being 145·8 as compared with 137·8 for the inactive barium. These results confirm the original view of the existence of a new element, radium.—On the preparation and properties of the crystallised phosphides of strontium and barium, by M. A. Jaboin. Crystallised strontium phosphide is prepared in a pure state by heating pure strontium phosphate with lamp black in the electric furnace. The phosphide has a dark colour, breaks with a crystalline fracture, and is rapidly attacked by moist air, or by chlorine, at about 30° C. At the temperature of the electric furnace carbon replaces the phosphorus slowly, giving strontium carbide. Barium phosphide is prepared in a similar manner and has corresponding properties.—On the estimation of phosphorus in organic compounds, by M. Ch. Marie. The organic material is destroyed by heating with nitric acid and potassium permanganate, and the phosphoric acid precipitated with molybdate, certain special precautions being necessary.—On some new asymmetric compounds of nitrogen obtained synthetically and possessing rotatory power, by MM. W. J. Pope and S. J. Peachey. α-Benzyl-phenyl-allyl-methylammonium iodide is heated with dextrocamphorosulphonate of silver, the silver iodide filtered off, and the resulting salt recrystallised from a mixture of acetone and ethyl acetate. From the less soluble fractions a dextrorotatory form ($M_D = +208°$) is readily isolated, the more soluble salt ($M_D = -87°$) being lævorotatory. From these salts a dextrorotatory iodide ($\alpha_D = 52°·4$), bromide ($\alpha_D = +68°·6$), and a lævorotatory iodide ($\alpha_D = -51°·4$) and bromide ($\alpha_D = -67°·3$) were obtained. In these compounds the rotatory power is clearly due to the asymmetrical arrangement of the groups round the nitrogen atom.—On the absorption of iodine by plants, by M. P. Bourcet. From a series of analyses of plants grown under identical conditions in soil containing iodides, it was found that certain plants absorb much more iodine than others, some absorbing none at all.—On the morphology and sexual evolution of a parasite of *Hemioniscus balani*, by MM. Maurice Coullery and Félix Mesnil.—On the absorptive power of seeds for moisture, by M. L. Maquenne.—On the origin of the symmetry in crystallised bodies and of polymorphism, by M. Fred Wallerant.—The relations existing between diuretic actions and osmotic properties of the sugars, by MM. E. Hédon and J. Arrous.—On lipase in pathological conditions, by MM. Ch. Achard and A. Clerc.—New experiments relating to the antiphylloxeric disinfection of vine plants, by MM. Georges Couanon, Joseph Michon and E. Salomon.

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 23.

ROYAL SOCIETY, at 4.30.—(1) Note on the Spectrum of Silicium; (2) Preliminary Table of Wave-lengths of Enhanced Lines: Sir J. Norman Lockyer, K.C.B., F.R.S.—The Colour-Physiology of *Hippolyte varians*: F. W. Keeble and F. W. Gamble.—The Medusæ of Millepora: Prof. S. J. Hickson, F.R.S.

SOCIETY OF ARTS, at 4.30.—Old and New Colombo: John Ferguson.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Cost of Steam Raising: John Holliday.—Influence of Cheap Fuels on the Cost of Electrical Energy: R. E. Crompton.

FRIDAY, NOVEMBER 24.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Openings for Mechanical Engineers in China: The Right Hon. Rear-Admiral Lord Charles Beresford, C.B.

PHYSICAL SOCIETY, at 5.—(1) On the Conductivities of certain Heterogeneous Media for a Steady Flux having a Potential; (2) On the Thermal Conductivities of Mixtures and of their Constituents: Dr. C. H. Lees.

MONDAY, NOVEMBER 27.

SOCIETY OF ARTS, at 8.—Enamelling upon Metals: H. H. Cunynghame.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Desert Sand Dunes: Vaughan Cornish.

INSTITUTE OF ACTUARIES, at 5.30.

TUESDAY, NOVEMBER 28.

ZOOLOGICAL SOCIETY, at 8.30.—On the Hatching-stage of the Land Pagurines: L. A. Borradaile.—General Account of an Expedition to the Gambia Colony and Protectorate in 1898–99: J. S. Budgett.—On the Relations of the Efferent Branchial Blood-vessels to the "Circulus Cephalicus" in Teleostean Fishes: Dr. W. G. Ridewood.—On the Reptiles, Batrachians, and Fishes collected by the late Mr. John Whitehead in the Interior of Hainan: G. A. Boulenger, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Papers to be further discussed*: The Waterloo and City Railway; The Electrical Equipment of the Waterloo and City Railway.——*And, time permitting, Paper to be read with a view to discussion*: Combined Refuse-destructors and Power-plants: C. Newton Russell.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—Practical Three-colour Lantern Slide Making.

THURSDAY, NOVEMBER 30.

ROYAL SOCIETY, at 4.—Anniversary Meeting.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Bridges for Light Railways: L. H. Rugg.

FRIDAY, DECEMBER 1.

GEOLOGISTS' ASSOCIATION, at 8.—The Zones of the White Chalk of the English Coast. I. Kent and Sussex: Dr. A. W. Rowe.—A New Rhætic Section at Bristol: W. H. Wickes.

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THURSDAY, NOVEMBER 30, 1899.

THE INHERITANCE OF DEAFNESS.

Marriages of the Deaf in America. By Edward Allen Fay. Pp. 527. (Washington: The Volta Bureau, 1898.)

MR. FAY'S work is an inquiry concerning the results of marriages of the deaf in America, a research originally instituted by Dr. A. Graham Bell among the charges which he committed to the Volta Bureau when he endowed that institution. When Mr. Fay undertook this work—as a labour of love—the resources of the Bureau were placed at his disposal, and he was further helped in his investigations by his Government appointment as a special agent for the collection of statistics relating to the deaf of the United States during the taking of the eleventh census. By these means Mr. Fay was particularly well equipped for his work, and the volume before us is no mean result. Taking as the chief aims of his inquiry the solution of certain questions of interest and importance to the deaf as a class and as individuals, he has sought by all the means in his power to obtain satisfactory replies, and his success will be seen by all who care to give the book a careful study. The questions to be elucidated were as follows:—

(1) Are marriages of deaf persons more liable to result in deaf offspring than ordinary marriages?

(2) Are marriages in which both of the partners are deaf more liable to result in deaf offspring than marriages in which one of the partners is deaf and the other is a hearing person?

(3) Are certain classes of the deaf, however they may marry, more liable than others to have deaf children? If so, how are these classes respectively composed, and what are the conditions that increase or diminish this liability?

(4) Aside from the question of the liability of the offspring to deafness, are marriages in which both of the partners are deaf more likely to result happily than marriages in which one of the partners is deaf and the other a hearing person?

These are questions which have been submitted to considerable discussion both in Europe and America, with the result that the conclusions arrived at have differed widely. Indeed the conclusions have ranged between the dictum of Graham Bell, that "the evidence shows a tendency to the formation of a deaf variety of the human race in America," on the one hand, to that of the Commissioners of the Irish census of 1881, that "it appears evident that the question of deafness and dumbness in parents has no influence in propagating the defect."

Mr. Fay's inquiry commenced in 1889, and the work has continued uninterruptedly since that time. Exhaustive questions were sent out and about, and the replies received were both more numerous and more complete than was anticipated.

It would be beyond the purpose or scope of this review to enter with any detail into the large number of statistics placed before Mr. Fay's readers; suffice it to say that they bear the stamp of having been most carefully collected, tested, and arranged, and may therefore be taken as more trustworthy than statistics are usually found to be. In the tabular statement of marriages details are given of no less than 4471 unions—a fact that will give the reader some idea of the onerous nature of Mr. Fay's task.

It appears that marriages of the deaf are more common in America than in Europe, and they have increased at a high rate of progression during the present century. From the statistics it appears that marriages of deaf persons, one or both of the partners being deaf, are far more liable to result in deaf offspring than ordinary marriages. The proportion of deaf marriages resulting in deaf offspring is 9·7 per cent., and the proportion of deaf children born therefrom is 8·6 per cent. Accurate data as to the proportion of deaf children born of ordinary marriages are not easily obtainable, but that proportion is probably less than 1·10 per cent. On the other hand, marriages of the deaf are far more likely to result in hearing offspring, the proportion of hearing children being 75 per cent.

These results are in accordance with the two laws of heredity: (1) that a physical anomaly tends to be transmitted to the offspring, and (2) that offspring tend to revert to the normal type.

There is a greater liability to deaf offspring of marriages of the congenitally deaf, since congenital or innate characteristics are far more likely to be transmitted than are acquired characteristics.

It appears also that deaf persons having deaf relatives, however they are married, and hearing persons having deaf relatives and married to deaf partners, are very liable to have deaf offspring. Finally, the marriages of the deaf most liable to result in deaf children are those in which the partners are related by consanguinity.

The most important statistics (summed up in a separate table) are those showing the number of marriages of each class of which the results are reported and the number and percentage of each class resulting in deaf children, with the number of children born from marriages of each class, and giving the number and percentage of those deaf. These statistics show the comparative liability to deaf offspring of the several classes of marriages.

As regards the *happiness* of deaf unions, marriages in which both parties are deaf appear to be more likely, other things being equal, to result happily than those in which one of the partners is deaf and the other possesses normal hearing; the proportion of divorces and separations in the former class being 2·5 per cent., in the latter 6·4 per cent. This is easily explainable on the grounds of mutual fellowship and identity of social relations and sympathies which arise from the union of individuals suffering from similar conditions.

An appendix is devoted to illegitimate unions, but the totals of their statistics are too small to furnish any certain basis for trustworthy conclusions.

Mr. Fay has produced a valuable work, and one which should take a prominent place in the literature—necessarily not a very large one—of the subject. From a careful perusal one cannot fail to note the clearness of his statements and the logical way in which he works out his deductions. There is but one thing lacking, and that is the devotion of any special chapter to those diseases of the ear—notably the condition known as middle ear sclerosis—acknowledged to be hereditary, or to the diseases of the throat and nose which are predisposing causes of deficient hearing power. Considering the large percentage of all forms of nasal obstruction existing in the condition of civilisation—a percentage larger, we believe, in America than in Europe—it would be of interest to investigate the influences diseases of the throat and nose exercise upon the marriages of persons suffering therefrom.

In spite of the fact that statistics are always somewhat dry, and the deductions given from those in Mr. Fay's work are put without useless verbiage, the book is a very readable one to those interested in all branches of the subject, and should rank high as a work of reference.

MACLEOD YEARSLEY.

THE LIQUEFACTION OF GASES.

The Rise and Development of the Liquefaction of Gases. By Willett L. Hardin, Ph.D. Pp. viii+250. (New York: The Macmillan Co. London: Macmillan and Co., Ltd., 1899.)

La Liquéfaction des Gaz et ses Applications. By Prof. Julien Lefèvre. Pp. 175. (Paris: Gauthier-Villars et Fils, and Masson et Cie.)

A BOOK should be criticised with reference to the author's professed object in writing it. Dr. Hardin professes to have written for the popular reader, in the popular science style. Regarded from this point of view the work deserves a good deal of praise. It is, in the first place, interesting to read, collecting, as it does, a great many facts connected with the development of low-temperature research, and detailing numerous experiments which are explained with the assistance of copious and clear illustrations. It may therefore be recommended, with the reservations which are made below, to those who, with a very elementary knowledge of physics, desire to learn something of the details of recent progress in a very interesting subject. The recommendation should be all the heartier because the author's style is free from the patriotic brag and boom which disfigure another recent American book on the same subject, and because the right side is taken as to the marvellous industrial revolutions heralded from America as a consequence of later work in this department of science. A further merit in the work is the abundance of exact references to original authorities, for the benefit, as stated in the preface, of those who wish for fuller information.

The fact, however, that the author had the latter object in view emphasises what should be a binding obligation even in books intended solely for popular reading, namely, to take care that such science as is introduced shall be strictly correct; and this obligation Dr. Hardin has fallen short of in a serious degree. On pp. 183-185 he reproduces Edwin J. Houston's suggestions for an apparatus to produce intense refrigeration. The nearest thing to a novelty in these suggestions is the proposal to modify Windhausen's machine by substituting a two-stage compressor for a single-stage one, and so obtaining a higher pressure of sixty atmospheres. He expressly retains Windhausen's system of power expansion in a cylinder doing work on a piston; yet Dr. Hardin says:

"In the apparatus suggested, Houston anticipated the methods which were employed twenty years later in the liquefaction of air by Linde, Hampson and Tripler."

This is inexcusable in one who undertakes to "enable the popular reader to understand the principles involved." The same confusion is repeated much more deliberately later on. On pp. 205-208 the author works out mathematically the formula for the cooling produced by power expansion, $\left(\frac{p}{p_1}\right)^{\frac{k-1}{k}}=\frac{T}{T_1}$, which he calls equation (7). He then says:

"Applying these results to the liquefaction of gases by means of the regenerative coil, it is evident that the expansion of the gas in the tube lowers the temperature by an amount which corresponds to equation (7)."

The formula for power expansion is here applied where we ought to have had Thomson's formula for free expansion, $-\frac{d\theta}{dp} = A\left(\frac{273 \cdot 7}{t}\right)^2$. The title of the section is "Theory of the Self-intensification Method of Refrigeration," and a note, at the foot of the same page, refers us to Joule and Thomson for a more complete discussion, which, however, in the body of the section, instead of being abridged or summarised, is altogether replaced by another analysis. The way in which the book is written gives no reason to suppose that Dr. Hardin is incapable of distinguishing between the very different conditions involved in power-expansion and free expansion, or the very different mathematical analyses appropriate to these two sets of conditions. The only tolerable explanation of such a gross confusion is that it has never come in Dr. Hardin's way to read Thomson's papers on the cooling of gases by free expansion, or to examine intimately the nature of the phenomena involved, and so he has carelessly applied to these phenomena the well-known formula for cooling by power-expansion. This is not the proper way to write a book even for the satisfaction of the interest of the popular reader. These are not the only instances that the author shows of a lack of thorough acquaintance with his subject. If he had studied Mr. Tripler's British patent of 1893, which is put forth as the foundation of his claims as inventor of a form of self-intensive air-liquefier, and had paid attention to the chronology of the subject, Dr. Hardin would perhaps not have felt justified in treating those claims so well as he has done, by describing those parts of Mr. Tripler's apparatus which are not kept secret. On p. 227, the author gives Prof. Dewar's conclusion, that the liquefying points of hydrogen and helium are near together, without giving the subsequent correction.

The style of the writing is occasionally careless and slipshod, and the meaning sometimes undiscoverable. On p. 209 we are told

"the issuing jet experiences a much greater decrease in temperature owing to the greater difference between the initial and final pressures."

This is unintelligible in view of the fact that the difference between the initial and final pressures does not increase, while in case of supply from a cylinder of compressed gas, it actually decreases. On p. 232 we find the sentence: "Below the temperature of zero degrees ice slowly sublimes." Some misprints have escaped correction. On p. 208 the minus sign is omitted between k and 1 in equation (7). On p. 243 the second "i" in the name Lavoisier has been omitted.

If in a new edition such mistakes be corrected, and the latter part of Chapter iv., Section 3, be rewritten, the book will be useful as well as interesting to the class of readers for whom it is chiefly intended.

Prof. Lefèvre's book is very well written and clearly illustrated. Within the narrow limits of 175 pages it contains a considerable amount of correct theory, a very interesting history of the experimental development of gas-liquefaction, some discussion of industrial applications, and a very full list of references to original authorities; and all this with a surprising freedom from the evils of over-compression. The arrangement is not altogether perfect. Prof. Dewar's apparatus figured on pp. 55 and 61 apply the combination of free expansion with counter-current interchange, a method of which there was earlier authenticated invention both in England and Germany. These applications should have been described in Section 35 under the head "Machines à détente sans travail extérieur," and after the invention on which they depend; or, if it was thought advisable to discuss them out of chronological order, their dependence on the combination in that invention should have been clearly brought out. The illustration of Mr. Tripler's apparatus on p. 84 might well have been omitted. The employment of three-stage compressors, with cooling coils between the stages, with purifiers, water-separators, and pressure-gauge, was familiar to pneumatic engineers for years before they were employed by Mr. Tripler in liquefying air; and the vitally important interchanger and expansion valve remain such a mystery that the illustration gives no idea what they are like or whether they differ essentially from the invention of Dr. Linde and Dr. Hampson. On p. 70 the statement that helium was liquefied at the temperature of boiling hydrogen needs correcting in accordance with later results. Chapter ix., on modern commercial refrigerating machines, is very much out of proportion with the rest of the book; a discussion of this subject, which entirely passes by the great American and British developments in this field, might as well be omitted altogether.

A CONTRIBUTION TO ZOO-GEOGRAPHY.

Studien zur Geographie. Von Dr. W. Kobelt. Zweiter Band. Pp. x + 369. (Wiesbaden: Kreidel, 1898.)

IN this, the second part of his "studies," Dr. Kobelt deals at full length with the characteristics of the fauna and to some extent also, of the flora of the "Meridional Sub-region." This region very nearly corresponds to the Mediterranean sub-region of Dr. Wallace; its northern limits are a trifle more extensive, embracing as they do the Crimea and Bessarabia.

As might be expected from the nature of his own zoological studies, the author lays most stress upon the distribution of Mollusca, and gives a series of elaborate and apparently very full tables of species found in the different departments into which he divides the region described in this volume. It must not, however, be inferred from this that other groups of animals are neglected or even treated with indifference.

A great deal is said about the range of the vertebrata of this part of the world in the past as well as in the present, all the orders of that assemblage of animals being taken into consideration. There is one group of terrestrial, aquatic and semi-aquatic invertebrates which are not at all discussed by Dr. Kobelt. This group—that of the earthworms and their allies—might profitably have been dealt with, inasmuch as their range, so far as is known, marks out very well not only the limits of the Palæarctic region (excluding only Japan), but also enables a line to be drawn between the more northern and the Mediterranean portions of the region dealt with by Dr. Kobelt. Inasmuch as a large portion of the meridional region is occupied by the Mediterranean sea, the author is, we think, wise in paying some attention to the fauna of that sea, as well as of other stretches of water included within his area. A special chapter is devoted to the Mediterranean, and the author commences by addressing himself to the problem as to whether that inland sea is really an independent tract or a section of the Atlantic.

The colossal faunistic and structural monographs issued by the Naples Zoological Station, as well as the results of elaborate studies carried on at similar institutions along the coasts of the Mediterranean, have made us well acquainted with the shallow water fauna of that sea. We are less informed as to the pelagic creatures, especially mammals, and about the deep-sea fauna. As to the former, observes the author, "the mammalogist will, with a regretful shrug of the shoulders, confess himself incompetent" to speak with accuracy. So far as we know, the whales are not special to that sea; nor does palæontological evidence hint at the Mediterranean as a centre of origin. Oliver Goldsmith, in his "Animated Nature," pointed out that the Mediterranean dolphin occurred in the Red Sea. He was doubtless right, though the reasoning employed may have been defective, and there is no prevision of the Suez Canal! The sperm whale is found therein, and (if we may regard the sea beast from which Perseus delivered Andromeda as a "monstrous physetere"!) was even known to the ancients. Pliny's Orca was, it appears, rather that "sea should'ring whale" than a gladiator. The dolphin of the Mediterranean has received many names, but there seems to be little doubt that that whale of Greek coins is exactly the same as the dolphin of the coasts of the Atlantic. "As concerns mammals," concludes Dr. Kobelt, "the Mediterranean is an impoverished gulf of the Atlantic Ocean.'

In the characteristics of the Mollusca found, and some other animals, the Mediterranean presents tropical characters which are, partly at least, in reality due to the Suez Canal. Mr. E. A. Smith, of the Natural History Museum, contributed some years since a number of interesting facts to the Zoological Society bearing upon such immigrations. The Mediterranean, as is well known, sinks in places to profoundly abyssal depths; the actually greatest depth appears to be 4400 metres; but here no living organisms have been found. It is purely azoic; the reason for the want of life is, according to the author, the want of oxygen and the abundance of carbonic acid.

There is, in fact, no special deep-sea fauna found in this large tract of water.

Turning to the terrestrial mammalia, the author comes to the conclusion (elaborated in a special and highly interesting chapter) that their range to-day is in thorough agreement with the distribution of land and water. The Mediterranean southwards and the Bosphorus westwards form barriers which divide faunas. This is illustrative of what is apt to be a common error in text-books of zoology. When Mr. Sclater originally divided up the earth into zoological regions, he did not profess to do so for more than the Passerine birds, though his conclusions were shown later by himself and by others to apply to other groups also. They do not, however, in the least apply to various invertebrate groups; and in dogmatically dividing the world into the Sclaterian regions, the writers of some text-books have entirely lost the prime object of such a regional division. The more modern Eutherian mammals are controlled in their range by what are largely existing barriers; the more ancient molluscs show in their distribution the non-existence of such barriers in ancient times. Dr. Kobelt dwells upon the distinctness of northern Africa from Europe so far as concerns its mammalian inhabitants. He is disposed to dismiss the Gibraltar monkey as truly indigenous to that peninsula, though admitting the occurrence of fossil allies in European strata of Pleistocene and Pliocene age.

On the whole, however, we are not certain that Dr. Kobelt has taken so fortunate an instance as he might have done to illustrate the effects of modern barriers in the dispersal of mammals. It is perhaps a little too strong, in the face of the lists which he gives, to state of the Straits of Gibraltar and the narrow passage opposite to Carthage that they are "faunistic boundaries of the first rank." The division between the arctic and the non-arctic parts of the palæarctic region are more easily defined from their mammalian indigenes.

Dr. Kobelt's book is closely packed with solid fact, and there is no more speculation than is necessary to give prominence to such generalisations as appear to him to be the legitimate outcome of his laboriously collected material. This has been amassed from the most diverse sources; and the author by no means disdains the older writers, even the ancients being laid under contribution. We commend the book to the serious student of zoogeography only, for it is emphatically not to be trifled with in an arm-chair.

F. E. B.

A TEXT-BOOK OF HEAT MOTORS.

The Steam Engine and Gas and Oil Engines. By John Perry, D.Sc., F.R.S. Pp. viii + 646. (London: Macmillan and Co., Ltd., 1899.)

THIS is one of the best books which has been published in this country on the steam engine and other heat motors. The method and style is thoroughly characteristic of Prof Perry. Many will no doubt object to the order of arrangement of the various chapters, and will be inclined to think the author has put the cart before the horse; the author will probably reply that the book was not written for the beginner, but for advanced students.

There is something to be said for the plan adopted; if a text-book for students, engaged during the day in practical engine work, is given up in its early chapters almost entirely to the properties of steam and thermodynamic problems, there is great risk that the student will be discouraged and eventually give up the attempt to improve his knowledge of the principles underlying the working of heat motors.

The author's plan is to deal first with the more practical details, in the hope probably that in mastering these the student will find out what he lacks and what he needs of thermodynamics and kindred subjects. Granted this, it is still a little difficult to see that an improvement would not be effected by putting Chapters xv., xviii. and xix. on methods of calculation, on temperature and heat, and on the properties of steam, earlier in the book. This is shown by the necessity of a footnote on p. 99 to explain the way in which the total heat required in evaporating a pound of steam is determined.

Chapter ii. is devoted to description of cylinders, pistons, valves, frames, &c., of what the author calls the commonest form of steam engine, but as the details explained include parts of steam turbines, the title is hardly happy. The illustrations in this chapter are extremely good and complete.

Chapter iii. deals with the value of expansion, and the author points out, as a result of his calculations, that there are limits of economic expansion, and how easily the Willan's law can be deduced from such calculations.

Chapter iv. describes the indicator, its construction and the proper way to use it, and the errors it is liable to. Then, in the following chapter, come a most valuable series of exercises on calculations from indicator cards.

One of the chief merits of the book, apart from the fact that it is so thoroughly up to date in all its information and methods, is the way in which almost every chapter is filled with numerical exercises; any student genuinely working these out for himself cannot fail to become thoroughly master of the main problems confronting the student of heat motors.

In this chapter again (v.) we have a little awkwardness introduced from the particular arrangement adopted by the author. One of the exercises is the drawing of a $\theta\phi$ diagram, and no explanation of this has been given, the reader is referred for explanations to a much later chapter of the book. We fear the student is not likely to start with much knowledge of entropy, and will therefore probably skip these sections.

The next eight chapters are devoted to the mechanical details of valves, governors, air pumps, boilers and their fittings and accessories.

The first fourteen chapters may be said to mainly deal with the mechanical details of engines and boilers; while the rest of the book is devoted to what may be called theory and principle.

In Chapter xvi. the author deals with the cost of production of energy and the efficiency of various types of motors, a most complete and valuable chapter full of good examples. Then come some chapters on temperature and heat, properties of steam, and work, &c., all very thorough and very full of matter for careful thought.

In the chapter on the $\theta\phi$ diagrams, more advanced theory is taken up; and, in fact, there are several chapters here that will be above the average student, and will form good reading for the expert; the facts are marshalled with great skill, and the deductions show that the author is a thorough master of his subject.

The chapters on valve motion problems and inertia of moving parts are good, and the methods adopted to deal with these very difficult problems are as simple as it is possible for them to be.

Though only forty-two pages are devoted to gas and oil engines, the author has managed to get in a great amount of most useful information, and to give all that the general student needs.

The remaining chapters are devoted to certain important thermodynamic problems and to an inquiry into the properties of superheated steam.

Most certainly Prof. Perry has produced a text-book which must be on the shelf of every student of applied thermodynamics, and of every engineer who has to deal with the utilisation of energy. H. B.

OUR BOOK SHELF.

Practical Plane and Solid Geometry for Advanced Students; including Graphic Statics. By J. Harrison, M.I.M.E., and G. A. Baxandall. Pp. xii + 558. (Macmillan and Co., 1889.)

THIS book appears to compare very favourably with most English works of its class. The greater part of it deals with practical solid geometry, including the method of indexed plans; this subject is treated in a much more methodical way than is usually the case, and the authors very properly call attention from time to time to constructions which are of a fundamental character. It is a pity they did not go further, and clearly distinguish throughout the book the worked examples which involve new points of theory from those which merely illustrate general constructions previously given. The directions for making cardboard models ought to be very useful to the student; and the constructions are explained in such a way as to make the reasons for them intelligible. The section on plane geometry is distinctly above the average; in particular, there is a very interesting discussion of the description of an ellipse by means of a paper trammel. Of graphical statics only a brief outline is given; but it is useful enough so far as it goes. There is one error to which attention ought to be drawn: on p. 342 it is stated that the tangent plane to a surface at an anticlastic point cuts the surface in a curve with a double point *where there are two inflexions:* this is not generally the case, and, in fact, the anchor-ring gives an example of the contrary. Here the section is a bicircular quartic which has a real ordinary node when the tangent plane cuts the ring, and is not parallel to the polar axis.

Grundlinien der maritimen Meteorologie. By W. Köppen. Pp. vi + 83. (Hamburg: G. W. Hiemeyer, 1899.)

THIS little work serves two purposes; it is practically a concise elementary meteorology, and a guide for the use of sailors, showing the best routes in the different oceans, with directions for the management of vessels in storms, especially the dangerous West India hurricanes and the typhoons of the China seas. Dr. Köppen has been known for many years as one of the most prominent meteorologists, and having access to the large amount of materials collected by the Deutsche Seewarte, we might expect to find the result of his long experience embodied in a useful and an attractive form. The work meets our expectations in every way; all details which are unnecessary for the object in view have been carefully excluded, while all technical and nautical expressions are fully explained, so that the work, which is specially written for seamen, may be read with interest and advantage by all who are desirous of obtaining a knowledge of maritime meteorology. His treatment of the subject includes the general circulation of the atmosphere, as well as the movements of waves, tides and ocean currents, and the value of the treatise is much enhanced by explanatory figures in the text and by separate charts and diagrams.

Inorganic Chemical Preparations. By Felix Lengfeld. Pp. xviii + 57. (New York: The Macmillan Company. London: Macmillan and Co., Ltd., 1899.)

THIS is a compact series of instructions for the preparation of typical inorganic compounds, the selection of which seems to have been very judiciously made. References to original literature are given in connection with each preparation. The author takes care to explain "that the manual is merely a laboratory guide, and that unless the work is carefully supervised, it may become purely mechanical, and the course lose half its value." It is, in fact, a series of recipes, and no attempt is made to explain the innumerable difficulties that will confront the inexperienced worker. This is not said by way of complaint; on the contrary, it is the incidental and unexpected difficulties of an operation rather than the plain sailing that give the operator occasion to think, and lead to the close association of the teacher with the mind of the learner.

Mr. Lengfeld purposely refrains from giving a complete list of references to literature, being of opinion that the student should learn to use dictionaries of chemistry. It is doubtful, however, whether the student is able to make a discreet choice from the innumerable references of a dictionary, and we think that the author has rather lost an opportunity in not making his list of references more ample. To those teachers who are introducing more inorganic preparation work into their courses, this book is likely to prove welcome. A. S.

The Utility of Sulphate of Ammonia in Agriculture. By James Muir, M.R.A.C. Pp. 68. (London: Sulphate of Ammonia Committee, 4 Fenchurch Avenue, E.C., 1899.)

THIS is the essay which won the prize lately offered by the Sulphate of Ammonia Committee. Mr. Muir has carefully compiled his little treatise, and made a judicious selection of results of field experiments to illustrate the use of sulphate of ammonia, and to compare its results with those obtained from the use of nitrate of soda. Naturally, the results of the Rothamsted experiments are those most largely drawn upon; Woburn is also quoted from to a considerable extent, and the author considerately always gives references to his authorities. The comparisons between the effects of nitrate of soda and sulphate of ammonia are fully and very fairly drawn, and the farmer should find the essay a great help in deciding which of these nitrogenous manures to apply in any particular case. No doubt the farmer, for whom the essay is chiefly written, will turn to the last three pages, which contain a summary of conclusions and comparisons between the two important nitrogenous manures. This summary is in twenty-seven paragraphs, and but few of these lay themselves open to criticism. We can only suggest that the author might have pointed out more clearly in this summary, paragraph 3, that leguminous plants can, under favourable conditions, make use of free nitrogen; paragraph 7, that nitrogenous manures, and *especially* ammoniacal manures, do not give their bes results unless plenty of ash constituents are present, phosphates as well as potash; paragraph 20, that phosphates are a highly desirable addition in the manuring of barley; and paragraphs 24 and 27, that both phosphates and potash should be used on potatoes and on grass-land when sulphate of ammonia is used to supply nitrogen.

The Committee is to be congratulated on having secured and published a very useful and very justly written essay.

Euclid. Books I.–IV. Edited by Charles Smith and Sophie Bryant. Pp. viii + 288. (London: Macmillan and Co., 1899.)

WITH this book we have another addition to the great number of text-books on the Elements of Geometry. Its chief features seem to be that the editors endeavour to instil into the students the notion that it is the correct reasoning and proof of the propositions which should be mastered, and not so much an exact repetition of the words of the text-book or teacher.

Abbreviations are freely used early in the first book, and these should be adopted generally by beginners, as the reasoning of a proof can be more easily scanned. The editors have in several cases departed from Euclid's solutions and adopted in their stead more modern and simple methods. Included in the text are many examples, both original and selected, from mathematical journals and examination papers. In this form the Elements should be found useful in many schools.

Sylvia in Flowerland. By Linda Gardiner. Pp. 198. (London: Seeley and Co., Ltd., 1899.)

AN attempt is here made to employ the methods of Lewis Carroll in the teaching of botany. In the first chapter the foxglove explains: "This is Leap Year with us (the flowers), and so we have a thirty-first of June," and because the thirty-first of June does not occur every year, it is a day of special favour to humans, who are allowed "to hear with both eyes and ears." Sylvia talks with plant after plant, and is instructed by them in the fascinating mysteries of cross-pollenation and many other interesting questions of plant-life. The jam is sometimes scarcely thick enough to hide the powder; but we have little doubt that the volume will find many appreciative readers.

Magnetism and Electricity. By J. Paley Yorke. Pp. viii + 264. (London: Edward Arnold, 1899.)

MR. YORKE'S object is to provide an introduction to this branch of physics for those students who already possess some acquaintance with general elementary science. His treatment is non-mathematical, and no precise instructions are given for experimental work. It is a little difficult to understand the reason for the interpolation of chapter v., headed "Electricity," between the subjects of magnetism and the study of electric currents, more especially as the subject of electrostatics is resumed in chapter xii. The explanations are clear and simple, and the book should give an intelligent reader sound preliminary conceptions of an important subject.

Field and Folklore. By Harry Lowerison. With a chapter on Folklore by Alfred Nutt. Pp. vii + 77. (London: David Nutt, 1899.)

THE collection of short essays on various aspects of nature-study collected here should do a great deal towards enlisting the sympathy of school teachers in developing a love in their pupils for outdoor observations of animal and plant-life. Mr. Lowerison gives, in an informal way, a series of useful hints as to how to set about observing nature, and what books to consult to find the explanation of observations which are not at first easily understood. Mr. Nutt's chapter describes the scope of folklore and the aims of students of this department of knowledge.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Stockholm Conference on the Exploration of the Sea.

I CANNOT refrain from addressing to you a few words in support of Prof. Herdman's remarks on the outcome of the Stockholm Conference. With marine biology so eminently represented at the meetings, there was ground for an expectation that the report would contain primarily recommendations for work at sea. The representatives of chemical and physical work appear to have known their minds and to have obtained the just recognition of their claims.

Hitherto in biological investigation work has been too exclusively devoted to the food fishes themselves—too little to the food of these fishes—far too little to their biological environment. It will be to many eager students, both of fishery affairs and marine biology, a matter of dismay if nothing more definite results from this Conference. There are, and have been, too many committees, secretaries and bureaus engaged on this subject. As Prof. Herdman says, we want work at sea. To be precise, we want, to begin with, two well-equipped trawlers and the right men in them. If the Stockholm Conference had recommended even one, it would have been a sign of grace. Such boats are not mere scientific instruments—not merely the luxuries afforded by governments in times of prosperity—but sound financial investments in fishery affairs. The Norwegian Government has, I understand, ordered one, admirably devised for marine investigation. GEORGE MURRAY.

November 25.

Bust of Sir George Stokes.

YOU were kind enough to say last June that Mr. Hamo Thornycroft would undertake the production of bronze copies of the presentation bust of Sir George Stokes, about one-third of the size of the original, at a cost of seven guineas each, in case twenty-five were ordered, and that names would be received by Sir William Crookes and myself.

If anybody wants such a copy I hope that he will write to me at once. JOHN PERRY.

Royal College of Science, London, South Kensington, S.W., November 22.

A Geometric Determination of the Median Value of a System of Normal Variants, from two of its Centiles.

A SHORT account appeared in NATURE, October 12, p. 584, of a paper read by me at the British Association, entitled the "Median Estimate," which will appear in the forthcoming Journal of the Association. Its object was to solve a problem of the following kind:—40 per cent. of the members at a meeting vote that a proposed grant should be less than 100*l.*, 80 per cent. vote that it should exceed 500*l.* What is the Median Estimate, supposing the normal law of frequency to hold good? That is to say, What is the sum that one-half of the members would think too little, and the other half too much, and which therefore presents the best compromise between many discordant opinions? I showed that the calculation was exceedingly simple if certain tabular values are used that will be spoken of later. But, on after reflection, it seems to me that further simplification is both desirable and feasible. The problem is representative of a large class of much importance to anthropologists in the field, few of whom appear to be quick at arithmetic or acquainted even with the elements of algebra. They often desire to ascertain the physical characteristics of races who are too timorous or suspicious to be measured individually, but who could easily be dealt with by my method. Suppose it to be a question of strength, as measured by lifting power, and that it has been ascertained that *a per cent.* of them fail to lift a certain bag A of known weight, and that *b per cent.* of them fail to lift another heavier bag B. From these two data, the median strength can be determined by the simple method spoken of above, and not only it but also the distribution of strengths among the people. Having indicated the utility and importance of the general problem, I will proceed to work out the particular case of the voters by the now further simplified method. In Fig. 2 let the base line G represent 100*l*. and let each successive horizontal line above it represent an increment of 100*l*. A dot A is placed on G, at the division 40°, and another dot B is placed on the ordinate at the division 80° at the level of the fourth line above G. Therefore A and B are plotted at their respective places. Join the two dots with a straight line. The place where this line cuts the ordinate at 50°, shows the Median value. The principle on which this exceedingly simple process rests must be explained by beginning with Fig. 1, where an ordinary curve of distribution is drawn about the axis H, with a quartile equal to 1. The

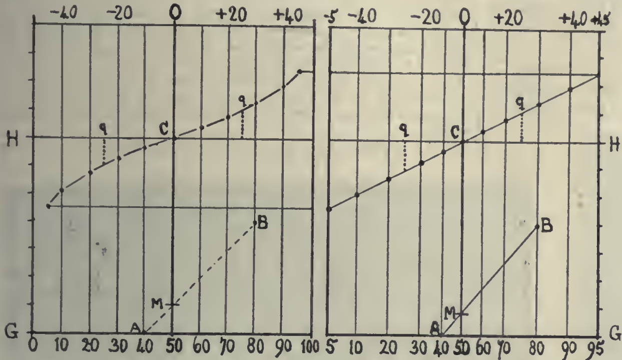


Fig 1. {Limits, 0° & 100°, otherwise, 0° & ±50°.

Fig 2 {Limits 5° to 95° otherwise 0° to ±45°

centiles from the axis to the curve are given in the following small table (see my "Natural Inheritance," Macmillan, 1889) which is reproduced here for convenience.

Centiles to the grades 0° *to* ± 50° (*negative for negative grades, positive for positive grades*).

±	0	1°	2°	3	4	5°	6°	7°	8°	9°
0	0·00	0·04	0·07	0·11	0·15	0·19	0·22	0·26	0·30	0·34
10	0·38	0·41	0·45	0·49	0·53	0·57	0·61	0·65	0·69	0·74
20°	0·78	0 82	0·86	0·91	0·95	1·00	1·05	1·10	1·15	1·20
30°	1·25	1·30	1·36	1·42	1·47	1·54	1·60	1·67	1·74	1·82
40	1·90	1·99	2·08	2·19	2·31	2·44	2·60	2·79	3·05	3·45

The theoretical values for ± 50° are infinitely large.
The curve ceases to be trustworthy outside about ± 45°.

When A and B are plotted on Fig. 1 there can be only one normal curve of frequency whose steepness, as measured by its quartile, allows it to pass through both of them. This curve might be drawn, but by a tedious process of trial and error, to avoid which the arrangement shown in Fig. 2 has been devised, and the troublesome curve is dispensed with. The ordinates in Fig. 1 are so stretched apart or compressed together, laterally, that the curve is changed into a straight line. Let x be any abscissa in Fig. 1, counting from the middle of the axis to the right or left as the case may be, and let y be the corresponding tabular value. Then, as in Fig. 2, draw an abscissa x' of the same *nominal* length as x, but of a real length $= ny$, where $n = 1$ or some more convenient number. Now let p_1, p_2, p_3, &c., be points on the curve in Fig. 1, having the co-ordinates x_1, y_1; x_2, y_2; x_3, y_3, &c., then the corresponding points in Fig. 2 will occupy positions having the co-ordinates of ny_1, y_1; ny_2, y_2; ny_3, y_3, &c. In other words, they will lie in the same straight line. The ordinates of any normal curve are expressed by multiplying the tabular numbers by the quartile of that curve. Let q be the quartile of any given curve, and write n' for nq. Then substituting n' for n in the above, we still find that p_1, p_2, p_3, &c., will lie in the same straight line in Fig. 2. Consequently the proposition is true generally.

Prof. Karl Pearson informs me that various curves representing technological formulæ were similarly translated into straight lines by Lalanne, and discussed by him in a series of papers (1846–1878). He termed the process by which a proper choice of scales enables us to represent a given curve by a straight line, *anamorphic geometry*. Prof. Pearson also tells me that in Lalanne's hands and in those of his followers (Hermann, Vogler, Kapteyn, &c.) this geometry has been of great service in exhibiting engineering and other data in a form suitable for easy reckoning.

A convenient scale for the pocket book may be made on a strip of paper squarely ruled in millimetres, on which the tabular numbers divided by 4 and multiplied by 100 are entered. Its range between ± 45° is consequently $100 \times \frac{1}{4} \times (2 \times 2{\cdot}44) = 122$ millimetres, which is less than 5 inches, or than the length of a half sheet of ordinary notepaper. The scale is to be used for plotting the values of a, b, and m, while the millimetre graduations along the opposite edge of the strip serve for the ordinates A and B. For frequent service, a ruled blank form, like Fig. 2, is quicker in use, and it need not, I think, be larger than half a sheet of foolscap paper, or eight inches wide. This would suffice to show clearly each alternate centile, as about the middle of the form, where the centiles lie closest together, the alternate centiles would be more than one-tenth of an inch apart.

An attempt is made at the bottom of Fig. 1 to exhibit the amount of error that would be produced by a simple interpolation between A and B, but it is better to make the comparison numerically.

Let a and b be the percentage of those who vote, &c., for less than A and B respectively, and let α and β be the tabular numbers *including their signs*, corresponding to a and b, on the scale reckoned from 0° to 100° (and not from 0° to ± 50°). Let m be the unknown median and q the unknown quartile of that curve of normal frequency which passes through the plotted positions of A and B, then

$$m + q\alpha = \mathrm{A} \qquad m + q\beta = \mathrm{B}.$$

Whence, by eliminating q, we have

$$m = \mathrm{A} - \alpha\left\{\frac{\mathrm{B}-\mathrm{A}}{\beta-\alpha}\right\}, \text{ or } = \mathrm{B} - \beta\left\{\frac{\mathrm{B}-\mathrm{A}}{\beta-\alpha}\right\}.$$

The "medians calculated" in the table below are thus derived: The simple interpolations require no explanation. Graduations on the scale 0° to ± 45° are in brackets.

	Values of b			
	(+20°) 70°	(+30°) 80°	(+40°) 90°	(+50°) 95°
$a = 20°$ (−30°)				
Medians calculated	348	300	259	236
Simple interpolation	340	300	271	260
$a = 40°$ (−10°)				
Medians calculated	231	193	167	154
Simple interpolation	233	200	180	173

The interpolated results are, of course, correct when A and B are symmetrically placed, as they are at 20° (−30°), and 80° (+30°). They are most incorrect when either A or B is near to the limits of the curve, and when both are on the same side of its middle point.

When applying the method practically, especially upon some unfamiliar characteristic whose law of frequency is doubtful, the determination of M should be considered as a first approximation, and the process be repeated with two new values A_1 and B_1, the one a little less, and the other a little greater than M. The new result M_1 could be accepted as final.

For perfection of simplicity some method, whether it be graphic or tabular, for converting observed numbers into percentiles, might be printed at the back of the blank form.

FRANCIS GALTON.

On the Cause of Dark Lightning and the Clayden Effect.

I HAVE been criticised in a letter which appeared recently in NATURE for not alluding in my letter on dark lightning to the peculiar photographic reversal known as the Clayden effect. I must confess that at the time of writing my letter I was unaware of this effect, a description of which has only appeared, so far as I know, in one of the photographic journals. Mr. Clayden has certainly explained dark lightning, and it only remains to explain his explanation. As I think that this effect is not generally known, I believe that it may be worth while to devote a few words to the statement of the case before describing the experimental work by which I have determined the factors which play a part in this very curious photographic phenomenon.

Mr. Clayden showed that if a plate which had received an

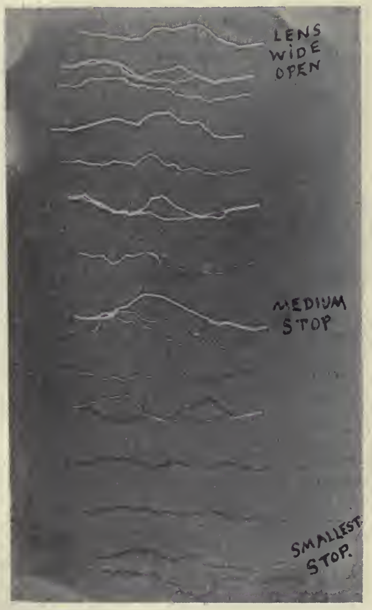


FIG. 1.

impression of a lightning flash or electric spark was subsequently slightly fogged, either by exposing it to diffused light or by leaving the lens of the camera open, the flash on development came out darker than the background. If, however, the plate was fogged before the image of the flash was impressed, it came out brighter than the background, as in the ordinary pictures of lightning. I refer to the appearance in the positive print in each case. This is quite different from ordinary reversal due to the action of a very intense light, for the order in which the lights are applied is a factor, and the phenomenon lies wholly in the region of under-exposure. I repeated Mr. Clayden's experiment, and obtained dark flashes without any difficulty.

The effect cannot, however, be obtained by impressing an image of the filament of an incandescent lamp on a plate, and subsequently fogging the plate. Clearly there is something about the light of the electric spark which is essential to the production of the reversal. It is not intensity, however, for I found that it was impossible to obtain reversed images of bright sparks with the lens wide open.

Fig. 1 shows a series of spark images, some normal, some partly reversed, and others wholly reversed. The sparks are those of a large inductorium with a good-sized Leyden jar in circuit. The sparks were all of equal intensity, but after each discharge the iris diaphragm of the lens was closed a little. It will be seen that the borders of the bright sparks are reversed. In some the image is reversed, with the exception of a narrow thread down the core. The images were impressed in succession on the plate by moving it in the camera. A plate holder was dispensed with, an opening being made in the ground-glass back by removing a strip a few centimetres wide. The plate was held against this opening, and a large number of exposures made in a few moments. Of course, the room was in total darkness. After exposure, the plate was exposed to the light of a candle for a second or two, and then developed.

In this series of pictures it will be seen that the edges of the bright images of the sparks are reversed, the intensity on the border of the image being less than at the core. As the intensity of the spark becomes less and less, the bright central core dwindles down to a mere thread, and eventually disappears, the spark's image being feeble enough to reverse over its entire area.

This explains why the dark lightning flashes are usually

FIG. 2.

ramifications of the main flash. The ramifications are less brilliant discharges and reverse, while the main one is too bright to cause the effect.

The first thing that occurs to one is that it may be some peculiar radiation, which the spark emits, which is wanting in the light coming from other bodies. If a small photographic plate is partly screened by a piece of black paper and illuminated by the light of a small spark at a distance of two or three feet, and a similar plate, screened in the same manner, is illuminated for a moment by candle light of sufficient intensity to produce the same amount of blackening on development, we shall have the means of showing that the spark light differs in its action on the plate from that of the candle. If these two plates, before development, be half-screened in a direction at right angles to the former one, and exposed to the light of the candle for a second or two, the part of the plate which has been illuminated by spark light plus candle light does not become as black on developing as the part which has received candle light alone, whereas the part which has been twice exposed to candle light is blacker than that which has been only exposed once. This shows that the light of the spark does not act in the same way as the light of the candle. Wherein does it differ? It seemed possible that the peculiarity lay in the nature of its radiation. To test this a prism was placed before the lens of the camera, which broke up the image of the spark into a series of spark images of different colour. The plate was exposed to the flashed spectrum of a single spark, then removed from the camera and exposed to the candle light, and developed. If the reversing effect was due to any peculiar radiation or wave-length we should find the reversal at that part of the spectrum where the effective radiation belonged, say in the infra red if the reversing power lay in long waves given out by the spark. It was found that the entire spectrum came out lighter on the negative than the fogged background. A second plate was exposed to the spectrum flash, then slightly fogged, and a second spectrum impressed on it in a different place. On developing, one spectrum came out light and the other dark. Clearly the effect does not depend on wave-length. It then occurred to me that the time-element might enter into the problem. The light of the spark is over in about 1/50000 of a second, and it did not seem impossible that a bright light of exceedingly short duration might act quite differently on a plate from a weaker light of longer duration. This may be tested in a variety of ways. We may open the lens wide, impress the image of a single spark on the plate, and then stop the lens down and superimpose a number of spark images sufficient to make the total exposure the same in each case. This was the first method which I tried. In order to compel the successive sparks to pass over the same path, that their images might be superposed, I shut them up in a capillary tube. With the lens open wide enough to give the maximum reversing action, I passed a single discharge through the capillary. Stopping the lens down to one quarter of its former aperture, four discharges were passed through the tube. The plate was then fogged in the usual manner, and on development the single discharge was reversed, but the composite one was not.

Fig. 2 is from a plate showing this effect. The upper images are those of single discharges through the capillary, with different apertures of the lens; the lower images are those of double or triple discharges through the same tube. The left-hand side of the plate was exposed to the candle light for different amounts of time, by moving the screen over small distances during the exposure. Only the single discharges reverse, though the density of the images on the unfogged portion of the plate is the same.

This was very strong evidence that the duration of the illumination was the important factor. Some years ago I measured the duration of the flash of exploding oxy-hydrogen, finding it to be about 1/12000 of a second. Possibly the flash of such an explosion would duplicate the effect. I exploded several glass bulbs filled with electrolytic gas, but found that the action was the same as that of ordinary light, it being impossible to get any reversal. The flash evidently lasted too long, or there still remained some undiscovered factor.

The difference between the action of spark light and the light of the oxy-hydrogen flash is shown in Fig. 3.[1] Plate "a" shows the effect of the explosion flash. Squares 1 and 2 received the light from an exploding bulb, the rest of the plate being covered. Squares 1 and 3 were then exposed to the light of the candle. Square 1, which has received the light from both sources, is the brightest, that is, the effects are additive, there being no reversal. Plate "b" shows the action of the light from the spark. Squares 1 and 2 were illuminated by the spark light, then squares 2 and 4 were exposed to the candle. In this case, square 4, which was illuminated by the candle, is brighter than square 2, which received both the spark light and candle light. In this case the effects are not additive, there being reversal.

To demonstrate conclusively that the time-factor was the only one, it was necessary to secure an illumination independent of the electric spark, and of as short duration. This was accomplished in the following manner: A disc 30 cms. in diameter was furnished with a radial slit 1 millimetre wide near its periphery, and mounted on the shaft of a high-speed electric motor. A second slit of equal width was arranged close to the rim of the disc, in such a position that the two slits would be in coincidence once in every revolution. This second slit was cut in the wall of a vertical chute, down which a photographic plate could be dropped. By means of a large convex lens of short focus, an image of the crater of an arc-lamp was thrown on the point of coincidence of the slits. The intensity of the illumination transmitted by the slits when in coincidence was almost sufficient to char paper. The motor was now set in motion, and a plate dropped down the chute. On developing this plate, three images of the slit appeared, not at all over-exposed, though the plate was the fastest obtainable, and the intensity of the light while it lasted comparable to that at the focus of a burning glass. By measuring the distance between the images and the vertical distance through which the plate had fallen, it was an easy matter to calculate the speed of rotation, which was found to be sixty revolutions per second, the air friction of the disc preventing higher speed. The duration of the exposure will be the time occupied by the rim in travelling a distance equal to the width of the slit, or 1 mm. This was found to be 1/55000 of a second, about that of the spark. The crucial experiment now remained. A second plate was dropped, and, before development, was exposed to the light of the candle. *The images of the slit were most beautifully reversed*, except at the centre, where the light was too intense. It seems, then, that we are justified in assuming that *the action of an intense light on a plate for a very brief time-interval decreases the sensitiveness of the plate to light*. It is curious to contrast with this effect the fact that exposure to a dim light for a moment or two appears to increase the sensibility by doing the small amount of preliminary work on the molecules, which seems to be necessary before any change can be effected that will respond to the developer.

I am not prepared to say what the nature of the change effected by the flash is. Possibly some one familiar with the theory of sensitive emulsions can answer the question. I have tried using polarised light for the reversing flash, and then fogging one half of the plate with light polarised in the same plane, and the other half with light polarised at right angles to it. As was to be expected, there was no difference in the effects.

R. W. WOOD.

Physical Laboratory of the University of Wisconsin, Madison, Wisconsin, October 20.

[1] The details in this figure, and in two others sent by Prof. Wood, are too indistinct to be reproduced satisfactorily.—ED. NATURE.

Experiments on the Floral Colours.

IN 1837 the illustrious Berzelius wrote: "The red pigment of several kinds of berries has generally been regarded as a blue pigment reddened by an acid. This is not the case with all berries. I have examined the pigment of *Prunus cerasus* and of *Ribes nigrum*, which contain the same pigment, and this is not blue. Probably this has been surmised from the circumstance that the sap of these berries gives a blue precipitate with acetate of lead; but these precipitates are malate and citrate of lead, wherewith the pigment is combined." He found that, after separating these acids from the colouring matter, the latter yields a green and not a blue precipitate with acetate of lead; and, moreover, when to its aqueous solution a little milk of lime is added sufficient to saturate all the free acid, the supernatant liquid is red and not blue, which latter it would be if its natural colour was blue. He arrives at similar conclusions with regard to the red pigment of the autumn leaves of cherry, red currant, &c.

On the other hand, Julius Wiesner, of Vienna, in 1862 and 1872, by a series of experiments, endeavoured to prove that the compounds of anthocyan—*i.e.* the blue and red pigment of flowers, with lead, alkalis, &c.—are always blue, and it is only when anthocyan is present in the cell-sap simultaneously with a substance which is coloured yellow by alkalis, &c., that it passes by the latter body into green, which thus arises as a mixed colour. He found that by completely washing out (as he thought) this latter body from the petals by warm dilute hydrochloric acid, and then immersing them in solutions of lead and iron salts, they became intensely blue; hence he was led to conclude, contrary to Berzelius, that the original and actual colour of anthocyan was blue and not red.

During last summer I have performed a series of experiments on a number of flowers, with a view of settling the question in dispute, as above set forth. In the first place, it was deemed advisable to observe the effect produced in each case by immersing the fresh petal into ether saturated with ammonia. The results were as follows:—(1) Petals which became blue, *e.g.* pæony, pink campion, deep red garden rose, sweet pea, vetch, mallow, balsam, geranium, fuchsia, scarlet rhododendron, crimson flax, blue centaurea; red daisy, periwinkle, lady's smock, became bluish-green. (2) Petals which became green, *e.g.*

anemone, larkspur, violet, willowherb, scarlet tropæolum, red rhododendron, bilberry, flowering currant, scabious, wild thyme, potato, forget-me-not.

The colouring matter was then withdrawn from these and other petals by macerating them for two days in cold methyl alcohol, the solution was poured off, evaporated to dryness, the residue taken up with warm water, and the solution after filtering tested as follows:—(1) One drop HCl or H^3PO^4, followed by several drops of ammonia; (2) solution of acetate of lead followed, or not, by acetic acid; (3) solution of acetate of magnesium. The results are tabulated as follows:—

Name of flower.	Natural colour.	HCl and NH^3.	Acetate of lead.	Acetate of Magnesium.
Pæony	red	deep blue-green	bluish-green	blue-green
Larkspur	blue	green	green	blue
Anemone	red	green	green	—
Violet	violet	nearly blue	green	dark blue
Oriental Poppy ...	scarlet	blue flush	green	green
Campion	pink	blue at neutral point	—	—
Ragged Robin ..	red	blue-green	green (blue, acid)	green (blue, acid)
Garden Rose ...	deep red	blue	bluish-green	green
Dog Rose ...	pink	green	green	green
Pyrus japonica ...	crimson	dark green	bluish-green	—
Clover	red	green	green	green
Vetch	red	blue	blue	—
Vicia sepium ...	red	green	green (blue, acid)	—
Sweet Pea ...	red	blue-green	green (blue, acid)	green
Mallow	red	blue	green (blue, acid)	—
Fuchsia	red	blue	blue-green (blue, acid)	green
Geranium ...	red	blue	red-purple (blue, acid)	red-purple
Flax	crimson	blue	blue	green
Flowering Currant	red	green	green	green
Daisy	red	dark-green	green (blue, acid)	—
Dahlia	deep red	blue	green (blue, acid)	green (blue, acid)
Scabious	blue	green	green (blue, acid)	green
Betony	red	green	green	—
Rhododendron ...	pink	dark green	dark green	deep green
Primula	red	green	green	—
Periwinkle ...	blue	blue-green	green (blue, acid)	—
Foxglove... ...	red	green	green	—
Snapdragon ...	red	green	green	—
Hyacinth... ...	blue	blue flakes	green (blue, acid)	green (blue, acid)
Tulip	red	red-brown	green	deep blue postea
Orchid	red	pure blue	green (blue, acid)	green (violet-blue, acid)

In a few cases the aqueous solution of the pigment, after acidification by HCl, was shaken up with amyl alcohol, and after allowing to separate, the lower acid liquid was withdrawn, and tested with excess of ammonia and of acetate of lead. In this way, rhododendron, red daisy, red tulip, violet, foxglove, *Vicia cracca*, red poppy, gave a brilliant pure blue coloration; while, on the other hand, flowering currant and woundwort gave greens with ammonia, but blue precipitates with acetate of lead. In order, however, to purify the pigment still more thoroughly, its alcoholic or aqueous solution was shaken up at intervals for two days with well-washed hide-powder, and the latter, after filtering off the liquid, was well washed and extracted with very dilute HCl. The bright red liquid thus obtained was treated successively with the aforementioned reagents. The result was extremely interesting; for while flowering currant and rhododendron gave greens, red tulip and purple orchis gave blues. In some cases the Wiesner's experiment was repeated, *i.e.* the fresh petals were warmed with dilute HCl, and the acid quite washed out with water, and the now reddened organs placed into solutions of acetate of lead and acetate of zinc, when rhododendron, flowering currant, violet (in some cells), foxglove, *Vicia cracca* (in some cells), became green; while, on the contrary, *Geranium pratense*, bugle, the rest of the cells of violet, and of *Vicia cracca* became blue. It was evident, therefore, that Wiesner's opinion that anthocyan is invariably blued by alkalis, &c., and never greened, was not confirmed; inasmuch as at least three petals, when treated in the manner he prescribed, were distinctly greened, the presumption being that all yellow intermixture had been obviated.

The general conclusion which I think must needs be drawn from these my experiments is, that there are different stages in the development of the floral pigment. In the lower stages the natural colour is red, whatever the chromogen may be; and so far Berzelius was right. In the higher stages, on the other hand, the natural colour of anthocyan is blue, or rather (at least with some chromogens) it becomes capable of forming blue compounds or lakes with alkalis and certain metallic salts. Moreover, as I have laboured to show elsewhere, chromogens exist which, except under very exceptional conditions and circumstances, are incapable of producing a blue pigment; and these in all stages naturally develop into a red, the brilliancy of which, when contrasted with that of a blue accidentally obtained in an allied species (*e.g.* in flax), unequivocally attests its real, original, and proper character. P. Q. KEEGAN.

The Colour of Flints.

AN examination of the pebbles lying on the beach of the coast of the English Channel shows that while these are principally flints they vary considerably in colour.

The flints derived from the chalk cliffs surrounding this part or the coast, and from which the shingle is generally supposed to be derived, are, so far as my experience goes, invariably black, with a white coating on the exterior.

Only about one-third of the flints on the beaches of such localities as Eastbourne, Hastings, Brighton, Hythe, Folkestone, Dover, &c., or in the large accumulations at Dungeness and at the Chesil Beach are apparently derived from the adjacent chalk cliffs, the remainder being different shades of brown, grey, white and red, the former being the most prevalent. In some cases the outside coating is of a different colour to the interior of the pebble. It follows, then, either that the flints from the chalk undergo some chemical action, either internally or externally, while exposed to the air and salt water of the beach, which changes their colour, or the majority of them must have been derived from inland gravels.

The first theory does not seem feasible, as flints are to be found in raised beaches and other positions, where they have been deposited for long periods, still retaining not only their interior black colour, but also the white coating on the outside.

If these various coloured beach flints are derived from inland gravel beds, they must have been deposited under different conditions from those which now prevail, as there is no action in operation on the south coast which can convey the flints from inland to the sea. The age of some of these shingle beds must, therefore, be much greater than has been generally supposed.

There are isolated pockets of gravel at the top of the chalk cliffs in some places, which fall on to the beach where the cliffs are eroded by the sea; but these are too few in number to account for immense deposits such as those at Dungeness, Pevensey and Chesil.

Failing to obtain any light on this subject from geologists to whom I have mentioned the matter, and whose opinions vary as to the changes flints undergo, I venture to appeal to NATURE for a solution. W. H. WHEELER.

Boston, Lincs., November 27.

THE PROPOSED CHANGES IN THE MATHEMATICAL TRIPOS.

THE Cambridge Board for Mathematics has presented to the Senate a report on the Mathematical Tripos. This report recommends certain changes in the regulations relating to that Tripos. The following note contains an abstract of the proposals made by the Board:—

The schedule of subjects for Part I. of the Tripos has been reduced by the entire omission of some subjects (calculus of variations, elliptic functions, Bessel's functions, hydrodynamics, sound). Other subjects have been limited in extent (*e.g.* rigid dynamics, electricity, optics, astronomy and others). Care has been taken to specifically exclude parts of some subjects. The arrangement of papers is to be entirely changed and no papers are to be exclusively devoted to problems. At the present time particular methods are prohibited in answering the questions set in certain papers ; such general restrictions of methods are no longer to be maintained. A special regulation provides that at least half the questions set throughout the examination shall be of an elementary character.

The Board also proposes to abandon the custom of publishing the list of successful candidates in order of merit, and to follow the method at present adopted in the Classical Tripos. There will be three classes (Wranglers, Senior and Junior Optimes), and each class will consist of three divisions, the names in each division being arranged in alphabetical order.

The proposed changes in Part I. have involved some corresponding changes in Part II. The class-list is to consist of three divisions only, the names in each division being arranged alphabetically ; and it is to be possible for a candidate to obtain a place in the first division in two ways. He may do so (as at present) by showing special proficiency in one section of the schedule of subjects, together with general proficiency in one or more other sections ; or by showing general proficiency over a wider range of subjects.

The Board hopes that these changes will induce more men to take Part I. in their second year ; it is at present possible to do so under a regulation which came into force in 1893, but very few have actually availed themselves of the rule (probably not 1 per cent. of the whole number of candidates since 1892). This is partly due to the fact that 90 per cent. of the candidates cannot cover the whole range of reading in two years, and partly to the natural desire of the more able men to appear in as high a place as possible in the list. By taking the Tripos in their second year, men who intend to study subjects such as physics or engineering will be able to gain a preliminary knowledge of mathematics, with indications as to how to extend their knowledge in any special branch which they may need in their future course. The second year Tripos will be of advantage also to the better mathematical men, who now spend half their third year in revision and in acquiring facility of solving artificial problems. Under the proposed regulations these men will have two years after Part I. (instead of one) in which to become acquainted with the ideas and methods of modern mathematics. This will be of special advantage to men who intend to devote themselves to mathematical research.

It is thought that the abolition of order of merit will assist the aims of the Board by making it possible for the papers to be easier, and by helping to remove artificial problems ; and also by inducing a greater number of men to take the Tripos in the second year of residence. It is further felt by many that the proposed Part I. is not of sufficient extent to even profess to classify the candidates in an exact final order of merit.

On November 23 the proposals of the Board were discussed by the Senate. As might be anticipated, the scheme was criticised at some length, and particularly the proposal to abolish the order of merit. The Board will now revise its suggestions in the light of the criticisms of the Senate, and the Senate will have to vote on the final recommendations of the Board.

It seems that the present Tripos must be modified in some way, as the number of candidates has been steadily falling off in recent years. Though once the largest Tripos in the University, the Mathematical Tripos is now smaller than both the Natural Science and the Classical Tripos. Taking an average of the candidates for the four years 1869–72, we find that, of the resident undergraduates, one in eighteen passed the Mathematical Tripos ; while for the five years 1895–99, the average falls to one in thirty-five (of course, this relates to Part I. only).

THE RESISTANCE OF THE AIR.

THE mportance of determinations of the resistance of the air to moving bodies, in connection with the problem of aërial navigation and numerous other practical applications, has led the Société d'Encouragement pour l'Industrie Nationale to offer a prize for investigations of an essentially experimental nature dealing with the reactions on a surface moving through the air under varying conditions as to form and velocity. One series of experiments with this object has been undertaken by M. l'Abbé Le Dantec, and a second set by M. Canovetti. The following account of these researches is based on the papers communicated by their authors to the *Bulletin* of the Society, and the report on them by M. Barbet.

The method adopted by M. l'Abbé Le Dantec is very simple, and had been used in some previous experiments by him in 1893. It is based on the property that the motion of a falling body is at first accelerated, but the resistance of the air, increasing as the velocity increases, soon balances the weight of the body, and the body thus soon acquires its terminal velocity, and then moves uniformly. The resistance of the air at this velocity is exactly equal to the weight of the falling body.

In the present experiments the surface whose resistance is to be observed slides down a vertical wire, which acts as a guide without introducing perceptible friction. Its weight and area can be easily and accurately measured ; and Le Dantec has now devised an electric recording apparatus, which enables the time of fall to be estimated with equal precision. A band of paper is unrolled by clockwork action, and on this band an electric arrangement records the vibrations of a seconds pendulum. Furthermore, when the falling surface is released, a current is started whereby a toothed wheel is brought into contact with the paper band, and traces on it a dotted line. The surface at the end of its descent comes in contact with a buffer, the current is broken, and the cessation of the dotted line indicates the exact instant at which the surface reached the buffer. The operator can vary the height in such a way that the descent occupies one, two, three or more seconds, and by subtraction the distances traversed in each successive second are obtained.

The experiments were conducted in the chapel of the Conservatoire des Arts et Métiers, the nave of which is of considerable height, and their accuracy is verified by the perfect agreement of the results. Thus several experiments conducted for the purpose of determining the height through which a surface fell in a certain number of seconds agreed to within a centimetre. The chief conclusions are as follows :—

(1) Even feeble air currents such as are produced by persons moving about in the neighbourhood of the apparatus suffice to considerably modify the results, and it is important therefore that the experiments should be conducted in a closed building, which must, however, be sufficiently large for the walls not to materially affect the stream-lines of the air flowing past the moving surface.

(2) A square surface 1 metre square, moving with a velocity of 1 metre per second, experiences a resistance of 81 grammes.

(3) Experiments conducted with three different surfaces, each of 1 square metre in area, but of different forms, viz. circular, square, and of the form of an equilateral triangle, respectively, show that the resistance depends on the form of the surface, and the results accord with the hypothesis that the resistance of a surface of given area is proportional to the length of its contour. This property appears to be new.

(4) For velocities varying within certain limits, the law of proportionality of the resistance to the square of the velocity was verified.

The resistance of the air to a moving surface can also be measured by attaching the surface to a small truck which is allowed to descend an inclined plane under gravity. If there were no resistance to motion the square of the velocity at any point would be equal to twice the product of the vertical height fallen into the acceleration of gravity, but since friction and atmospheric resistance retard the motion, and the latter resistance increases with the velocity, the truck soon acquires its terminal velocity, and in the uniform motion which follows, the total resistance is equal to the weight of the moving body resolved down the plane. By experimenting with the truck alone, the resistance experienced by it can be obtained separately, and by subtraction the portion of the resistance due to the surface under observation is found.

This method forms the basis of M. Canovetti's experiments. Instead, however, of an inclined plane, a copper wire was employed, three millimetres in diameter and 370 metres in length, of which one end was fixed on the side of a hill, and the other on the level ground at its base. This arrangement is similar to that used in many countries where bundles of wood are sent down from the hills by means of a wire. Owing to the wire hanging in a catenary, the lower part of the wire was much less steeply inclined than the upper, the wire even sloping upwards near its lower extremity. For this reason Canovetti did not take into account the last ninety metres of the path.

The mode of suspending the various surfaces by a trolley is shown by the accompanying figures. The wheels of the trolley were provided with ball bearings. In order to determine what part of the resistance was due to the trolley itself, the latter unloaded was allowed to descend a wire at an inclination considerably smaller than that employed when it carried one of the surfaces, the smaller resistance of the unloaded trolley rendering a reduction of the gradient necessary in order that the resistance might be calculated under similar conditions as to velocity. The experiments indicated that the resistance of the trolley alone was proportional to the velocity.

In determining the velocity, Canovetti contented himself with reading on a chronometer the instant of starting the trolley and the instant at which it passed a mast placed 90 metres in front of the stopping point. By dividing the 280 metres traversed by the time occupied between the two readings, the average velocity of descent was obtained, and this average velocity formed the basis of Canovetti's conclusions.

The most interesting of these results are those referring to the relative resistances of circular and rectangular planes, and the effects of attaching a cone or hemisphere to a circular disc forming a bow or stern. Canovetti finds that the resistance of the air on an area of one square metre moving with a velocity of 1 metre per second is 90 grammes for a rectangle and 80 grammes for a circle.

A right cone, whose altitude is 1·5 times the diameter of its base, attached to the rear face of the circle reduces the resistance to 60 grammes.

A hemisphere placed in front of the circle as a prow (Fig. 1) reduces the resistance to 22·5 grammes.

Finally, in a double cone, formed by placing a cone of altitude double the diameter of the base in front of the circle, and a cone of altitude equal to the diameter of the base behind (Fig. 2), the resistance is reduced to 15 grammes, or less than a fifth of the original resistance.

Canovetti made a series of further experiments on solids resembling in form the Chalais balloon by suspending a cone and hemisphere, joined by their bases in a net (Fig. 3). In one of these observations the resistance was equal to 80 grammes. This high resistance was due largely to the net, but also in part to the instability of motion, which caused the whole model to undulate. In proof of this latter influence experiments were separately made on models rigidly attached to and freely suspended from the trolley. By taking a model formed of a cone and hemisphere, and attaching it to the trolley by rigid supports fixed one near the common base and another near

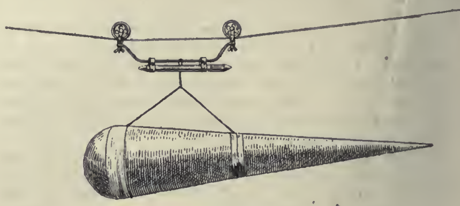


FIG. 1.

the vertex of the cone, a coefficient of resistance equal to one-seventh of that of the corresponding circular disc was obtained.

To sum up, then, Le Dantec's experiments appear to have been conducted with every precaution to secure

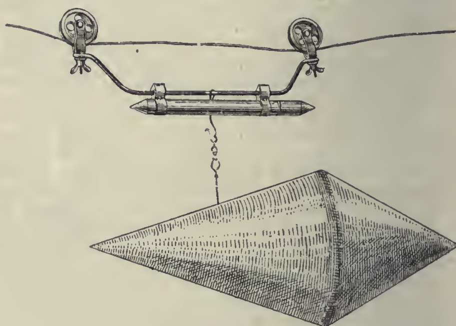


FIG. 2.

accuracy. The coefficient of resistance which he calculates from determinations made in a room from which draughts are carefully excluded must be regarded to some extent as the limiting value of a physical constant ob-

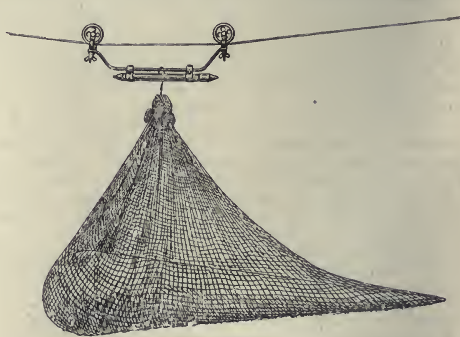


FIG. 3.

tained under conditions which are difficult to realise in practice. We may compare such determinations, *e.g.* with the determination of the weight of a cubic centimetre of absolutely pure water, since in all probability a large volume of air free from all currents and a cubic centimetre of water free from all impurities, are both of them well-nigh equally difficult of realisation. The exact determination of such constants is nevertheless of the greatest scientific interest, and even the difference between their values and those obtained under more normal conditions affords a measure of the allowance that must be made for the discrepancies which exist between theory and practice.

Canovetti's experiments, on the other hand, are essentially of the rough and ready order in several respects. The wire hanging as it does in a catenary, the differences of inclination at different parts of the course render the motion far from uniform over the 280 metres, and the estimated velocities can only be regarded as average velocities in a motion with variable velocity, the details of which have not been fully investigated. A further source of error is due to the sagging of the wire at the point where the trolley rests on it, and the consequent absorption of energy in producing vibrations. It is thus not surprising to find that Canovetti obtains 90 grammes for the resistance of a rectangle where Le Dantec finds 81 grammes; one might not unreasonably have expected a greater discrepancy. Although Canovetti avoided windy days, yet his experiments were conducted in the open air under conditions which might be regarded as normal in ordinary calm weather, and so far as the results bear on the question of the relative efficacies of different forms of balloons and other bodies in overcoming air resistance, they may be regarded as furnishing data of considerable practical value. G. H. BRYAN.

DR. HENRY HICKS, F.R.S.

BRITISH geology suffers a severe loss in the death of Dr. Henry Hicks, a loss which will long be felt on personal as well as scientific grounds. His chief work was in South Wales, among the older Palæozoic formations, whose life-history was previously but little known. He pushed his inquiries into the very oldest pre-Cambrian rocks, both in Wales and Scotland; and then turning from these most ancient records he gave attention to those immediately preceding the present order of things, and pursued with equal ardour the evidences of glaciation in South Wales and Middlesex, the records of old bone-caves, and the remains of mammoth in the Thames Valley. No man had a keener eye for fossils. To him rocks which had for long been deemed unfossiliferous yielded up some evidences of life.

Now and again his enthusiasm led him to draw conclusions and express opinions that were too slenderly supported by evidence, and consequently he was brought perhaps more than any other man of his time into active conflict on the battle-field of geology. No one, however, seemed to enjoy more heartily the animated debates which his own papers so often provoked than Dr. Hicks.

Henry Hicks was born at St. David's, in Pembrokeshire, in 1837, and was educated at the Collegiate and Chapter School in that city. Coming to London to study for the medical profession, he entered Guy's Hospital, and was admitted a Member of the Royal College of Surgeons and a Licentiate of the Society of Apothecaries in 1862. Returning then to his native place he commenced a practice which he continued until 1871, when he removed to Hendon. He now devoted special attention to mental diseases, took the M.D. degree at St. Andrews in 1878, and continued his active and useful medical work until the close of his life.

It was in 1863, while resident at St. David's, that Dr. Hicks' attention was first attracted to geology, and the inspiration came through the late J. W. Salter, then palæontologist to the Geological Survey. In the previous year Salter had himself discovered, for the first time in Britain, remains of the large Trilobite *Paradoxides*, which was then stated to occur in the "Lower Lingula Flags," of St. David's. Dr. Hicks' interest was aroused; he diligently commenced to search for fossils among the old rocks around him, and as he himself has told, the enthusiasm with which every new find was welcomed by Salter, "to whom they were first sent, was in itself a sufficient stimulus for any exertions required." A grant in aid was received from the British Association in 1863, and in the following year Salter was enabled to report at the Bath meeting that the energetic work of Dr. Hicks "has already brought to light more than thirty species of fossils, most of them Trilobites"; and as he elsewhere remarked, these discoveries "made a large addition to the Primordial fauna."

With the help and encouragement thus given by Salter Dr. Hicks pursued his work with unflagging devotion. His first communication to the Geological Society was made in 1865, and dealt with the genus *Anopolenus*; and from that date onwards for some years he contributed a series of most important papers on the stratigraphy and palæontology of the Cambrian and Lower Silurian rocks of South Wales, two or three of the earlier papers in conjunction with Salter or Robert Harkness. These researches led to the establishment of the Menevian group in 1865 by Salter and Hicks for part of the Middle Cambrian division which is characterised by *Paradoxides Davidis* &c.

In 1876 he communicated a more particular account of the pre-Cambrian rocks of Pembrokeshire, and here he came perhaps more into conflict than on any previous occasion. The granitoid rock which he named Dimetian and claimed as pre-Cambrian was regarded by Sir A. Ramsay as metamorphosed Cambrian, and afterwards by Sir A. Geikie as a granite mass intruded into the Cambrian rocks. The Pebidian volcanic series, also regarded as pre-Cambrian by Dr. Hicks, was grouped with the Cambrian by Sir A. Geikie. The evidence for a third and intermediate series named Arvonian by Dr. Hicks was subsequently admitted by him to be inconclusive. In his views concerning the antiquity of the Dimetian, Dr. Hicks was strongly supported by Prof. Bonney, Prof. Hughes and Mr. Thomas Davies. With regard to the Pebidian, it is now recognised that the beds are of the type of the Uriconian of Shropshire, generally classed as pre-Cambrian.

Between 1878 and 1883, Dr. Hicks published a series of papers on the metamorphic and overlying rocks of parts of Ross-shire and Inverness-shire, with petrological notes by Prof. Bonney and Mr. T. Davies.

Since he went to reside at Hendon, Dr. Hicks gave much attention to the local geology, and recorded many facts of interest. In course of time the subject of bone-caves greatly occupied him, and Cae Gwyn Cave in particular was explored in company with Mr. E. B. Luxmoore and others. It was then shown that this Denbighshire cavern was occupied by an early Pleistocene fauna and by man before the deposition of any of the local glacial deposits.

In 1890 Dr. Hicks bent his steps into North Devon, and was much struck with the evidences of folding, faulting and crushing near Ilfracombe. He then for the first time found a *Lingula* in the Morte Slates, and expressed the opinion that these rocks were older than the Devonian. Working zealously in Devonshire, and revisiting South Pembrokeshire for the sake of comparisons, he elaborated his views in 1896 and 1897. He had now succeeded in finding a number of fossils in the Morte Slates and in different localities, but whether these were in part true Silurian fossils as maintained by Dr. Hicks and the Rev. G. F. Whidborne, or wholly Lower Devonian, Dr. Hicks had clearly shown that the succession across North Devon was not continuous and unbroken as had been supposed. The discovery of the fossils was indeed a grand one, and it indicated also that the Morte Slates "vary considerably in different areas, and probably include beds of very different age."

These, his last researches, were carried out with all the enthusiasm of his earlier work, and when first announced to the Geological Society they roused as much opposition. The fact is that when he read the first paper only one *Lingula* had been found in the Morte Slates, and it was felt that the conclusions drawn by the author were not justified. Undaunted, he returned again and again to the field; he reaped a rich harvest where others had altogether failed, and if he did not succeed in demonstrating that Silurian rocks occur in North Devon, he at any rate made manifest that until better preserved fossils are obtained it is not safe to say they are not there.

Dr. Hicks became a Fellow of the Geological Society in 1871; for many years he served on the Council, he was one of the honorary secretaries from 1890-93, and president from February 1896 to February 1898. The Bigsby Medal was awarded to him by the Council in 1883. Dr. Hicks had also been President of the Geologists' Association, 1883 to 1885. He was elected a Fellow of the Royal Society in 1885. In his busy professional life he found geology a "means of recreation and of much intellectual enjoyment"; and until near the close of his life he maintained a youthful energy and vivacity, and looked the picture of health. To his many friends the sad tidings of his death at Hendon on November 18, at the age of sixty-two, came as a surprise, and everywhere raised feelings of the utmost sorrow.

H. B. W.

NOTES.

THE sum of fifteen thousand marks appears in the Budget of the German Imperial Home Office as Germany's contribution towards the preparation of an international catalogue of science.

THE *Electrician* states that a school for wireless telegraphy is being established on one of the Government hulks in Portsmouth harbour.

M. DE COPPET has forwarded to the treasurer of the French Physical Society a cheque for 1000 francs towards meeting the expenses of printing the "Receuil des Constantes Physiques."

AT the annual meeting of the Royal Institution of Cornwall held at Truro on November 21, under the presidency of the Rev. S. Baring-Gould, the Henwood Gold Medal was presented to Mr. Rupert Vallentin for his observations on the fauna of Falmouth, accounts of which are published in the last three numbers of the *Journal* of the Institution.

THE Walsingham Gold Medal of the University of Cambridge has been awarded to Mr. H. H. W. Pearson, Assistant for India in the Kew Herbarium. This medal is obtained by competition in original essays on any branch of biological science. Mr. Pearson's essay was on the botany of the Ceylon Patamas, recently published in the *Journal* of the Linnean Society.

PROF. KARL PEARSON, F.R.S., will deliver a lecture entitled "Matter and Motion" in the chemical theatre of University College, Gower-street, on December 6 at 5 P.M. The members of the Chemical and Physical Society invite the presence of all who are interested in the subject.

THE fourth international congress of psychology will be held at Paris, in connection with the international exhibition, on August 20-25, 1900. It is hoped that all who are interested in the study of psychology in its various aspects will take part in the congress. The general secretary is Dr. Pierre Janet, Rue Barbet-de-Jouy 21, Paris, to which address all communications concerning membership should be sent.

WE regret to learn, from the *Botanisches Centralblatt*, of the death of Prof. P. Knuth, at Kiel, on October 30, in the forty-fifth year of his age, shortly after his return from a long journey. Dr. Knuth had worked on the same lines as the late Dr. Hermann Müller, in collecting an immense amount of information respecting the visits of insects to flowers and their agency in cross-fertilisation. Only last year he published the first and second volumes of his "Handbuch der Blütenbiologie," in which every observation of importance made by himself or others recorded during the last quarter of a century, since the publication of Müller's "Befruchtung der Blumen," is collated. A third volume remained unpublished at the time of his death.

IT appears from a detailed article in *Engineering* that the British display at the Paris International Exhibition next year will be quite unworthy of the manufacturing power of this country. This, we need hardly remark, is a matter for deep regret, especially as our chief competitors are arranging for exhibits on a very large scale. The German display will be of the first magnitude. Thus the German exhibit in the group of appliances and general processes relating to literature, science and art, will be contained in a separate pavilion, the contents of which will be valued between three and four million marks. In the group devoted to decoration of buildings, furniture, &c., the value of exhibits is estimated at 150,000*l.*, and a similar value is set on Germany's electrical exhibits. The value of exhibited general machinery is stated to be 35,000*l.*; agricultural exhibits 20,000*l.*; the naval and military exhibit 30,000*l.*, and so on. The total value of German exhibits is estimated at a million sterling. British industries and science will only be represented by 642 exhibitors. Referring to the inferiority of the representation of Great Britain at the Exhibition in comparison with other countries, *Engineering* remarks: "Manufacturers best know what are their own interests, and they have presumably come forward in such small numbers only after careful consideration. Possibly this apparent indifference is partly due to the remarkable absence of information available about the Exhibition, and partly because of the unsatisfactory arrangement, from an exhibitor's point of view, by which exhibits will be scattered over a large area, instead of being concentrated into a British section. But whatever the causes, we must be prepared to meet our chief competitors in as many thousands as we number hundreds; if manufacturers are then disappointed, they will only have themselves to blame. One reason of our inferiority in numbers is, no doubt, to be found in the antipathy of the British industrial to co-operate in industrial exhibits. He stands alone in this prejudice, and has, of course, to pay the penalty."

THE claims of inorganic chemistry to increased attention have recently been urged in Germany on two important occasions. Addressing the Naturforscher-versammlung at Düsseldorf last year, Prof. van 't Hoff gave a most interesting review of the recent achievements of inorganic chemistry, and made a strong plea for the cultivation of this branch of the science. This plea has been put in a more concrete form at the Göttingen meeting of the German Electrochemical Society. The subject was introduced on this occasion by Prof. W. Hittorf, and the proceedings culminated in a letter addressed to the Minister of Education asking definitely for the establishment of professorships and laboratories for inorganic chemistry.

PROF. HITTORF points out how largely German chemists have deserted inorganic for organic chemistry; how, with the exception of the late Victor Meyer, hardly an organic chemist of the later school has made important contributions to inorganic chemistry; how at the present time only two of the largest Universities and one Hochschule have independent professors of the subject. He urges the cultivation of inorganic chemistry not only in the interests of technology, but from the conviction that the study, especially in relation to electro-chemistry, will give a deeper knowledge of the nature of chemical combination, and so strengthen the foundations of the whole science. He would not in the least deprecate the study of organic chemistry, but maintains that at present inorganic chemistry is in the position of a cinderella.

A NUMEROUS and influential deputation waited upon the Town Council of Edinburgh last week to urge the Corporation to give their influence towards the promotion of the movement for the establishment of a zoological garden in Edinburgh. Prof. Cossar Ewart described the advantages of zoological gardens, and pointed to what was being done to establish and carry on such institutions in the British Isles and elsewhere. Such an establishment in Edinburgh would be very valuable for the advancement of biological science, besides being a constant source of recreation and instruction to the public. Prof. Ewart remarked that though the climate of Edinburgh might not equal that of Dublin, it is better than that of Amsterdam, where there is a flourishing if not a very large zoological garden. The expenditure in Dublin is 3000*l.*, while the income, including a Government grant, is just over 3000*l.* When it is borne in mind that some 10,000*l.* or 12,000*l.* was raised in four days in connection with the recent show of the Highland Society in Edinburgh, the raising of 3000*l.* annually should not prove insuperable. Among other advantages, a zoological garden would prove a very valuable addition to the educational institutions of Edinburgh. The chairman of the School Board of the city, who was a member of the deputation, supported Prof. Ewart in this view, and pointed out that a zoological garden would be particularly valuable in connection with object lessons in natural history. In replying to the deputation, the Lord Provost said that the Corporation could not embark at the present time upon any large capital expenditure, but asked the deputation to consider what the Corporation should do in support of the movement.

IN connection with the subject of the foregoing note, the account of the New York Zoological Park given in *Forest and Stream* is of interest. This establishment was opened on November 8, at South Bronx Park, New York, and is the largest zoological garden in the world. The well-known Zoo of London has an area of 30½ acres; that at Amsterdam of only 25; that of the Société d'Acclimitation at Paris of 50 acres; that at Berlin of 60. In the United States the Philadelphia Zoo occupies 33 acres, the Cincinnati Zoo 36, while the National Zoological Park at Washington, maintained by the U.S. Government, and with an area of 168 acres, has until now been the largest zoological garden in the world. The New York Zoological Park, however, is more than one-half larger, covering 261 acres. The new park belongs to the New York Zoological Society, which was incorporated by a special act of the Legislature with purposes to establish and maintain a zoological garden in the city of New York, to encourage the study of zoology, and to furnish instruction and recreation to the people. As a condition of the grant of South Bronx Park and the maintenance of the collections and the park by the city, the Zoological Society was required to raise 250,000 dollars, of which amount 100,000 dollars was to be in hand before the society entered into occupation of the park. This fund was to be expended in the erection of the necessary buildings and inclosures, and in the purchase of collections, as well as for the general purposes of the society, but as stated, the city was to prepare the ground of the park, to maintain it in good order and to bear the expense of caring for the collections. The 100,000 dollars were raised by the New York Zoological Society, and in July, 1898, ground was broken. Recently the last touches were put on the more important buildings that have been erected. The animals began to arrive a few weeks ago, and the number already received is very large, although, of course, as yet only a beginning has been made.

THE Berlin correspondent of the *British Medical Journal* states that on the occasion of Prof. Rudolph Virchow's jubilee—the fiftieth anniversary of his tenure of office as professor ordinarius—the Senate of the University, with its rector, Prof. Fuchs, at their head, assembled to greet their revered and honoured colleague, and to present an illuminated and illustrated address, the text of which had been written by Prof. Waldeyer. In it Virchow's wonderful many-sidedness, and his achievements as investigator, archæologist, and politician were recounted in glowing terms. Prof. Virchow, who was surrounded by his family and many personal friends, in his reply gave expression to his thanks for the support which he had always met with on the part of the university, and said it was true that his chief feeling had ever been that of "the professor." In cases of conflicting interests he had always chosen the course of "professor." In the evening the Berlin Medical Society did homage to its president (Prof. Virchow) by a graceful little spontaneous ceremony. The presidential chair was wreathed and decorated with flowers and garlands, and the vice-president, Prof. v. Bergmann, greeted Prof. Virchow with a speech full of hearty good feeling, respect and admiration.

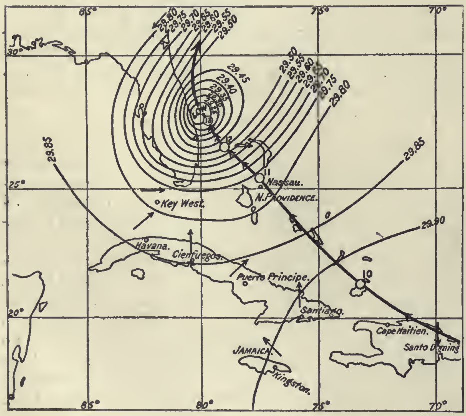
IN a letter to the *Times*, Captain G. Neville, R.N., describes what was apparently the fall of a meteorite, witnessed by him on November 19 from H.M.S. *Dido*, off the Greek coast. He remarks that during a thunderstorm which had lasted all the day "we passed between the islands of Zante and Cephalonia and were about to anchor under the shelter of Cape Clarenza for the night, when there was a sudden flash, a splash in the water about 100 yards from the ship, a report as of a 12-pounder gun being fired, and a little cloud of blue smoke over the spot where the splash had been. It looked exactly as if a shell had struck and exploded, except that there were no fragments flying about." The description suggests that a large meteorite fell in the water, and it would be worth while to attempt to find some of its parts by dredging, and to bring them to the surface.

THE following announcements are made in *Science*:—Dr. Samuel W. Stratton, associate professor of physics in the University of Chicago, has been appointed director of the Bureau of Weights and Measures, United States Coast and Geodetic Survey.—The Rumford Committee of the American Academy of Arts and Sciences has made a grant of five hundred dollars to Prof. E. B. Frost of the Yerkes Observatory, to assist in the construction of a spectrograph especially designed for the measurement of stellar velocities in the line of sight.

THE *Pioneer Mail* states that the Commission appointed to consider the advisability or otherwise of forming an Agricultural Department for Ceylon has reported favourably upon the formation of an agricultural department. It is recommended that the department should be combined with the irrigation department. Further, the Commission has recommended the appointment of four experts to be attached to the department—an entomologist, a cryptogamist, a chemist and a veterinary surgeon. The connection of the Botanical Gardens with the proposed department is not very clear; but it is understood that it will also come under the department, as will the Agricultural School.

REFERRING to the subject of standard time, Prof. Cleveland Abbe remarks in the U.S. *Monthly Weather Review*:—"Our international commercial intercourse will become precise only when we adopt Greenwich dates and Greenwich time throughout the world. This improvement, conducing as it does to the transaction of daily business, will not injure but rather be helpful to meteorology. No one has ever attempted to plot upon an ocean chart the observations of a storm by a hundred vessels at sea, but has found inextricable difficulty with records that are kept by the rules of the ancient navigators; the trouble is with the date of the month and day of the week. The modern navigator and the modern business man will do well to think, speak, and write of Greenwich days and dates only, if he would attain precision in current history."

THE West Indian hurricane of August 7–14 is described by Prof. E. B. Garriott in the *National Geographic Magazine*, from which the accompanying diagram of the storm has been reproduced. During August 7 and 8 the character and extent of the destruction caused in the Leeward Islands, Porto Rico, and Santo Domingo were such as will make the hurricane rank among the historical storms of the West Indies. At San Juan, in Porto Rico, the barometer began to fall at 10 p.m. on August 7, and the lowest recorded reading, 29·23 inches, was



The West Indian Hurricane.

reached at 8·30 a.m. on August 8. The hurricane was strongest at San Juan between 7 and 9 a.m. on August 8, when the wind velocity was calculated by a U.S. Weather Bureau observer at 85 to 90 miles an hour. The rainfall was very heavy, a total of 6·37 inches falling, of which 4·18 inches fell from noon to 8 p.m. on August 8. By prompt action the U.S. Weather Bureau were able to warn many places of the approach of the hurricane centre. Prof. Garriott states that the warnings outran the storm by a period which varied from a few hours at the easternmost Leeward Islands to thirty-six and forty-eight hours at points along the South Atlantic coast and gulf parts of the United States.

THE pilot chart of the North Atlantic ocean for November contains a very useful map of the hurricane tracks during the ten-year period, 1890–99, and the distance travelled by each storm centre during twenty-four hours. With a few exceptions the tracks exhibit the usual features, the motion of the centre in that portion of the track to the southward of latitude 25° being directed towards a point between north and west, and thence moving in a north-easterly direction. The position of this point of recurvature or point of greatest westing is arranged in a tabular form. From this table it is evident that to rely upon the assertion that the storms of a particular month in the West Indies recurve within certain fixed and narrow limits of latitude may lead to serious error at a most critical time. Thus the hurricanes of September, instead of recurving between 27° and 29°, as formerly maintained, may recurve in any latitude from $20^\circ\ 20'$ to $33^\circ\ 30'$ north. Likewise those of October, instead of recurving in latitude 20°—23° north, may continue their north-westerly course until the parallel of 39° is attained.

THE Deutsche Seewarte has published in a quarto volume the results of meteorological observations made on board German ships for the ten-degree square of the North Atlantic comprised between latitude 20°–30° N. and longitude 60°–70° W. This is the seventeenth square, for which the observations have been similarly discussed and published, in the district of the North Atlantic lying between latitude 20° and 50° N., leaving but a small area to complete this very valuable work. It joins on to the nine ten-degree squares lying between latitude 20° N. and 10° S. and longitude 10° to 40° W. discussed and published some time ago by the Meteorological Council, so that shipmasters navigating that part of the ocean have at their disposal a large amount of trustworthy information extending over a considerable number of years. The observations are given in a tabular form for each month, and for each one-degree square, and the results are then combined for each five-degree square. They show the distribution of winds under 16 points of the compass, the prevalence of storms, the mean barometric pressure, air and sea temperature, duration of rainfall and other useful data, and the form adopted allows of the results of future years, or of those obtained by other countries, being added; so that, if desired, comprehensive charts, from accumulated materials, could be constructed without going through the preparatory work *de novo*.

TWO or three months ago reports were published in the daily press of the discovery of an electrical method of giving sight to the blind. It was alleged that Mr. Stiens had succeeded in constructing an electrical apparatus which performed all the functions of the eye and was an efficient substitute for it. Like many other newspaper reports of so-called scientific discoveries, this has proved to be without sound foundation. Mr. G. H. Robertson, who is himself afflicted with blindness, describes in the *Electrician* the results of personal inquiries into the matter with a member of the staff of our contemporary. In spite of several visits to Mr. Stiens, no experimental proof in substantiation of the claims which were put forward on his behalf was obtained, and the conclusion arrived at is that these claims are foundless. Life is so short and crowded with so many important duties that it is impossible to investigate the many sensational statements made by irresponsible interviewers, but we are grateful to any one who will take the trouble to examine some of the rumours which are put forward in the name of science.

IN the *Bulletin* of the French Physical Society, No. 137, is described an ingenious disposition for estimating the duration of Kerr's phenomenon, in which certain dielectric liquids are made to assume the optical properties of double refracting crystals by placing them between the plates of a condenser. The light observed is produced by the spark by which the condenser is discharged, and the time interval between the discharge and the passage of the light through the condenser may be varied by an arrangement of mirrors, whereby the rays may be made to traverse any length of path required. The experimenters, MM. Abraham and Lemoine, find from these investigations that Kerr's phenomenon is reduced to half its original value in the four-hundred-millionth of a second, and becomes insensible in the one-hundred-millionth of a second after the discharge of the condenser. MM. Abraham and Lemoine have also succeeded in showing Kerr's phenomenon for a conducting liquid. The Kerr's condenser, having water between its two armatures, is arranged in the circuit connecting two ordinary condensers in series. On discharging these by the spark used as the source of light the charges liberated instantaneously charge the plates of the Kerr's condenser. For a very small interval of time the water is affected in the same way as a dielectric, and on observing the analyser a brilliant reappearance of light establishes the existence of the phenomenon.

IN the *Bulletin International* of the Cracow Academy, M. P. Rudski continues his papers on the elastic properties of rocks. It would appear that even such rocks as granite cannot be regarded even "grosso modo" as isotropic; but the expression for the elastic potential generally involves five constants. There are no grounds for assuming the separate propagation of dilatational and torsional waves in gneiss, granite and similar rocks; on the contrary, the actual waves are partly torsional and partly dilatational.

THE *Mineralogical Magazine*, vol. xii., No. 56, which has just appeared, contains a description of a new three-circle goniometer designed by Mr. G. F. H. Smith, and intended for comparatively rapid measurements of the geometrical constants of crystals and the indices of their faces. The paper gives a historical account of the one-circle goniometer of Wollaston, the two-circle or "theodolite" goniometer of Miller, and then describes the new instrument, which is a combination of those forms. The great advantage of the combination is that the crystal is adjusted once for all. The measurements may be made in any desired zone, the orientation of which is at once determined. For crystals small enough to be firmly held by wax in all positions, the most convenient arrangement is to give all three motions to the crystal; but, if necessary, the telescope and collimator may have one or more.

THREE noteworthy papers on the cultivation and manufacture of tobacco have recently appeared. One of these publications is Report No. 60 of the U.S. Department of Agriculture, and in it Mr. Milton Whitney and Mr. T. H. Means describe their investigations upon the temperature changes in fermenting tobacco in Florida and Connecticut. The report also comprises a *résumé* of Dr. Oscar Loew's investigations of the cause of fermentation, which throw light upon and explain the observed temperature changes, and the necessity of maintaining a definite amount of moisture in the tobacco during the curing and fermentation. In another paper (Report No. 62), published by the U.S. Department of Agriculture, Mr. Marcus Floyd describes the cultivation of cigar-leaf tobacco in Florida, where striking developments of the tobacco industry have taken place in recent years. The object of collecting information of this kind is to investigate whether the crops produced on the various types of tobacco soils are the best obtainable with the present state of knowledge and skill in manipulation. In this way the Department of Agriculture is making a scientific study of the possibilities of the improvement and extension of an important industry. The third paper mentioned, on the cultivation and manufacture of tobacco, appears in the *Revue Générale des Sciences* for October 30, and is accompanied by a map showing the districts in which tobacco is cultivated in France.

"THE Geology of the Country around Dorchester" is the title of a Memoir (price 1*s.*) just issued by the Geological Survey in explanation of the new series map, No. 328. The Memoir is written by Mr. Clement Reid, and it deals mainly with the chalk, eocene strata and drift. Among the more interesting natural features in the region are the numerous swallow-holes on Puddletown Heath and adjacent tracts. Perhaps the largest is that known as Cull-pepper's Dish, a hollow about one hundred yards long and forty feet deep. Another is known as Hell Pit. Altogether there are some six hundred of these pits, due to the dissolution of the chalk and the subsidence of superincumbent tertiary deposits. Mr. Reid points out that the lower tertiary (Reading) beds consist locally of sands with impersistent beds of clay. The rainfall readily sinks into the porous ground until arrested by one of the clay-bands, and these guide the water in particular directions, whence it descends and dissolves the chalk. The Reading beds and London clay vary considerably from their equivalents elsewhere, the London clay consisting largely of sand and sandy loam. The Bagshot beds furnish evidence of true river-deposits which replace the more estuarine strata of the eastern part of the Hampshire basin. Large pits near Moreton station show (beneath plateau gravel) Bagshot beds comprising current-bedded sand, pipe-clay and gravelly seams containing chalk-flint, Greensand chert, Purbeck limestone, Radiolarian chert, and Schorl-rock. Here, in fact, are found fragments of all the rocks which occur further west in gravels which have been regarded as drift, but which Mr. Reid considers, with good reason, to be of Bagshot age. The accounts which he gives of these and other deposits will be read with interest. Among the latter we may mention the Pliocene formation at Dewlish, the clay-with-flints, plateau gravels, and more recent deposits.

SOME interesting experiments on the rate of multiplication of various yeast cells have been carried out by Dr. D. P. Hoyer, of Vienna, and are published in the *Centralblatt für Bakteriologie*, Part ii., No. 21. The author has determined the time required at different temperatures, 13° C. and 20° C. and 25° C. respectively, by various yeasts to produce a new generation from a parent cell. Thus at 13° C., *S. ellipsoideus I. Hansen* requires nine hours and four minutes, and at 25° C. six hours and twelve minutes; *S. membranae-faciens* at 13° C. seven hours and one minute, and at 25° C. five hours and thirteen minutes to form a new generation. At 6° C. it appears that the majority of the yeasts investigated did not, even after a week, produce a new generation, and the experiments conducted at this temperature were discontinued. The yeasts thus so closely scrutinised were grown on gelatine, and were not more than from three to four days old. Many bacteria have been submitted to similar observations; but until these experiments, made by Dr. Hoyer, were published, scarcely any investigations of this kind, in regard to yeasts, have been recorded.

THE *Bulletin of Miscellaneous Information* (Trinidad) for October contains a fuller diagnosis of the new fungus-parasite of the cacao-plant, *Nectria Bainii*, Mass. It seems, however, still doubtful whether it is the cause of the disease, or simply saprophytic.

IN the number of the *Agricultural Gazette of New South Wales* for October is a very interesting further account, by Mr. J. H. Maiden, of a botanical visit to Mount Kosciusco. The flora presents some Alpine features, but the flowers are not specially large or brilliant. There is an extraordinary predominance of white flowers, almost exactly one-half of those gathered at high altitudes. The flora presents, on the whole, a strong affinity with that of Tasmania. A list of the plants collected is appended.

THE *Journal of the Royal Horticultural Society* for November, besides purely horticultural papers, contains several *résumés* of the present state of our knowledge in various branches of botany:—On the dispersion of seeds, by Prof. Boulger; and on the importance of light and heat to plants; on movements of plant organs; and on fertilisation by insect agency, by the Rev. G. Henslow, read at the meetings of the Society. In the last of these papers, Mr. Henslow sums up strongly against Darwin's dictum that "Nature abhors perpetual self-fertilisation," which, however, he quotes as "Nature abhors self-fertilisation," an assertion never made by Darwin.

THE second volume of Dr. Isaac Roberts' "Photographs of Stars, Star Clusters and Nebulæ" is about to be issued from the publishing office of *Knowledge*. It will contain seventy-two photographs reproduced by the collotype process, in addition to many pages of text. Only a limited number of copies of the work will be available for the public.

A SECOND fully revised edition of "The Physiology of Plants: a Treatise upon the Metabolism and Sources of Energy in Plants," by Dr. W. Pfeffer, professor of botany in the University of Leipzig, translated and edited by Dr. Alfred J. Eward, will be issued immediately from the Clarendon Press.

THE members of the St. Marylebone Natural Science Society apparently derive a large amount of pleasure and instruction from one another, for the report on the meetings held during the present year shows that a number of interesting papers on diverse subjects were read before the Society. Every organisation which creates and fosters a love of natural knowledge furthers the interests of science; therefore, we are glad to know of the activity of the scientific society of St. Marylebone.

THE only ionising inorganic solvents hitherto found in addition to water are nitric acid and liquefied ammonia. In the current number of the *Berichte* Prof. Walden, of Riga, gives a preliminary account of experiments with liquid sulphur dioxide, which shows that this liquid acts to an unsuspected degree as a solvent for inorganic and organic substances. Since it permits of double decompositions, and gives electrolysable solutions, liquid sulphur dioxide must now be reckoned as an ionising solvent. Many substances dissolve in liquid sulphur dioxide with characteristic colours. Thus the iodides of the alkalis and alkylammoniums dissolve with a yellow colour. As an example of double decomposition, the action of potassium iodide on trimethylammonium chloride may be cited. These substances in sulphur dioxide solution give a precipitate of potassium chloride. Ferric chloride and ammonium sulphocyanide give the usual red colour of ferric sulphocyanide. The electrical conductivity of salts in sulphur dioxide solution is not the same in order as that in aqueous solution, nor does the molecular elevation of the boiling point in liquid sulphur dioxide correspond altogether with that found in aqueous solutions. Prof. Walden promises a thorough investigation of the many points of interest raised by this new discovery.

THE additions to the Zoological Society's Gardens during the past week include a Vervet Monkey (*Cercopithecus lalandii*, ♂) from South Africa, presented by Mrs. A. Rousbey; a Persian Gazelle (*Gazella subgutturosa*, ♂), a Chaplain Crow (*Corvus capellanus*) from Persia, presented by Mr. B. T. Ffinch; two Chipping Squirrels (*Tamias striatus*) from North America, presented by Mr. C. M. Stewart; two Snake Fishes (*Polypterus senegalus*) from the River Gambia, presented by Mr. J. S. Budgett; an Indian Antelope (*Antilope cervicapra*, ♂), a Banded Parrakeet (*Paloeornis fasciatus*) from India, a Sooty Phalanger (*Trichosurus fuliginosus*, ♂) from Tasmania, a Fennec Fox (*Canis cerdo*) from North Africa, deposited; two Red-backed Buntings (*Emberiza rutila*) from Japan, purchased.

OUR ASTRONOMICAL COLUMN.

HOLMES' COMET (1899 *d*).

Ephemeris for 12h. Greenwich Mean Time.

1899.	R.A. h. m. s.	Decl. ° ′ ″
Nov. 30	... 2 8 58·72	... +46 44 50·0
Dec. 1	... 8 24·88	... 36 25·1
2	... 7 53·24	... 27 54·2
3	... 7 23·83	... 19 18·2
4	... 6 56·65	... 10 37·7
5	... 6 31·72	... 46 1 53·4
6	... 6 9·05	... 45 53 5·9
7	... 2 5 48·62	... +45 44 16·0

COMET GIACOBINI (1899 *e*).

Ephemeris for 12h. Berlin Mean Time.

1899.	R.A. h. m. s.	Decl. ° ′
Nov. 30	... 18 4 13	... +12 13·7
Dec. 1	... 5 55	... 12 30·5
2	... 7 36	... 12 47·4
3	... 9 18	... 13 4·4
4	... 11 0	... 13 21 4
5	... 12 42	... 13 38·5
6	... 14 24	... 13 55·7
7	... 18 16 7	... +14 13·0

SPECTROSCOPIC BINARIES.—(1) *α Aurigæ* (*Capella*). Prof. W. W. Campbell, from examination of six spectrum plates of the star obtained with the Mill's spectrograph during 1896–97, finds decisive evidence of its being a spectroscopic binary. The component having a spectrum of the solar type showed velocities of 34, 54, 49 and 3 kilometres per second from 1896, August 31, to 1897, February 4. The spectrum of the second component appears to consist chiefly of Hγ and the more prominent iron lines (*Astro. Physical Journal*, vol. x., p. 177). (2) *α Ursae Minoris* (*Polaris*). Photographs of the spectrum obtained in 1896 showed no decided evidence of variable velocity. Others taken in August 1899 gave such different values, ranging from $-15·2$ to $-9·0$ kilometres per second, that the star was suspected to be a short period variable, and a curve was plotted from additional observations specially made. (*Astro. Physical Journal*, x., p. 180). The 1896 values of the velocity lie altogether out of the recent measures, and this is the reason assigned for suspecting the presence of a disturbing force in the form of a third component. The period of the chief pair is about 3d. 23h. All the observations were made with the Mill's spectrograph on the 36-inch refractor.

In the same number of the *Journal*, p. 184, Prof. E. B. Frost, of the Yerkes Observatory, gives the velocities in the line of sight of this star, obtained from spectrograms taken with the 40-inch refractor. The resulting values quite confirm the short period variation found by Prof. Campbell, and the range in velocity (7 kilometres) is also closely in agreement.

POSITION OF PERTH OBSERVATORY.—Mr. W. E. Cooke, Government Astronomer at the Perth Observatory, Western Australia, has recently, with the co-operation of Sir Charles Todd, of the Adelaide Observatory, determined the latitude and longitude of the station. The latitude was determined by observations of meridian zenith distances of circumpolars, and the final adopted value is

Latitude 31° 57′ 09″·63 S.

The longitude was found by interchanges of clock signals between Perth and Adelaide, the adopted value being

Longitude = 7h. 43m. 21·74s. E.

VARIATIONS IN THE SPECTRUM OF ORION NEBULA.—Prof. Scheiner, in the *Astronomische Nachrichten*, Bd. 150, No. 3593, made some lengthy criticisms of Prof. Keeler's observations of the spectrum of the Orion Nebula, obtained with the Lick telescope. Prof. Keeler's reply is given in No. 3601, and the *Astro. Physical Journal*, vol. x., pp. 164–8, contains both the reply and a translation of Prof. Scheiner's article. The experiment consisted in obtaining two photographs of the nebula, one on an ordinary plate, the other on an isochromatic plate protected by a greenish-yellow screen. The resulting negatives showed considerable differences in the relative intensities of several parts of the nebula. Prof. Scheiner pointed out the doubtful comparison of different types of plates, the possible photographic exaggeration of really minute differences of intensity, and the difficulty of observations of such faint phenomena.

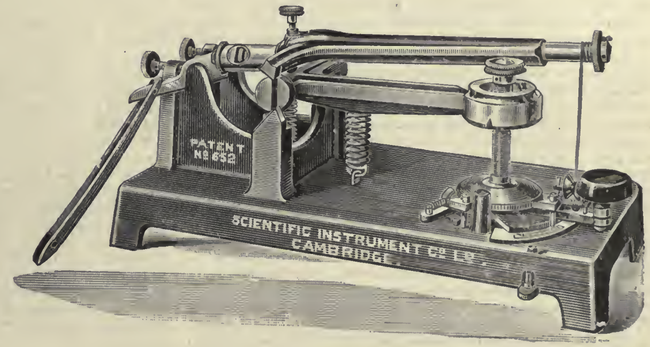
To this Prof. Keeler replies, "That the difference between the plates is not sufficient to explain the irregularities found, as the *star* images on both plates are equally intense; the differences in intensity are measured from point to point on the *same* negative, not from one to the other; the observations are neither difficult or delicate, as the light given by the 36-inch is quite sufficient for the purpose.

A NEW ROCKING MICROTOME.

SERIAL section-cutting has sprung into such prominence during the last fifteen years, and has now become so essential to almost every branch of biological research, that we are apt to forget that we are still using, practically unmodified, one of the earliest invented automatic microtomes. The Rocking Microtome designed by the Cambridge Scientific Instrument Company was first put before the public in 1885, within a short time of the appearance of the very earliest of all automatic microtomes, that designed by Caldwell and Threfall. The simplicity, efficiency and cheapness of the former soon caused it to become both widely known and used by all biologists, and it may be doubted whether any instrument has ever spread so rapidly and deservedly over so wide an area as the familiar "rocker" which is now a characteristic feature in all laboratories in which any branch of biology is taught.

Considering the number of years which the microtome has been in use, and the variety of purposes which it has been made to serve, it is not surprising that several small alterations have been made in it from time to time; none of these, however, have affected the essential features of the rocker, which remains the same instrument to-day that it was years ago.

Recently the Cambridge Instrument Company brought out an enlarged and improved form to obviate what has generally been regarded as the chief defect of the "rocker," viz., the fact that, owing to the principle upon which this instrument is constructed, the cutting surface was of a necessity a curved one. This microtome, however, is too expensive to replace the rocker for which, in spite of its curved cutting surface (a defect of no moment in most work), there was and is still a great demand. The makers have, therefore, set to work to remedy certain minor defects in the rocker, and have, as a result, placed what they consider to be a greatly improved microtome on the market.



The new microtome, as will be seen from the figure, is of much the same form as the old design, and is built upon the same principle, the chief difference being in the bearings of its working parts, and in the addition of one or two new features.

The following advantages are claimed for the new model:—

(1) Increased rigidity.
(2) Impossibility of tearing sections on the upward movement of the object.
(3) Impossibility of cutting thick and thin sections.
(4) Graduated arc for showing the thickness of the sections.
(5) Catch for holding object above the razor edge.
(6) Improved method of fixing the cord.
(7) New object-holder.

Most of these are small but useful additions to the microtome, which by themselves would call for no special comment. The chief features presented by this instrument, and through which it claims more than passing notice, are Nos. 2 and 3 in the above list.

Every one who has had much experience in serial section-cutting will at one time or another, no matter what automatic microtome he was using, have found that the sections were torn or lifted off the edge of the razor, and adhered to the block of paraffin on the upward stroke. It is to obviate this trouble that the modified rocker has appeared.

All possibility of this injury to the section is prevented in this model by the fact that in the upward movement the object cannot touch the razor, since, by means of an additional pawl which at the end of the stroke turns the screw down by four teeth on the notched wheel, the object is drawn backward before the upward movement commences.

This apparatus acts perfectly, but may possibly introduce a new source of damage to the machine, viz., additional wear to the notches on the toothed brass wheel. As one who has used a rocker since its first appearance, I can state that the only serious trouble I ever had with this instrument was due to the wearing down of these teeth; therefore, it seems to me that the addition of a second steel pawl will cause these important structures to wear away more quickly. After all, is the occasional displacement of the section in the upward movement due to a defect in the older microtomes? Or is it not rather due to carelessness on the part of the manipulator, a blunt razor, a paraffin block with imperfectly trimmed edges, and the latter not arranged parallel to the edge of the razor? Personally, I believe the operator is generally to blame, and that it is due to a combination of the above mistakes on his part. But even if it is so, we ought to thank the makers for trying to save us from ourselves, and if the extra pawl will not wear the very important teeth too much, it should prove a very useful addition to the microtome, since even the most careful of us are apt to err at times, and it is very trying to struggle with an object which will not ribbon.

Most of the bearings of the machine are based on a new design, which is said to reduce wear and friction. That at the base of the big screw, as now spherical instead of conical, this is believed to prevent the cutting of thick and thin sections. How far this is a fact time only can tell, but a trial of the instrument with very hard and trying objects gave highly satisfactory results.

The whole instrument is much more rigid than the old form, and the addition of a catch for holding the object above the razor, the improved cord fixer, the graduated scale for showing the thickness of the sections, and the new compact object-holder provided with universal movement, will add much to the utility of the machine. It is to be hoped, however, that the scale will be quite accurate; the divisions on the scale attached to the machine (a rough model only), which has been examined, did not appear quite equal, some giving two and some three teeth.

It may be mentioned that the new microtome will be issued at practically the same price as the old form, and should, with its new additions, prove a boon to all biologists. M. F. W.

CORRESPONDING SOCIETIES OF THE BRITISH ASSOCIATION.

THE meetings of the Conference of Delegates of the Corresponding Societies were held in the Mayor's parlour at the Town Hall, Dover, on September 14 and September 19.

First Meeting.—The Corresponding Societies Committee of the British Association were represented by Rev. T. R. R.

Stebbing (Chairman), Rev. J. O. Bevan, Mr. G. J. Symons, Prof. W. W. Watts, and Mr. T. V. Holmes (Secretary).

A short report, stating that the resolution passed at the Bristol meeting of the conference of delegates on the desirability of securing the co-operation of the coastguard as observers of coast erosion had been favourably received by the Admiralty, and giving copies of the forms issued to the coastguard for the promotion of uniformity in their observations was in the hands of every delegate present, and was taken as read. Then Rev. T. R. R. Stebbing, after alluding to the result of last year's discussion on coast erosion, read a short paper on the living subterranean fauna of Great Britain and Ireland.

The first undoubted mention of an underground crustacean seemed to be that of an amphipod found in London and named by Dr. Leach, of the British Museum, in 1813. Since that time many valuable treatises on the subterranean fauna of various parts of the globe have appeared in many European languages, Polish among others. The English student might be advised to study "The Cave Fauna of North America," by Dr. Packard, published in the *Memoirs* of the National Academy of Sciences, vol. iv., Washington, 1888. Also "The Subterranean Crustacea of New Zealand," by Dr. Charles Chilton, published in the *Transactions* of the Linnean Society of London, 1894. Packard enumerated 308 European cave animals and 102 American. This list of 410 included a few Protozoa, a sponge, two hydras, a few worms, one mollusc, several crustacea and myriapods, numerous arachnids and a host of Coleoptera, the other insects being chiefly Thysanura. The vertebrates consisted of four American fish and one European batrachian, the celebrated *Proteus anguineus*. The known well fauna of Great Britain and Ireland comprised only four species which belong to the amphipoda. These, however, de Rougemont would reduce to a single species. In addition, it may be mentioned that an insect and a copepod have been found in the recesses of coalpits in Scotland and northern England. After noticing the colourlessness and blindness characteristic of subterranean fauna, Mr. Stebbing remarked, in conclusion, that it would be strange should the caverns and wells of Great Britain and Ireland not yield, on investigation, a fauna comparable in some degree to that found in other parts of the world. In this research he hoped that some members of our local scientific societies might take a share.

In answer to a question as to the best way of catching the well shrimp, Mr. Stebbing replied that a good plan was to wait till the well was nearly empty, then let down a bucket and withdraw it as quickly as possible. Sometimes well shrimps were brought up when pumping was going on.

Some discussion then arose, in which Rev. J. O. Bevan, Mr. T. Workman, Mr. Hotblack and Mr. Stebbing took part, as to whether the bats in the Mammoth Cave at Kentucky passed all their time there. The matter could not be absolutely settled, though there seemed to be a presumption against their doing so; Mr. Workman stating that he had not found them in the depths of the cave, though they were in large numbers near the mouth.

SECOND MEETING OF THE CONFERENCE, SEPTEMBER 19.

The Corresponding Societies Committee were represented by Rev. T. R. R. Stebbing (Chairman), Dr. Garson, Mr. G. J. Symons, Prof. W. W. Watts, and Mr. T. V. Holmes (Secretary).

After a long and desultory debate on the best ways of increasing the usefulness of the meetings of the Conference, during which Mr. Stebbing was obliged to leave, and Prof. W. W. Watts became Chairman, Mr. Hugh Blakiston, Secretary of the "National Trust for Places of Historic Interest or Natural Beauty," delivered an address on the aims and work of the Trust.

Section A.—Mr. G. J. Symons stated that the Committee for Seismological Observations was much in need of a home.

Section C.—The Chairman remarked that the Erratic Boulders Committee had presented a report. The Geological Photographs Committee would be glad to receive contributions of photographs. They hoped shortly to be able to publish a selection of typical photographs. Their duplicate collection of prints and slides would be sent to any local society wishing to exhibit them.

Section D.—Rev. T. R. R. Stebbing said that the Secretary of Section D recommended the study of the fauna of wells and caverns to the Corresponding Societies.

Section K.—Mr. H. Wager had to inform the delegates that the Section had appointed a committee to consider the geographical distribution of mosses.

PROGRESS OF AGRICULTURAL CHEMISTRY.[1]

AN important address has been recently delivered by Prof. Maercker, of Halle, to the German Chemical Society (*Ber.* 1897, p. 464), summarising the advances which have been made in agricultural chemistry during the last twenty-five years. Prof. Maercker pointed out that the term Agricultural Chemistry meant more at the present time than the mere application of chemistry to agriculture, as shown by the fact that the agricultural chemist, in his efforts to assist the farmer, was often more concerned with the biological sciences than with chemistry; while, in addition to his purely scientific work, he was required to take account of economic questions of the day possessing special interest to agriculturists. The following account of the most important parts of the address is given under the following heads:—I. Plant-food; II. Soils and Manures; III. Artificial Selection. It is reproduced here by the kind permission of the editor of the *Imperial Institute Journal*.

I. PLANT-FOOD.

In supplying nourishment to plants we must know what substances are necessary, and in what form and quantity they should be provided. Little progress was made in our knowledge of the subject till the quite recent introduction of the method of water-cultures of Sachs, Knoop, and Nobbe and the method of sand-cultures of Hellriegel permitted of the conduct of experiments in pure media, and thus rendered it possible to ascertain not only what substances are essential for plant-life, but also the part played by each substance in the plant cell. Thus we know now that phosphoric acid is essential for the formation of nitrogenous substances in the plant, because the albumens, which are of fundamental importance in the transformations of substances in plants, result from an intermediate phosphoric acid compound, as is indicated by the regular occurrence of lecythin in protoplasm. Again, iron is an essential constituent of chlorophyll and sulphur of albumen, and hence must be supplied to plants. The true function of calcium was for long doubtful; its action is now known to be of a medicinal character, since it serves to neutralise the poisonous oxalic acid, which is always an intermediate product of the oxidation of the carbohydrates. It was formerly thought that calcium fulfilled some important function in the leaves, being chiefly found in the foliage of plants. Since, however, the leaves are also the chief seat of the oxalic acid, this distribution of the calcium is easily explained.

The part played by potassium has only within the last three years been explained by Hellriegel, who, by exact experiments with beet-root showed that the amount of sugar in the beet stands in close relation to the amount of potassium provided for the plant. P. Wagner has made the interesting observation that the potassium may be *partly* replaced by sodium.

The exact value of magnesium to plants is not yet well understood, but it appears to be of importance in the formation of the nitrogenous substances of seeds, as in these considerable quantities of magnesium phosphate occur.

Nitrogen is an indispensable plant-food, for it is an essential constituent of albumen.

In addition to the quantities of mineral substances required by plants to enable them to exhibit a healthy growth, further quantities are found to be essential to satisfy what has been termed, though not very aptly, the "*mineral-hunger*" of the plant. This is best explained by an example. E Wolff found that for the production of 100 parts of oat-plant (dried), ·5 parts of phosphoric acid were necessary, when the remaining mineral substances were supplied in excess to the plant. By other similar experiments he showed that the following quantities of mineral substances were necessary for the production of 100 parts of oat-plant:—

Phosphoric acid	·50 parts
Potash	·80 ,,
Lime	·25 ,,
Magnesia	·20 ,,
Sulphuric acid	·20 ,,
	1·95 parts.

A total of 1·95 parts of mineral substances is therefore *necessary* in the case of the oat-plant. However, there is no oat-plant in nature which contains so little as 1·95 per cent.

[1] Reprinted from the *Kew Bulletin* (No. 144).

The minimum is 3 per cent. The difference, 1·05 per cent., is the measure of the "mineral-hunger" of the plant, and represents the mineral substance which does not perform any special function. This excess of mineral substance may be supplied in the form of some indifferent substance, such as silica. The observation is of considerable interest to the farmer, for it shows that it is not economical to manure crops with pure substances.

II. SOILS AND MANURES.

Having ascertained in general what substances are necessary as plant-food, the agricultural chemist has next to apply this general information to the manuring of soils which are more or less deficient in certain ingredients. It has been found, unfortunately, that the chemical analysis of a soil is of little use as a guide unless accompanied by what may be termed a "mechanical analysis," by which is meant chiefly a determination of the amount of finely-divided constituents present in the soil. It is only the finely-divided earth which presents a sufficiently large surface for the exercise of the solvent action of the water and its dissolved carbonic acid. There is one case, however, in which chemical analysis alone is of the greatest importance, viz. when only traces of some necessary element are present in a soil. Here there is no question of the need for a manure containing this substance.

If, on the other hand, large quantities of an element are present, it does not follow that there is a sufficiency in the soil even when the latter is in a satisfactory state of division, for the substance in question may be present in an insoluble or refractory form. This is commonly the case with nitrogen, which exists in the soil chiefly in the form of a mixture of indefinite nitrogenous substances known as *humus*, or mould. These substances sometimes easily give up their nitrogen to plants, but in other cases are very refractory. The uncertainty as to their action is indeed so great that certain peaty soils are known which consist almost entirely of humus, but contain, nevertheless, an insufficiency of available nitrogen.

Phosphoric acid affords another illustration. The soluble phosphoric acid of the manure is absorbed by the soil as dicalcic phosphate, which is comparatively easily soluble in the soil-water. With time, however, it may change in the soil to the insoluble tricalcium phosphate, or even to iron or aluminium phosphates, which are still less soluble.

In the case of calcium, chemical analysis has been found to be of considerable service in determining what manuring is required, since calcium is chiefly valuable in the form of carbonate or humate, and these are easily estimated in the soil.

Since then the direct method of soil-analysis is an insufficient guide to manuring, it is fortunate that chemists have been able to develop successfully an indirect method. This is the *cultivation method*, by which plants are allowed to grow in the soil under examination, after taking care to provide a sufficiency of all plant-food stuffs except the one, *e.g.* phosphoric acid, whose presence in available form is being tested. The plants are then analysed, and the results compared with the analyses of the same plants grown on soils provided with all the necessary plant-food stuffs. As an important result of the method it has been found that different plants take up very different quantities of the same mineral substances. On this is largely based the system of rotation of crops, where the second crop is so chosen that it chiefly removes the ingredients of the soil which have been left by the preceding crop.

With the aid of the cultivation method it has also been possible to draw up the following table, which represents the relative values of the different nitrogen compounds for plant-food.

Nitrogen of Saltpetre	100
,, ,, Ammonia	85–90
,, ,, Albumen	60

This table may be made use of in determining the nitrogen value of a manure.

The cultivation method may be used for testing the value of manures of all kinds. Thus it was by a few cultivation experiments that Wagner in Darmstadt first showed the very great value for agricultural purposes of the "Thomas" Slag, produced as a bye-product in the manufacture of iron by the basic process of Thomas Gilchrist. The million tons of phosphate meal annually produced in Germany is now wholly utilised by the agriculturist, and its preparation for the farmer has become an important offshoot of the iron industry.

Similarly the demonstration by the cultivation method of the value of potash salts in manures has given an enormous impetus to the potash industry.

Speaking generally, the method gives us complete control over the fertility of a soil in so far as this depends on manuring. One consequence of this has been that our views as to the value of agricultural land have completely changed, for whereas formerly sandy soils were generally considered poor, they are now, by means of a system of intelligently directed manuring, made to give yields which are scarcely inferior to those of the best soils. The beet-sugar industry, which formerly could only be conducted in the best soils, has now been extended with marked success to sandy soils.

III. ARTIFICIAL SELECTION.

It might seem that with a perfect knowledge of the manuring of plants, the need for further investigation would cease, for when we have learned exactly what each plant requires to attain its highest development, we have reached a certain limit. The supply of excessive nourishment is a disadvantage, and only tends to produce sick plants.

There still remains, however, a method by which the fertility of plants may be increased far beyond the limit which nature appears to have fixed. This is the method of artificial selection, which has been applied in Germany on the most approved scientific principles. German agriculture would have long since broken down under the stress of foreign competition had it not been for the perfect technology of its agriculturists. As an example the sugar-beet may be quoted. This plant contained originally but a small amount of sugar, and could only be used as a source of sugar when the price of the latter was very high. With the fall in price came the urgent need for increasing the percentage of sugar in the beet-root. This was effected by utilising the fact that sugar-richness is hereditary, so that by selecting artificially the roots richest in sugar, getting seed from these, planting the seed, again selecting the richest roots, and so on, a race of plants is at length obtained in which a high percentage of sugar is normal.[1] Accordingly the producers of beet-root seed in Germany have erected great laboratories in which the percentage of sugar in the roots is carefully determined. By applying the principle of artificial selection with regard also to the form and size of leaf and the purity of the sap, it has been found possible to improve the roots from year to year, so that now beet-sugar can easily hold its own against cane-sugar, and is indeed cheaper than flour, costing as it does in Germany less than a penny a pound.

Similar success has attended the efforts to increase the crops of different kinds of grain. The improvement in malt-barley has been specially marked.

It has been found that plants which have been highly cultivated by artificial selection easily lose their acquired characters when they are exposed to unfavourable conditions of cultivation; and this has led to many exact investigations, conducted for the most part in Germany, during the last ten years, on the chemistry of plants. The most interesting of these trace the chemical history of nitrogen as it passes from the atmosphere to the soil, then into the substance of plants, and finally back into the atmosphere.

The corresponding cycle for carbon has long been known.

Most plants assimilate nitrogen only in the form of compounds. As, however, the total quantity of nitrogen compounds in the atmosphere is comparatively small, there must be some other source of nitrogen for plants. Now the classical researches of Hellriegel have shown that there is one class of plants, the *Leguminosae*, or nitrogen collectors, which are able to assimilate elementary nitrogen and so to leave a soil in which they have been grown richer in nitrogen compounds. It has been found that the power of acting as nitrogen collectors is always associated with the presence of micro-organisms on the roots, and that the assimilation of the nitrogen is in some way not understood due to the micro-organisms. The recognition of the power of leguminous plants to act as nitrogen collectors is manifestly of great practical importance, for it shows clearly that the best rotation of crops is one in which a leguminous crop is followed by one of nitrogen consumers, *i.e.* plants which cannot assimilate nitrogen directly.

[1] See *Kew Bulletin*, 1897, pp. 317, 318.

Leguminous plants, whether first used as fodder for animals or simply left to decay in the soil, have their albumen changed in the first instance to amides, which under the influence of ammonia-ferments are decomposed with formation of ammonium-carbonate. The saltpetre bacillus then converts the ammonium-carbonate (and probably also amides) into saltpetre, *i.e.* into the best form of nitrogen plant-food.

Unfortunately the whole of the nitrate thus formed is never available for plants, on account of the destructive action of the nitrate-destroying bacilli, which decompose the nitrates with evolution of free nitrogen, and so complete the nitrogen cycle.

The nitrate destroyers are usually present in stable-manure, and cause a deplorable loss to agriculture, amounting in Germany to a sum of several million pounds annually.

Efforts which, as Prof. Maercker assured the German Chemical Society, are likely to meet with success at an early date, are being made to avoid this loss; and for this purpose special bacteriological investigations are now being conducted at many agricultural stations in Germany.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Dr. Langley, F.R.S., has been appointed Chairman of the Examiners for the Natural Sciences Tripos.

Mr. E. A. N. Arber, of Trinity, has been appointed Demonstrator in Palæobotany.

Mr. W. F. Cooper, of Clare, has been nominated to the occupation of the University table in the Naples Zoological Station.

Mr. H. H. W. Pearson, of Gonville and Caius, and Mr. J. Barcroft, Fellow of King's, have been awarded the Walsingham medals for research in botany and in physiology, respectively.

The degree of Master of Surgery was on November 23 conferred on Mr. Timothy Holmes for his distinguished contributions to the art and science of surgery.

Sir Ernest Clarke has been re-appointed Gilbey Lecturer in Agricultural History and Economics for the ensuing year.

Prof. Woodhead, and Drs. Anningson, Collingridge, Notter, and Stevenson, have been appointed Examiners in State Medicine.

Dr. Somerville, Professor of Agriculture, has been elected a Fellow of King's College.

THE Lawrence Scientific School of Harvard University has received a gift of twenty thousand dollars to be used to equip the mining and metallurgical laboratories.

DR. PAUL STAECKEL, assistant professor of mathematics at Kiel, has been appointed professor ordinarius. Dr. J. Traube, privatdocent in physical chemistry at the Berlin Technical High School, has been appointed professor.

THE new leather industries buildings in connection with the Yorkshire College, Leeds, which have been erected by the Skinners' Company of London at a cost of 5000*l.*, were opened on Monday by the Master of the Guild, Mr. J. Colman. In addition to the gift of the buildings the Company has granted an endowment of 250*l.* a year for ten years, thus placing the instruction in the branches connected with the leather industry on a solid foundation.

THE Canadian *Educational Review* announces that Sir W. C. McDonald, of Montreal, whose magnificent gifts to McGill University have made him justly celebrated as a public benefactor to education in Canada, has placed in the hands of Prof. Robertson, Dominion Agricultural Commissioner, sufficient funds to establish for three years technical schools in various centres throughout the Dominion. The nature of the plan is to take one city or town in each province in which to establish regular classes in some of the ordinary schools on one or two days a week, in which scholars between nine and thirteen years of age shall spend a portion of the day in actual work with tools. This will be supplemented whenever desired by more advanced and special evening classes in manual training and technical instruction.

A COPY of the *Magnet*, the magazine of University College, Bristol, has been received. There are several noteworthy articles and items of information in the magazine, not the least interesting being the editorial note on the appointment of Dr. Ryan, professor of engineering, to the principalship of the Woolwich Polytechnic. Dr. Ryan has been at the College for fourteen years, and has devoted his best energies to bringing the engineering department to its present satisfactory position. He would have done much more if the funds at his disposal had permitted him to develop the work of the department; but, unfortunately, the College possesses only a small endowment, and Bristol manufacturers are not so actively interested in the progress of their University College as are many commercial men in Liverpool, Birmingham, and other cities. Leaving this point, attention may be called to an article in the *Magnet* on life in a mediæval university, by Dr. Hastings Rashdall. The description of the ceremonies through which the freshman or bejannus of the middle ages had to pass before he could call himself a student of the university would suggest many comparisons to an ethnologist. It must be remarked that the periodical does not show the signs of active interest in scientific work which are given in the form of notes and articles in some other magazines of the same type.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, November 24.—Prof. G. Carey Foster, F.R.S., Vice-President, in the chair.—A paper on the conductivities of certain heterogeneous media for a steady flux having a potential was read by Dr. C. H. Lees. Two formulæ have already been proposed to express the conductivity of a mixture in terms of the conductivities of its constituents. In the first formula the conductivity is represented as the sum of a number of terms, each one of which is the product of the conductivity of any constituent and the fractional part of the mixture which is made up of that constituent. In the second formula the resistivity of a mixture is expressed in the same way with respect to the resistivities and percentages of its constituents. In general, the first of these suppositions gives results which are above the experimental values, while the second gives results which are below. If we suppose that the mixture is made up of a series of columns of the separate parts stretching normally between two equipotential surfaces, then the conductivity would be accurately represented by the first formula. If, however, we assume that the constituents are arranged in parallel layers, then the second formula would apply. In the present paper the author has attacked the problem two-dimensionally, and has investigated the relation which holds between the conductivities, when the constituents are arranged in the mixture alternately like the squares on a draughts board. Dealing first with two components it is easily shown that the problem reduces itself to finding the form of the equipotential curves and of the stream lines in a square which is divided by a diagonal into two parts of different material. By means of conformal representation Dr. Lees has referred the square under consideration to a kite-shaped quadrilateral with two opposite angles right angles, and the other two so determined by the conductivities of the constituents as to give straight equipotential lines in the two portions of the figure which represent the two materials and which are separated the one from the other by the axis of symmetry. The general relation which exists between the vector co-ordinates in the two systems has been proved by Love to consist of elliptic functions; but near the angular points of the figures a close approximation can be obtained by the use of a simple exponential expression. Taking the known solution to the problem in the case of the kite-shaped quadrilateral, it is easy to calculate the result for the square under consideration. This leads to the conclusion that the conductivity of the square is the geometric mean of the conductivities of the constituents. Allowing the medium to become fine-grained and introducing new materials, it follows at once that the logarithm of the conductivity of a mixture is equal to the sum of a number of terms, each one of which is the product of the logarithm of the conductivity of any constituent and the fractional part of the mixture which is made up of that constituent. By a superposition of fluxes, the author has shown that the above law holds for flows in four directions, and he therefore considers that with the assumed structure the formula represents the conductivity for any flux.—Dr. Lees then read a second paper on the thermal conductivities of mixtures and their constituents.

In this paper the three formulæ considered in the preceding communication are applied to the known experimental results upon the conductivities of mixtures of liquids. The author finds that the least satisfactory formula is the first one, whereas the least unsatisfactory is the logarithmic one. Mr. Appleyard said that it was frequently of importance to be able to determine the resistance of a mixture of gutta-perchas from the known resistances of component parts. He had attempted, without success, to do this by means of the old formulæ, and he would be interested to see whether Dr. Lees' logarithmic formula gave better results. In electrical work Mr. Appleyard pointed out that the nature of the contacts affected the conductivity, the resistance of a sheet of rubber being different when measured between metal plates and mercury sheets. Mr. Campbell said that the difference between the calculated and observed results might be due to the thermoelectric properties of the materials. Lord Rayleigh had observed that the high resistivity of alloys might be due to a back E.M.F. produced by the contact of dissimilar metals. Mr. Campbell said that he had measured the resistances of ferro-nickels both with direct and alternating currents, and found them the same in the two cases. In reply, Dr. Lees said that all his experimental work on conductivity had been carried out with mercury contacts.—The Society then adjourned until December 8, when, by the invitation of Prof. S. P. Thompson, the meeting will be held in the Physical Laboratory of the Finsbury Technical College.

Chemical Society, November 16.—Prof. Thorpe, President, in the chair.—The following papers were read.—The chlorine derivatives of pyridine. Part IV. The constitution of the tetrachloropyridines, by W. J. Sell and F. W. Dootson. The authors have determined the constitutions of the three known and theoretically possible tetrachloropyridines.—Contributions to our knowledge of the aconite alkaloids. Part XV. On japaconitine and the alkaloids of Japanese aconite, by W. R. Dunstan and H. M. Read. The authors show that Japanese aconite, *A. Fischeri* ("Kuza uzu"), contains japaconitine, $C_{21}H_{29}(OMe)_4(OCMe)(OCPh)NO_3$, which, contrary to the views of many investigators, is chemically distinct from aconitine.—The dissociation constants of very weak acids, by J. Walker and W. Cormack. Using a special form of apparatus, the authors have determined the electrical conductivity of solutions of feebly acid substances, such as phenol, hydrogen sulphide and acetic, carbonic, boric and hydrocyanic acids; the behaviour observed is in accordance with Ostwald's dilution law.—Preparation and properties of solid ammonium cyanate, by J. Walker and J. K. Wood. Pure solid ammonium cyanate may be obtained by mixing cooled ethereal solutions of ammonia and cyanic acid; its molecular heat of transformation into solid urea is 49 K, whilst in aqueous solution this constant is 75 K.—Etherification of derivatives of β-naphthol, by W. A. Davis.—On the determination of transition temperatures, by H. M. Dawson and P. Williams. The authors' method of determining transition temperatures depends upon ascertaining the point at which the two branches of the density or electrical conductivity curves at temperatures above and below the transition point, intersect each other.—Constitution of amarine, of its supposed dialkyl- and diacyl-derivatives and of isoamarine, by F. R. Japp and J. Moir. The authors regard amarine as a *cis*-diphenyl compound of the constitution $\left.\begin{matrix}CHPh.NH\\ |\\ CHPh-N\end{matrix}\right\rangle CPh$, Snape's isoamarine being the corresponding *trans*-isomeride; the latter is readily obtainable by fusing amarine with sodium or heating its hydrochloride above the melting point.—The atomic weight of nitrogen, by G. Dean. The ratio Ag : AgCN was found to be 107·93 : 133·962, whence CN = 26·032 and N = 14·031 if C = 12·001.

Mineralogical Society, November 14.—Prof. A. H. Church, F.R.S., President, in the chair.—Dr. E. Hussak and Mr. G. T. Prior gave an account of a new Brazilian mineral, Florencite, a hydrated phosphate of aluminium and cerium earths ($3Al_2O_3.Ce_2O_3.2P_2O_5.6H_2O$), crystallising in the rhombohedral system. The mineral is isomorphous with the recently discovered Hamlinite, to which it is also very similar in chemical composition; the strontium and barium of Hamlinite being replaced in Florencite by cerium earths.—Mr. A. Hutchinson described a new mineral, Stokesite, from Cornwall, of peculiar chemical composition. It is a hydrated silicate of tin and calcium, $CaO.SnO_2.3SiO_2.2H_2O$, and crystallises in the orthorhombic system in forms closely resembling gypsum, from which it is easily distinguished by its much greater hardness.—Mr. R. H. Solly contributed a paper on sulpharsenites of lead from the Binnenthal, and gave descriptions of the crystallographic characters of the rare minerals, Rathite and Jordanite. Analyses made by Mr. H. Jackson gave to Jordanite the ordinary formula, $4PbS.As_2S_3$, and to Rathite the formula, $3PbS.2As_2S_3$.—Mr. L. J. Spencer described complex twinned crystals of Stannite on specimens from Bolivia collected by Sir Martin Conway. The crystals appear to be tetragonal, with crystal element close to that of copper-pyrites. The analysis by Mr. G. T. Prior tends to confirm the usually accepted formula.

Royal Meteorological Society, November 15.—Mr. F. C. Bayard, President, in the chair.—Mr. R. H. Curtis read a paper on the diurnal variation of the barometer in the British Isles. The principal features of a curve exhibiting the diurnal march of barometrical pressure are two minima and two maxima—the first minimum occurring early in the morning and the second in the afternoon, while the first maximum falls in the forenoon and the second not far from ten o'clock in the evening. In the tropics the oscillation may amount to as much as a tenth of an inch, but its amplitude decreases as the latitude increases, and the greatest amplitude in the British Isles amounts to not much more than three-hundredths of an inch. The author discusses the mean hourly readings of the barometer from twenty-five years' observations, 1871–95, at four observatories maintained by the Meteorological Council, viz. Kew, Aberdeen, Falmouth and Valencia. The author is of opinion that the primary cause of the diurnal oscillation of the barometer is solar radiation, and that its amplitude is chiefly determined by the temperature of the lower strata of the atmosphere. The relative magnitudes of the different phases of the barometer oscillation, as observed, depend largely upon the geographical position and physical surroundings of the place of observation, in so far as these are capable of modifying its temperature conditions, and especially the relative distribution of temperature over the regions immediately surrounding it.—Mr. G. J. Symons, F.R.S., described some experimental observations which he made during the hot weather in July with two thermometers one foot below the surface of the ground, with the view of ascertaining (1) the influence of slight shade, (2) the amount of daily range, and (3) the approximate curve of daily fluctuation.

PARIS.

Academy of Sciences, November 20.—M. van Tieghem in the chair.—Note on the Leonids, by M. Lœwy. An account of the results obtained in various French observatories on the Leonid swarm. The results were disappointing. At Paris only thirty-three Leonids were seen on three nights; at Algeria, sixty-five in two nights; at Lyons, forty during three nights; at Toulouse, forty-three. The most favourable conditions for observations appear to have existed at Marseilles, where twenty shooting stars were seen on the night of the 13th, seventy-one on the 14th, and forty-three on the 15th, or 134 in all.—Note on the observations of the shooting stars known as the Leonids, made at the Observatory of Meudon, by M. J. Janssen. In order to prevent the possible interference of clouds or fog with the observations, two balloons were employed, at an altitude of about 200 metres. Full details will be given in a later paper.—On the course of a system of plane waves, laterally indefinite, moving in an isotropic heterogeneous medium, formed of plane parallel layers, by M. J. Boussinesq.—Action of fluorine and hydrofluoric acid upon glass, by M. Henri Moissan. The statement of Louyet, that anhydrous hydrofluoric acid does not attack glass is shown to be based upon a misconception, since although under certain conditions glass maintains its polished surface in contact with hydrofluoric acid, it can be shown to have been attacked by its loss of weight. In the present experiments glass was invariably found to be attacked at the ordinary temperature by gaseous hydrofluoric acid, even although very carefully dried. In the first experiments made with fluorine, a similar effect was observed; but this was afterwards found to be due to the presence of a minute trace of hydrofluoric acid. Pure fluorine, freed from traces of acid by passing through a V-tube cooled in liquid air, may be kept in sealed glass bulbs for weeks without the glass being attacked.—Observations of the Leonid swarm of November 13 to 16, 1899, made at the Observatory of Paris, by M. G. Bigourdan.—Observations of Leonids at the Observatory of Toulouse, by M. Baillaud.—Observation of the Leonid swarm at the Observatory of Meudon, by M. H. Deslandres.—Observations of the new planets (E W) and (E R) made at the Observatory of Algiers with the 31·6 cm. equatorial, by MM. Rambaud and Sy.—Observations of the sun made at the Observatory of Lyons during the second quarter of 1899, by M. J. Guillaume. The results are collected in three tables, showing the number and area of spots, distribution of the spots in latitude, and of the faculæ in latitude.—Contribution to the theory of the function $\zeta(s)$ of Riemann, by M. Edm. Landau.—On systems simultaneously isolated, by M. Andrade.—A new theory of the optical phenomena of the entanglement of ether by matter, by M. G. Sagnac.—On a new binocular lens, by M. Émile Berger.—Chemical effects produced by the Becquerel rays, by M. P. Curie and Mme. Curie. Radio-active barium chloride possesses the property of converting oxygen into ozone. This necessitates an expenditure of energy, and hence is a proof that the radiation represents a continual disengagement of energy.—Reciprocal displacement of metals, by M. Alb. Colson. The disturbing effects of oxygen and occluded gases were eliminated in these experiments by working in a Crookes vacuum. It was found that the reactions

$$Hg_2Cl_2 + 2Ag = 2Hg + 2AgCl$$

and

$$AgS + Hg = HgS + Ag$$

are reversible, the reaction being limited by a definite pressure of mercury vapour for a given temperature.—Action of nitric oxide upon chromic dichlorhydrin, by M. V. Thomas. Nitric oxide combines vigorously with chromyl dichloride, giving an amorphous compound, the results of the analysis of which can be best expressed by $Cr_5Cl_5O_7.2NO_2$.—On a methylene sulphate, by M. Marcel Delépine. By the interaction of dry trioxymethylene and fuming sulphuric acid, a neutral crystallised substance, $CH_2O.SO_3$, is obtained, thermochemical data for which are given.—On a mode of synthesis of parabanic acid, by M. P. Cazeneuve. Oxamide added to boiling phenyl carbonate gives parabanic acid and phenol, the acid being identified by means of its silver salt. The yields do not exceed 5 per cent. of the oxamide employed.—On a new Myxosporidium, *Nosema Stephani*, a parasite of *Flesus passer*, by M. Hagenmuller.—On the cytological phenomena preceding and accompanying the formation of the teleutospore in *Puccinia Liliacearum*, by M. R. Maire.—On the histological modifications produced in stems by the action of *Phytoptus*, by M. Marin Molliard. The chemical action which corresponds to the presence of parasites such as *Phytoptus* determines the formation of a new tissue which differentiates itself at the expense of any cells, independently of what these cells would have become in the ordinary course of development.—On the negative variation of the axial nervous current, by M. Mendelssohn.—The cryoscopy of urine as an aid to diagnosis, by MM. H. Claude and V. Balthazard.—Effect of a diet poor in chlorides upon the treatment of epilepsy by sodium bromide, by MM. Ch. Richet and Ed. Toulouse. The use of sodium bromide in the treatment of epilepsy, although efficacious to a certain extent, leads to other troubles owing to the large doses necessary, 8 to 15 grams per day. By the use of a diet as free as possible from salt, equally good effects were produced with only 2 to 4 grams of sodium bromide daily. The special diet appears to have no effect upon the general nutrition.

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 30.

ROYAL SOCIETY, at 4.—Anniversary Meeting.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Bridges for Light Railways: L. H. Rugg.

FRIDAY, DECEMBER 1.

GEOLOGISTS' ASSOCIATION, at 8.—The Zones of the White Chalk of the English Coast. I. Kent and Sussex: Dr. A. W. Rowe.—A New Rhætic Section at Bristol: W. H. Wickes.

MONDAY, DECEMBER 4.

SOCIETY OF ARTS, at 8.—Enamelling upon Metals: H. H. Cunynghame.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—The Fireproofing and Preserving of Timber: Sherard Cowper-Coles.

VICTORIA INSTITUTE, at 4.30.—Pictorial Art among the Australian Aborigines: R. H. Mathews.

TUESDAY, DECEMBER 5.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Paper to be further discussed*: The Waterloo and City Railway, and its Electrical Equipment.——*Paper to be read with a view to discussion*: Combined Refuse-destructors and Power-plants: C. Newton Russell.

WEDNESDAY, DECEMBER 6.

SOCIETY OF ARTS, at 8.—Artificial Silk: Joseph Cash.

GEOLOGICAL SOCIETY, at 8.—On the Occurrence in British Carboniferous Rocks of the Devonian Genus *Palaeoneilo*, with a Description of the Species *Palaeoneilo carbonifer*: Dr. Wheelton Hind.—On the Geology and Fossil Corals and Echinids of Somaliland: Dr. J. W. Gregory.—Note on Drift-gravels at West Wickham, Kent: G. Clinch.

SOCIETY OF PUBLIC ANALYSTS, at 8.—Note on Asafœtida: C. G. Moor.—On some Analyses of Modern Dry Champagne: Dr. P. Schidrowitz and Dr. Otto Rosenheim.—On the Determination of the Iodine Value: Dr. J. J. A. Wijs.—Treacle or Golden Syrup: E. W. T. Jones.—On a Method for Distinguishing between Hops and Quassia: Alfred C. Chapman.

ENTOMOLOGICAL SOCIETY, at 8.

THURSDAY, DECEMBER 7.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: Vapour-density of Bromine at High Temperatures: Dr. E. P. Perman and G. A. S. Atkinson.—Polytremacis and the Ancestry of Helioporidæ: Dr. J. W. Gregory.—Gold Aluminium Alloys: C. T. Heycock, F.R.S., and F. H. Neville, F.R.S.—On the Association Attributes in Statistics; with Examples from the Material of the Childhood Society, &c.: G. U. Yule.—Data for the Problem of Evolution in Man. III. On the Magnitude of certain Coefficients of Correlation in Man, &c.: Prof. Karl Pearson, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Cost of Steam Raising: John Holliday.—Influence of Cheap Fuels on the Cost of Electrical Energy: R. E. Crompton. (Adjourned Discussion.)

LINNEAN SOCIETY, at 8.—On some Vegetable Poisons used for the Capture of Fish by the Australian Aborigines: J. W. Fawcett.—On some New Zealand Schizopoda: G. M. Thomson.—On the Structure of Porites: H. M. Bernard.

CHEMICAL SOCIETY, at 8.—Ballot for the Election of Fellows.—The Oxidation of certain Organic Acids in presence of Iron: H. J. H. Fenton, F.R.S., and H. O. Jones.—The Determination of the Constitution of Fatty Acids, Part II.: Dr. A. W. Crossley and H. R. Le Sueur.—On Sulphates of the Form R'_2SO_4, $2M''SO_4$, especially those of Isometric Crystallisation: F. R. Mallet.

RÖNTGEN SOCIETY, at 8.—Observations on Practical X-Ray Work, with Exhibition of Apparatus and Stereoscopic Skiagrams: Mackenzie Davidson.—Bullet in the Brain: J. Moore.

FRIDAY, DECEMBER 8.

ROYAL ASTRONOMICAL SOCIETY, at 8.

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THURSDAY, DECEMBER 7, 1899.

LYON PLAYFAIR'S LIFE.

Memoirs and Correspondence of Lyon Playfair, First Lord Playfair of St. Andrews, P.C., G.C.B., LL.D., F.R.S. By Wemyss Reid. Pp. xii + 487. (London: Cassell and Co., Ltd., 1899.)

IN writing the life of Lyon Playfair, and editing his autobiography and correspondence, Sir Wemyss Reid has had a congenial task, and this he has accomplished with his usual tact and success. The result is a volume full of interest both for the scientific and for the layman, for Playfair himself truly defines his position as half man of science and half politician, and his biographer has rightly appreciated the remarkable dual part which he played, and the work which in each direction he accomplished:

"The man the story of whose life is to be told in these pages, never rose to that dazzling eminence which justifies the world in describing a human being as supremely 'great.' He did not pretend to the genius which lifts a few men high above their fellows. It cannot be affirmed that he was one of the great figures of his generation. Yet his life, though it was lived without ostentation and without parade, was undoubtedly one of the fullest and most useful lives of his time. It was emphatically a life of work, and of work not for the accumulation of wealth, or for the achievement of fame, but for the acquiring of truth, and for the service of his fellow men."

The most interesting portions of the volume are doubtless those containing Playfair's own description of his life and labours. These, although fragmentary, give a truer picture of the man and his doings than can be attained even by so skilled a biographer as Wemyss Reid. Playfair did not write them with a view to publication, and begins by remarking that if they are ever made public,

"My only apology is that they may form some encouragement to others, who, like myself, have had in early life few friends and no influence, to believe that their future position depends upon themselves and not upon their surroundings."

This is indeed the keynote of the life. The story, told by Playfair in his own way, is one not of adventure but of work. Many a poor Scots lad has done as great things, and risen in the social scale as high as, or higher than, Lyon Playfair, but no one carried out his life's work more devotedly than he.

"To Lyon Playfair the good of his country," truly says his biographer, "was a thing to be pursued not merely in the Senate or on contested fields, but in the laboratory and the council room, in social intercourse and in the humdrum round of daily life. It was something calling not so much for isolated deeds of heroism as for a prudent and unremitting care extending even to the most trivial tasks and incidents."

And he was fortunate in the period over which his life's work extended. In early days he showed his partiality for scientific studies, and especially for chemistry. In 1835 he left the Glasgow University, where Thomas Thomson was the professor, for the Andersonian College, where a younger and more active man—Thomas Graham—occupied the chair. This was a fortunate step, for Graham, himself actively engaged in research, fired Playfair with a desire to do likewise, and sent him to Giessen.

"On presenting myself to Liebig," he says, "I was much struck by his handsome appearance and classically cut face. I mentioned my name and told him that I was a pupil of Graham's, and he laughingly said, 'You might have said that you are the discoverer of iodo-sulphuric acid,' which I had recently described in short papers,"

the titles of which are not, however, to be found in the Royal Society's Catalogue. This introduction and the friendship which followed were the most important events in Playfair's early life. He translated the "Agricultur Chemie," though "my knowledge of German was not good." This candid admission is amusingly borne out in a letter written many years later to his wife, in which he says of a German girl that she speaks English "*schlecht*," but French "*vorläufig*," instead of "geläufig"!

Notwithstanding the above opinion, there is no doubt that Playfair's English translations of Liebig were well done, and that they were the means of introducing him to many men of position and influence in this country, by whom his talents were soon appreciated and whose friendship formed a starting-point in his career.

The story of his introduction to the great Sir Robert Peel is well told, and the results were as unexpected as they were gratifying. The question of sanitary reform then arose, and Playfair was fortunate in being one of the first to be employed in carrying out the battle against dirt and disease, and to his last days he remained what he was in his youth, the most energetic of sanitary reformers.

Then, again, he was fortunate in being a forerunner of the great educational movement which has been one of the chief glories of the nineteenth century. That he was well fitted to be the pioneer of technical instruction was due to his true appreciation not only of the value of pure science as a means of culture, but of the importance of the application of scientific principles to the arts and manufactures.

"Not to teach trades or manufacturing, but the principles, scientific and artistic, which underlie those trades and manufactures,"

was his definition; and that he lived to see these principles carried into effect must have been to him a source of keen satisfaction.

"In the chapter which history devotes to the social progress of our century, Playfair's name must always hold a place of honour."

Early in the year 1851 he was brought into personal and intimate contact with Prince Albert, and soon the confidence of the Prince was gained, so that Playfair from that time forward became his trusted adviser and friend. Although Playfair acted as Gentleman Usher to the Prince Consort, and was afterwards a Lord-in-Waiting upon the Queen, he, as he tells us, was not a courtier in the sense often ascribed to the word. He spoke his mind fully and frankly both when his views were in agreement with, and also when they were opposed to those held by "exalted persons." Of the Prince Consort's character and abilities he had the highest opinion.

"The attachment to his service," he says, "gave me the privilege of being associated with the illustrious

Prince in many of the works which he undertook to promote education, science, and art. . . . In all my future intercourse with the Prince, I never on any occasion saw him animated by a single desire that was not connected with the public weal. . . . Only those who had the honour of his confidence can fully know the purity, ability, and simplicity of his character."

The history of the Great Exhibition of 1851, of the many difficulties satisfactorily surmounted, and of the grand final success, are all graphically told, including the celebrated story of the "Junk Chinaman" dressed up to represent a "yellow jacket" mandarin, and placed in the procession between the Archbishop of Canterbury and the Duke of Wellington! Greater than his services to the Exhibition were those which he bestowed on the appropriation and consolidation of the large funds placed at the disposal of the Royal Commissioners. Without the advice and the business capacity of Playfair this fund, now large and altogether devoted to purposes of science and art, would have been in danger of being frittered away, if not lost. "Nobody but yourself," writes the Prince of Wales to Playfair in 1889, "could have got us out of the serious pecuniary embarrassments in which we found ourselves placed."

"So long as South Kensington continues to exist in its present state, there will be no need to raise any monument to the memory of Lyon Playfair."

The letters and memoir contain interesting descriptions of professorial life at Edinburgh. He does not scruple to dilate on some amusing but not very creditable University squabbles in which he was often called upon to act as arbitrator. Then comes his Parliamentary career in both Houses, the details of which are both interesting and entertaining. How he represented the Universities of Edinburgh and St. Andrews. How he retired from this constituency in consequence of the Government putting Scotch education under a Scotch Secretary. How he was elected for South Leeds, "a working-man's constituency, where he received an almost enthusiastic appreciation, which quickly developed into a feeling of warm confidenec and affection."

As Chairman of Committees in the Commons, he had hard times in consequence of Irish insubordination. But he did yeoman service in speaking out strongly and fearlessly about the follies and the crimes of the Anti-vivisectionists and the Anti-vaccinators. The correspondence which occurs throughout the volume with persons of all ranks is full of interesting matter. The letters to his wife and children, and to the members of the Russell family, show the depth of his feelings, although, as one of his children writes:

"No letter he ever wrote could give an idea of his deep and intense sympathy, of his loving help in any trouble to those dear to him, and even to strangers. I never in the whole of my life have seen him cross or impatient, or known him speak a harsh word to any one."

Then his sense of humour was keen, and his powers as a *raconteur* were of the first order, and not the least interesting portion of the memoirs is that in which these powers are shown by the numerous anecdotes with which the volume abounds. Altogether the book is one which will be found full of interest, as giving a striking picture of a wonderfully full and varied life. H. E. R.

THE GOLD-FIELDS OF ALASKA.

Alaska and the Klondike: a Journey to the New Eldorado, with Hints to the Traveller, and Observations on the Physical History and Geology of the Gold Regions, the Conditions of Working the Klondike Placers, and the Laws governing and regulating Mining in the North-west Territory of Canada. By Angelo Heilprin, F.R.G.S., F.G.S.A. Pp. 315; with 35 plates from photographs, and 3 maps. (New York: D. Appleton and Co. London: C. A. Pearson, 1899.)

THE search for gold still holds something of the romantic glamour which has surrounded it from the earliest days of our civilisation. It is true that modern conditions have enmeshed the winning of gold from vein and banket, reducing it, like diamond-mining, to a systematised industry scarcely more inspiriting to the labourer himself than the mining of coal or ironstone. But placer-deposits still offer a possible chance of sudden riches to the man possessed only of bodily vigour and a few simple uncostly implements, and men's imaginations still take fire whenever the rumour reaches them that the old conventional symbol of wealth is to be had for the digging. And still, as in the ancient days, the greater the difficulties to be overcome, the stronger to the adventurous spirit seems the probability of success. So when, in 1896-7, through an ever-widening circle, was spread the news of rich discoveries of the precious metal in a remote and barely accessible corner of north-western America, thousands were found ready to cast aside their everyday pursuits and make, in the words of the wise Camillo,

"a wild dedication of themselves
To unpathed waters, undream'd shores, most certain
To miseries enough."

To any one knowing anything of the land, the newspaper information which led to the rush seemed strangely inadequate and misleading—a characteristic compound of half-truths, whole truths and untruths, out of which stood the bare fact that placers of unusual richness had been found. What was heedlessly lost sight of in the excitement was that this discovery was not the sudden outcome of a single traverse of a previously unknown Golden Land, but had been attained only at the end of twenty years of persistent exploration, during which, though in the aggregate much gold had been won, the average net individual gain had been rarely more and often less than "day-wages."

As usual, these initial stages (unmentioned in the volume before us) attracted little or no attention from the outside world, for the restless spirits who undertake the hardships of pioneer life in the unbroken wilderness, though perhaps *too* fluent in speech, write no descriptions of their journeyings. Almost everywhere these men penetrate in advance of the "original explorer," who often in his own narrative forgets to mention their presence; but unless some unusual happening brings their doings into prominence, their traces in the land they have traversed are slight. In this instance it was surely a matter for prime consideration that a body of more or less experienced men—in numbers, according to a table published recently in the eighteenth Annual Report of the U.S. Geological Survey (p. 132), rising from 50 in 1882 to 1000 in 1894, and to 1700 in 1896—should for many years have been prospecting up and down the Yukon from its mouth nearly to its sources with only moderate success. This in itself was sufficient to show that the riches of the land were neither unlimited nor easily attained, and that most of the tyros in gold-hunting who made their laborious march in the wake of these men must do so in vain. According to Prof. Heilprin, "probably not less than thirty-five thousand to forty thousand people, possibly even considerably more, have in the short period following the discovery of gold in the Klondike region already passed to or beyond the portals of what has not inaptly been designated the New Eldorado. To some of these a fortune has been born; to many more a hope has been shattered in disappointment."—And how could it be otherwise?

The sudden movement of this great army, made up of units marching independently and without organisation, with self-interest as the only motive, into the heart of a wild land incapable of furnishing more than a very small number with the barest elements of sustenance, dependent therefore for their very existence upon supplies from a base many hundreds of miles away, possesses extreme interest to the student of economics and sociology; and perhaps the chief value of Prof. Heilprin's book is that it contains the record of a certain stage in the transient and unstable conditions which arose under these circumstances. That within the space of a few months this transplanted social mass should with scarcely any disorder have struck root amid novel and arduous surroundings, and by the play of individual interest alone should have found itself provided with all the actual necessaries, and many—indeed, too many—of the luxuries of life (brooms and window-glass being, according to Prof. Heilprin, the chief things lacking) is, in its way, as remarkable an object-lesson as the century has afforded. At no previous period in human history could this have happened, and it is all the more deserving of careful record. The flood of hazily inaccurate or wilfully misleading information from the newspaper press is past; we have reached the second stage at which, as in the volume before us, the underlying facts emerge; and there will follow, no doubt, in the fulness of time, the brightly coloured growth of fiction which imaginative writers will cultivate for our entertainment around the picturesque elements of the movement when its sordid details are forgotten.

As for the actual contents of Prof. Heilprin's book, it aims to place before its reader the impressions of one accustomed to examine critically and record accurately, during a tour to the Klondike by the Upper Yukon route, made under favourable circumstances between the end of July and the middle of October of last year. Prof. Heilprin went in from tide-water at Skaguay by the White Pass to the head of inland navigation on Lake Bennett in a day and a half, and came out, late in the season, by the Chilkoot Pass in one day with comparative ease, and concludes that the difficulties of both trails have been greatly exaggerated.

"To a mountaineer or traveller of ordinary resource neither the White Pass nor Chilkoot Pass will appear other than it actually is—*i.e.* a mountain pass, sufficiently rough and precipitous in places, and presenting no serious obstacle to the passage of man, woman, or child" (pp. 15-16).

But he justly observes that what to a person in his own circumstances seemed easy enough, both in these passes and on the trails of the interior, might wear a very different aspect to the man struggling onward with a load of 60 or 80 lbs. on his back In fact, all through the book we realise that the impressions are those of one travelling in ordinary tourist fashion, light and with sufficiency of means, and that the prospector mentioned on p. 177, "who was moving by slow stages, and without assistance of any kind, an equipment weighing somewhat over 400 lbs." would have another tale to tell.

However, with the completion of the railway in course of construction on the White Pass route, the journey to Dawson City becomes simply a matter of the payment of fares. Already, we learn from the newspapers, the journey from Vancouver to Dawson has been made in so short a time as six days, while from eight to twelve days is now ordinarily the length of the through trip.

From Lake Bennett Prof. Heilprin went by river-boats down the lakes and the Lewes or Upper Yukon River to Dawson in 4½ days, reaching the last-mentioned place on August 6. Here he took quarters in the recently opened "foremost hotel of the land," paying 35 dollars per week for his scantily furnished room, and 25 to 35 dollars per week more for board. He estimated the number of inhabitants of the two-year old city at 16,000, and this sudden concentration of humanity ahead of the resources of the country had, necessarily, curious consequences upon the relative values of merchandise. Thus we read (p. 101), that chickens "earlier in the season had sold for 100 dollars for three," but later "were obtainable at 10 dollars apiece"; eggs were 2½ dollars per dozen; radishes 75 cents a bunch of five pieces, and so on; while at the same time at the auction rooms many articles could be bought for less than the original outside cost (p. 104). But with regard to the enhanced value of food-stuffs, it may be well to mention that the Canadian Geological Surveyors, who were in Dawson during the same summer, state in their report that "it was found quite possible to purchase provisions at retail prices at the stores, for the maintenance of a party, at less than a dollar a day per man (Rep. Geol. Survey of Canada for 1898, p. 62).

That the conditions were peculiarly evanescent, and with the establishment of Dawson City as a distributing centre are not likely to be repeated in the district, should make the fluctuations of the Dawson markets during the last three years an instructive chapter in economics.

One notices at times in Prof. Heilprin's book an unpleasant oblique mode of expression, not uncommon in the literature of forty years ago, but now happily rare. This is especially pronounced in the chapter on the inhabitants of Dawson, as, for example, in the passages describing "Sir ——," "Count C——," the "professor-doctor" and the "Gold Commissioner" (pp. 110—112).

The author notes that the number of blacklegs was surprisingly small, and remarks on "the feeling of security which every one seems to experience and enjoy." This he ascribes in great measure to the efficiency of the Canadian military police, and comments on "a condition so wholly different from that which but a few weeks before dominated the atmosphere of Skaguay and the American side of the trails" (p. 119).

In praising the summer climate of the Klondike Prof. Heilprin waxes enthusiastic—

"From August 6th to September 20th, barring three days of partial rain, and perhaps a fourth of cloudiness and mist, the weather was simply perfection—a genial, steady, mild summer with a temperature rising at its highest to about 80° or 82° F. in the shade. . . . In August . . . the evenings were but little less pleasant than the days, the balmy night air rarely necessitating clothing warmer than that ordinarily worn" (p. 70).

Neither did he personally experience any trouble from mosquitoes. He also thinks that the rigour of the winters has been exaggerated, as "most of the Dawsonites are inclined to make light of the winter's cold, and assure you that, except for head and foot wear, they take little stock in that over-burdening with heavy clothing which outfitters so delight in foisting, as 'absolute necessities,' upon the too credulous tenderfoot" (p. 73).

In short, there appears to be nothing in the region inimical to the permanent residence of civilised man the year round in comparative comfort. Even the agricultural possibilities of the country are spoken of hopefully (p. 83), and Dr. Dawson's previous favourable estimate in this direction is quoted with approval (p. 85).

As to that which to most people constitutes the sole interest of the region—its future possibilities for gold-production—Prof. Heilprin, while writing with somewhat oracular caution, takes on the whole a sanguine view. After describing the conditions and methods of working the placers which differ, in the frozen state of the subsoil and in some other particulars, from any placers hitherto worked on the continent except those of Cassiar in the northern part of British Columbia, and after pointing out that some of the best claims, viz. those of the hillsides and high benches, were located in the early part of 1898, at the time when the incomers had been warned that the region for a hundred miles or so about Dawson had been fully staked and occupied, the author concludes that "many good locations in the Klondike territory are still open, although it may not be easy or possible to say just which they are" (p. 207). This, we fear, will seem rather "thin" guidance to the anxious gold-seeker! The output of the past year Prof. Heilprin estimates to have been "in the neighbourhood of nine or ten million dollars, perhaps more; but that it will be vastly greater in the current year (1899) is certain" (p. 204). Like other investigators of the district, he thinks that capital judiciously expended in hydraulic-mining should yield profitable returns.

A summary of the Canadian laws regulating mining in the Yukon region forms one of the most useful chapters in the book.

The longest chapter is that which deals with the physical history and geology of the Klondike gold-fields (Chapter xi. pp. 212–280), and this is, perhaps, the least satisfactory part of the volume. To the general reader it may indeed be of some service; but to the student of geology or of physiography more adequate sources of information are available, and the chapter contains little that need detain him, especially since though passing mention is made of previous investigators exact references to their works are rarely given. Besides the early scientific descriptions of the Yukon country by Dawson, McConnell, Russell and others, the recently issued report of the Canadian Geological Survey for 1898 includes (pp. 55–62) a concise and practical summary of the geology and conditions of the Klondike gold district by those excellent observers Messrs. R. G. McConnell and J. B. Tyrrell, which gives a clearer view of the structure of the country than the volume before us; and the eighteenth Annual Report of the U.S. Geological Survey (Part iii. pp. 101–391) contains an elaborate memoir on "the Geology of the Yukon Gold District" by Mr. J. E. Spurr, with a particularly interesting preliminary chapter, previously referred to, on "the history and condition of the district to 1897," and a discussion of the drainage peculiarities, by Mr. H. B. Goodrich. To these works, then, rather than to Prof. Heilprin's book, the scientific student should turn for information.

Prof. Heilprin, after much discussion of the subject, comes to the conclusion that "the known facts of the Klondike region, so far as they relate to the primal origin of the gold in the placers, favour the theory of chemical solution and precipitation, as opposed to the generally accepted view of accumulation from disintegrated reefs, bodies or veins" (p. 280).

But his arguments are unconvincing, and his views are neither shared by Spurr for the placers on the American side of the frontier, nor by McConnell and Tyrrell, the latter investigators stating that "the gold in the Klondike has certainly been derived from the rocks of the immediate vicinity" (Rep. Can. Survey, *op. cit.*, p. 60). It is of course evident that during whatever time the rich ground may have remained permanently frozen, no percolation of the supposed solutions can have taken place.

With regard to the auriferous high-level deposits, Prof. Heilprin adopts a view similar to that held by Spurr to account for the high benches of the American side, viz. that they are "evidences of the past existence of large lake-like bodies of water, perhaps even of a vast inland sea" (p. 226). On this supposition he builds various speculations, and thinks that the old shores have formerly been of far greater extent and have yielded by condensation much of the gold of the valley placers. But Messrs. McConnell and Tyrrell offer a more simple and adequate explanation of the phenomena in question, as follows:—

"On Bonanza and Eldorado creeks, and doubtless also on a number of the other creeks that rise in the high land near the Dome, the work of concentration has been greatly expedited by small local glaciers, which, at a period not very remote, have originated at the heads of these creeks, and have filled the bottoms of their valleys through parts at least of their lengths. Thus the Eldorado glacier would appear to have had a greatest thickness of about 200 feet at French Gulch, and to have joined the Bonanza glacier at the Forks, below which both continued on some distance together. The gravel that fills the bottom of the valley from side to side is a typical glacier-wash, having been deposited by the stream which flowed from the face of the glacier. The lower benches on Bonanza Creek were also deposited in a similar way, but the higher so-called benches have been formed either as lateral moraines along the sides of the glacier, or by streams which flowed between the side of the glacier and the bounding slope of the valley" (Rep. Can. Survey, 1898, p. 61).

There are no existing glaciers in the Klondike region, and while the former presence of small local valley-glaciers has been recognised, all the observers are agreed as to the absence of any trace of widespread glaciation. This probably implies that, as in Siberia, the climate throughout the Glacial Period was dry, and that then, as now, heavy precipitation was confined to the vicinity of the coast.

To sum up our impressions of this book, Prof. Heilprin may be complimented on having given us a vivid picture of transient conditions in the Klondike; but, from a physical standpoint, his work can scarcely be taken as a solid contribution to our knowledge of the district.

The numerous excellent reproductions of photographs with which the book is illustrated are for the most part well adapted to show the general character of the scenery and conditions, though now and again a picture is introduced for effect rather than for instruction. The deep yellow binding with its pictured dog-trains, reminiscent of the "yellow press," is not particularly happy. G. W. L.

A NEW TEXT-BOOK ON CHEMISTRY.

Inorganic Chemistry for Advanced Students. By Sir Henry E. Roscoe, F.R.S., and Arthur Harden, Ph.D. Pp. 432. (London: Macmillan and Co., Ltd., 1899.)

THIS book is intended to supplement "Chemistry for Beginners," which was published about six years ago by Sir Henry Roscoe, with the assistance of Mr. J. Lunt. It is not a complete treatise on the elements of inorganic chemistry, but part of a complete treatise. It is intended for students who have already gained a little knowledge of the subject, and those who would use it must first learn something about oxygen, hydrogen, chlorine, carbon, and their simpler compounds, and about many other matters, either from "Chemistry for Beginners" or from some other suitable elementary work.

We suppose that a small text-book is put into the hands of most beginners when they reach the stage at which they need such a book, and that presently, when they are older and more advanced, this small book is changed for one of the larger treatises. Now, at this latter stage a certain amount of confusion and some loss of time are very apt to occur owing to the overlapping of the contents of most elementary and advanced works on chemistry, and to the fact that the majority of young students are not able to skip with discretion. It is evident that this confusion and loss of time might be avoided by the use of two books, such as those which have now been provided by Sir Henry Roscoe and his colleagues, Dr. Harden and Mr. Lunt; and we believe that those who have had much experience in teaching chemistry under school conditions will at once recognise the merits of their method of dealing with the subject in two volumes, one quite elementary, one more advanced, and each the complement of the other.

The present volume, like its predecessor, follows in the main the lines laid down so successfully a generation ago in the familiar "Roscoe's Chemistry." That is to say, the book is intended for students who want to learn the fundamental principles of chemistry, and something about its methods and its data, rather than for those who desire to use the subject as part of a system of mental gymnastics. But though the new book follows lines which have so long been made familiar to us by the previous work of its eminent senior author, it differs from that earlier work in several respects, notably in its somewhat more limited scope, for organic chemistry finds no place between its covers, in the greater attention given to chemical theory, and in the fact that a great number of experiments for the student are described in the text.

The subject-matter of the volume is divided into thirty-nine lessons, the elements treated of being grouped in such a manner that from the beginning the student may be said to be preparing the way for his subsequent study of the periodic system of classification. The chapters on chemical theory are dispersed among the rest. This arrangement may, perhaps, seem open to the objection that the student's reading in certain subjects may be somewhat broken up; but the authors have adopted it, as they tell us in their preface, with the object of relieving him of the tedious task of working without a break through a long series of metals and their compounds. The parts of chemical theory chiefly discussed in these lessons are atomic and molecular weights, equivalents, specific and atomic heats, crystals and isomorphism, valency, the constitution of hydroxides and oxyacids, dissociation, thermochemistry, electrochemistry, the periodic law and spectrum analysis. There are questions to be worked out, and numerous summaries. We are not quite convinced that so many of these latter make for sound learning. Should not every student prepare a good many of his own abstracts after he has read a few chapters and compared them with some summaries provided as examples? This, however, is a small matter, as it is obvious that the existence of summaries in the text need not prevent any student from constructing his own abstracts during his reading. We feel sure that the new book will be welcomed by those who are familiar with its predecessor, and by many others, and we wish it and its companion volume all success. W. A. S.

OUR BOOK SHELF.

Elements of Natural Philosophy. By Alfred Earl, M.A. Pp. viii + 320. (London: Edward Arnold, 1899.)

MR. EARL is already well-known as the author of the admirable "Practical Lessons in Physical Measurement," and one naturally examines a new book of his with great expectations. The preface states that the present volume is "intended as a handbook for the laboratory," and "has been written for the use of beginners." The book does not, in our opinion, exactly fulfil these conditions; yet it may still prove of use, though rather to teachers than taught. A laboratory manual should give clear, precise instructions as to what the student has to do—guidance of a sufficiently explicit nature for the pupil to work from without unduly bothering the teacher, who, very often, has too large a number working at the same time for purely individual instruction. Yet, in dealing with the measurement of simple quantities, for example, Mr. Earl gives some nineteen pages of general description, with little or no practical work, contenting himself by adding thirty-eight exercises at the end of the chapter. These exercises leave little to be desired, but a beginner will not always be clear about the several steps by which he is to arrive at the required result. The divisions adopted by the author lead to some very miscellaneous chapters; thus Chapter vi., entitled "Changes Belong to Several Classes," runs to thirty-two pages, and includes a brief treatment of inertia, the electrophorus, voltaic cells, the thermopile, gravitation, expansion, the Gulf Stream, Trade winds and several other subjects. Chapters viii. and ix. take the pupil "along the well-beaten track of chemical rudiments," and were written by Mr. F. Collins. Too much is attempted in this section, and things are often taken for granted of which a beginner has no knowledge whatever. Thus, on p. 185, the modes of chemical action are partly explained by chemical equations, though the only guidance towards understanding them which has been given to the pupil is the table of elements, with their symbols and atomic weights, on p. 181. The value of the book would have been much increased by using simpler language, and adding more illustrations.

Elementary Practical Chemistry. By A. J. Cooper, B.A., B.Sc. Pp. viii + 86. (London: Whittaker and Co., 1899.)

SOME idea of the profound changes which have occurred in the teaching of elementary chemistry during the last decade can be obtained from the large number of books recently published, all of which claim to supply a long-felt want. Mr. Cooper's book covers familiar ground in a more or less familiar way. He starts with a brief account of the metric system (which, however, is too short to be of much use), describes the balance, how to determine relative densities, and to measure liquids and fit up apparatus. No wonder the student often asks why these subjects must be studied both in the chemical and physical laboratories. But like many another recent writer of an elementary course of chemistry, Mr. Cooper rightly avoids the thaumaturgic art of test-tubing, and it is in this connection we are able to perceive an advance has been made in the way of studying science. Though the "Heuristic" method, of which so much is heard nowadays, is not suitable throughout a complete course of chemistry, it is unfortunate that so many statements occur like "note the white powder of metastannic acid that is formed"; "the name of the gas which you have just prepared is nitrous oxide"—which have no significance to a beginner.

The Teaching of Geography in Switzerland and North Italy. By Joan Berenice Reynolds. Pp. xii + 112. (London: C. J. Clay and Sons, 1899.)

NO more hopeful indication of the growing desire on the part of British teachers to improve the methods of instruction in our schools could be desired than this little volume provides. It is particularly gratifying to find that the old insular prejudice is giving place to an intelligent study of foreign educational systems, and that it is at last becoming recognised there is much to be learnt from Continental pedagogic authorities. Miss Reynolds was, in 1897, awarded the Travelling Studentship for Teachers in connection with the University of Wales, and her report, which she presented in 1898 to the Court of this newest of our Universities, demonstrates conclusively that she made the best use of her opportunities. Equipped with the information provided by a wide course of reading in the geographical literature of the countries she intended to visit, Miss Reynolds was able to intelligently note all the features of Swiss and Italian teaching practice which would prove of assistance to our own teachers, and she has here set them down in a clear and interesting manner. Her book should be read by every teacher of geography.

Liverpool Marine Biology Committee's Memoirs. I. Ascidia. By Prof. W. A. Herdman, D.Sc., F.R.S. Pp. v + 52; with five plates. (Liverpool: T. Dobb and Co., 1899.)

THIS is the first of a series of memoirs which is being prepared by the Liverpool Marine Biology Committee under the editorship of Prof. Herdman, to supply a want which "has been constantly felt of a series of detailed descriptions of the structure of certain common typical animals and plants, chosen as representatives of their groups, and dealt with by specialists." The expense of preparing the plates in illustration of the first few memoirs is being met by a donation of Mr. F. H. Gossage, of Woolton. Prof. Herdman has omitted detailed references to original memoirs, the object of his manual being more to provide students of marine biology with a concise and accurate description of the appearance, structure, and life-history of the Ascidian than to publish a bibliography.

In an appendix a statement is given of the classification and characters of the Tunicata, in order to indicate the position of *Ascidia* as a type of the group and its relations to the other British Ascidians.

The Story of the Wanderings of Atoms, especially those of Carbon. By M. M. Pattison Muir, M.A. Pp. 192. (London: George Newnes, Ltd., 1899.)

AN attractive title does not by itself make an attractive book. Assuming that "The Library of Useful Stories" is intended for the general reader, we are afraid that this short account of the compounds of carbon is largely beyond his comprehension. There is an abundance of information, but the repeated references to Mr. Muir's "Story of the Chemical Elements" will tantalise the man who expects to get knowledge and recreation by the same process. A sound knowledge of organic chemistry is only obtained by experimental methods based upon a thorough grounding in the elements of chemistry, and this end is most satisfactorily obtained by studying simple inorganic substances first. The author has adopted a style more suited for the class-room than the platform of the popular lecturer, and the ordinary person who takes up this little volume will, after reading very few pages, find himself completely out of his depth.

General Index, by Robert Newstead, F.E.S., Curator of the Grosvenor Museum, Chester, to Annual Reports of Observations of Injurious Insects, 1877–1898. By Eleanor A. Ormerod, F.R. Met. Soc., &c. With Preface by the author. Pp. xii + 58. (Simpkin, 1899.)

THE twenty-two annual volumes of Miss Ormerod's Reports are known to all students of agricultural entomology, and their usefulness as indispensable works of reference will be largely increased by the present compendium, which includes, in addition to the general index, separate indices of plants, animals and unclassified "hosts." Miss Ormerod's preface contains remarks on the origin and method of the reports, notices of a few of the more important insects which have been dealt with, and miscellaneous observations. It is worthy of special note that she considers all birds which are even moderately insectivorous as beneficial to such an extent as to overbalance any mischief they may do in other ways, unless they are present in overwhelming numbers; but she especially excludes the house sparrow, which she denounces as a national evil. W. F. K.

A Hand-List of the Genera and Species of Birds. By R. Bowdler Sharpe, LL.D. Vol. I. Pp. xxi + 303. (London: Printed by order of the Trustees of the British Museum, 1899.)

THE system of classification adopted in this new "hand-list" is that proposed by Dr. Bowdler Sharpe in 1891. The book is founded upon the "Catalogue of the Birds in the British Museum," a large part of which was written by Dr. Sharpe, but the new species described since the publication of the twenty-seven volumes which comprise the "catalogue" are here included. Proofs of the work have been read and corrected by a number of leading ornithologists throughout the world, assistance sufficient, as Dr. Sharpe says, to give the work "the importance of an international publication."

Human Nature: its Principles and the Principles of Physiognomy. By Physicist. Part ii. Pp. viii + 175. (London: J. and A. Churchill, 1899.)

THE nature of the volume can be indicated by stating one of the propositions of the author's theory of colour: "That exhausted viable matter absorbs the luminous rays, and reflects the invisible (potential) rays, therefore it is dark or nearly colourless, sometimes violet or purple being perceptible; and that viable matter stored with energy reflects the luminous rays, therefore it is yellow or some colour containing excess of yellow, as brown, or cream colour, &c., and absorbs the invisible or potential rays."

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Cause of the Darjeeling Landslips.

PROF. JOHN MILNE'S prompt contradiction in the *Times* of October 3, and in NATURE (5th) of the telegraphic statement concerning the cause of the recent Darjeeling landslips is a distinct "score" for the seismograph. With the Committee appointed by the Bengal Government to investigate the causes of the recent disaster, and to formulate measures for anticipating its possible recurrence, I made special inquiries into the alleged occurrence of earthquakes at Darjeeling on the night of September 24–25, and we all agreed that there was no evidence to show that any seismic phenomena whatever occurred. No movements were felt in well-built houses, and those that were noticed, as well as the sounds which were heard during the violent cyclone, were only of a kind that might be expected in the ill-built, rickety structures which, for the shelter of those who temporarily reside in our hill stations, are known to their owners as "houses." Local earth-tremors may have resulted from the slips, but they were the effects, not the cause, of the latter.

The unprecedented rain which accompanied the September cyclone was a sufficient and satisfactory immediate cause for the numerous landslips near and in Darjeeling. Up to the morning of the 23rd, the monsoon rains measured some 17 inches in excess of the average for previous years, and the thick soil-cap was consequently already saturated. The cyclonic depression first reported by the Meteorological Department to be formed to the south-east of False Point in the Bay of Bengal moved northwards until its centre, on the 24th, had reached lat. 25°, causing heavy rain over most of the province. During the twenty-four hours ending at 8 a.m. on the 23rd, 5·31 inches of rain fell at Darjeeling, followed by 19·40 inches during the next twenty-four hours. Of the latter amount 14·32 inches fell between 4 p.m. on the 23rd and 4 a.m. on the 24th, being thus over an inch an hour for a stretch of twelve hours. It was during this last period, when the rainfall was at its heaviest, that the disastrous slips occurred.

The hill-sides in the neighbourhood of Darjeeling are by natural means already at or near their angle of repose for earth-slopes, and the reduction of frictional stability, due to the thorough saturation by the heavy rainfall of September 23–24, was sufficient to permit slipping of the less stable portions of the soil-cap. The biotite-gneiss massif below is undisturbed and perfectly stable: there is nothing here comparable to Naini Tal, where the slates, by differential movement along their bedding planes, have caused cracks in the masonry structures built upon them. In Darjeeling the slips were confined entirely to the soil-cap, which ran down the steep hill-sides as rivers of mud, and, with occasional included boulders, bombarded the back quarters of some of the houses. A more interesting example on the eastern side of the Jalapahar ridge shows movement on a comparatively large scale now in progress. The sides of the moving mass are defined by longitudinal shear cracks, whilst its upper region—the *Abrissgebiet* of Heim—shows gaping fissures with, in the uppermost ones, a vertical displacement of about 8 feet. A description of this interesting landslip, with map and photographs, will be issued at a later date by the Geological Survey Department.

T. H. HOLLAND.

Geological Survey of India, Calcutta, November 8.

Barisal Guns.

I MUST first state how I came to notice this phenomenon so well known in Bengal. Early in February, 1890, I was posted to Backergunge, as District Superintendent of Police, and remained there till December, 1891, a period of twenty-two months. In order to travel quickly over the district a steam launch was always at my service, and as I had to visit each of the numerous police stations scattered all over the district at least twice every year, there are few places in Backergunge I have not visited repeatedly.

Shortly after my arrival I received a letter from my friend, Mr. G. A. J. Rothney, of the firm of Messrs. John Dickinson and Co., 65, Old Bailey, who has a very wide experience of India, and takes a keen interest in natural phenomena, asking me to try and elucidate this phenomenon of the Barisal Guns; to make careful observations and record them on the spot. This I did, and I now forward a copy of the note I sent him.

The causes usually assigned for this phenomenon are three in number, viz.:—

(1) High banks of rivers falling in;
(2) Surf breaking on the shore, and
(3) Subterranean explosions.

The first of these theories cannot stand in face of the undisputed fact that any such sound would be purely local and could be heard only at very short distances, whereas it is admitted these guns are heard at places a hundred miles apart. The second is equally untenable when we remember the whole delta is composed of alluvial deposit, without a rock for hundreds of miles. And, thirdly, this alluvial deposit entirely does away with the possibility of subterranean explosions.

It is well known to all navigators of these waters there is a peculiarly deep depression to the south of this delta, which either has never been sounded, or, if sounded, has shown a most unaccountable depth, and it is assumed these reports emanate from this depression. But I am not inclined to accept this as a sufficient explanation, as the sounds are so very irregular in their frequency. We all know that Geysers in various quarters of the globe are celebrated for shooting out great masses of water from time to time; but these usually have some periodicity, and their times for discharge have been, more or less, tested and reduced to some well-known law or theory. Now the very irregularity of the Barisal Guns proves they can be subject to no such law, for, if they were, the phenomenon should be heard with some regularity, whereas, as I have shown in my note to my friend, their irregularity is one of their most noticeable features.

There are two special occasions to which I would draw attention: the first in February, 1891, when from the southernmost outpost, Chaltabuni, I followed the reports for some forty miles out to sea; the second, mentioned in my letter to the Surveyor-General of Bengal, when, in August, 1891, for more than six hours, I followed the reports without getting any appreciably nearer, and also never hearing them to the north of me.

HENRY S. SCHURR.

34, Bloomsbury Street, W.C., November 28.

(*Report.*)

BARISAL GUNS are heard over a wide range extending from the Twenty-four Pergunnahs through Khulna, Backergunge and Noakhali, and along the banks of the Megna to Naraingunge and Dacca. They are heard most clearly and frequently in the Backergunge district, from whose headquarters they take their name.

These Guns are heard most frequently from February to October, and seldom in November, December or January. One very noticeable feature is their absence during fine weather, and they are only heard just before, during, or immediately after heavy rain.

The direction from which they are heard is constant, and that is the south or south-east. I have heard them west of me when down in the extreme south of the district, but never north of me. On the other hand, I have been told by captains of river-going steamers that they have heard these reports to their north. These gentlemen, however, ply along waters outside the range of my observations, which lie on the mainland and its adjacent waters.

These Guns are always heard in triplets, *i.e.* three guns are always heard, one after the other, at regular intervals, and though several guns may be heard the number is always three or a multiple of three. Then the interval between the three is always constant, *i.e.* the interval between the first and the second is the same as the interval between the second and the third, and this interval is usually three seconds, though I have timed it up to ten seconds. The interval, however, between the triplets varies, and varies largely, from a few seconds up to hours and days. Sometimes only one series of triplets is heard in a day; at others, the triplets follow with great regularity, and I have counted as many as forty-five of them, one after the other, without a pause.

The report is exactly like the firing of big guns heard from a distance with this peculiar difference, that the report is always double, *i.e.* the report has (as it were) an echo. This echo is so immediate that I can best describe its interval by an illustration. Suppose a person standing near the Eden Gardens heard the 9 o'clock gun fired from Fort William, he would first hear the report of the gun and its immediate echo from the walls of the High Court. The Barisal Guns sound exactly like this, only as if heard from a distance of several miles, very much the same as the sound of the Fort gun heard at Barrackpore on a clear night in the cold weather.

The report varies little in intensity, and I cannot recollect that there was much difference in the sound, whether heard at Barisal itself or some 70 or 80 miles to the south at the extreme end of the district. The state of the atmosphere may affect it, but to no appreciable extent.

The Backergonian peasant is celebrated for the bombs he is in the habit of firing at his weddings and festivals, and many residents have asserted they can distinguish no difference between the reports of these festive bombs and the so-called "guns"; but to any one with a fairly acute sense of hearing, who listens attentively, the difference is very marked, and their assertions are completely refuted by the facts—

(1) that wedding bombs vary very noticeably in the intensity of their sound;

(2) are wanting in the very marked feature of the triplets, and

(3) are naturally confined to the wedding season, a very short season in each year, whilst the Barisal Guns are heard almost throughout the year, and very noticeably during the annual fast—the Roza—when, of course, there can be no festivals of any kind.

Letter from Geological Surveyor-General, Bengal.

I have to thank you for your most interesting report on the Barisal Guns. What you say about following the sounds in a launch is very interesting, and points to a Seismic origin, that is to say, that wherever the sounds came from they really originated locally, wherever you were at the time. In this case, following them would be like trying to reach the foot of a rainbow, whereas if they originated in surf on the sea-shore, or the falling-in of river-banks, they should be traceable to their source. R. D. Oldham.

Butterfly Shadows.

While photographing insects lately in the hills above Pegli (Italy), I was much struck by the curious way in which many of the butterflies turned and shifted their position after they had settled, their apparently eccentric behaviour making it difficult to obtain a good picture. It suddenly struck me that this turning and shifting was the result of an endeavour to settle in such a position as would cast no shadow, thereby ensuring to themselves less risk of detection. This seemed to be a motive particularly with such butterflies as Circe, Semele and Janira; and its success as a method of concealment was very striking in the case of Circe, which constantly settles on the bark of trees or on the rocky ground.

I submit this observation with the hope that it may attract the notice of others who are able to give more attention to the matter; it may, too, be of interest in connection with the recent letters which have appeared dealing with the capture of butterflies by birds.

Continental butterflies appear to be remarkably tame. I was constantly able to catch Podaliarius and other kinds with the hand. D. Wilson-Barker.

Greenhithe, November 27.

A Canadian Lake of Subterranean Inflow.

Imagine a cliff about 180 feet in height, rising almost perpendicularly from the steamboat landing at Glenora on the south side of the Bay of Quinte, a great arm of Lake Ontario, and perched immediately on the top of the cliff, within 300 feet from the edge, a lake of clear fresh water about one a half miles long, with a width of about three-quarters of a mile, its waters continually flowing out to give the power which operates the Glenora mills, but its inflow invisible, and yet steadily maintained from month to month and from year to year. This is the Lake-on-the-Mountain.

Various origins have been suggested in accounting for the inflow. That its source is not attributable to springs from any possibly higher grounds in the same county seems established by the fact that during the long drought in the months of August and September of this year the level of the lake was well maintained. The source is, I think, rather to be sought in the Trenton limestone area twenty-five or thirty miles to the north-eastward of the Bay of Quinte. The dip of the rocks is favourable, and for the whole distance and into the Laurentian area beyond there is a steady rise until at about fifty miles away a height of nearly 400 feet above Lake Ontario is reached. A fair amount of rain fell in this higher country during the drought elsewhere.

To ascertain their bearing on the origin of the inflow, I this past summer took a series of depths and temperatures in the lake. Whilst a considerable part of its area was shallow, not exceeding a few feet, the lake was found to have, close alongside its southern boundary, a great rent, as it were, in its bottom, of towards a mile long, one-third of a mile or more wide, and varying from 75 to 100 feet deep. That this rent is due to a widened fault in the Trenton limestone here is very probable, and the same forces which gave rise to this fault may also account for a subterranean connection with higher ground many miles away. The temperature readings were equally interesting. In Lake Ontario, at its outlet opposite Kingston, during August, the surface of the water ranged in temperature around 72° F., and at a depth of 78 feet (the bottom) it was 56½° F., which latter was very much colder than during last and some previous years. At the Lake-on-the-Mountain, whilst the temperature of the surface was 74¼° F., at 30 feet depth it was 69½° F., at 45 feet 47° F., at 60 feet 43° F., and at 99 feet 42° F. Thus, whilst during the first thirty feet there was not very much change in the temperature, between thirty feet and forty-five feet there was a rapid fall of twenty-two and a half degrees, and between the latter depth and the bottom at ninety-nine feet a further fall of only five degrees.

Andrew T. Drummond.

Cause of Recent Sunset Colours.

May I suggest to your readers that the striking colours of the recent sunsets are possibly due to the dust in the air from the Leonid meteors?

They certainly remind one of the sunsets after the Krakatoa eruption. Horace Darwin.

The Orchard, Huntingdon-road, Cambridge, December 4.

Substitute for Gas in Laboratories.

It is proposed to extend the modern side of a large secondary school by the erection of chemical and physical laboratories and lecture-rooms. The school, however, is some miles distant from any town which has a gas supply, so that it is necessary to consider what is the best substitute. I am interested in the arrangements, and shall be thankful if any of your readers will give me their experience on this point. It is proposed that the laboratories will accommodate forty boys working at one time. William Gannon.

County Technical School, Stafford, December 4.

THE METHODS OF INORGANIC EVOLUTION.

In the study of the facts of inorganic evolution presented to us by stellar spectra, there is one point of paramount importance to be inquired into. In the problems of inorganic evolution which we have now to face, it is sufficiently obvious that we have to deal with a continuously increasing complexity of chemical forms, precisely as in organic evolution the biologist has had to deal, and has dealt successfully with, a like increase of complexity of organic forms.

How has this inorganic complexity been brought about? In the case of known compound bodies an easy answer is given by analysis. Chloride of sodium, for instance, is formed by the combination of chlorine and sodium. But when we wish to deal with the formation of the so-called "elements" themselves, no such easy solution of the problem is open to us.

If in order to investigate this problem we take the analogy furnished by compound bodies as our guide, we should say that the molecules of the elements themselves were produced by the combination of unlike forms.

But as a matter of fact, this method of producing complexity is not the only one known to chemists. There are bodies of the same percentage composition which differ in molecular weight; the methane series of hydrocarbons is a case in point; the higher molecular weights or greater complexes are produced by additions of the unit $C.H_2$, so that these higher complexes are produced by the combination of similar lower complexes. This process is termed polymerisation.

We are then familiar with two methods of increasing complexity, which we may represent by $a + a$ (polymerisation) and $x + y$ (combination), producing a form A.

This, then, is the problem from the purely chemical side. On which of these methods have the elements themselves been formed, now that we are justified in considering them as compound bodies? I suppose that chemists when hypothetically considering the possible dissociation of the chemical elements would favour the view of depolymerisation; that is, the breaking up of a substance A into finer forms (a) weighed by A/2 (or A/3), rather than a simplification of A into x and y.

The method of attacking this problem from the chemical point of view in the first instance, must be a somewhat indirect one.

The Stars and the Periodic Law.

In a recent lecture I referred to the hypothesis put forward by Newlands, Mendeléef and others in relation to the so-called "periodic law," which law indicates that certain chemical characteristics of the elements are related to their atomic weights. I further showed that the order of the appearance of the various chemical substances in the stars of decreasing temperatures did not appear to be on all-fours with the requirements of the periodic law.

It will be well to study this question with a view of discussing it more fully in the light of all the facts known to us, among which the stellar evidence and that afforded by the study of series are, I think, of especial importance, since it may be said that we are now absolutely justified in holding the view that of the lines which make their appearance in the spectra of chemical substances when exposed to relatively high temperatures, a varying proportion is produced *by the constituents of the substance*, whether it be a compound like the chloride of magnesium, to take an instance, or of magnesium itself.

Now the periodic law based upon atomic weights deals with each "element" as it exists at a temperature at which the chemist can handle it; that is, if it be a question, say of magnesium, the chloride or some other compound of the metal must have been broken up, and the chlorine entirely got rid of before the pure magnesium is there to handle, and of this pure magnesium the atomic weight is found and, having also regard to its chemical characteristics, its position in the periodic system determined.

But if the magnesium be itself compound, the position thus assigned for the element is certain not to tally with the stellar evidence if the temperature of the star from which information relating to it is obtained is high enough to continue the work of dissociation; that is to break up magnesium itself into its constituents as certainly as the chloride of magnesium was broken up in the laboratory in the first instance.

It is now known that dealing with this very substance magnesium, high electric tension brings us in presence of a spectrum which consists of at least two sets of lines, numerous ones seen also at the temperature of the arc, and a very restricted number which make their appearance in the spark.

If this be the work of dissociation—and, as I have shown elsewhere, the proofs are overwhelming—the "atomic weight" of the particle, molecule or mass, call it what you will, which produces the restricted number of lines—the enhanced lines—must be less than that of the magnesium by the breaking up of which it is brought into a separate existence.

And now comes the chief point in relation to the periodic law. *Seeing that the smaller masses which produce the enhanced lines have not been yet isolated, their "atomic" weights and their chemical characteristics have not been determined, and so of course their places in the periodic table cannot be indicated as it at present exists.*

My contention, therefore, is that some, at all events, of the apparent discrepancies between the stellar evidence and the "periodic" hypothesis arise from this cause.

The magnesium, and I will now add calcium, which the chemist studies at relatively low temperatures have atomic weights of 24 and 40 respectively, and the stellar evidence would be in harmony with the periodic law if magnesium (24) made its appearance after sodium (23), and calcium (40) after chlorine (39), and generally each substance should make its appearance after all other substances of lower atomic weight than itself.

But, and again for the sake of simplicity I shall confine myself to magnesium and calcium for the moment, in the stars we find lines in the high temperature spectrum of magnesium and calcium appearing before known lines in the spectrum of oxygen which has an atomic weight of 16.

How are these results to be reconciled? I suggest that the explanation is that the substances revealed by the enhanced lines of magnesium and calcium and noted in the hottest stars have lower atomic weights (smaller masses) than the oxygen of the periodic table.

Let us next, then, see what these atomic weights may possibly be. Assuming A/2 the atomic weight of proto-magnesium would be $24/2 = 12$; of proto-calcium $40/2 = 20$, supposing only one depolymerisation has taken place. If we assume two, we get 6 and 10 as the "atomic" weights of the simpler forms of magnesium and calcium which make their appearance in the hottest stars.

In this way we can explain the appearance of those finer forms of magnesium and calcium before oxygen, with a small number of depolymerisations, and the stellar record of the order of atomic weights would be the same:

Hydrogen	1
Proto-calcium	10
Proto-magnesium	12
Oxygen	16

So much, then, for a possible reconciliation. The next point to be considered is, is depolymerisation on such a small scale sufficient?

To do this we have to see the basis of the atomic weight of oxygen 16, and consider the series question in relation to oxygen. This necessitates a digression.

The simplest case presented in series phenomena is that placed before us by sodium and other elements which run through all their known spectral changes at a low temperature. Dealing with the line spectrum stage we have three "series," one principal and two subordinate (first and second). The former contains the orange line D, constantly seen at all temperatures, the first subordinate the red line, the second subordinate the green line, representatives of two series of lines which are best seen both in the flame and arc.

The two subordinate series of sodium, like those of all other elements so far examined, have the peculiarity that they end at nearly the same wave-length, while the end of the principal series occurs at a different, sometimes widely different, wave-length. This is a touchstone of the highest importance, as we shall see; it points to a solidarity of the two subordinate series, and to a difference between them and the principal series.

Although the original idea was that all three series were produced by the vibrations of the same molecule, observations of the sodium phenomena alone are simply and sufficiently explained by supposing that we have three different masses vibrating, and that two of them, producing the subordinate series, can be broken up by heat, while that producing the principal series cannot. The series represented by the red and green lines seen best at the lower temperatures have been seen alone, and it is a matter of common experience that the orange line representing the principal series is generally seen alone: it is not abolished at high temperature as the others are. Because the mass the vibrations of which give us the orange line is produced by the breaking up of more complex forms at a low stage of heat, and it cannot be destroyed by the means at our command, it is the common representative of the element sodium. Because the masses the vibrations of which produce the two subordinate series represented by the red and green lines are easily destroyed by heat, they are more rarely seen, scarcely ever at high temperatures when the quantity is small, since, as I pointed out years ago, "the more there is to dissociate, the more time is required to run through the series, and the better the first stages are seen."

This view is greatly strengthened by considering another substance which, if we accept Pickering's and Rydberg's results, has, like sodium, three series, one principal and two subordinates in quite orthodox fashion. I refer to hydrogen.

Till a short time ago we only knew of one "series" of hydrogen, and on this ground Rydberg assumed it to represent the finest form of matter known, regarding the other substances which give three normal series as more complex. This idea is in harmony with the view expressed above.

Pickering in 1897 announced the discovery in the stars of another series, and seeing that this ends in the same part of the spectrum as the other, we can provisionally regard the terrestrial and stellar hydrogen as representing the first and second subordinate series.

Rydberg in the same year gave reasons for supposing that one line seen chiefly in the bright-line stars may represent still another series of hydrogen which we may take as the principal series. The other lines in this series he calculated to be out of range.

If we accept all these conclusions we must regard hydrogen as identical with sodium in its series conditions. But there is this tremendous difference. In sodium we easily at low temperatures—the bunsen is sufficient—see all three series, while in the case of hydrogen even the Spottiswoode coil can show us nothing more than one of the subordinate series. At the same time, the other subordinate and the principal series are visible in stars which we have many reasons for believing to be hotter than the spark produced by the Spottiswoode coil.

The argument for the existence of three different masses producing the three different series derived from the sodium observations is therefore greatly strengthened by what we now know of hydrogen.

I shall therefore assume it in what follows, and now return from the digression.

Oxygen, instead of having three series like metals of low melting point such as sodium, and the gas hydrogen, has *six*. These six have been divided by Runge and Paschen into two normal sets of three, each set possessing one principal and two subordinate series.

There is evidently a new problem before us; we require to add the series of hydrogen to the series of sodium to get a "series" result similar to that obtained from oxygen.

Before we go further it will be well to consider the possible order of simplifications. Let us take the simplest case represented by sodium and hydrogen in the first instance. The facts are shown in the following table:—

High temperature.

Sodium.			*Hydrogen.*		
Line stage	Principal	Celestial and terrestrial vapour.	Line stage	Principal	Celestial gas.
	Subordinate	Terrestrial vapour.		Subordinate	
	Subordinate			Subordinate	Terrestrial gas.
Flutings			Structure spectrum ...		
Continuous		Solid and liquid.	Continuous		

Low temperature.

We may now bring these results to bear upon oxygen. We learned first from Egeroff that this gas at ordinary temperature and pressure is so molecularly constituted that it produces a fluted absorption in the red part of the spectrum. On account of the constancy of the results obtained by chemists we cannot be dealing with a mixture of molecules, the fluting absorption therefore must be produced by molecules of one complexity having an "atomic weight" of 16.

If we subject it to an induced current at low pressure (at which the action of such a current is feeblest), it at once breaks up into two normal sets of three series, that is six series altogether; it is almost impossible to consider this state of things in the light of what happens in the case of sodium and hydrogen without assuming on the ordinary chemical view that the "molecule" with the fluted spectrum is broken up into two, until finally we get—

High Temperature.

	SET A.	SET B.
Line spectrum ...	Principal series	Principal series.
	Subordinate	Subordinate.
	Subordinate	Subordinate.

Fluted spectrum.

Low temperature.

But if we accept this, we give up depolymerisation, for the molecules of the subordinate series of sets A and B thus produced cannot be identical because their spectra are not identical.

If we hold to depolymerisation we must arrange matters thus—

Set B or A	Principal
	Subordinate
	Subordinate
Set A or B	Principal
	Subordinate
	Subordinate
	Fluted spectra

and we get six depolymerisations.

The number of lines measured by Runge and Paschen in the spectrum of oxygen at low temperature was 76; of these the six series referred to contain 56, leaving 20 residual lines. Now if we employ a strong induced current at atmospheric pressure, we practically extinguish these six series of lines and produce a new spectrum altogether, containing a still greater number of lines: 114, according to Neovius. Only one line is common to his table and that of Runge and Paschen. About the series conditioning of these new lines we are at present profoundly ignorant.

Let us take the simplest course in harmony with the principle of continuity, and suppose that the great number of new lines is due to the breaking up of the molecules of the upper principal series given in the previous table into representatives of a still finer form, as hydrogen, as we know it, is broken up into a finer form at the highest stellar temperatures.

Have we, on the line of reasoning we are pursuing, any means of estimating the number of finer forms which may be at work to produce the 113 new lines?

One possible way—a statistical way—seems open to us. Taking the number of lines already recorded in the spectra roughly between λ 7000 and λ 2600 of the following substances, which give us three series—lithium, sodium, potassium, helium, asterium, hydrogen—we find that the number of lines in each series and the total numbers are as follows:—

	Maximum number.		Minimum number.		Average number.
Principal series ...	10 Ast	...	1 H	...	7
First subordinate ...	17 He	...	6 Na	...	9
Second subordinate...	12 He	...	4 Li	...	8
Totals	39		11		24

This indicates that in oxygen we are slightly above the average with $\frac{56}{2} = 28$ lines per set. If we take the facts for oxygen itself, which give us 56 lines for two sets of three, the 113 lines will give almost exactly four additional sets of three series, and therefore the possibility of twelve more depolymerisations if this method of simplification is considered.

Of course we can halve the number of depolymerisations by assuming that the fluting molecule instead of being depolymerised is broken up into x and y, the bases of the two systems of series.

Now it is this last crop of new lines alone which are represented in the hottest stars, and no one, I think, will now urge that some kind of simplification which may include depolymerisation has not taken place before they were brought into evidence.

Our base of 16 then vanishes, and with it the previously considered possible atomic weights of the forms of magnesium and calcium which precede the appearance of oxygen in the hottest stars. We must therefore assume further depolymerisations in the case of these metals beyond those considered in the first instance.

I now come to another point. How do the above considerations bear upon hydrogen with its atomic weight of 1? Of this hydrogen we know nothing spectroscopically. There is evidence that it is broken up into something which gives the complicated structure spectrum with hundreds of lines not yet sorted into series, again into the one series seen in our laboratories and in the cooler stars, still again into two other forms we cannot get here.

Let us apply the statistical method we employed in the case of oxygen.

In the region included in these inquiries the number of hydrogen lines in the three series referred to is 17. Hasselberg has measured 454 lines in the structure spectrum between λλ 642 and 441. Now if this spectrum is built up of series similar to those observed at the highest temperatures, we must have more (seeing that Hasselberg's work was limited) than $\frac{454}{17} = \pm 27$ series or 9 sets of 3 each. We deal then altogether with 12 depolymerisations.

But to be on the safe side, let us assume 6 on the ground that the lines in the series may be more numerous, and that some of Hasselberg's lines may be due to flutings. It will be clear that the masses or "atomic weights" we arrive at must be very small. Here is the story:—

Spectrum.	Where existent.	Series, &c.		Mass.
Line spectrum ...	Celestial	Principal	...	·0019
		Subordinate	...	·0039
	Terrestrial	Subordinate	...	·0078
Fluted spectrum	Set B Terrestrial	Principal	...	·0156
		Subordinate	...	·0312
		Subordinate	...	·0625
	Set A Terrestrial	Principal	...	·125
		Subordinate	...	·25
		Subordinate	...	·5
Continuous spectrum...	...	Hydrogen weighed in the cold	...	1·

Such a conclusion as this, and therefore the reasoning which has led up to it, must stand or fall according as science knows anything of such masses.

I shall show subsequently that, thanks to the investigations of Prof. J. J. Thomson, science is beginning to know a great deal of such masses, and the result of this work may therefore favour the view that polymerisation is a *vera causa* for molecular complexity, at all events in the cases of elements of low atomic weight.

Let us then consider the case of those elements the atomic weight of which is greater. In the first stages of evolution, in which we deal with substances of relatively low atomic weight, the stellar evidence supplies us with definite landmarks, and these are definite because the spectra of the hottest stars are not overcrowded with lines. After we have passed the gaseous and proto-metallic stages, however, we find the spectra full of lines which we see at the temperature of the arc, and metals of relatively high atomic weight and melting point are involved; the exact sequences are naturally more difficult to follow, and therefore the *method* of evolution may escape us.

Kayser and Runge have shown that the melting point has a profound influence on the "series" conditions. Those with the highest melting-points, such as barium and gold, present us with no series. There is generally such a flood of lines that it has been so far impossible to disentangle them; we have the "structure spectrum" of hydrogen repeated in these metals at arc temperatures in the so-called "arc spectrum."

NORMAN LOCKYER.

(To be continued.)

TESTIMONIAL TO MAJOR-GENERAL SIR J. F. D. DONNELLY, K.C.B.

AT a meeting in the Lecture Theatre of the Victoria and Albert Museum on Wednesday, November 29, which was very numerously attended by members of the present and past staff of the Department, and by men of science and artists who have been connected with it, Sir John Gorst presented, on the behalf of some five hundred subscribers, the testimonial to Sir John Donnelly.

This consisted of a silver salver, a set of library furniture, a collection of books of reference, a Zeiss binocular, and a diamond brooch for Lady Donnelly, and the inscription on the salver stated that it was in recognition of their high regard and in remembrance of their cordial relations of more than forty years.

Sir John Gorst, in presenting the testimonial, said: Ladies and gentlemen—I have been invited this afternoon to perform one of the most pleasant duties that has fallen to my lot since I have had the honour of being Vice-President of the Committee of Council on Education. It is to present, in the name of the gentlemen who have been employed at South Kensington as colleagues of Sir John Donnelly, a memento of the long period of public service which he has performed in this place, and a testimonial of the affection and sympathy with which he is regarded by the gentlemen who have been his colleagues.

I have myself been a colleague of Sir John Donnelly for about four years, and speaking of my own personal experience, I can only say that I have received from him, upon all occasions, the most loyal co-operation, which has been enhanced by a very strong personal friendship.

I had an opportunity about three years ago of seeing an attack, made ostensibly on the department of which he was the head, but which really had a considerable amount of personal animus in it.

There was an inquiry by a Committee of the House of Commons, in which Sir John Donnelly was virtually put upon his trial, and I can only say that, in the opinion of his official chiefs—the Duke of Devonshire's opinion was the same as my own—from that inquiry Sir John Donnelly emerged with the conclusion, in the minds of those who have read the evidence, that he had been a most loyal servant of the Department, that there were no allegations made against him which could be substantiated, that his administration of the Department had deserved the approbation of the country, and that the insinuations made against him were absolutely baseless.

Sir John Donnelly had served the department for upwards of forty years, and the testimonial, of which you have been good enough to ask through me his acceptance, is before you on the table. There is one point about it which deserves special allusion on my part. Among the objects which Sir John Donnelly has been asked to accept is a binocular, and, I think, you will be interested to know that that binocular is entirely the gift of the junior staff of the Department. It has been subscribed for by 150 persons, comprising stokers, ex-policemen, labourers, boys, and those who form quite the bottom of this great Department. I think the value of this gift—which shows the estimation in which he was held by this very important but not very wealthy class of the public service—will be to him as much as any of the more costly gifts. I am also asked, at the same time, to present a diamond brooch to Lady Donnelly, and I am sure that it will be extremely gratifying to Sir John Donnelly to know that the estimation in which he has been held by this Department has been shared by Lady Donnelly. In the name of the employés of the Department of Science and Art I beg your acceptance, and Lady Donnelly's acceptance, of these testimonials.

Sir John Donnelly and Lady Donnelly made suitable replies.

It has been arranged to entertain Sir John Donnelly at dinner at the Victoria Room, Criterion, on Tuesday next, December 12. Many representatives of science and art, who are or have been connected with the Department and its affiliated Institutions, will be present as a recognition of the valuable services he has rendered.

THE NOVEMBER METEORS.

IN nearly all the accounts of the observations of the Leonids the same result is recorded, namely, the apparent dearth of these bodies. It is true that unfavourable weather conditions were experienced in many localities; but even taking this fact into account, it may be safely said that the expected shower did not arrive in anything like the density it was expected, at any rate during the nights in which watches were kept.

In a previous number of this journal (vol. lxi. p. 81) many communications were published describing, for the main part, observations made in the British Isles. Several accounts of other observations have recently come to hand, and the following brief summary shows that the result of these watches did not differ very much from that mentioned above.

Paris was evidently blessed with more favourable weather conditions than London. In the first balloon ascent, on the morning of November 14–15, the following number of Leonids was seen:—

	h. m.		h.			
From	1 45	to	2	...	2	Leonids.
,,	2	,,	3	...	13	,,
,,	3	,,	4	...	10	,,
,,	4	,,	5	...	26	,,
,,	5	,,	6	...	40	,,

Of these 19 were of the first magnitude, 43 of the second, 29 of the third, and 9 of the fourth. It is further stated that this number would probably have been considerably increased if the moon had been absent.

At the second ascent, on the night of November 15–16, in a watch from 1h. 20m. a.m. to 6 a.m., only 8 Leonids were observed. M. Bailland, at the Observatory of Toulouse, observed from 1–6 a.m., on the morning of the 16th, and only saw 43 Leonids in that long watch. M. Deslandres, at Paris, who had made great photographic preparations, was no more fortunate than the British observers.

From Strasbourg we learn that on the morning of the 15th many Leonids were seen; the maximum number occurred about six o'clock, when the rate reached sixty per hour. This seems to be the greatest number per hour this year recorded, and is in harmony with the observations made at the first balloon ascent referred to above.

The above accounts corroborate the statement that night observations made in different parts of the world have failed to record a *great* shower. If the earth did not actually pass through the dense part of the swarm in the daytime at some place, then we must conclude that the actions of some of the planets have so perturbed the orbit of the meteors that this year we have only skirted the outlying portion of the stream.

Two accounts of "daylight" observations of the Leonids have come to hand, and for one of these we must thank Prof. N. Story Maskelyne, who, when he heard of them, requested a written statement of the display from each of the spectators, asking them to describe in simple words what they were quite certain they saw.

The place of observation was Little Hinton, Wanborough, Swindon, Wilts, a village about 400 feet above sea-level, and a mile or so from the old Roman road from

Cricklade to Newbury; to the east of that road where it traverses Wanborough (a few miles east of Swindon).

The observers, whose descriptions are given below, were Miss May Jeans, aged eighteen; Mr. Purcell Jeans, aged sixteen; and Miss Emily Swayne.

Miss Jeans' description is as follows:—

"*November* 22.—Last Wednesday afternoon, November 15, as I was lying down in an easy chair, looking out of a window facing north, and was not thinking of seeing the meteors, but suddenly I noticed them. Immediately I called Miss Swayne to come and look and see if she could also see them. We then went out of doors to look at them; the air seemed full of them, both large and small meteors. There was a thick mist at the time, which cleared off after the shower was over. The element seemed alive with them; small ones were on the background, and larger ones suddenly appearing and shooting across the sky. The shower lasted about an hour. It was half-past one o'clock when first I noticed them. Just before half-past two, my brother, Purcell Jeans, came in from a walk, and I called him to see them. They were nearly over then. We also called Mrs. Prismall of this village, our washerwoman. They were like silver balls shooting about everywhere, shining brightly, more like a very starlight night; only the stars, instead of being a gold colour, were silver, and every star shooting in all directions. It is so difficult to describe, as I have never seen anything like it before."

Mr. Purcell Jeans writes:—

"When I came back from a walk, on Wednesday, about a quarter-past two o'clock, Miss Swayne told me to come and look at the Leonids, which I did. They were nearly over then, but the elements seemed full of them. I went indoors for a few minutes, and when I came out there was nothing more to be seen of them. There was a mist prevailing at the time, which we thought must have been the cause of our being able to see them. I was very much surprised at the sight, as I never thought it possible to see stars in the daylight. They looked like a lot of little silver balls floating about, and apparently falling to the earth."

Miss Emily Swayne's description of the shower is as follows:—

"I had just come indoors, on Wednesday last, November 15, at half-past one o'clock, and remarked to the washerwoman what a peculiar feeling there was in the air, as if we should have snow, and yet it did not feel cold enough. Almost as I finished speaking Miss Jeans called me. I found her sitting in an armchair quite close to the window. She exclaimed, 'Come and see. I believe I can see stars.'

"I thought it impossible, and would not believe it, but I looked, and certainly saw what appeared to be stars. We then went out, calling the washerwoman to come with us.

"I was facing the north. The air seemed filled all round me with little floating silver balls, which apparently fell from the sky, and on looking right up I saw what seemed to be large shooting stars, all starting from one point, some going east and others west; some leaving longer lines of light behind them than others. I thought it a very wonderful sight, and have never seen anything at all like it before."

The above descriptions give a fairly good account of a meteor shower seen during the daytime, and it will be interesting to hear if any other people in that neighbourhood noticed anything on that date.

The second communication hails from Aveley, in Essex, and the correspondent, Mr. E. Shaw, writes as follows:—

"We observed what appeared to be the meteor shower yesterday (Wednesday, November 15) afternoon between the hours of three and half-past four, resembling a shower of snow, only they were stars, working in and out and round about. We are not mistaken, for two persons in my house saw them."

Considering the accounts of these "daylight" observations in conjunction with those made at Paris and Strasbourg, there seems to be a certain amount of continuity between them.

At both the latter places the shower had every appearance, judging by the numbers of meteors observed, of increasing in intensity as the morning of the Wednesday wore on, and there seems no reason why the actual maximum should not have occurred about mid-day on the same day, and thus escaped more general notice. At the time of the observations made at Little Hinton, the constellation of Leo was already well below the horizon, so that the shower should also have been seen from some place during the night time. As no news of any such display having been seen has come to hand, these observations therefore receive no corroboration. Miss Swayne's statement that the shooting stars were "all starting from one point, some going east and others west," shows that they could not have been Leonids in any case. The observations are, however, worth recording, but that they refer to the Leonids is very much open to doubt.

The Andromedes.—This swarm of meteors, which follows the Leonids somewhat closely as regards the time of year, seems to have been seen by several observers.

From America we learn that Prof. Young, at Princeton, on the night of November 24, saw forty-two Andromedes and secured several photographs, but the period of observation is not stated. Mr. E. C. Willis, of Norwich, made many observations on the same night, and these are given below:—

November 24.

Time.	Meteors seen.		Remarks.
	Andromedes.	Others.	
10.0 –10.15	20	1	Fine.
10.15–10.30	9	2	Fine, but some cloud.
10.30–10 45	4	2	Fine.
10.45–11.0	6	2	Fine.
11.0 –11.15	9	2	Fine.
11.15–11.25	4	1	Partly clouded, moon just risen.

Before 10h. no systematic watch was made, but if the meteors had been exceptionally abundant, they would have been noticed.

11h. 30m.–16h. 45m. Sky entirely overcast.

16h. 45m.–17h. 15m. Slight breaks in the cloud, but no meteors seen.

W. J. S. Lockyer.

FERDINAND TIEMANN.

Chemists will learn with regret of the death of Prof. Ferdinand Tiemann, which occurred at Meran, of heart disease, on November 17.

Johann Carl Wilhelm Ferdinand Tiemann was born at Rübeland in 1848. He graduated as Ph.D. at Göttingen in 1870, and afterwards held the post of demonstrator under Hofmann in Berlin, in whose laboratory most of his researches were carried out, frequently in collaboration with students and pupils. In 1882 he was appointed professor of chemistry in the University of Berlin, and in the following year he succeeded Wichelhaus as editor of the Reports of the German Chemical Society, a post which he resigned in 1897.

Tiemann's best known researches deal with the constitution of odoriferous principles. In 1874 he showed that the glucoside coniferin, which occurs in the sap of coniferous trees, could be hydrolysed by emulsin into glucose and coniferylic alcohol, and that the latter compound, when oxidised, yielded vanillin, identical with the odoriferous principle of vanilla. A manufactory was established at Holzminden under the direction of his pupils, Haarmann and Reimer, both of whom had been associated with him in his researches on vanillin, and the commercial production of this substance from the cambium of the larch became an accomplished fact. But Tiemann was not content with this merely material success; in a masterly series of researches, the constitution of vanillin and various allied naturally-occurring compounds — the protocatechuic series—was established. Fresh syntheses of vanillin—from eugenol and from guaiacol—were also discovered.

In 1893 he published, along with Krüger, his well-known paper "On the Aroma of the Violet." It was, however, the aroma rather of the iris root or orris root (with which that of the violet may or may not be identical) that he investigated. The quantity of the odoriferous principle contained in iris root is so infinitesimal, and that of the root to be extracted, consequently, so large, that, as he states, the resources of a mere scientific laboratory proved unequal to the task, and this preliminary part of the investigation had to be carried out in the works at Holzminden. The substance thus isolated was thoroughly investigated and its constitution established. In order to indicate its origin and, at the same time, its ketonic constitution, he termed it *irone*. His attempt to synthesise it was not, from the point of view of the pure chemist, successful, although for the manufacturing chemist it was of the utmost value. Starting with citral, obtained from oil of lemons or from lemon-grass oil, he condensed this substance with acetone, converting it into a compound which he termed pseudo-ionone; this, when treated with dilute sulphuric acid, yielded ionone, isomeric—not identical—with irone, but so closely resembling it in smell that very few people can detect the difference. For the purposes of the perfumer, therefore, ionone is every whit as good as irone. It is now manufactured, and the value of the process to the patentees may be judged of from the attempts that have been made to evade or to invalidate the patent—attempts that have been foiled in courts of law both in this country and in Germany.

Amongst Tiemann's numerous other researches may be mentioned his work on the terpenes, on camphor, and on the synthesis of amido-acids.

He was a brother-in-law of the late A. W. von Hofmann.

NOTES.

AT a general monthly meeting of the members of the Royal Institution, held on Monday, the following letter from the Clerk of the Goldsmiths' Company, Sir Walter S. Prideaux, was read:—"I am directed to inform you that the attention of the Court of the Goldsmiths' Company having been drawn to the fact that the Royal Institution of Great Britain has lately celebrated its centenary, they have, in order to mark their sense of the importance of that event, been pleased to make to the Institution the further grant of 1000*l.*, for the continuation and development of original research, and especially for the prosecution of further investigations of the properties of matter at temperatures approaching that of the absolute zero of temperature. I enclose a cheque for this amount, and I shall feel obliged to you to acknowledge the receipt." The following resolution, proposed by the Lord Chancellor, and seconded by Sir A. Noble, was then passed:—"That the members of the Royal Institution of Great Britain, in general meeting assembled, having been informed that the Court of the Goldsmiths' Company have made a donation of 1000*l.* to the funds of the Royal Institution in commemoration of its centenary, and in aid of the investigations which are being carried on in its laboratories into the properties of matter at low temperatures, desire to express to the Court their profound and grateful appreciation of this second munificent manifestation of their practical interest in the work of the Institution—a manifestation which has been made on this occasion at once reminiscent of past services to science and prescient of services yet to come."

THE Dover Town Council has received a letter from the President of the French Association for the Advancement of Science, enclosing a handsome silver medal, presented to the municipality in commemoration of the Association's visit to the town in September last. The Mayor, Sir William Crundall, said the medal would be placed with the corporation plate. It was decided to make a grateful acknowledgment of the gift.

DR. T. E. THORPE, F.R.S., has been appointed to succeed the late Sir Edward Frankland in the work of analysing the water supplied by the London water companies.

THE death is announced of Dr. Birch-Hirschfeld, professor of pathology in the University of Leipzig, at the age of fifty-seven. Prof. Birch-Hirschfeld was one of the most distinguished pathologists in Germany.

THE *British Medical Journal* states that a State Institute of Serumtherapy, Vaccination, and Bacteriology, to bear the name of Alfonso XIII., has been created in Madrid. The new institute is organised on the lines of the Institut Pasteur.

AN International Congress of Mining and Metallurgy will be held in Paris on June 18–23 next year. The congress, like that of 1889, will be under the direct patronage of the French Government. In the provisional programme the following subjects are down for discussion:—Mining: use of explosives in mines; use of electricity in mines; mining at great depths; labour-saving methods as applied to mining. Metallurgy: progress in the metallurgy of iron and steel since 1889; application of electricity to metallurgy—(*a*) chemical, and (*b*) mechanical; progress in the metallurgy of gold; recent improvements in the dressing of minerals. The general secretary is M. Gruner, rue de Châteaudun, 55 Paris.

A COURSE of twelve demonstrations will be given in the psychological laboratory of University College during the Lent Term, commencing on January 19, 1900, by Mr. W. McDougall, Fellow of St. John's College, Cambridge. The Class will meet once a week on the day and at the hour that are found to be most convenient to the majority of the students. The methods of investigating experimentally all the chief types of elementary mental process will be demonstrated, and the students will be afforded opportunities to practise the methods. The subjects will include the several aspects of skin-sensibility and the "muscular sense"; the colour sense, visual distance and optical illusions; appreciation of tone-intervals and localisation of sound; sensibility to pain; simple measurements of memory; estimation of periods of time, &c. Students should send in their names to Mr. McDougall, St. John's College, Cambridge, before Tuesday, January 16, 1900, when the Term begins.

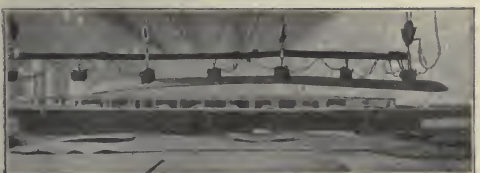
IN the early part of last week a "Bottlenose" whale was reported to have stranded on the river-bank at North Woolwich. The animal was a female, and on Wednesday, November 29, it was delivered, some time after death, of two young. On Friday a visit was made to Woolwich to see if either of the specimens were required for the Natural History Museum. That morning the carcase of the mother had, however, been towed out to sea by the sanitary authorities; but the body of a young one (which measured sixteen feet in length) was on view in front of the station, where it had attracted crowds the previous day. A glance showed that, instead of being a "Bottlenose," it was a "Finner" or Rorqual; and, since the mother was stated to have measured over sixty feet in length, there could be no doubt that it was the common species (*Balaenoptera musculus*), of which there is now a life-sized half-model in the Natural

History Museum. The young one differed from the adult in that the under-surface of the body was flesh-coloured instead of white.

WE learn from a German contemporary that a complete horn—that is to say, both the horn-core and its sheath—of the Avrochs or extinct European Wild Ox (*Bos taurus primigenius*) was disinterred some years since from a peat-bog at Treten, in Pomerania, and is now preserved in the zoological museum of the high school. The specimen has been examined by Dr. A. Nehring, of Berlin, who pronounces it to be about 300 years old; it is only in peat, or in an extremely dry cave, that the conservation of horn would be possible for such a lengthened period.

OWING to the frequent settlement of the land in the salt districts it has always been found a difficult matter to maintain in proper order bridges and other similar structures. To meet this difficulty the engineer of the Weaver Navigation, in constructing two new swing bridges over the river at Northwich, has so designed these that, instead of resting on the land, the weight of the bridges is carried on steel pontoons floating in the water, and the bridges are therefore independent of any settlement of the land so far as their foundations are concerned, and they are so built as to be easily adjusted to any settlement of the ground at the two ends. These bridges also are opened and closed by electric power, being the first to be so operated in this country. The two bridges have cost 25,000*l*.

AN interesting use of electro-magnets in steel works is referred to in the *Electrical Review*. It appears that in the works of the Illinois Steel Company, which makes very extensive use of electric power for all the purposes of steel manufacture, electro-magnetic cranes are used to carry plates from the rolls to the shears. A long plate being conveyed in this manner is shown in the accompanying illustration.



Electro-magnets carrying a steel plate.

MONSIEUR CHARLES JANET, President of the Zoological Society of France, has for some years been engaged in investigating the minute anatomical structure of ants, wasps, and bees. The results of his investigations are published at intervals under the title of "Études sur les Formis, les Guêpes, et les Abeilles"; and of these we have just received Nos. 17, 18, and 19, the last published in the *Mémoires* of the French Zoological Society for 1898. All these treat of the anatomy of different portions of the body of the Red Ant (*Myrmica rufa*). Another memoir, on the cephalic nerves of the latter insect, appears in the journal last mentioned for 1899, although not under the same general title. The work being of an extremely technical nature, its details cannot be described in a note; but we may observe that these are worth the best attention of all students of insect morphology. The illustrations alone serve to indicate the extreme care and labour that the author has devoted to his subject, the elaboration of detail being little short of marvellous.

WE learn from the *Scientific American* that the Naval Board appointed to inspect and report on the performance of the *Holland* submarine boat has reported that in the recent tests, held on November 6, in New York Harbour, she fulfilled all the requirements laid down by the Department. These requirements were that she should have three torpedoes in place in the boat, she should have all arrangements for charging torpedoes without delay, and that she should be prepared to fire a torpedo at full speed both when submerged and at the surface. Lastly, the *Holland* was to make a run for two miles under water, starting from one buoy, running submerged for a mile to a second buoy, rising to discharge a torpedo at a mark near the second buoy, and then, after diving again return submerged to the starting point. In his report Chief Engineer John Lowe, U.S.N., who was specially ordered to observe and report the preliminary trial, says: "I report my belief, after full examination, that the *Holland* is a successful and veritable submarine torpedo boat, capable of making a veritable attack upon the enemy unseen and undetectable, and that therefore she is an engine of warfare of terrible potency which the Government must necessarily adopt into its service."

THE November number of the *Journal* of the Franklin Institute contains several of the addresses delivered on the occasion of the recent celebration of the seventy-fifth anniversary of the Institute. Dr. J. W. Richards, president of the chemical section, which is the oldest of the sections, inaugurated the proceedings of the commemorative week with an address in which he showed that the Institute has always stood for the happy combination of theory and practice—the union of pure and applied science. Mr. H. W. Wiley gave an address on the relation of chemistry to the advancement of the arts. The following remark illustrates the dominant influence of chemical science in one direction: "The agricultural experiment stations of the United States which have been directed by chemists, have taken such a leading position in the development of agricultural science as to practically monopolise all those investigations which have been most useful to agriculture throughout the country." Dr. E. J. Houston gave an account of the position of electrical science at the time of the birth of the Institute, in 1824, and showed that the Institute has exerted a marked influence on the extension and application of electricity by its great international exhibition of 1824, and through other means. Mr. R. W. Pope gave an address on a similar theme, namely, the influence of technical societies in promoting the progress of the arts. All the addresses in the *Journal* are of interest in connection with the subject of the bearing of science upon industry.

THE current number of the *Lancet* contains an article of particular interest dealing with the effects upon the wounded of the Mark II., the Mauser, the Dum-dum, and the Mark IV. bullets. The article, which has been written by Dr. Arthur Keith and Mr. Hugh Rigby, gives a clear idea of the relative amount of destruction caused by each of these modern military bullets, and the experiments upon which the writers' views are founded, confirm fully the experiences which have already been reported from the seat of war in South Africa. A glance at the illustrations shows the terrible havoc wrought by the Mark IV. and Dum-dum bullets and shows also that the old Martini-Henry bullet made an enormous and jagged wound compared with the neat little track that is left behind the Mark II., which our forces are using in South Africa, or the Mauser which is being used by the Boers. Dr. Keith and Mr. Rigby have not, however, been able to obtain results in their experiments with Dum-dum bullets that endorse Prof. von Bruns's statement of the case against the English open-nosed bullet. All open-nosed bullets cause fearful injuries, but it is contended that Prof. von Bruns must have used Dum-dum bullets of an exceptional nature to get the results which he recorded.

DR. F. A. COOK, who recently returned with the *Belgica* expedition, contributes to the December number of *Scribner's Magazine* an interesting article, accompanied by a number of illustrations reproduced from photographs, on the possibilities of Antarctic exploration. He shows that important results of immediate practical use to both science and commerce are likely to be obtained by Antarctic exploration. Referring to the need for exploration merely from a geographical point of view, Dr. Cook remarks:—"The actual existence of a land corresponding to what is charted as Graham Land is a matter of considerable doubt. On the map it extends from the sixty-ninth parallel of latitude, northward four hundred miles. But Alexander I. Land, the southern termination, is an island, and we saw no land eastward. The character of the land which may or may not exist between this and the newly-discovered Belgica Strait is in doubt. It offers scientific and commercial prospects promised by no other new polar region. At the one hundredth degree of east longitude, close to the circle, there is another interruption in the unknown. This is the much disputed Wilkes Land. It is by far the largest land mass in the entire Antarctic area. Including Victoria Land, its better known eastern border, it covers more than one-sixth of the circumference of the globe. In a territory of this extent, even under the most hopeless spread of snow, would it not be strange if something of value and much of interest were not found? Enderby Land and Kemp Land furnish other problems. They are probably not fixed to the continent, for the American, Morrell, found open sea below them; but whether they are isolated islands or parts of an archipelago remains to be ascertained. Does Peter Island exist? The *Belgica* drifted close to the position assigned to it by Bellingshausen, but saw no land. These are but a few examples of the many geographical problems to be solved in the Far South."

IN the *Journal de Physique* for November, M. A.-B. Chauveau discusses the diurnal variations of atmospheric electricity, to explain which no less than about thirty different theories have been proposed, of which four appeared in a single year (1884). M. Chauveau's principal conclusions, based on a comparison of curves from the Bureau central, Batavia, Sodankylä (Finland) Trappes, the College de France, and Greenwich, are as follows:—(1) That the influence of the soil which is greatest in summer (and of which the principal factor probably is the evaporation of negatively electrified water from the surface of the earth) intervenes as a disturbing cause in the diurnal variation. (2) That the general law of variation is represented by a simple oscillation having a maximum in the day, and a minimum (moreover, remarkably constant) between 3.30 and 4.30 a.m.

FROM the *Bulletin* of the French Physical Society we learn that M. Sagnac has given a theory of the propagation of light through matter which supposes that the light waves are transmitted by the same ether as *in vacuo* without the properties of this medium being in any way altered by the presence of material particles; the only effect of these is to scatter the vibrations in the same manner as small conductors, each of which reflects and diffracts all vibrations of sufficiently great wave-length. The author shows that, without introducing any electromagnetical or dynamical considerations, it is possible to give a *purely kinematical* explanation of the laws of reflection and refraction, the existence of the optic layer, and the existence of refractive indices greater than unity. M. Sagnac shows how the optic phenomena of entrainment of ether by matter can be explained by his hypothesis without the assumption of either an ether denser than the ether of a vacuum or any mechanical reaction between the ether and matter. This kinematical theory of the entrainment of the ether presents no difficulties or complications in accounting for the existence of dispersion or double refraction; and M. Sagnac has extended the theory to the explanation of anomalous dispersion and to the investigation of certain new optic phenomena.

IN the year 1891 the Hydrographic Office of Vienna established an elaborate service of rainfall and river observations in all the principal river systems. The volumes for the year 1897 have just been published and contain results of rainfall observations for no less than 2615 stations, together with tables showing the general distribution of temperature in the Austrian Empire. The depth of snow is also regularly gauged at over 40 stations. The work is accompanied by numerous diagrams and by a general discussion of the results for each of the 14 districts into which the service is subdivided.

WE have received the *Boletin Mensual* of the Manila Observatory for the first quarter of the year 1898. It is satisfactory to note that observations have been regularly recorded at this important observatory, under the direction of the Jesuit Fathers, for the last thirty-three years. The present volume contains hourly and daily means of the principal meteorological and magnetical elements, together with maximum and minimum values for Manila, from self-recording instruments and eye observations made twice daily at a number of secondary stations in the Philippine Islands. It also contains a monthly discussion of the observations and of earthquake phenomena, with curves of the meterological and magnetical elements.

MESSRS. BAILLIÈRE, TINDALL AND CO. have published the fourth edition of "A Synopsis of the British Pharmacopœia," compiled by Mr. H. Wippell Gadd, with analytical notes and suggested standards by Mr. C. G. Moor.

MR. A. C. SEWARD reprints from the *Proceedings* of the Cambridge Philosophical Society a paper on the Binney collection of Coal-Measure plants, in which a new genus, *Megaloxylon*, is described, belonging to the Cyadofilices, and considered by the author as furnishing an additional link between the Palæozoic representatives of this family and recent ferns. The paper is copiously illustrated.

THE sixth edition of M. Eric Gerard's "Leçons sur l'Électricité" has been published in two volumes by MM. Gauthier-Villars, Paris. The first volume deals with the general principles of electricity and magnetism, and the theory and construction of dynamo-electric machinery. The second volume is concerned with the most important industrial applications of electricity. The work has increased in size, and many new illustrations have been added.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*, ♀) from India, presented by Mr. J. A. Ewen, J.P.; a Brown Capuchin (*Cebus fatuellus*) from Guiana, presented by Mr. Douglas Mason; a Badger (*Meles taxus*), British, presented by Mr. G. A. Bronson; two Golden Agoutis (*Dasyprocta aguti*) from Central America, presented by Mr. C. Bevan; a White-bellied Sea Eagle (*Haliaëtus leucogaster*) from Tasmania, presented by Captain Francis Mayor; a Common Trout (*Salmo fario*), British fresh waters, presented by Mr. Arthur Irving; a Rufous Rat Kangaroo (*Æpyprymnus rufescens*, ♂) from New South Wales, two Ornamental Lorikeets (*Trichoglossus ornatus*) from Moluccas, a Banded Parrakeet (*Palaeornis fasciata*), four Starred Tortoises (*Testudo elegans*) from India, two Undulated Grass Parrakeets (*Melopsittacus undulatus*) from Australia, a Lapwing (*Vanellus vulgaris*, var.), four Bewick's Swans (*Cygnus bewicki*), European; two Wrinkled Terrapins (*Chrysemys scripta rugosa*) from the West Indies, two Emperor Boas (*Boa imperator*) from Central America, deposited.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN DECEMBER:—

December 9. 12h. 14m. Minimum of Algol (β Persei).
10–12. Epoch of Geminid meteoric shower (radiant 106° + 33°).
12. 9h. 3m. Minimum of Algol (β Persei).
15. 2h. 48m. to 3h. 34m. Occultation of the star κ^2 Tauri (mag. 5·5) by the moon.
15. 2h. 55m. to 3h. 27m. Occultation of the star κ^1 Tauri (mag. 4·6) by the moon.
15. 5h. 52m. Minimum of Algol (β Persei).
15. Venus. Illuminated portion of disc = 0·928.
15. Mars. Illuminated portion of disc = 0·998.
16. Partial eclipse of the moon.
11h. 45m. First contact with shadow.
13h. 26h. Middle of the eclipse.
15h. 7m. Last contact with shadow.
Magnitude of the eclipse = 0·995.
16. 15h. 36m. to 16h. 11m. Occultation of Neptune by the moon.
17. 5h. Neptune in opposition to the sun.
18. 18h. 31m. to 19h. 9m. Occultation of *f* Geminorum (mag. 5·2) by the moon.
20. Jupiter 9° W. of Mercury, on Dec. 24, 11°, and on Dec. 27, 14°.
21. Saturn. Outer minor axis outer ring = 15″·76.
21. 18h. 4m. Transit of Jupiter's Sat. III. Egress.
22. 17h. Mercury in conjunction with Uranus (Mercury 2° 17′ N.).
25. 1h. Mercury at greatest elongation (22° 5′ W.).
25. 14h. 39m. to 15h. 47m. Occultation of the star D.M. − 10°, 3570 (mag. 6) by the moon.
26. 16h. 22m. to 17h. 3m. Occultation of the star 83 Virginis (mag. 5·8) by the moon.
29. 7 a.m. Jupiter, 6° E. of the moon.
30. ,, ,, 8° W.N.W. of the moon.
31. ,, Mercury, 5° W.N.W. of the moon.

The red spot on Jupiter will be about central on Dec. 21, 7.44 a.m.; Dec. 26, 6.54 a.m., and Dec. 28, 8.33 a.m.

MERCURY AND JUPITER AS MORNING STARS.—In the dark mornings of December it is almost as convenient for amateurs to effect observations of celestial objects as it is in the evening hours. It may therefore be of interest to mention that at about Christmas time Mercury and Jupiter will be favourably visible above the S.E. horizon just before sunrise, and that the crescent of the moon will be placed near these planets on the last three mornings of 1899. The following are the times of rising of Jupiter, Mercury and the sun on thirteen days:—

	♃ rises. h. m.	☿ rises. h. m.	☉ rises. h. m.
Dec. 18	5 36 a.m.	6 7 a.m.	8 3 a.m.
19	5 33	6 6	8 4
20	5 30	6 5	8 4
21	5 27	6 5	8 5
22	5 24	6 6	8 5
23	5 21	6 8	8 6
24	5 19	6 9	8 6
25	5 16	6 11	8 7
26	5 13	6 12	8 7
27	5 10	6 14	8 7
28	5 8	6 17	8 8
29	5 5	6 20	8 8
30	5 2	6 24	8 8

HOLMES' COMET (1899 *d*).

Ephemeris for 12h. Greenwich Mean Time.

1899.	R.A. h. m. s.	Decl. ° ′ ″
Dec. 7	2 5 48·62	+45 44 16·0
8	5 30·45	35 24·2
9	5 14·52	26 31·2
10	5 0·82	17 37·6
11	4 49·35	45 8 43·8
12	4 40·08	44 59 50·6
13	4 32·99	44 50 58·3
14	4 28·08	+44 42 7·4

COMET GIACOBINI (1899 *e*).

Ephemeris for 12h. Berlin Mean Time.

1899.	R.A. h. m. s.	Decl. ° ′	Br.
Dec. 7	18 16 7	+14 13·0	
8	17 50	14 30·4	0·42
9	19 33	14 47·8	
10	21 17	15 5·4	0·41
11	23 0	15 23·0	
12	24 44	15 40·7	0·40
13	26 29	15 58·5	
14	18 28 13	+16 16·4	

SPECTRUM OF P. CYGNI.—Herr A. Belopolsky has recently obtained several photographs of the spectrum of the variable star P Cygni (mag. 5), and states the results of his measurements in the *Astronomische Nachrichten* (Bd. 150, No. 3603). The instrument used was the two-prism spectrograph (camera 25 cm. long) attached to the 30-inch refractor of the Pulkowa Observatory. Both bright and dark lines are given, and it is noted that while the *bright* lines generally occupy a normal position, the *dark* lines are displaced towards the violet or more refrangible end of the spectrum. It is also interesting to note that several of the lines found are ascribed to nitrogen. The following table gives the wave-lengths of the lines in the star's spectrum with their probable origins:—

Bright Lines.	Dark Lines.	Wave Length Rowland, Runge, Neovius.	Origin.
4861·6	4858·2	4861·5	Hβ
4713·5	4711·0	4713·3	Helium
—	4648·3	4651·0	N
—	4640·8	{4643·4 / 4640·5}	N
4631·5	4629·2	4630·9	N
—	4620·3	4622·0	N
—	4606·2	4607·2	N
4601·9	—	4601·3	N
—	4561·7	—	?
—	4551·7	—	?
4472·1	4469·6	4471·8	Helium
4420·1	—	—	?
4396·1	—	—	?
—	4386·7	4388·1	Helium
4345·7	4344·8	—	?
4340·8	4338·1	4340·7	Hγ

ANNIVERSARY MEETING OF THE ROYAL SOCIETY.

FOLLOWING the usual custom, the anniversary meeting of the Royal Society was held in the apartments of the Society at Burlington House on St. Andrew's Day, November 30. The auditors of the Treasurer's accounts read their report, and the Secretary read the list of Fellows elected and deceased since the last anniversary. The President, in his anniversary address, referred to M. Haffkine's experience and views regarding preventive inoculation, and then proceeded to the award of the medals.

COPLEY MEDAL.

The Copley Medal is conferred upon Lord Rayleigh for his splendid services to Physics.

Lord Rayleigh's investigations have increased our knowledge of almost every department of physical science, covering the experimental as well as the mathematical parts of the subject. Acoustics, optics, electricity, and magnetism, the molecular theory of the constitution of bodies, the theory of elasticity, the composition of the atmosphere, are but a selection from the subjects of his investigations. In acoustics he has added to our knowledge of resonance (the subject of his first paper in the *Philosophical Transactions*), the behaviour of singing flames, the vibrations of jets, the general theory of the vibrations of dynamical systems, while his masterly "Theory of Sound" has thrown light on and given unity to the whole of the subject. In optics, his researches include the theory of the scattering of light by small particles, with its application to the explanation of the blue of the sky, anomalous dispersion, the nature of white light, reflection from crystals, and the general theory of optical instruments. In electricity and magnetism, in addition to theoretical investigations of great importance on the distribution of alternating currents in conductors, he has made, in co-operation with Mrs. Sidgwick, those classical investigations of the value of the ohm in absolute measure, the electromotive force of the Clark cell, the electrochemical equivalent of silver, and the specific resistance of mercury. His researches on the theory of elasticity are valued by all students of mathematical physics. In his researches on the density of gases he met with small discrepancies between the density of nitrogen derived from the air and that derived from chemical compounds. Investigations into the cause of this discrepancy, followed up with wonderful skill and perseverance, led to the discovery of a new element (argon) existing in large quantities in the atmosphere, and possessing qualities of a very novel and remarkable kind. Lord Rayleigh's researches, from the range of subjects they cover, their abundance and their importance, have rarely been paralleled in the history of physical science.

ROYAL MEDALS.

One of the Royal Medals is conferred upon Prof. G. F. Fitzgerald, for his brilliant contributions to Physics.

A foremost position has been occupied by Prof. G. F. Fitzgerald during the last twenty years in the domain of Radiation and Electrical Theory. At the time when very few people had definite notions of the changed aspects which these subjects had assumed after Maxwell's theoretical advances, he was prominent as an expositor and developer of the new views. Thus his paper on "Electromagnetic Effects due to the Motion of the Earth" (*Trans. Roy. Dub. Soc.*, May 1882) was, perhaps, the earliest explicit effort to bring the facts regarding the astronomical aberration of light and general optical knowledge as to the relation of the æther to moving matter, into relation to electrical theory. Enough was there established, in both the optical and the purely electrodynamic domain, to show that no fundamental discrepancy was to be anticipated in the new point of view. Again, his paper "On the Quantity of Energy transferred to the Æther by a Variable Current" (*loc. cit.* November 1883), forms probably the earliest investigation of the field of an electric radiator. The case explored is that of a uniform current of periodically varying intensity; but the historical significance of the investigation is not impaired by the circumstance that subsequent research has transferred the source of actual radiation to the oscillations of the ions in the molecule. Already, in the preceding year, reflecting that crucial evidence with regard to the new standpoint of Maxwell was probably to be sought only in the domain of radiation, he had pointed to the oscillatory electric discharge in a condenser as a means of obtaining actual electric radiation, if only the period of the oscillations could be sufficiently reduced. Reference may also be made to the paper "On a Model illustrating the Properties of the Æther" (*Proc. Roy. Dub. Soc.*, January 1885), which has been widely useful, owing to the very simple manner in which the model—which is on the principle of Maxwell's own idle-wheel representation—visualises a large range of relations of the æther that had previously been amenable only to abstruse mathematical representation.

At an earlier period, Prof. Fitzgerald was occupied with magneto-optic phenomena, particularly with the theoretical bearing of Dr. Kerr's then recent discovery of the peculiarity in the reflection of light from a magnetised substance. That subject is considered at length, with restrictions, however, to transparent media in the analysis, in the latter half of the memoir, "On the Electromagnetic Theory of the Reflection and Refraction of Light" (*Phil. Trans.*, 1879). But the main interest of this memoir consists, perhaps, in the dynamical formulation of the electric theory of light on the basis of the Principle of Least Action, and in the comparison of that theory with the optical work of the author's countryman, MacCullagh. He has thereby contributed to a broader appreciation of that writer's position, and has shown that his theory of light, which was reached inductively along purely optical lines, runs parallel, and is, in fact, identical with the theory of Maxwell which presented itself in the course of a far wider induction originating in the domain of electrodynamics. The remark with which this memoir concludes, as to the advantage of "emancipating our minds from the thraldom of a material æther," has not, perhaps, yet lost all its force.

Not the least of Prof. Fitzgerald's services has been his success in guiding and energising an Irish School of Natural Philosophy. His efforts, and those of his pupils, have had a prominent share in the development and illustration in this country of the phenomena of electric radiation. Thus, in 1889, he was engaged, with Mr. F. T. Trouton, in verifying the laws of polarisation, by reflection, for Hertzian radiation; in 1890, he brought forward a new means of detecting such radiation by a galvanometer inserted across the spark-gap; in 1892 he returns to the problem of practical electric vibrators by a series of suggestions as to ways in which a continuous vibration of the requisite high frequency might possibly be established. He has experimented, with Dr. Trouton, in 1896, on the scattering of Röntgen radiation in passing through paraffin; and, along with Mr. W. E. Wilson, he has conducted a research on the effect of the pressure of the surrounding atmosphere on the temperature of the electric arc, which must have important bearings on the theory of radiation from solid bodies. He has also completed the work of Maxwell and Chrystal on Ohm's law of conduction by minutely testing its validity for the case of electrolytes.

More recently his efforts have contributed to the elucidation of the modifications impressed on the lines of a radiant spectrum, by change of pressure of the atmosphere surrounding the radiator, and by a field of magnetic force.

His critical activity pervades an unbounded field, enlivened and enriched throughout by the fruits of a luxuriant imagination.

The other Royal Medal is given to Prof. William Carmichael McIntosh for his very important labours as a zoologist.

Prof. McIntosh may be regarded as one of a distinguished succession of monographers of the British Fauna who, beginning with Edward Forbes, have during the last fifty years done work highly creditable to British Zoology.

McIntosh's great monograph of the British Annelids, published by the Ray Society, is still in progress. Two folio volumes appeared more than twenty years ago, a third is now in the press, and a final volume is contemplated. As a result of this work, and of numerous papers on the subject, McIntosh is justly regarded as the European authority on this group of animals. But his work has by no means been wholly that of a systematist. He is the author of one of the large and important *Challenger* Reports (that on the Polychæta), and of several minor reports of the same and other Government expeditions. His other papers extend over a wide range of subjects, and deal with many structural points. His name, moreover, is associated with the discovery or the description of several of the more remarkable or problematical of marine animals—such as *Pelonaia*, *Phoronis*, and *Cephalodiscus*.

Some of Prof. McIntosh's earlier papers were on fishes and their life history, and during the last ten or twelve years he has returned to that subject, and has added to the knowledge of our sea fisheries to a remarkable extent—both by observations anatomical and embryological (published in the *Trans. Roy. Soc. Edin.*), and in his book on British marine fishes, and by experiments on a large scale calculated to yield results of industrial importance.

Finally, Prof. McIntosh has been a notable teacher in Scotland, and many of those he has trained now occupy zoological posts and have conducted important researches. He is himself still a very active worker, both in his own investigations and in directing the researches of others. He was the first to found a marine biological station in this country, and the establishment of the present well-known Gatty Marine Laboratory at St. Andrews is entirely the outcome of his energy and influence.

DAVY MEDAL.

The Davy Medal is bestowed upon Edward Schunck for researches of very high importance in Organic Chemistry.

Edward Schunck is the author of a remarkable series of contributions to the chemistry of vegetable colouring matters, dating from 1841 up to the present time, and it is noteworthy that his first English paper appeared in the first volume of memoirs issued by the Chemical Society of London.

His earlier work includes two investigations which are everywhere regarded as classical, the one relating to the Madder plant, the other to the Indigo plant, from which the two most important dye-stuffs known to us are derived. In these, besides establishing the fact that the colouring matters are not present as such in the plant, but as glucosides, he brought to light much other information of importance in relation both to alizarin and indigo, and to allied substances with which they are associated.

In 1871, by his discovery of anthroplavic acid in artificial alizarin, he gave an important impetus to the further study of the dye products of the manufacture of this substance, and thus contributed to a development of the industry which soon became of the utmost consequence.

Of late years he has devoted himself to the study of the green colouring matter of plants, and has contributed a series of remarkable papers to the Royal Society on the "Chemistry of Chlorophyll." These deal with one of the most difficult and at the same time most interesting chapters in the whole range of organic chemistry; they are full of observations of fundamental importance, and will serve as a sure foundation for all future researches on the subject. For the first time Schunck has succeeded in obtaining well-defined crystal-like products bearing a close relationship to the natural substance. Nowhere is his remarkable skill as a manipulator, his extreme delicacy of touch, more apparent than in this his latest work.

The Society next proceeded to elect the officers and Council for the ensuing year. The list of Fellows recommended for election has already been given (p. 38), and the only change was the substitution of the name of the Right Hon. James Bryce, M.P., for that of Sir John Murray.

The following are some of the subjects dealt with in the Council's Report:—

ASSOCIATION OF ACADEMIES.

With reference to the proposal for an International Association of Scientific Academies, mentioned in the Council's last Report, letters have been received from the Académie des Sciences, the Lincei at Rome, and the Imperial Academy of Sciences at St. Petersburg, expressing their approval of the suggestion and their readiness to join such an organisation. A preliminary Conference was held at Wiesbaden on October 9, to which the two Secretaries, with Prof. Armstrong and Prof. Schuster, were appointed as delegates from the Royal Society (the Senior Secretary was, however, unable to attend). The Conference exhibited the most perfect accord in the desire to further the practical establishment of an Association for the purpose in view, and proposed a draft scheme for the organisation of the Association on the following lines:—

(1) The Association shall consist of a General Assembly and a Council.

(2) The General Assembly shall consist of delegates appointed by the constituent Academies, each Academy having the right to appoint as many delegates as it may think necessary. On matters of organisation, each Academy shall have but one vote. No Academy shall be bound to take part in enterprises approved by the Association.

(3) The Assembly shall meet once every three years, but under specified conditions the time of such meeting may be altered.

(4) The Assembly shall be divided into two sections, for Natural Science and for Literature and Philosophy respectively. These sections shall have the right of separate meeting. Decisions arrived at by them shall be reported to the General Assembly for information, and, in case the decisions affect both sections, for confirmation.

(5) In the interval between the meetings of the General Assembly, the affairs of the Association shall be managed by a Council, to which each Academy shall send one or two representatives according as it belongs to one or both sections. In either case each Academy will have but one vote. The Council will have a President and a Vice-President, who must belong to different sections.

INTERNATIONAL CATALOGUE OF SCIENTIFIC LITERATURE.

The Second International Conference, held in the Society's rooms in October, 1898, appointed a Provisional International Committee, which was to consider reports on various questions discussed at the Conference, to be obtained by the Delegates to the Conference from local committees in their several countries.

The Committee met in the Society's rooms on August 1–5, those present being Prof. Armstrong, Sir M. Foster, Prof. Klein, M. Köppen and Profs. Poincaré, Rücker, Schwalbe and Weiss.

At the close of a series of very arduous sittings, during which questions of great difficulty and delicacy were discussed, a Report was agreed to; and in accordance with the decision of the second Conference, this has been issued by the Royal Society to the various Governments concerned, and will in due course be considered by the Council of the Society.

It should be mentioned that it was agreed to recommend: "That an International Conference, to arrive at a final decision on all matters concerning the catalogue, be held at Eastertide, 1900."

NATIONAL PHYSICAL LABORATORY.

The questions of detail concerning the establishment of this Institution, mentioned in the Council's last Report, having been settled with H.M. Treasury, a scheme of organisation prepared by a Committee of the Council has been approved by the Lords Commissioners of the Treasury. Under this scheme the Kew Observatory Committee, as at present constituted, will cease to exist, and will be incorporated with the National Physical Laboratory, but six members of the Committee have been appointed to serve for a definite period on the Executive.

The ultimate control of the Laboratory will be placed in the hands of the President and Council of the Royal Society, and the income and all other property will be vested in the Royal Society. The Governing Body will consist of a General Board and an Executive Committee, the former composed of the Officers of the Royal Society, the Permanent Secretary of the Board of Trade, twenty-four nominees of the Council, and twelve members nominated by the Councils of the six leading technical Societies, viz. The Institution of Civil Engineers; the Institution of Mechanical Engineers; the Institution of Electrical Engineers; the Iron and Steel Institute; the Institution of Naval Architects; and the Society of Chemical Industry.

The Council, on the recommendation of the Executive Committee, have appointed Mr. R. T. Glazebrook, F.R.S., to the Directorship of the Laboratory, and he will assume the duties of that post on January 1, next year. In the meantime, a number of sub-committees have been appointed to advise the Executive with regard to important questions as to the nature of the work to be undertaken in the Laboratory. Upon their Reports must depend largely the decision which will be taken by the Executive with regard to the buildings for the Laboratory and their site, subjects which are engaging the earnest attention of the Committee.

PROTECTION OF ROYAL OBSERVATORIES.

The protection of Royal Observatories from the effects of magnetic influence, referred to in the Council's last Report, having received the attention of the Government, delegates were appointed at the invitation of the Treasury to represent the Council at a conference of the officers of that Department. After some discussion, a model clause has received the sanction of the Chairmen of the Committees of the Houses of Lords and Commons respectively, and has been introduced into the Bills which were passed during the last Session of Parliament, for electric railways or tramways in the neighbourhood of London.

Under this clause, any Government Department which desires protection against the electrical or magnetic disturbances produced by electric railways or tramways will be at liberty to appeal to the Board of Trade, which will have power to decide whether the return conductor shall be insulated, or what other precautions shall be adopted.

SCIENTIFIC ADVICE TO THE GOVERNMENT OF INDIA.

Early in the year a letter was received from the India Office relating to scientific inquiry in India, and stating that, when the question had arisen of devising a scheme of investigation, the responsibility of suggestions had usually fallen on officials who were not competent to give advice. The Government of India suggested that they should have the advantage of the advice of leading men of science in England, who would exercise a general control over researches instituted by the Government. Lord George Hamilton having inquired whether the Royal Society would be willing to meet the wishes of the Indian Government by assisting in this capacity, the Council decided to appoint a Standing Committee to give such advice as it can on matters connected with scientific inquiry in India. Since the researches on which such a Committee would be consulted would probably in most instances refer to biological matters, the Committee has been chosen chiefly from among the biological Fellows.

The Committee thus constituted has a parallel in the Indian Observatories Committee established at the request of the Government some time since, and mentioned in various Reports of the Council.

CHELSEA PHYSIC GARDEN.

Towards the end of last year the Council received from the Charity Commissioners a request for their views upon a scheme which, at the request of the Society of Apothecaries, the Commissioners had drawn up for the future government of the Chelsea Physic Garden, in the ownership of which the Royal Society had by the deed of grant of Sir Hans Sloane, a reversionary interest. The Council appointed a Committee to consider the Charity Commissioners' scheme, and this Committee having reported to the Council in favour of the scheme, with certain amendments which the Charity Commissioners expressed their willingness to adopt, the Council have concurred in the scheme, which provides for the maintenance of the Garden, under the Charitable Trusts Acts, for the purposes of botanical study, and gives to the Royal Society, among other Institutions, a representation upon the Committee of Management.

"PRIVILEGED" CANDIDATES FOR FELLOWSHIP.

The attention of the Council having been drawn to the regulations governing the election of Fellows under privileged conditions, a Committee was appointed early in the year to consider whether any alteration in them would be desirable. The Committee have duly reported, and, in accordance with their report, the Council have under consideration a modification of the Statutes, enabling the Council to recommend to the Society for election persons who either are Members of Her Majesty's Privy Council, or have rendered signal service to the cause of science, provided that not more than three such persons shall be elected in any one year, the persons so recommended to be selected by the Council by ballot in accordance with a procedure to be established by Standing Orders of Council. The Standing Orders which the Council propose to make correspond in the main with the procedure for the adjudication of the medals, but are still more stringent in character.

In the evening the Fellows and their friends dined together at the Whitehall Rooms.

STEREOCHEMISTRY AND PHYSIOLOGY.

IN a recent number of the *Zeitschrift für physiologische Chemie*, Prof. Emil Fischer has reviewed the facts by which, in conjunction with Thierfelder, he has sought to explain the selective action exhibited by the enzymes either in effecting fermentation or in producing hydrolysis.

Pasteur was the first to show that a solution of racemic acid becomes lævo-rotatory in presence of penicillium, owing to the destruction of the dextro-tartaric acid by the fungus—an observation which has been frequently utilised in the attempt to isolate one of the optically active constituents of a racemic compound.

Configuration and Alcoholic Fermentation.—This selective action is exhibited in a very marked degree by the beer yeasts in producing fermentation of the carbohydrates. Of the eleven known aldohexoses (glucose type) only the three natural products are fermentable, viz. dextro-glucose, dextro-mannose and dextro-galactose, and of the ketohexoses only dextro-fructose is decomposed.

All the yeasts susceptible of inducing fermentation transform dextro-glucose, mannose and fructose with about equal velocity; but the action of yeast on dextro-galactose is slower, and certain species—*Saccharomyces apiculatus* and *productivus*—are totally without action upon it.

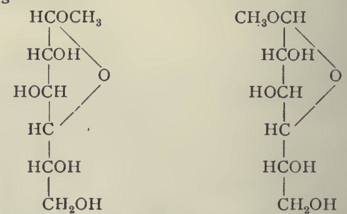
A comparison of the configuration of these four sugars will exhibit the differences in molecular grouping.

COH	COH	COH	CH_2OH
HCOH	HOCH	HCOH	CO
HOCH	HOCH	HOCH	HOCH
HCOH	HCOH	HOCH	HCOH
HCOH	HCOH	HCOH	HCOH
CH_2OH	CH_2OH	CHOH	CH_2OH
d-glucose.	*d*-mannose.	*d*-galactose.	*d*-fructose.

In glucose, mannose and fructose the grouping of the H and OH round the three lower asymmetric carbon atoms is the same, but differs from that of galactose, a fact which may account for the slower fermentive action of the latter. The other hexoses are not fermentable. The small difference in configuration which suffices to arrest the action is seen in the case of *d*-talose, which only differs from *d*-galactose by the position of one hydroxyl group.

COH
HOCH
HOCH
HOCH
HCOH
CH_2OH
d-talose.

Configuration and Zymolysis of the Glucosides.—By the combination of glucose with methyl alcohol, to form methyl glucoside, a new asymmetric carbon atom is created, and consequently two stereo-isomeric derivatives are possible. E. Fischer has obtained from *d*-glucose both modifications, which he terms α and β methyl *d*-glucosides, also the corresponding α and β methyl *l*-glucosides and similar products from the other aldoses. Fischer has allotted to the α and β methyl *d*-glucosides the following formulæ.



An aqueous solution of the emulsin of bitter almonds hydrolyses the β modification, but has not the least action on the α modification. Exactly the reverse happens with an aqueous extract of dry yeast. In this case the α compound is hydrolysed, whilst the β modification remains unchanged. The ethyl and phenyl glucosides, which are only known in one modification, behave like the α methyl compound, and probably belong to the same category. Neither emulsion nor yeast affect the two methyl *l*-glucosides.

D-galactose forms two methyl derivatives, one of which is attacked by emulsin and the other by the enzyme of yeast, but more slowly than the corresponding glucosides, the difference in rate corresponding with that observed in fermentation. Neither methyl *d*-mannoside nor methyl *l*-mannoside is attacked by emulsin or the enzyme of yeast. The second *d*-mannoside, which would probably be hydrolysed by one or the other ferment, is still unknown. The pentoses and heptoses are non-fermentable, and their methyl glucosides are likewise indifferent to both enzymes.

The following is a list of natural and artificial glucosides. The action of the enzyme is denoted by a + when it produces hydrolysis and by a − when it is without action.

		Artificial glucosides.	Emulsin.	Enzyme of yeast.
Aldosides.	Hexosides.	α methyl *d*-glucoside ...	−	+
		β methyl *d*-glucoside ...	+	−
		α methyl *l*-glucoside ..	−	−
		β methyl *l*-glucoside ...	−	−
		α ethyl *d*-glucoside ...	−	−
		phenyl *d*-glucoside ...	+	−
		α methyl *d*-galactoside ...	−	+
		β methyl *d*-galactoside ...	+	−
		methyl *d*-mannoside ...	−	−
		methyl *l*-mannoside ...	−	−
		methyl arabinoside ...	−	−
		α methyl xyloside	−	−
		β methyl xyloside	−	−
		methyl rhamnoside ...	−	−
		methyl gluco-heptoside ...	−	−
Ketosides.		methyl sorboside ...	−	−
		methyl fructoside (not crystallised)	−	+

	Natural glucosides.	Emulsin.	Enzyme of yeast.
Simple derivatives of glucose.	Salicin	+	−
	Helicin	+	−
	Æsculin	+	−
	Arbutin	+	−
	Coniferin	+	−
	Phylbyrin	−	−
	Aprin	−	−
	Syringin	+	−
	Saponin	−	−
	Phloridzin	−	−
	Glucoside of mandelic nitrile	+	−
	Amygdalin	+	−
	Quercitrin	−	+

It would appear that the natural glucosides, which are for the most part phenol derivatives, probably belong to the group of β-glucosides. The indifference of some of these glucose derivatives to both enzymes is at present unexplained.

Configuration and Zymolysis of the Polysaccharoses.—The recent researches of E. Fischer on the hydrolysis of the polysaccharoses point to the fact that none of these carbohydrates is directly fermentable by the enzyme of yeast, but that without exception they first undergo hydrolysis by a hydrolytic enzyme associated with the ferment. The di-saccharoses—cane sugar, maltose, milk sugar, melibiose, trehalose, &c.—are anhydrides formed by the union of two hexoses. The structural formulæ of maltose and lactose are probably identical, seeing that each splits up on hydrolysis into two molecules of aldohexose, but since maltose yields only glucose, whereas lactose forms an equal number of molecules of glucose and galactose, the two compounds must be regarded as stereoisomeric. They probably correspond, too, with the α-methyl- and β-methyl-dextroglucoside, for emulsin hydrolyses lactose, but not maltose; whereas the enzyme of yeast produces the reverse effect.

Without discussing in detail the ingenious methods by which Prof. Fischer has successfully attacked the problem of the hydrolysis of the polysaccharoses, the following results may be briefly recorded.

The action of invertase, an enzyme which accompanies beer yeast, in hydrolysing cane sugar into glucose and fructose previous to fermentation, was first observed by O'Sullivan, and although Bourquelot and Lintner recorded a similar decomposition in the case of maltose, the experiments were not decisive. Fischer, however, extracted with water from dry yeast an enzyme which, unlike invertase, hydrolyses maltose, and which he has therefore named maltase of yeast. Instead of the aqueous extract, the dry yeast itself may be employed; in which case a little toluene must be added to the maltose solution to arrest the alcoholic fermentation.

The conclusion may be drawn that yeasts incapable of inducing alcoholic fermentation of cane sugar and maltose are destitute of invertase and maltase. This conclusion has been fully corroborated by subsequent experience.

Kephir grains and the yeast which ferments milk sugar do not ferment maltose, and are also without hydrolytic action upon it.

Saccharomyces martianus, which according to Hansen does not ferment maltose, does not hydrolyse it, and is therefore free from maltase. Beyerinck's *Schizosaccharomyces octosporus*, which acts on maltose but is indifferent to cane sugar, contains maltase but no invertase. *Monilia candida* is a particularly interesting case, since it contains neither invertase nor maltase, but nevertheless produces fermentation of both cane sugar and maltose. No aqueous extract which hydrolyses these two sugars could be obtained from it, but if the dried yeast is added to a solution of cane sugar in presence of toluene a vigorous hydrolysis is produced. The hydrolytic enzyme is present, but in this case it is insoluble in water.

Milk sugar, which is not attacked by beer yeast, is fermented by kephir grains and milk sugar yeast, which Beyerinck suspected to contain the hydrolytic enzyme lactase. The existence of this enzyme has been placed beyond question by Fischer, who has prepared the enzyme from kephir grains and milk sugar yeast in the dry state. It is accompanied by invertase, but maltase is entirely absent, and indeed no substance is yet known in which maltase and lactase are associated.

The hydrolysis of trehalose by an enzyme contained in *Aspergillus niger* and in green malt was observed by Bourquelot, and has since been confirmed by Fischer, who found also that a Frohberg dry yeast affected a similar but much more feeble decomposition.

Melibiose, which is a disaccharose, is obtained from raffinose. It is fermented by a low fermentation brewer's yeast. Fischer and Lindner have now been able to prove the existence in this yeast of a hydrolytic enzyme which they call melibiase.

In regard to the action of different yeasts on α-methylglucoside and its congeners, Fischer has shown that all yeasts which ferment maltose attack the α-methyl glucoside. The question then arises, has each glucoside or polysaccharose its special enzyme and each fermentable sugar its special ferment or zymase? Fischer considers such a proposition untenable, but inclines to the view that one and the same enzyme of yeast, maltase, attacks α-methyl glucoside as well as melibiose and the complex carbohydrates known as dextrins.

Theoretical considerations.—All these facts indicate that the chemical action of enzymes, in which may be included the zymase of yeast, is of quite a special character and distinct from that of the more simple organic and inorganic compounds. The cause of this selective action probably resides in the asymmetrical structure of the enzyme molecule. Although these substances are not yet known in the pure state, their relation to the proteids is so close and their derivation from the latter so probable, that they may be regarded as optically active molecular aggregates, and consequently asymmetrical. Fischer and Thierfelder have based upon this the hypothesis that between the enzymes and those substances which they attack, there must exist a correspondence in molecular configuration, which they compare to a lock and key. The observations of G. Bertrand on the relation of the polyvalent alcohols to their oxidisability by the sorbose bacteria, shows clearly that stereochemical considerations may be applied to other fermentive processes. Fischer applies the same idea to the chemical changes occurring in the bodies of higher organisms, which lead to the conclusion that in the chemical changes in which the proteid substances take a part as active masses, undoubtedly the case with protoplasm, the configuration of the molecule (*i.e.* space arrangement of the atoms) plays a part fully as important as its structure (*i.e.* plane, or relative arrangement of the atoms). It is easy to conceive on this hypothesis that the three isomeric tartaric acids should be assimilated at an unequal rate in the organism of the dog, and that of two sugars so closely allied as glucose and xylose, it is only the former which is oxidised or converted into glycogen, whereas xylose passes unaltered through the system.

The results of stereochemistry may also throw some light on chemical transformations occurring in the organism. The four sugars, *d*-glucose, *d*-mannose, *d*-fructose and *d*-galactose are not only those that are exclusively attacked by yeast, but those which in the animal system are assimilated as glycogen. The conversion of glucose, mannose and fructose into one another was first achieved by Fischer by a process of alternate reduction and oxidation, since when Lobry de Bruyn and van Ekenstein have arrived at the same result by simply warming with alkalis.

As von Baeyer pointed out twenty-eight years ago, all these phenomena may be explained by the intramolecular migration of an oxygen atom from one carbon atom to the other. The intermediate phases of this process are unknown; but alcoholic fermentation is an example of the facility with which the operation is effected. In regard to the assimilation of carbon dioxide by plants, which gives rise to exclusively active sugars, a similar explanation may be found, seeing that the carbon dioxide in process of assimilation is associated with the optically active chlorophyll bodies.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Mr. F. C. Kempson, of Caius College, has been reappointed a Demonstrator of Anatomy for one year; and Dr. Elliot-Smith, Fellow of St. John's College, a Demonstrator of Anatomy for five years.

The work of Mr. W. Rosenhain, advanced student of St. John's College, which includes the joint Bakerian Lectures, with Prof. Ewing, delivered this year, has been approved for the University certificate of research.

Dr. Hill, Dr. Allbutt, Dr. Sladen, and Prof. Woodhead have been appointed representatives of the University for the organisation of a Congress on Tuberculosis to be held in London in 1901.

AT the annual prize distribution of the Merchant Venturers' Technical College, Bristol, on December 20, an address will be given by Sir W. H. White, K.C.B., F.R.S., Director of Naval Construction to the Admiralty.

WE learn from the *British Journal of Photography* (December 1) that Dr. Hans Harting, formerly of Messrs. Zeiss, of Jena, has joined the Board of Management of Messrs. Voigtlander and Sohn. He succeeds Dr. Miethe, who was recently appointed Professor of Chemistry and Spectrum Analysis at the Technical High School, Berlin.

THE annual prize distribution and conversazione of the Northampton Institute, Clerkenwell, will be held to-morrow evening, December 8. Sir Henry Roscoe will distribute the prizes. A comprehensive programme of exhibits and short lectures referring to the various sides of the Institute's work has been prepared. Dr. Walmsley will describe alternating currents; Mr. John Ashford, flying machines in fiction and fact; and Mr. A. W. Martin, high speed telegraphy. There will also be special demonstrations of liquefaction of air, alternate currents, ice-making, mortising by machinery, colour photography, rapid stereotyping, and other subjects.

THE *Pioneer Mail* announces that the Government of India have given their cordial approval to the Tata scheme for an India University of Research, recently formulated by a conference at Simla, and already referred to in these columns. As soon as all the details have been worked out, the necessary legislation for the incorporation of the new University will be undertaken. Meanwhile the Government of India commend the scheme to the liberality of the public, and wish it every success, while they acknowledge in the most cordial manner the public spirit shown in Mr. Tata's munificent endowment. The Government of Bombay will be asked to appoint an officer to arrange with Mr. Tata for the transfer of the property which is to constitute the endowment.

THE Calendars of University College, London, and the University College of Sheffield, for the session 1899-1900, have been received. In the former, the Dean of the Faculty of Science, Prof. T. Hudson Beare, refers to the part taken by the College in connection with the reorganisation of the University of London, and expresses pleasure that in the new University engineering is to be put on an equal with the sister professions, law and medicine, and that (if the draft statutes are adopted) it is to have its own Faculty and its own representatives on the Academic Council. A noteworthy addition to the Dean's report is a complete list, covering nine pages, of the original memoirs and writings which have emanated from the different scientific departments of the College during the past two years. In the Calendar of the University College of Sheffield it is announced that a bacteriological laboratory has been established, with a special demonstrator to devote the whole of his time to bacteriological investigations.

SOME interesting particulars with reference to the relative attention given to science in our secondary schools, as judged by the number of candidates who present themselves in scientific subjects in the public examinations usually taken by the pupils, is given in the December number of *The School World*. It appears that in January of this year, of 1250 candidates examined for matriculation in London University, 842 selected a language as their optional subject, and 408 a branch of science. The total number of candidates who were examined in the five optional science subjects was little more than half the number that selected French as the optional subject. At the last Oxford Senior Local Examinations, the number of papers worked in English subjects was 6977, in languages 2418, in science subjects 796; in addition to which 969 candidates took mathematics. In the Senior Cambridge Local Examinations in 1898, the number of papers in English subjects was 10,327, in languages 3391, in mathematics 1590, and in science 1838. Similar proportions are shown to exist among candidates who present themselves for other general examinations. The numbers show clearly that in most of our secondary schools science still occupies but a minor place in the curricula.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Microscopical Society, November 15.—Mr. E. M. Nelson, the President, in the chair.—Mr. C. L. Curties exhibited a new form of portable microscope by Leitz. It had a folding foot and a movable stage, to enable the instrument to be packed in a small compass. The body was not made to incline, but was furnished with coarse and fine adjustment, and the stage was fitted with a modified form of Abbé condenser, with iris diaphragm. The President thought the instrument would be useful to those requiring a very portable one; its great compactness was effected in an ingenious manner, while the working parts were well made and finished.—The President read a short note descriptive of a set of three simple hand microscopes on the Coddington principle sent for exhibition by Mr. Edward Swan. They were apparently made for a medical man, and could not be very old. Dr. Hebb said Prof. Groves had made some modification in the form of a hand microtome, and had sent it for exhibition. The President called attention to six photomicrographs of the larvæ of gnats, taken from life by Mr. J. T. Holder. The President exhibited an old Gillett condenser, dated July 20, 1849, which had a collar adjustment.—Dr. H. C. Sorby's paper on the preparation of marine worms as microscopical objects was read by the President in the unavoidable absence of the author. The subject was illustrated by beautifully mounted slides under microscopes.—The attention of the meeting was then directed to a fine exhibition of *Foraminifera* by Mr. A. Earland, shown under a large number of microscopes, with written descriptions explaining the points of interest in each slide.

Linnean Society, November 16.—Mr. G. R. Murray, F.R.S., in the chair.—Mr. J. E. Harting communicated particulars of several cases in which parrots had been poisoned by eating parsley. After commenting on instances in which plants that were innocuous to man had proved fatal to some of the lower animals, he mentioned in support of the converse case that the berries of the yew and privet, which are generally considered to be poisonous to man, were greedily eaten by blackbirds, thrushes, bullfinches, and other birds; while, on the other hand, several cases were on record of pheasants having been poisoned by eating yew leaves. The immunity of goats from yew poisoning was remarkable in view of the fact that deer and cattle died after eating the leaves of that tree, although it had been stated that the ill effects were due to the leaves having been eaten in a desiccated state, and not while growing on the tree.—Mr. W. C. Worsdell read a paper on the comparative anatomy of certain species of *Encephalartos*. The chief features of the anatomy were shown to be the presence of several vascular cylinders in the stem, a character found also in *Cycas* and *Macrozamia*; and the *medullary* system of vascular bundles, forming, as in *Macrozamia Fraseri*, Miq., a complex network, intimately united with a corresponding network of mucilage-canals. The system of mucilage-canals in the pith is continuous with that of the cortex, but the medullary bundles form an independent *primary* system. The mucilage-canal-system is probably of use as a storehouse of moisture during the dry season, when the roots and foliage die away.—Mr. W. T. Calman read a paper on a collection of *Brachyura* from Torres Straits. These Crustacea had been collected by Prof. Haddon on his first expedition to Torres Straits in 1888. It comprised about seventy-five species, three of which were described as new, namely, *Cryptocnemus Haddoni*, *Pilumnus cristipes*, and *Lambrus confragosus*. Among the species already known, concerning which some fresh details were given, was the minute parasitic *Hapalocarcinus marsupialis*. Although described forty years ago by Stimpson, it had escaped re-examination until now, notwithstanding that the curious gall-like growths to which it gives rise on corals are well known. The occurrence in this collection of the three known Indo-Pacific species of *Palicus* (*Cymopolia*), two of which have been recorded hitherto only from widely distant localities, afforded the author of this paper an opportunity for a detailed examination of their distinctive characters.

Geological Society, November 22.—W. Whitaker, F.R.S., President, in the chair.—On some remarkable calcisponges from the Eocene Tertiary Strata of Victoria (Australia), by Dr. George Jennings Hinde, F.R.S. The greater number of the sponges described were discovered by Mr. T. S. Hall, of Melbourne

University, in incoherent detrital beds of Eocene age, in the southern part of Victoria; a few were picked out of some washings of fragmental polyzoa from the same district and horizon, by Mr. B. W. Priest. Some of the specimens are in an extremely perfect condition, and their structural details are as distinctly shown as in recent sponges. They are also of more than local interest in that they are the first fossil forms described of a group of calcisponges, the Lithonina, characterized by the peculiar aberrant forms of some of the spicules, and the mode in which they are closely fitted and organically fused together to form the skeletal mesh. This structure has, so far, only been recognised in one recent species, *Petrostroma Schulzei*, Döderlein, from the Japanese sea. The sponges are small, unattached, with a glassy, firm resistant skeleton, calling to mind that of siliceous Lithistida. They are built up of a great variety of spicular forms, some are simple rods, with three and four-rayed spicules, similar to those in recent calcisponges; but the majority are aberrant four-rayed forms, with three of the rays curved and with obtuse or expanded ends which are clasped, and fused as well, to the surfaces of adjacent spicules. The connected spicules form continuous anastomosing or radial fibres resembling those in the fossil Pharetrones, to which they are in some other respects similar, and it is probable that the spicules in the fibres of some members of this family were likewise organically cemented together. The common *Porosphæræ* from the Upper Chalk, generally regarded as Hydrocorallines allied to the recent *Millepora*, are also closely related to the above sponges, and the author hopes shortly to publish the evidence for their affinity to this group. The Victorian sponges are placed in four new species, belonging to three genera: two of these are new, the other, *Bactronella*, Hinde, was founded on some peculiar calcisponges of Jurassic Age, now known to be Lithonine in character.—In the discussion which followed, Prof. Sollas referred to the importance of these sponges from an evolutionary point of view.—The Silurian Sequence of Rhayader, by Herbert Lapworth. The stratigraphical relations of the Silurian formations which occur in the country surrounding the town of Rhayader (Radnorshire) were described in detail. Typical and confirmatory sections were given, demonstrating the complete local sequence of the rocks of the Rhayader district. These were illustrated by lists of characteristic graptolites. These fossils were compared with those of Southern Scotland, Sweden, and North Wales, showing that the graptolite succession is everywhere similar, and fixing the age of the Rhayader series as representing the Lower Llandovery, Upper Llandovery, and Tarannon of other areas. Finally, several new species of *Climacograptus* and *Diplograptus* were described. Tables of fossils enabled the author to establish a complete comparison of the whole of the local zones of the Rhayader district with those of Southern Scotland, Wales, and Sweden. In the Rhayader area there is found, for the first time in Britain, the entire Valentian succession developed in one general sequence of rocks, with a more or less common lithological character and with a fauna composed throughout of similar palæontological types.

MANCHESTER.

Literary and Philosophical Society, November 28.—Prof. Horace Lamb, F.R.S., President, in the chair.—Prof. F. E. Weiss exhibited some specimens of *Melanospora parasitica* found by Mr. H. Murray at Flixton. This species is now known to be parasitic on another fungus, *Isaria farinosa*, which infests the larvæ and pupæ of various insects. The latter fungus (*Isaria*) is now recognised as being another stage of growth of *Cordiceps militaris*, which has been particularly common this autumn.—Report on the Marine Mollusca obtained during the Jackson-Harmsworth Expedition to Franz Josef Land 1896–97, by J. Cosmo Melvill and Robert Standen. The collection was formed by Mr. W. S. Bruce, naturalist to the expedition, mainly at Franz Josef Land, and at Kolguev, the results from the first-named locality being by far the most voluminous both in quantity and quality, and forming an important contribution to science as being the most northerly dredgings of Mollusca yet obtained in the Polar regions. Only one species—a *Buccinum* (*B. Brucei*) of peculiar form—is considered new to science, but a *Thracia*, of which only very imperfect valves were obtained, is also probably so; whilst a *Sipho* (*S. togatus*) is particularly interesting on account of its peculiar epidermis. Considering how fully the Arctic mollusca have been studied, especially during the past thirty years, the results of this expedition are very gratifying. The total number catalogued are Kolguev, 36; Franz Josef Land, 66. Naturally, the nearer the poles are attained, life—pelagic as well as terrestrial—is adversely affected; for instance, the total number of northern mollusca round the Norwegian coasts is, according to Sars, 460 species.

DUBLIN.

Royal Irish Academy, November 30.—The Lord Bishop of Canea, Vice-President, in the chair.—Mr. Trouton showed an apparatus with which he had determined the heat required to evaporate steam from saturated salt solutions. The plan adopted consisted of an inner vessel completely surrounded by a larger one. The same solution is placed in both. The outer one is kept boiling by the application of external heat; the inner by an electric heater. The steam from the inner vessel is collected and weighed. In this way by knowing the heat supplied electrically the latent heat is found. Determinations made with various salts were described. The connection was also considered between the latent heat of evaporation from salt solutions and the cooling which accompanies the solution of the salt in water. In addition an apparatus was shown by means of which the cooling can be observed, through bringing the salt and water together at a temperature higher than the boiling point. This consisted of two spherical vessels placed over each other and connected by a tube which passed through the upper to near the bottom of the lower one. By means of a stopcock connection is closed till required. The water is placed in the lower, the salt in the proper proportions in the upper one. The whole is heated in a thermostate to such a temperature that on mixing, the resultant solution falls to the boiling point. In the case of sodium nitrate this cooling was 40° C.

PARIS.

Academy of Sciences, November 27.—M. van Tieghem in the chair.—The Perpetual Secretary gave an account of the present state of the fund for the Lavoisier monument.—The propagation of a pencil of parallel light, limited laterally, in a heterogeneous transparent medium; integration of the equations of motion, by M. J. Boussinesq.—Experiments on the destruction of Phylloxera, by M. Lanfrey. An aqueous 1 per cent. solution of picric acid is applied during June, July or August. The same treatment may be advantageously applied to other fruit trees.—Observations on the Leonids made in 1899 at the Observatory of Lyons, by M. J. Guillaume. Fog prevented observation on the nights of November 14 and 15, but on November 12, 13 and 16, only twenty-six Leonids were noted.—Observations of the Leonids made at the Observatory of Algiers, by M. Ch. Trépied. The numbers observed were, on November 13, three; on the 14th, thirty-six; the 15th, thirty. Forty per cent. of the shooting stars observed did not belong to the Leonid swarm. The classification of the Leonids in order of magnitude showed that 10 were of the 1st magnitude, 22 of the 2nd, 19 of the 3rd, 9 of the 4th, and 6 of the 5th.—Observations of the Leonids at Algiers, by M. Harold Tarry. During the three nights 92 shooting stars were counted.—On the definition of the area of a surface, by M. H. Lebesgue.—On the number of roots of an algebraical equation comprised in the interior of a given circumference, by M. Michel Petrovitch.—On the generalisation of Lagrange's development in continued fraction of the function $(1 \times x)^m$, by M. H. Pade.—On the stability of equilibrium of floating bodies and particularly of a ship carrying a liquid cargo, by M. P. Duhem. Referring to a recent note of M. P. Appell on this subject, in which a paper by the author is quoted, it is here pointed out that this work was completed in a second paper, with results agreeing with those recently published by M. Appell.—Remark on the preceding communication, by M. Appell.—On the transmission of sound by electricity, by M. Dussand. A description of a microphone by which the spoken sounds can be transmitted with very slight loss of intensity.—On the chemical action of the X-rays, by M. P. Villard. The X-rays, freed from kathode rays by an aluminium screen, cause a violet coloration of the glass, apparently due to an oxidising action.—The action of dry hydrochloric acid upon silver and the reverse reaction, by M. Jouniaux. The interaction of hydrogen and silver chloride in sealed tubes was studied at various temperatures—350°, 440°, and 600°. A limiting value for the percentage of hydrochloric acid formed was found in each case, but the velocity with which this limit was attained differed greatly with the temperature, requiring several months at 250°, five weeks at 350°, seventy hours at 440°, and only one hour at 600°. Starting with the system silver, hydrochloric acid, a limit was similarly obtained for each temperature; but the final state of equilibrium was not the same as in the first case for temperatures below 600°. It is an example of the false equilibrium of M. Duhem.—On camphenylone, by MM. E. E. Blaise and G. Blanc. Camphene is treated with nitrogen peroxide at 0°, and the nitrate converted into camphenylone by treatment with potash. This ketone is treated with hydroxylamine, and the oxime dehydrated with acetyl chloride. The nitrite thus obtained gives on reduction a base, which is not identical with dihydroaminocampholene or the aminocampholenes. Hence camphenylone and its derivatives do not contain the trimethylcyclopentanic ring which exists in bodies belonging to the camphor series.—The colouring matter of digitalis, by MM. Adrian and A. Trillat. The new substance forms yellow needles, and has the composition $C_{16}H_{12}O_4$. It is very stable towards chemical reagents.—On an experiment relating to submarine currents, by M. J. Thoulet.—The resistance of seeds to high temperatures, by M. Victor Jodin. If seeds are gradually dried they will resist a temperature of 100°. Thus some seeds heated directly to 98° for ten hours were all killed; but if heated for twenty-four hours at 60° and then ten hours at 98°, from 30 to 60 per cent. of the seeds germinated.—On the glacial period in the Central Carpathians, by M. E. de Martonne. A detailed topographical study confirmed the views of Lehmann, showing undoubted signs of glacial action in the Carpathians.—The negative variation is not an infallible sign of nervous activity, by M. A. Herzen.—Cellular embolism, by MM. Charrin and Levaditi.—On a case of endothelioma of bone, by M. Paul Berger.

DIARY OF SOCIETIES.

THURSDAY, DECEMBER 7.

ROYAL SOCIETY, at 4.30.—Vapour-density of Bromine at High Temperatures: Dr. E. P. Perman and G. A. S. Atkinson.—Polytremacis and the Ancestry of Helioporidæ: Dr. J. W. Gregory.—Gold Aluminium Alloys: C. T. Heycock, F.R.S., and F. H. Neville, F.R.S.—On the Association of Attributes in Statistics; with Examples from the Material of the Childhood Society, &c.: G. U. Yule.—Data for the Problem of Evolution in Man. III. On the Magnitude of certain Coefficients of Correlation in Man, &c.: Prof. Karl Pearson, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Cost of Steam Raising: John Holliday.—Influence of Cheap Fuels on the Cost of Electrical Energy: R. E. Crompton. (Adjourned Discussion.)

LINNEAN SOCIETY, at 8.—On some Vegetable Poisons used for the Capture of Fish by the Australian Aborigines: J. W. Fawcett.—On some New Zealand Schizopoda: G. M. Thomson.—On the Structure of Porites: H. M. Bernard.

CHEMICAL SOCIETY, at 8.—Ballot for the Election of Fellows.—The Oxidation of certain Organic Acids in presence of Iron: H. J. H. Fenton, F.R.S., and H. O. Jones.—The Determination of the Constitution of Fatty Acids, Part II.: Dr. A. W. Crossley and H. R. Le Sueur.—On Sulphates of the Form R'_2SO_4, $2M''SO_4$, especially those of Isometric Crystallisation: F. R. Mallet.

RÖNTGEN SOCIETY, at 8.—Observations on Practical X-Ray Work, with Exhibition of Apparatus and Stereoscopic Skiagrams: Mackenzie Davidson.—Bullet in the Brain: J. Moore.

FRIDAY, DECEMBER 8

PHYSICAL SOCIETY (City and Guilds' Technical College, Leonard Street, Finsbury), at 5.—Cylindrical Lenses: Prof. Silvanus Thompson, F.R.S.—Exact Formulæ for Lenses: T. H. Blakesley.—On an Organic Compound of Great Double-Refraction: Prof. Silvanus Thompson, F.R.S.

ROYAL ASTRONOMICAL SOCIETY, at 8.—Note on the Values of the Coefficients of the Terms of the Third Order in the Lunar Theory: E. W. Brown.—Observations of the Leonids at the University Observatory, Oxford: H. H. Turner.—On the Proper Motions of Berlin B. 5072 and 5073: F. A. Bellamy.—New Nebulæ discovered Photographically with the Crossley Reflector of the Lick Observatory: J. E. Keeler.—Observations of the Leonids: Durham Observatory.—On the Relation between Magnetic Disturbance and the Period of Solar Spot Frequency: W. Ellis.—The Extra-Equatorial Currents of Jupiter in 1899: Rev. T. E. R. Phillips.

MALACOLOGICAL SOCIETY, at 8.—On the Anatomy of *Hemiplecta Floweri*, Smith, from Perak, with Notes on some other Eastern Genera: Lieut.-Colonel H. H. Godwin-Austen.—(1) Note on *Ampullaria Brohardi*, Granger; (2) Description of a New Species of *Leptopoma* from Borneo: E. A Smith.—Note on the Anatomy of *Zonites Rollei*, Kobelt: W. E. Collinge.—On some Recent Conchological Discoveries in Victoria: Mrs. A. F. Kenyon.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—A Continuous Mean-Pressure Indicator for Steam-Engines: Prof. William Ripper.

MONDAY, DECEMBER 11.

SOCIETY OF ARTS, at 8.—Art Enamelling upon Metals: H. H. Cunynghame.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—A Journey through Abyssinia to the Nile: H. Weld Blundell.

TUESDAY, DECEMBER 12.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Combined Refuse-destructors and Power-plants: C. Newton Russell.

ANTHROPOLOGICAL INSTITUTE, at 8.30.—Survival in Primitive Rites of the Disposal of the Dead, with special reference to India: Wm. Crooke.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—(1) Notes on the Use of the Dallmeyer Focometer; (2) The Origination of Printing Types by Photographic Methods: T. Bolas.

WEDNESDAY, DECEMBER 13.

SOCIETY OF ARTS, at 8.—Sea Angling and Legislation: F. G. Aflalo.

THURSDAY, DECEMBER 14.

ROYAL SOCIETY, at 4.30.

SOCIETY OF ARTS, at 4.30.—Round about the Andamans and Nicobars: Colonel R. C. Temple.

MATHEMATICAL SOCIETY, at 8.—Sums of Greatest Integers: G. B. Mathews, F.R.S.—Note on Circular Cubics: A. B. Basset, F.R.S.—Formulæ involving Central Differences; and their Application to the Calculation and Extension of Mathematical Tables: W. F. Sheppard.—On the Expression of Spherical Harmonics as Fractional Differential Coefficients: J. Rose-Innes.—The Genesis of the Double Gamma Functions: E. D. Barnes.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Discussion on Mr. Crompton's and Mr. John Holloway's Papers.—Electrical Time Service: F. Hope-Jones.

FRIDAY, DECEMBER 15.

EPIDEMIOLOGICAL SOCIETY, at 8.30.

INSTITUTION OF CIVIL ENGINEERS, at 8.—On Sludge: Blamey Stevens.

CONTENTS. PAGE

THURSDAY, DECEMBER 14, 1899.

THE HISTORY OF GEOLOGY.

Geschichte der Geologie und Paläontologie bis Ende des 19.Jahrhunderts. Von Karl Alfred v. Zittel. Pp. xi + 868. (München und Leipzig: Druck und Verlag von R. Oldenbourg, 1899.)

WHEN the illustrious author of the "Handbuch der Palæontologie" undertook to write this history of geology and palæontology, he entered upon no light task, for special difficulties must attend the labours of any author who, in bringing together material to illustrate completely the rise and development of these wide-embracing sciences, would produce a volume acceptable to professionals and laymen alike. For such a task as this Prof. Zittel, by his wide scholarship and long experience as a teacher, no less than by his acquaintance with an abundant special literature and his proficiency as a linguist, is eminently qualified; and the work before us amply shows those evidences of patience, thoroughness, and indefatigable zeal, which have characterised the previous literary undertakings of its author. Some idea of the labour involved in the preparation of this volume may be gained from the fact that upwards of 2000 authors receive mention in its pages: it may be doubted indeed whether a single writer whose work has had important bearing on the development of geology in its various branches has been overlooked, while many, the significance of whose labours is unquestionably small, are here accorded recognition. As stated in the author's prefatory remarks, the original scope of the work, which was primarily intended to comprise a history of geology in Germany, was subsequently extended, in accordance with the necessity of treating from a wider standpoint the development and progress of a study to the growth of which all civilised nations have contributed.

The difficulties of expediently arranging so vast an amount of material as that embodied in this work have been perhaps most aptly met by the general plan, chronological and categorical, here adopted. The book is divided into four main sections, each dealing with a given period in the history of the science; and while these periods are of very unequal length, their limits have been so chosen that the mass of detail dealt with under more special headings may be advantageously grouped, thus enabling the reader to obtain the more readily a connected idea of the successive advances made in the study of the subject in its various departments.

The first section, comprising only a few pages, is principally devoted to the works of the ancient Greeks and Romans, and it is clearly shown in what small degree the labours of these early writers have furnished sound foundation for the development of geology in later times. In a short introduction to the second section the author points plainly to those causes which for so many years effectually retarded the progress of scientific thought and discovery, and gave rise to that intellectual lethargy which only became dissipated at the close of the middle ages. The early opinions regarding the nature of fossils, the origin and history of the earth, and the phenomena of volcanoes and earthquakes, are then successively discussed; and it may be well to indicate here the method adopted by the author in dealing with the work of the numerous observers and writers in these various branches of the subject, for the manner of treatment here employed is more or less closely adhered to throughout the succeeding portions of the book. For the most part under special sub-headings, the work of successive contributors to the science, when the names of these are deserving of more than mere mention, is concisely and impartially summarised, and numerous useful biographical footnotes have been appended. In many cases criticism is totally withheld, and the treatment of the material is in great measure purely objective. In illustration of the thoroughness and impartiality with which the author has carried out his work, we note the space accorded in this second period not only to writers such as Steno, Lehmann, Füchsel and Guettard, whose work has marked important points of progress in these earlier days of geological science, but also to others—for example, Fallopio, Burnet and Justi—whose almost valueless efforts consisted so largely in the proposal of wildly fantastic theories.

The third section, under the happily chosen title "Das heroische Zeitalter der Geologie von 1790 bis 1820," deals with a period which was witness of such remarkable activity in the study of geology; a period during which, indeed, the foundations of the science as we know it to-day may be said to have been laid. Here are to be found some of the most fascinating pages in the book, and the sketches of Saussure, Werner, v. Buch and Humboldt may be cited as examples of apt and terse delineation. But in a work of such wide scope as the one before us, brevity must of necessity characterise the condensed accounts in which are set forth the achievements of these and of other men whose influence has left its indelible mark in the onward march of the science, and we must not look for that degree of fulness and literary embellishment to be found in works of narrower limits, as, for example, in the admirable sketches furnished by Sir Archibald Geikie in his "Founders of Geology." If, in Prof. Zittel's account of Werner and his work, we perceive a certain reluctance to estimate at its true value the detrimental effect produced for a time by the hotly promulgated and falsely based theories of that influential teacher, we speedily find compensation in the eulogistic narratives of Hutton and Playfair, whose philosophical ideas were so effectually opposed to the baneful dogmatism of the Freiberg school.

The development of stratigraphy during this period is dealt with at considerable length, and the progress made in each country receives separate treatment. Prominent amongst the many workers whose labours here find ample record are Freiesleben, v. Buch, Ebel, Brongniart, Cuvier and William Smith. The early development of petrography is then traced, and the views held respectively by the neptunists, vulcanists and plutonists are briefly discussed. In following the progress of palæontology during this time, the author first draws attention to works of a more general character, such as those of Schlotheim, Defrance and Parkinson, and then proceeds to indicate the advances made by the publication of more special work confined to the consideration of single classes of animals. With the exception of the important labours and influence of Cuvier, to which both merited tribute and critical consideration are here accorded, this portion of the subject is dismissed with a scantiness of treatment that is somewhat disappointing. In this work geology and palæontology are dealt with together, in correspondence with the fact of their close association and concurrent development, for it is only of comparatively recent years that the study of palæontology has come to be rightly regarded in its true relation to that of zoology.

Fully three-quarters of the volume are occupied by the fourth section, dealing with the newer development of geology and palæontology, and for convenience of treatment the large mass of material here to be incorporated is divided into seven chapters. In the first three of these the more recent advances in the study of cosmic, physiographical and dynamic geology receive careful and detailed attention. In the third chapter we are presented with an excellent summary of the work of Lyell; while from a good epitome and brief criticism of Suess's "Antlitz der Erde" we learn in what high estimation that work is held by Prof. Zittel. The chapter on the development of dynamic geology is throughout exhaustive; but in attempting to give credit to the work of so many contributors, the author must often impose a tax on the attention of his readers. This will be noticeable, indeed, in all these later chapters of the book, when the historian has approached a period in the development of the science marked by an ever-increasing prolificacy in the production of special publications, and as a result of this effort to give recognition to a legion of authors great and small, the pages show a tendency to become burdened with the mere lists of names of many who have contributed to our knowledge in the respective branches of the subject. A chapter devoted to topographical geology, in which the most prominent position is accorded to Germany, gives useful information regarding the growth of geological surveys.

The three concluding chapters deal with the more recent development of stratigraphy, petrography and palæontology. In tracing the growth of stratigraphy, the several geological systems are separately treated, and the Triassic System is dealt with at greatest length. The development of study in the Alpine Trias here finds a prominent place, and in this connection it is noteworthy that Prof. Zittel, even when recounting the progress of a recent warmly-conducted polemic discussion on a question of nomenclature, has succeeded in preserving neutrality. Chapter vi. furnishes a brief though comprehensive account of the later development of petrography, in which the principal work of recent years, for the most part without criticism, is recapitulated.

The volume concludes with an account of more recent labours in palæontology, but it must be with a feeling akin to disappointment that we complete the perusal of this portion of the work. In a chapter dealing with that subject in which Prof. Zittel has acquired his well-merited reputation as the leading authority, the method and fulness of treatment fall below our expectations. The endeavour to refer, though it be by mere mention, to so much that has been of recent years accomplished in this department, and this at the risk of reducing a certain proportion of the text to the character of a mere compendium of authors' names, is here too plainly apparent. By this objective presentation of details the author must in great measure forfeit that interest which a broader and more critical treatment would have commanded.

Great care has been bestowed in editing this work, and such errors as the misspelling of the name "MacCulloch" on p. 165, and the omission of two reference numbers on p. 793, are of rare occurrence. Carefully quoted literature references have been appended, on the whole, with sufficient liberality; but the author's apology for devoting so much space to this purpose appears superfluous, and it must be obvious, especially when looked at from the student's point of view, that frequency in referring to original sources of information can only enhance the value of a book of this kind.

Little need be added in recommendation of this comprehensive work; the terse and lucid style of its author will commend it to English readers. By the completion of his arduous task, Prof. Zittel has well supplied a long-felt want, and all who interest themselves in the study of geology, towards the development of which Great Britain has so conspicuously contributed, will warmly welcome the appearance of this volume from the pen of one who takes rank among the ablest living expounders of a noble science.

F. L. K.

THE FLORA OF NEW ZEALAND.

The Student's Flora of New Zealand and the Outlying Islands. By Thomas Kirk, F.L.S. A Fragment. Pp. vi + 408. Large 8vo. (Wellington, N.Z., 1899.)

List of the Genera and Species of New Zealand Plants. By A. Hamilton. (Wellington, N.Z., 1899.)

IT was well known in botanical circles that the late Prof. Thomas Kirk, of Wellington, New Zealand, who died about a year ago, had long been engaged in the preparation of a comprehensive, descriptive, and illustrated work on the flora of that country; and it was a great disappointment when it transpired that he had left his work in an unfinished state, because it was felt that it would be extremely difficult, perhaps impossible, to find another botanist so well qualified for the task. Prof. Kirk spent some thirty years of his life in the investigation of the flora of his adopted country, and his various writings thereon betoken the careful and accurate botanist. From time to time he published the new species discovered by himself and others; but his fully illustrated "Forest Flora of New Zealand" gave evidence of the extent of his knowledge of his subject. A more remarkable and, in a scientific sense, a more important contribution to the botanical literature of New Zealand is contained in an address delivered before the Philosophical Society of Wellington, N.Z., a few years ago (see *Transactions* of the New Zealand Institute, vol. xxviii.). In this address he dealt with the "Displacement and Replacement of the Native Vegetation of New Zealand" in such a manner as to be of permanent value to science. He has there put on record facts connected with the introduction and colonisation of exotic plants in New Zealand that positively throw a new light, and suggest new ideas, on the present distribution of plants in cultivated countries generally. Fortunately the botanical investigation of New Zealand was begun before its settlement by Europeans; and it has been continued by a small band of them with such ardour and exactitude, that future workers in the field have a substantial foundation to build upon. In the absence of authentic records, the present conditions in the vegetation of the country could not have been understood. Kirk estimated that about 500 exotic species of plants had become more or less completely established in New Zealand; and they are spread all over the country, from the sea-coast almost to the altitudinal limits of vegetation. But the most surprising part of it is the extent to which vigorous native plants have been displaced by comparatively delicate foreigners; and it would indeed be incredible in the absence of indisputable evidence. However, I must not pursue this subject here, and I have only alluded to it in connection with the plan and scope of the fragment of Kirk's "Flora" before me. The Government wisely decided to publish so much of this work as was printed off, or ready for the printer, at the time of the author's death. This contains the natural orders Ranunculaceæ to Compositæ, in the sequence of Bentham and Hooker's "Genera Plantarum"; and its value only makes one wish that the author had lived to complete it. Perhaps the only serious criticism one could fairly bring to bear upon the work before having had considerable practical experience in using it for the determination of species, is its size and weight, which would preclude its being used in the field. Rather less than half of the known flowering plants (671), and 260 introduced plants, are described on some 360 pages. Completed on this scale it would make, with glossary, index, &c., at least 850 pages. By using a smaller type with less spacing, and a lighter paper, it would be possible to reduce the book to pocket dimensions. This objection has been raised here, because we believe the New Zealand Government is making arrangements with another botanist to write a complete Flora.

It might be suggested that the introduced plants should be left out; but, considering that they constitute something like a third of the number of species occurring in a wild state, that some of them are dispersed from one end of the islands to the other, and that in some districts or localities introduced plants preponderate, it is as absolutely essential that they should be included as that the European element should figure in any account of the present inhabitants of New Zealand. To begin with, the young student cannot distinguish between the introduced and indigenous elements. To the beginner, one is as good as the other, and, as a matter of knowledge, to know the one is of as much importance as it is to know the other; and we think it would be a grave mistake to exclude the foreign element from a book treating of the flora of the country. Kirk gives less detailed descriptions of them, and prints them in a smaller type, so there is no difficulty in distinguishing between the two.

When we come to consider the question, "What have the discoveries made since the publication of Sir Joseph Hooker's 'Handbook of the New Zealand Flora,' in 1864, added to our knowledge of phytogeography?" the answer must be "next to nothing." Perhaps the most interesting thing in this connection is the discovery of a number of Tasmanian species, especially on Stewart Island, in the extreme south. The outlying islands, such as Macquarie, Antipodes, and the Kermadecs, have been more fully explored; but the results merely go to strengthen the previously conceived idea that the highest southern vegetation, like the highest northern, is very much the same all round the world.

With regard to botanical discoveries in New Zealand since 1864, it may be truly said that they are of comparatively little interest. Only one new generic type (*Tetrachondra*) of a really distinct character has been found, and this is a minute herb, having the habit of *Tillaea*. It is of anomalous structure, and has been provisionally placed in the Boraginaceæ, though it has opposite leaves. Two new genera have been proposed for species formerly referred, in part, at least, to the curious leguminous genus *Carmichaelia*. The differential characters are chiefly in the form of dehiscence of the pods. Perhaps the very rare and imperfectly known *Siphonidium*, allied to *Euphrasia*, deserves generic standing, but it is almost certainly a congener of Hooker's section *Anagosperma* of *Euphrasia*, which has recently been raised to generic rank.

Coming to species, it is true that the number has been nominally increased by upwards of one-third. In other words, more than 500 species of flowering plants have been proposed in addition to the 935 described by Hooker; but of these probably not less than a third will prove untenable. For instance, in *Olearia*, Kirk retains thirty-four species, and reduces a dozen of the so-called new ones. As compared with what was previously known, there are few striking plants among the recent discoveries. The majority of the new species belong to such familiar genera, of almost world-wide range, as *Ranunculus*, *Epilobium*, *Senecio*, *Veronica* and *Carex*, and to such characteristic Australasian genera as *Coprosma*, *Olearia*, *Celmisia*, *Carmichaelia* and *Astelia*. Among Australian genera, not previously found in New Zealand (as distinguished from Australasian), new or old species have been recorded of *Actinotus*, *Liparophyllum*, *Caleana* and *Calochilus*.

I have not entered into strict criticism of the late Prof. Kirk's work, because, had he been spared, he might have corrected errors and made good many omissions; but I may mention that the derivation of generic names is partially given; the same of the native countries of introduced plants; several published names have been overlooked; and a key to the species of *Oxalis* is wanting.

The illustrations referred to in the opening sentence of this notice are to be issued in a separate volume. They will include the unpublished Banksian copper-plates of New Zealand plants, kindly placed at the disposal of the New Zealand Government by the Trustees of the British Museum. I may note in this connection that the Trustees have now made provision for the reproduction of the whole of the valuable collection of plates, about 700 in number, engraved at the expense of Sir Joseph Banks, but never printed; and illustrating the botany of Cook's voyages.

In conclusion, I may add that Mr. Hamilton's list of the flowering plants will be found useful, as it contains references to the place of publication, mostly in the

Transactions of the New Zealand Institute. In consequence of the want of a good botanical library, some species described in European publications are not included. W. BOTTING HEMSLEY.

ENCYCLOPAEDIA BIBLICA.

Encyclopaedia Biblica. Edited by Rev. T. K. Cheyne, D.D., and J. S. Black, LL.D. Vol. i. A to D. Pp. xxviii + 572. (London: A. and C. Black.)

IN this work we have an illustration of the fact that similar ideas spring up contemporaneously in different minds. In the same year in which Dr. Hastings' "Dictionary of the Bible" reaches its second volume extending to the letter K, we have the first volume of the work here under review issued to the public. Both have their source and publishers in Edinburgh, testifying to the high interest which Scotland has ever shown in Biblical criticism and Biblical subjects. To us it appears that both works are very much on the same lines, though the writers of the articles are for the most part different, and include those of other nationalities besides British. It would be difficult to say why one of these works takes the title of an "Encyclopædia" and the other of a "Dictionary," as the articles in both are equally elaborate and comprehensive. Perhaps, in the case of the latter, the idea of a dictionary, as first contemplated, gradually expanded in the minds of the editors, and under force of circumstances, till it became merged in that of an encyclopædia; the more recent work has had the advantage of starting with the more ambitious title. Both works, however, have had their origin in the late Dr. Smith's invaluable "Bible Dictionary," which for many years past has been a companion to students of Holy Scripture. But so great has been the advance in the critical study of the sacred pages, as well as in our knowledge of Bible lands, for which we are largely indebted to the labours of the committee of the "Palestine Exploration Fund," that a new work embodying these investigations has become a necessity which the authors of both the Dictionary and Encyclopædia have endeavoured to meet.

In looking over the subjects bearing upon natural history and topography within the compass of this volume, extending to the letter D, we observe little that requires criticism. The word "adamant" is considered to be corundum rather than the diamond, which was unknown out of India till the time of Alexander's successors; at the same time it is not impossible that the stone translated diamond in Exodus xxviii. may have been simply quartz, or rock crystal, which is inferior in hardness to either corundum or the diamond, and, therefore, capable of being engraved with the name of one of the tribes. Needless to observe that the rendering into Greek, Latin or English of the precious stones of the Old Testament will ever be attended with much uncertainty.

The description of the Dead Sea by Prof. Gautier is lucid and correct as regards its present condition; and we are glad to observe that he gives no countenance to the view that the waters of the Jordan once ran into the Gulf of Akabah, which would have required that their surface n the position of the Dead Sea must have risen, not only to the level of the Red Sea and Mediterranean, which was the case, but higher by about 650 feet; of this supposed high level there is no evidence in the form of old terraces in the Arabah Valley, as is the case with regard to the Mediterranean level. The geological changes which have brought about the formation of the Dead Sea basin may be looked for in a future volume, under the head of Palestine.

Under Deluge the various myths and legends found in countries widely separated are related in much detail by Dr. Cheyne and Prof. Zimmern. That the Hebrew tradition, as contained in Genesis, had its origin in Babylonia there can be no doubt, as the late Mr. George Smith has shown in his remarkable work, "The Chaldean Account of Genesis" (1876). But the question still remains to be decided—whether the original story had its origin amongst a myth-generating people or in the tradition of an actual physical catastrophe, such as a great inroad of the sea due to subsidence of the land in prehistoric times. This latter is the view taken by Lenormant in "Les Origines de l'Histoire," supported by Sir J. William Dawson, and more recently by Sir Joseph Prestwich. The Biblical story of the Deluge is necessarily restricted to the Euphrates Valley; but the more widely extended tradition seems to imply a more extended region wherein there was a submergence of the lands during the human period. Of such submergence we have ample evidence in many countries, including the British Isles, Northern Europe and Scandinavia, the Nile Valley, and Western Palestine. Such movements have left their vestiges in the high-level gravels with existing shells, and are certainly of more recent date than the early Glacial stage, the close of which may be assigned as the age of man. According to Dawson, this subsidence of the land after a period of high elevation brought about the extinction of palæocosmic man, an inhabitant of caves, and a mighty hunter before the Lord, like Nimrod. We must beware of watering down what is really founded on a historic basis in the Bible into legend. When we find the patriarch Abraham treated "not so much an historical personage as an ideal type of character, on the ground of the 'dreamy, grand, and solemn' impression which this patriarch makes upon us," we may well pause and ask whether this process of idealism is to extend to succeeding characters, such as Isaac, Jacob, Moses, David and the rest; and whether the whole of the Old Testament is not to be regarded in the same light as the "Æneid," the "Odyssey," or "Paradise Lost"? We protest against this extravagance of criticism. Whatever may have been the mythical origin of the earlier chapters of Genesis, the historical narrative clearly commences with the call of Abraham, and the history of that "grand personage" claims to be treated with as much scrupulous deference as any personality of ancient history. As Prof. H. E. Ryle observes—

> "the endeavour to find in Abraham's story a philosophical description of abstract qualities seems to presuppose a stage of literary development to which the materials of the Hexateuch can make no claim, and to desiderate a literary unity which those materials emphatically contradict."

With such exceptions as the above the work must be accorded very high literary merit coupled with wide research. E. H.

OUR BOOK SHELF.

Statistical Methods; with special reference to Biological Variation. By C. B. Davenport, Ph.D. Pp. vii + 149. (New York: John Wiley and Sons. London: Chapman and Hall, Ltd., 1899.)

THIS little volume is a kind of "Molesworth" for the statistical biologist. Some two-thirds of the book are taken up with numerical tables (ordinates of normal curve, probability integral, gamma functions, squares and cubes, logarithms, &c.), a brief introduction, giving an outline of methods and formulæ, occupying only the first fifty pages.

The idea is a good one, and the tables, collection of formulæ, &c., are arranged in a handy form. The introduction should, however, be subjected to revision before the next issue. The sentence on p. 19, "Here x is the actual deviation from the mean expressed in the unit of the maximum," appears to be an abbreviation of "x/σ is the deviation from the mean expressed in the unit of the standard deviation, and y/y_0 the ordinate in the unit of the maximum," or some such sentence. The y_0 on p. 22 should be defined as the ordinate at the origin, not the mode; it is not the modal ordinate, *e.g.*, in Type IV. The methods of measuring correlation do not necessarily depend on the assumption that the frequency-distribution is normal (p. 30). The author does not appear to have fully grasped the physical meanings of correlations and regressions, as he speaks of them as interchangeable (p. 36), for the correlation coefficient always measures the approach towards a single linear law true for every case, and ranges only between ± 1, while the regression coefficient measures the average alteration in one variable corresponding to unit alteration in the other, and may take any value. The word "binomial," on p. 38, appears to be a misprint for bimodal. On p. 33 we notice a lengthy method, quoted from Duncker, given for reducing the product-sum; this should be replaced by the ordinary straightforward process of reduction to the mean. The definition of the probable error, on p. 14, needs revision; it is not a measure of "closeness of approximation to the truth," but of degree of unreliability.

In a subsequent issue the author might reconsider the question of retaining some sections. New and untried suggestions of measurements and indices are, in our opinion, somewhat out of place in a reference pocket-book. These remarks apply to some sections of chapter i. and chapter iii. ("Index of Isolation"), &c., and from the same point of view the brief chapter v. is hardly necessary.

The selection of tables seems very good; the only addition we would suggest is a brief table giving probable errors of the correlation coefficient.

Evolution of General Ideas. By Prof. Th. Ribot Translated by Frances A. Welby. Pp. xi + 231. (London: Kegan Paul and Co., Ltd., 1899.)

PROF. RIBOT is a leading exponent of the newer experientialism which, having mastered the lesson of evolutionist theories, declares for continuity through transformism. All that he writes is lucid and suggestive, and the course of lectures here translated is a characteristic contribution to psychology.

A dissociative act of attention brings some one element in a presentation into high relief, while reducing the rest by impoverishment to a residual form. This is abstraction, and, where we have a fusion of abstracted resemblants, we get generalisation. These processes have three stages: first, that to be found in brutes, infants, and deaf-mutes. With these we have the generic image, best known through the composite photograph. We have what is sometimes called inference from particulars to particulars, and we have analogy. But there is no use of the sign, no method involving substitution. Second, a phase of mean abstraction, where the image is associated with the word, increasing stress being laid as we proceed upon the latter, though it never becomes a pure symbol. Third, a stage of advanced abstraction, where the accompanying perceptual imagery is already symbolic, while at last there is no consciousness of any.

The second stage is introduced by a chapter on speech, which is of some interest. The third is discussed in relation to Prof. Ribot's personal inquiries into types of ideation. When asked for replies within a few seconds as to what they experienced when such terms as "cause" and "animal" were suggested, more than a hundred persons gave answers, of which the visualisation of the printed word, the sound of the spoken word, and alleged vacuity were the farthest from unsymbolic picturing. He seems not to have come across the "Je ne pense qu'en parlant" type. His connection of the *flatus vocis* of extreme nominalism with verbal imagery reminds us of his clever association elsewhere of Berkeley's idealism with visualisation. In his insistance that symbolic or substitutional thought implies the actual existence of that for which it is substituted, he shows the dependence for him of psychological appearance upon a wider psychophysiological reality, and effects the transition to a future treatment of the unconscious. In a further chapter Prof. Ribot traces the development of such concepts in the algebra of thought as space, time, cause. Here, as in his account of the universal as such, he is handicapped by the exclusion of epistemological and metaphysical considerations. A short paragraph would have shown the irrelevance of Kant's apriorism for a psychology such as the present. The notes on metageometry are too short if they are to find a place at all. Some of his terms trespass on other people's rights, *e.g.* "the *logic* of images," "schema." The translation is well done, though probably "experiential" would be better than "experimental" in more than one place.

H. W. B.

Handbook of Optics for Students of Ophthalmology. By Prof. William Norwood Suter, B.A., M.D. Pp. viii + 209. (London: Macmillan and Co., Ltd.)

Optics: A Manual for Students. By A. S. Percival, M.A., M.B. Pp. x + 399. (London: Macmillan and Co., Ltd.)

PROF. SUTER gives a simple and yet clear account of the science of optics, as applied to the most important problems connected with ophthalmology. The study of the eye as an optical system has many points of interest, both for the physicist and for the medical student. In many works on optics only scant consideration is given to this part of the subject, so that the book before us may be said to fill a recognised gap in scientific literature. Its value would have been greatly enhanced, however, if measurements in connection with the various optical constants of the eye had been considered in greater detail. Mr. Shelford Bidwell's researches on the formation of multiple images in certain circumstances, due to the cellular structure of the eye, might have been mentioned with advantage; but it is, perhaps, hardly fair to criticise a book of the dimensions of the one before us for errors of omission. A serviceable index has been provided.

In a few cases, the descriptions might have been improved. Thus, on p. 42, line 7, the expression "the planes perpendicular to the curved surfaces" should read "the planes tangential to the curved surfaces." On p. 37, line 10, the term "centre of the refracting surface" might be altered, with advantage, to the "centre of curvature of the refracting surface." Mathematical expressions such as the following (see p. 44) are likely to cause unnecessary trouble:—

$$AF_1 = \frac{r}{n-1} = F_1$$

where the symbol F_1 is used, in a single formula, to denote both the position of a point on the diagram, and the distance of that point from another point A. With a few such exceptions, however, Prof. Suter's book handsomely fulfils the purpose for which it was written.

The aim of Mr. Percival has been to supply the reader, within reasonable compass, with such a knowledge of optics as would be of use to an ophthalmic surgeon. The author further expresses a hope that mathematical students may find it useful as an introduction to more advanced works on geometrical optics. The subject is treated throughout, from a mathematical point of view, in a manner that leaves little to be desired. An ophthalmic surgeon might possibly prefer to have the subject presented less from the mathematical, and more from the physical point of view; whilst a student of physics would probably wish to see greater prominence given to experimental methods. Lord Rayleigh's investigation on the advantage of stopping out the middle of a lens, in preference to its peripheral region, is not mentioned. Further, the name of Helmholtz is not mentioned in connection with the ophthalmoscope. But the most serious blemish is the total absence of an index; this absence is particularly damaging to a book which, from its nature, should serve as a work of reference. The type and general structure of the book are otherwise admirable. A few sentences, such as the following, could be improved:—

"The *first principal focus* (F_1) is the point on the principal axis where the incident rays intersect, or would intersect if produced, which emerge from the system parallel to the axis" (p. 253, lines 6–9).

"The two nodal points are mutually the image of each other" (p. 253, lines 30–31). E. E.

A Practical Introduction to the Study of Botany; Flowering Plants. By Prof. J. Bretland Farmer, M.A. (London: Longmans, Green and Co., 1899.)

PROF. FARMER'S work is that of an expert dealing with a science with the details of which he is thoroughly familiar, both as a student and as a teacher. Its pages show the firm grasp that enables him to make clear even abstruse parts of the science, and that gives confidence to those who use the book with the care and close attention that it deserves. The plants employed as examples are excellently selected, and the necessity of verifying each point described upon the plant itself is constantly enforced. The discipline and information gained by any one that works honestly through the course of study here planned out will be found most valuable as a sure base on which to build up a thorough knowledge of botany. The woodcuts are good, but might have been more numerous with advantage to those that use the book without the aid of a teacher. In the absence of figures a beginner may, if unaided, find it difficult to obtain some of the plants named, though the selection has been very largely made from species that ought to be known to most people of ordinary education. The use of technical terms is restricted within due limits, and their meanings can be gathered from the examination of the specimens in connection with which each is first employed. The procedure to be followed in the examination of the specimens and in the experiments in physiology is simply and clearly explained, though here and there one meets with evidences of haste or pressure.

Primeval Scenes; being some Comic Aspects of Life in Prehistoric Times. By Rev. H. N. Hutchinson, B.A. Illustrated by J. Hassall and F. V. Burridge. (London: Lamley and Co., 1899.)

THE drawings in this volume are similar in character to the amusing "Prehistoric Peeps" contributed to *Punch* by Mr. E. T. Reed a few years ago. In preparing his drawings, Mr. Reed worked to produce striking effects; and as there is artistic as well as poetic licence, he was justified in introducing into his pictures any objects which would appeal to the sense of the ludicrous. But to the mind of the palæontologist, a picture containing prehistoric humans in company with such old forms of life as Pterodactylus and Stegosaurus, and creatures which had their origin in the artist's imagination, appears a trifle grotesque, though it may afford amusement to thousands of persons who do not understand the incongruity of the arrangement of characters depicted.

In the present volume an attempt is made to combine instruction and amusement by representing creatures in various comical aspects which were possibly all seen by some of our primeval ancestors. In other words, the drawings are in keeping with the discoveries of prehistoric archæology and the facts of geology. Twenty scenes are depicted, and adjacent to each is a brief description of the chief characteristics. The pictures are, in the opinion of the writer, not to be compared as regards their diverting character with Mr. Reed's inimitable sketches, and the descriptions which accompany them are of too general a character to call for criticism. But the scientific accuracy of the drawings in so far as they represent animals which are known to have been contemporaries of man is certainly a merit; and for this reason the book is a suitable present for a boy with scientific predilections and a lively imagination.

A Treatise on Surveying. Compiled by R. E. Middleton, M.Inst.C.E., and O. Chadwick, M.Inst.C.E. Part i. Pp. xiii + 283. (London: E. and F. N. Spon, Ltd., 1899.)

THIS work seems to have had its origin partly out of consideration for the needs of surveyors whose home-training is too restricted to qualify them for colonial appointments, where a knowledge of geodetic work is required, and has in addition no less an object than the raising of the standard of qualification for English diplomas in surveying. We are told that the Council of the Surveyors' Institute was approached by the authors and others interested in these matters, and agreed to adopt this text-book if satisfied with it, but we are left in doubt as to whether it has received the approval of that body.

A general idea of the scope of the present volume may be gathered from the titles of the chapters, namely, "chain surveying; optics, magnetism, &c.; description and adjustment of instruments; traverse surveying; minor triangulation; the plane-table and methods of using it; levelling and contouring." Geodetical and astronomical determinations, as well as marine, route, and other special surveys are left for the companion volume, so that the form of publication is well suited to the requirements of the two chief classes of students. We find the explanations of the various instruments, processes, and principles sufficiently full and clear, while sound practical methods of making and entering observations and presenting the final results are given throughout. No particular originality is claimed, but the special merit of the book lies in the great care with which the compilation has been made, and the thoroughly practical spirit which pervades it. It certainly makes a good bid for a place among standard text-books.

The X-Ray Case Book, for Noting Apparatus, Methods and Results. By David Walsh, M.D. (London: Baillière, Tindall and Cox, 1899.)

FORMS are provided for recording the electrical and photographic conditions under which Röntgen photographs of medical and surgical cases are obtained, and for the entering of notes on the points brought out by an examination of the photographs, or by visual observations with a fluorescent screen. Full diagrams of the human body are given for convenience in recording observations.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Proposals of the Stockholm Fisheries Conference.

As one closely connected with scientific fisheries work on the North Sea, I cannot help taking a keen interest in the proposals that emanated from the Stockholm Congress, and in the criticisms that have appeared in NATURE on those proposals. These criticisms have been decidedly adverse, and readers of this journal who take an interest in fishery questions and research, but who have not been in a position to obtain the knowledge necessary to judge fairly the points in dispute, will naturally feel somewhat perplexed over the difficulties that have arisen. As the matter is of the greatest importance to Great Britain, with its large fishing industry, this perplexity is to be regretted, because it is very necessary that something like unanimity should obtain amongst those who have charge of affairs. This unanimity will come with greater clearness on the points at issue, and in order to aid towards this clearness I would ask your permission to allow me to continue the discussion.

The criticisms on the proposals of the Stockholm Congress may be resolved into two portions—direct criticisms of an adverse kind on the proposals in part or as a whole, and counter-proposals which it is considered the British Government should accept in preference.

Under the first heading come the criticisms of Prof. Herdman, and with them we may begin. Prof. Herdman considers that too much stress is laid on the hydrographical and meteorological work than on the biological. Two reasons may be given for this criticism. Firstly, at the present time, the biological investigations of the fisheries in the North Sea are in certain respects in a more advanced state than the hydrographical and meteorological. On such questions as those of migration, for example, many facts have been accumulated and theories founded thereon, but we are at a loss to follow up the investigations and test the theories because trustworthy statistics of the meteorological conditions—direction of the surface and deep water currents, temperatures in different places at different depths, fluctuations in salinity, and so on—are utterly lacking. Hence, biologists should really welcome this work, and not object to its seemingly greater prominence. This work, however, was not intended to hinder the further prosecution of strictly biological research, and here we come to the second reason for Prof. Herdman's criticism.

He does not seem to have fully appreciated the scheme proposed by the Congress under the heading of "The Biological Work." He says: "Surely what we need most at the present time in the interest of more exact fisheries knowledge, is the nearest possible approximation to a census of our seas—beginning with the territorial waters. Most fisheries disputes and differences of opinion are due to the absence of such exact knowledge. . . . The Stockholm report unfortunately says nothing to the point in regard to all this."

Now, the Stockholm report states clearly and definitely what is wanted, and how we are to obtain it. Under "Biological Work," in addition to other practical recommendations for the taking of this "census," under Parts I. and II., III.(*a*) and III.(*b*), run:—

"It is desirable to collect uniform statistics of the number, weight, and value of the fish landed, of the means of capture, and of the persons engaged in the industry; for example, as in the General Reports of the Scottish Fishery Board."

"It is desirable to collect material for the preparation of maps, showing the fishing grounds and the kinds of fishing there practised."

Under "A.—The Hydrographical Work," further recommendations are given under VI.–X. as to the taking of the "census." As these recommendations are quite clear, and fully cover the ground of all research into the total numbers of fish, the varying numbers at different times and places, as well as the total quantities of the different forms of fish-food and their fluctuations at different places and seasons, it seems impossible to ask for anything more. What more does Prof. Herdman see under the word "census"?

That Prof. Herdman has not fully weighed the scheme proposed is again shown in his statement, "Part of the report is called a programme of work, but it contains no definite programme of biological work." It is needless to discuss this until we have Prof. Herdman's conception of a "definite programme" before us, and then we shall be able to compare the two. If Prof. Herdman can show a better, more definite and workable programme, it is only right that he should do so after passing such criticism on the other.

"In my opinion," says Prof. Herdman, "what we want is not conferences, or committees, or a central bureau, so much as boats and men, *and work at sea*." This catches the eye at once as being eminently practical, but surely Prof. Herdman does not mean that the Congress did not contemplate the use of "boats and men, *and work at sea*"? But he fears evidently that an "opportunity" is being lost because the Congress has advocated the formation of the central organising body before starting to actual work. But where so much has to be done, so many different studies to be organised, so many different arrangements and experiments to be made, we should rather approve of the methodical and calculating arrangements of the Congress, even though for the moment progress is *seemingly* slow, just as we approved of the slow but certain progress of General Kitchener to Khartoum.

As Dr. Murray has ranged himself with Prof. Herdman in his criticisms, and as his proposals can be discussed under those of Mr. Allen, I trust he will not think it from disrespect that I pass on now to the points raised by Mr. Allen. These have been thought out with great care, and one cannot but acknowledge his fair and generous method of treating the subject. The general plan of the investigations is approved of, and only on minor points can there be differences of opinion. The matter of the areas of investigations will assuredly come under reconsideration, as he suggests. The only question—and the chief one—that will repay discussion, is that of the "central bureau."

Mr. Allen recommends that the British Government, in order to give effect to the proposals of the Congress, should first of all co-ordinate the work of the different stations in the British Isles. (Would this not harm their "originality"?) When this is done, the "essential requirements" are a sufficient number of capable naturalists and sea-going steamships efficiently equipped. The experts of the different countries would meet once a year in order to co-ordinate the investigations and insure uniformity of method This scheme is contrasted with that of the Congress, and it is maintained that the establishment of a "central bureau" is too elaborate and expensive.

Now, if Mr. Allen had restricted himself to asking further particulars regarding the central "laboratory," one would have taken no exception to his remarks; but since he objects to what seems very necessary—namely, a central body to organise and keep the different researches and departments in actual touch with one another, to do the secretary work and look after the printing of reports, &c.—one must turn and ask what he intends to put in its place. Mr. Allen surely does not think that a meeting of experts once a year is equally adequate?

Until Mr. Allen unfolds this part of his scheme a little further, we may regard certain other aspects of it. No one will deny that the co-operation of the various marine stations in England for definite fisheries work would be of immense value; but why has this not been considered and done before? Again, if this scheme were effective and less expensive than that proposed by the Congress, would the representatives of the other countries not have taken it into consideration? These representatives have had much greater experience of fishery work than Mr. Allen has had, and a much better notion therefore of what is needed, and it is unlikely that they would ask their Governments to pursue a course which is more expensive than another equally effective. This is said without intending any disrespect for Mr. Allen; it is merely drawing a comparison between two experiences, and the comparison tells against Mr. Allen.

Again, is Mr. Allen's scheme workable and adequate to the work that is wanted? It should be remembered that Great Britain has not been asked to co-ordinate its various small marine stations, however desirable this may be. It has simply been asked to carry on a certain programme of work for a period of five years at least. The course of events, let us imagine, will be somewhat as follows:—The Scottish Fishery Board will be asked by Government to carry on a certain amount of routine hydrographical work, with the instruments suggested and the methods proposed, at certain periods of the year over the area prescribed, also biological plankton investigations similarly. What extra expense this will be to the Board it is not for me to say; but with its staff and knowledge of the methods to be employed, the experience and equipment it has at its command, this will not be anything very great. There is no necessity here for co-ordinating, first of all, the work that might be done at St. Andrews, Millport, and Granton. These places will carry on their own work in their own way, because biological research must always be acceptable. But, if the Fishery Board should desire any special work to be done at those stations, it has the staff, the knowledge of ways and means, and the funds at its disposal, and the work will be done.

England, unfortunately, is not prepared to the same extent. It has no central body whose knowledge and experience of fishery work in this and other countries could command the co-operation of the different stations. It is doubtful also whether the biologists in England have worked on the methods suggested by the Congress. If so, they have not yet published any results. They are so far removed, further, from the centre for work, viz., the North Sea, that their work is formed on a different plan; they have not the same aims, and they do not look at fishery problems as the biologists along the coasts of the North Sea do. And it is a curious comment on this condition of England, that on its East Coast—from which as much fishing is carried on, and where the value of the fisheries is as great, as in all those of the other countries round the North Sea combined—it is curious that there is no station there which can adequately take up the work proposed, and that a great part of this coast is ascribed to Holland as within its area of investigation. All this is said without intending any disrespect whatsoever to Mr. Allen, but it comes to one's mind in reading over his proposals.

The co-operation of the marine stations in England would not remedy this. "A central bureau" for England alone would require to be established, with experienced trained men at its head. This would take much time and money, and when Great Britain has been offered a "central bureau" of more power and value at a less cost, there can be little doubt for which the Government will decide.

Without intruding further upon your space by entering into the advantages of the organisation proposed by the Congress, and of co-operation with foreign countries, let me, in conclusion, express my earnest desire to do justice to both sides. If Prof. Herdman can prescribe a better programme of work, if Mr. Allen can show a better organisation, then let us have them by all means. The British Government will then have two definite schemes to consider, and if it finds it cannot decide between the two, then let us have two definite rival organisations, each doing its best with the means at its disposal to add to the knowledge and power of our country. Here we should be at one, and rivalry will not be tinged with envy or bitterness, but stimulate to greater exertions, and breed that respect and community of sentiment which springs from a common ideal and hard work well done. H. M. Kyle.

Naples, December 8.

Supposed Daylight Leonids.

The interesting details referred to by Dr. W. J. S. Lockyer (Nature, December 7) of a shower of Leonids having been witnessed by Miss Jeans and others at Swindon, and by Mr. E. Shaw at Aveley, in Essex, on the afternoon of November 15 last are corroborated by several other descriptions of a similar nature which recently appeared in the newspapers. One of these referring to a later date, was published in the *Liverpool Echo* of November 21, and runs as follows:—

"Sir,—Not having seen any account in the papers concerning the arrival of the meteoric showers, I beg to state that I saw them on Thursday afternoon, the 16th inst. I first noticed them at 12.15; they were shooting in all directions and kept on until about 4 o'clock. Then on Friday, the 17th, I again saw them at the same time. I called the attention of several people, with the result that they could also see them. Owing to the bright sky, one had to stare for a few seconds before perceiving the stars, as they were very dazzling to the eyes.

"Yours, &c.,

"Liverpool, November 20." "Mima Arden.

I need not quote any further descriptions, for there is not the slightest doubt that the objects were illusory and had nothing whatever to do with the November meteors. On November 15 the radiant of the Leonids sets at 2.30 p.m., so that the observations of Mr. E. Shaw (quoted by Dr. Lockyer), Miss Arden and some others are entirely put out of court, for we cannot have a shower of Leonids with the radiant below the horizon.

The objects seen must have been purely imaginary, and they may be easily produced by bending the neck and gazing intently for a few minutes at a bright sky. I have observed many of these spectral meteor showers on occasions when I have been looking for Venus or some other object in bright daylight.

It is astonishing that if one calls the attention of people to imaginary phenomena of this kind and asks them to look, they will, in ninety-nine cases out of one hundred, see the same thing and encourage similarly mistaken ideas! Yet if we observe an unequivocal object, it is often very difficult to make others perceive it and comprehend its character and the nature of the observation. Fictitious objects are in point of fact often seen more readily and apparently under more convincing aspects than real ones, but this applies usually to inexperienced observers.

In addition to the two reports of the recent shower of Andromedids mentioned in the last number of Nature, there is a third from Austria (*Daily Chronicle*, November 25). It appears that the astronomers of the Vienna observatory, watching the sky "from the beginning of evening up to moonrise, saw sixty-seven shooting stars, mostly from Andromeda. A magnificent fireball was also observed shining in the constellation. Twelve photographs were taken." W. F. Denning.

Bristol, December 8.

Birds Capturing Butterflies.

Referring to the letters on this subject in your papers of September 28 and November 16, I can certify to the fact of robins chasing and catching large white butterflies on the wing and swallowing them whole. In June we had ten robins coming freely to the hand for food, and thus had frequent opportunities of observing them daily. My gardener and his son have witnessed the same habit of the robins. Howard Fox.

Rosehill, Falmouth, December 7.

VALVE MOTIONS OF ENGINES.

Engineers want a diagram which for any position of the main crank of a steam engine (the angle θ which it makes with the inner dead point being given) shows at once, with sufficient accuracy for practical purposes, the position of the piston in its stroke, and the distance of the valve from its mid position. This is a mathematical problem. Men who are cunning in geometrical constructions ought to help the engineers; but hitherto they have not done so. In the hope of enlisting their services I venture to put before the readers of Nature the only easy construction with which I am acquainted. It has never before been published, except to his students, by the inventor, Mr. J. Harrison, of the Royal College of Science. Until I became acquainted with this method, I used a very laborious method of working, which necessitated the drawing of sine curves of different periods as described in my book on "Steam."

It will save trouble in expressing my meaning if I assume a uniform rotation of the crank. If we assume that the motions of piston and valve are simple-harmonic, a construction is very easy. When the valve is worked directly by an eccentric its motion is very nearly S.H., and in this case a construction, taking account of the shortness of the connecting rod, is easy.

But, as I have been trying to impress upon students for many years, when a valve is worked by any ordinary link motion or radial valve gear, the motion is not simple-harmonic; there is a small octave or kick of twice the fundamental frequency, and if this is taken into account, as well as the fundamental S.H. motion, it will be found that higher harmonics are of very little importance. Now in radial valve gears it is not at all difficult to write down the values of the terms a, α, b, β of the following expression from mere inspection of the gear. In link motions it is more difficult at present, but we are already seeing our way to easy rules. Here, then, is the problem which Mr. Harrison has solved :—

Given the ratio of length of connecting rod to that of the crank. Given that the distance of the valve to the right of its mid stroke (Fig. 1) is

$$y = c + a \sin(\theta + \alpha) + b \sin(2\theta + \beta),$$

b being small in comparison with a, show on a diagram the position of the piston and the value of y when θ has

For any value of θ: Make AOK $= \theta$, project K vertically to P; P shows the position of the piston, EP is its distance from the beginning of its stroke. OK cuts the valve circle in Q. The perpendicular distance QN of Q from DC_1D' is y, and the part of it QM is the opening of the left-hand port to steam. Similarly, in the *out* stroke, when the crank has passed through the angle AOK′ which is greater than 180°; project K′ to P′ to get the piston position in the out stroke. Let OK′ cut the valve circle in Q′; then the perpendicular distance Q′N′ is the distance of the valve to the left of its mid position (Fig. 2), and Q′M′ is the opening of the right-hand port to steam.

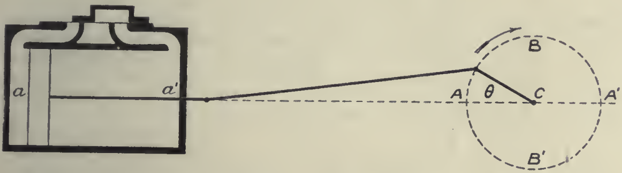


FIG. 1.—A is called the inner dead point. A′ " outer " "
The motion from a to a' is called the *in* stroke. " " a' to a " *out* "

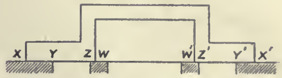


FIG. 2.—Valve shown in the middle of its stroke. X Y and X′ Y′ are the *laps* (sometimes called the *steam laps*). Z W and Z′ W′ are the inside laps (sometimes called the *exhaust laps*).

any value. Further, the laps XY and X′Y′ (Fig. 2) being given, show on the diagram the amounts of opening of the ports to steam, these being obtained by subtracting the laps from y or $-y$.

With centre C (Fig. 3) and radius CA or CA′ representing the crank, describe the crank circle ABA′B′. Draw BCB′ at right angles to ACA′. With centre on CA produced, and radius equal to length of connecting rod, describe the arc BOB′. Make angle $COC_1 = \beta - \alpha$ and $OC_1 = 2b$. We give the name "false centre" (relatively to both circles) to the point O.

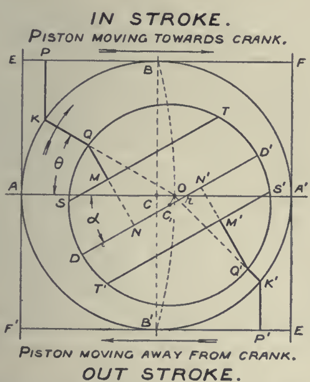


FIG. 3.—Mr. Harrison's diagram showing positions of piston and valve when crank makes an angle θ with inner dead point. The valve displacement to right of mid position (Fig. 2) being y, where $y = c + a \sin(\theta + \alpha) + b \sin(2\theta + \beta)$.

With centre C_1 and radius a, describe the circle DQD′Q′. Draw DC_1D' making an angle with AA′ equal to α. Draw ST parallel to DD′ at a perpendicular distance from it equal to the lap XY of Fig. 2. Draw S′T′ also parallel to D′D at a perpendicular distance from it equal to the lap X′Y′ of Fig. 2.

Draw tangents at A, B, A′, B′. In the *in* stroke of the piston, when the crank moves from A to B to A′, let us show on EF the positions of the piston, and in the *out* stroke, when the crank moves from A′ to B′ to A, let us show on E′F′ the positions of the piston.

It is easy to see how we get the openings of the ports to exhaust in exactly the same way. Lines joining O with S, T, S′, T′ show the angular positions of the crank when admission and cut off take place. In fact, we see that this diagram gives us the positions of the piston when admission, cut off, release and compression occur both in the *out* and *in* strokes. It gives us an easy way to study how changes in b and β enable us (even when the laps are equal) to balance, or even more than balance, the inequality of admission of steam on the two sides of the piston due to shortness of connecting rod.

It is easy to see how such a diagram may be modified for problems concerning cut off valves on the back of the main slide valve.

The same expedient of false centres may be used to show the velocity or acceleration of a slide.

In a modified diagram Mr. Harrison sometimes lets the two circles coincide, using two false centres.

The solution is a close approximation to the truth in all the usual cases, because b is always small in comparison with a.

JOHN PERRY.

INSECTS AS CARRIERS OF DISEASE.[1]

THE recent researches of bacteriologists into the *rôle* played by insects as carriers of infection, and the hunt after microbes to locate their natural habitat, is a necessary procedure before it becomes possible to enter on a scientific crusade against them. In those diseases which may be caused by infection carried by insects, it is a more hopeful task to deal with the insects which we can see, than to deal with the microbe which lurks unseen and unheeded. At the same time, it is an uncomfortable thought that insects which we have regarded as undesirable but harmless may be the cause of a serious illness.

The bacteriologist has now shown a fair-sized category of diseases to be caused by microbes, and having arrived so far the hygienist steps in and wants to know firstly, what is the habitat of these microbes outside the human or animal body if they have one, and secondly, by what means they are conveyed to the body from their resting-place outside or from one patient to another?

[1] "On the *Rôle* of Insects, Arachnids and Myriapods, as carriers in the spread of Bacterial and Parasitic Diseases of Man and Animals. A critical and historical study." By Dr. G. H. F. Nuttall (from the *Johns Hopkins Hospital Reports*, vol. viii.).

That certain diseases may arise from the "bites" of insects has been surmised long before the microbial origin of disease was known, many theories were naturally based on insufficient evidence because the key to the riddle had not then been found. In some of the earliest records of epidemics any concurrent phenomena was thought to be the cause, thus the plague at Nimeguen, in Holland, in the seventeenth century, was said to be announced by swarms of insects and meteors.

All observations are of use, although in the light of present knowledge they may not bear the same interpretation as was originally put upon them; as a suggestion for investigation by experimental methods they may serve a purpose.

Dr. George H. F. Nuttall in this monograph has been at great pains to collect observations on the point from all sources, and has supplemented these with some experimental researches of his own.

Insects—using the term in its popular sense—may play a passive *rôle* in the propagation of disease. It is obvious that flies, for instance, after soiling their bodies in contaminated matter, may afterwards infect articles of food, especially milk; and no doubt many cases of typhoid fever are caused in this way. In India, where typhoid fever attacks so many of our troops, the refuse matter is placed outside the camp, and it has been suggested that articles of food in the camp might become infected by dust carried by the wind when it blows from the direction of the refuse matter; but it is more than likely that flies carried by the wind play a more important part, for they would seek out the food. The same may be said of cholera; in fact, an instance is given where milk was left out in the open in a jail in India at the time of a cholera epidemic, and it became infected with the cholera microbe by means of flies, whereas milk left out in another yard where there were no cholera cases and which was separated from the other yard by a high wall did not become infected.

In playing an active *rôle* insects may conceivably cause infection by "biting" after having "bitten" an individual suffering from an infectious disease or after feeding on contaminated substances, for instance, the body of an animal dead of anthrax. Experiments in this direction do not seem to have been very successful in the cases of bugs and fleas, which were the insects experimented with; but it was shown that anthrax and plague microbes do not survive more than a few days at most in the bodies of the insects. Even if the "bite" of an infected insect is harmless, it might be otherwise if the insect were crushed on the spot bitten, and the place scratched; such a procedure might be fraught with danger supposing the insect had recently been feeding on infected matter.

With respect to the tsetse-fly disease in domesticated animals, there is conclusive experimental proof that the fly carries the micro-organism or hæmatosine in this case from diseased to healthy animals.

The filariae, according to Manson, go through changes in the stomach of the mosquito, and finally make their way out into water in which the insects have died, and man becomes infected by drinking the water. In this case and in malaria the insect seems to act as an intermediary host to man. The mosquito—of which one species, the anopheles, seems to be mostly concerned—takes up the organism in the blood of the malarious subject, and, according to Manson, infects soil or water by dying in it; Ross and others, however, say it infects healthy persons by biting them after biting a malarious patient.

It is interesting to note that most of our previous notions as to the localities and time of year that malaria occurs, and the precautions adopted to prevent being attacked still hold good, *mutatis mutandis*, for the mosquito theory. C. B. S.

ETHNOGRAPHICAL MUSEUMS.

IN NATURE of September 14, attention was called to the rapid progress of ethnographical museums in Germany, and to the unsatisfactory state of ethnography in our own country. Since that time two things have happened which confirm the view then taken of the position of our national collections.

In the first place, one of the distinguished keepers of the Museum für Völkerkunde in Berlin has recently visited London, and has stated that the enlargement of the museum or its supercession by a completely new building will be seriously considered in the near future. When it is remembered that the Museum für Völkerkunde is already so enormously superior to anything which we have in this country, that it stands absolutely in a class by itself, it can easily be guessed that the projected improvements threaten to leave us in a position of inferiority positively humiliating. For even as matters now stand, the German collections are nearly ten times as good as our own.

The second occurrence to which we have alluded, is the issue of a report upon European anthropological museums by Mr. George A. Dorsey, of the Field Columbian Museum, who made a tour of the principal European cities in the autumn of last year. Extracts from his report have been published in the form of a short paper in the *American Anthropologist* for July, 1899, and it is therefore accessible to every one who feels any interest in the subject.

Mr. Dorsey begins by complaining that the collections illustrating the various branches of anthropology in Europe are all scattered about in different buildings. In London, if you wish to study man as an animal, you must go to the British Museum of Natural History in Cromwell Road, or to the Royal College of Surgeons; if you wish to study primitive art and industry, you must go to Bloomsbury. In Paris you must wander from the Jardin des Plantes to the Trocadéro, and so on in other cities. The great fields of anthropology are nowhere adequately represented in a single building, and the advantages of concentration are lost.

After this preliminary condemnation, Mr. Dorsey proceeds to discuss several museums in detail. He has a well-merited word of praise for the Pitt-Rivers collection in the University Museum at Oxford, where the development of different branches of human industry may be studied in a manner impossible anywhere else. Coming to Berlin, he thinks that the Museum für Völkerkunde contains the largest amount of ethnographical material to be found in any one museum in the world; and he is inclined to believe that it possesses a greater number of specimens than any other two museums combined. The one drawback is that, large as the building is, it has long proved inadequate to the enormous expansion of the collections, and is in consequence terribly overcrowded. As we have already seen, this is an inconvenience which will in all probability soon be remedied.

Of the ethnographical collections in London, our American critic has naturally something to say. After noticing that, from the ethnographical point of view, London, like Paris, is disappointing, he continues: "The large hall [gallery] devoted to this subject in the British Museum is not well adapted to the purpose for which it is used; it is rather inaccessible, poorly lighted, and does not admit of a ready scientific classification of the objects therein deposited. Naturally, this hall contains many of the rarest and most valuable objects that have ever been obtained by any museum in the world; but owing to the causes already mentioned, and to the crowding of the cases, it is practically impossible for the visitor in a short time to form any idea of the value of the collection. There are many rare and unique specimens, but the collection as a whole cannot be regarded as well illustrating the various fields of ethnography. . . . It is to be regretted that the capital of a nation which embraces in its domain so many and such diverse peoples should not possess a museum which shows the ethnic characteristics of some of these peoples in an adequate manner."

Mr. Dorsey has returned to his own country convinced that in the matter of the housing and exhibition of anthropological collections the United States have nothing to fear from comparison with Europe. He thinks that there is no building in Europe so admirably planned for museum purposes as the American Museum of Natural History at New York. Here ample space for future expansion has been allowed on a scale unequalled in Europe, and large, well-lighted and commodious quarters have been provided for storage and workrooms. He truly says that numerous workrooms with abundant light should be an essential feature of every museum. It is clear that in the United States the study of ethnology is being pursued with the same enthusiasm as in Germany, and that it has succeeded in a similar manner in securing a large measure of popular support. Viewed in the light of these facts, the conditions of things in Great Britain appears doubly deplorable.

NOTES.

THE complimentary dinner given to Major-General Sir John Donnelly on Tuesday, by his friends and former colleagues of the Department of Science and Art, is a testimony of the esteem in which he is held by all who have been associated with him in the work of the Department. Sir John Gorst presided, and in proposing the health of the guest of the evening, he pointed out that in 1859, when Sir John Donnelly was entrusted with the control of the science branch of the Department, the total number of science students under instruction was 395, and the payments made on account of their instruction amounted to 2000*l*. In 1897, the number of students in Departmental classes was 197,796, and the grants amounted to 169,000*l*. These figures form the best of evidence as to the growth of the work of the Department under Sir John Donnelly's administration. In addition to Sir John Gorst and Sir John Donnelly, among other speakers at the dinner were:—Captain Abney, Major-General Festing, Sir Norman Lockyer, Prof. Rücker, Sir George Gabriel Stokes, and Rear-Admiral Sir William Wharton.

DRS. STEVENS AND CHRISTOPHERS, of the Royal Society Malaria Commission, left Liverpool on December 9 for Sierra Leone, where they will continue their investigations on malaria. At Blantyre, in East Africa, where they were before, they gave more attention to investigating the relation of malaria to blackwater fever, which is very prevalent at that spot. Many persons deny the connection between the two, but it is a point that still requires to be settled. On the West Coast they will probably investigate the disease from the point of view of the mosquito theory.

PROF. GEORGES LEMOINE has been elected a member of the section of chemistry of the Paris Academy of Sciences, in succession to the late Prof. Friedel.

THE following are among the lectures to be delivered at the Royal Institution before next Easter:—Mr. C. Vernon Boys, six Christmas lectures (specially adapted for young people) on fluids in motion and at rest, experimentally illustrated; Prof. E. Ray Lankester, twelve lectures on the structure and classification of fishes; Dr. W. H. Rivers, three lectures on the senses of primitive man; Prof. H. H. Turner, three lectures on modern astronomy; Dr. Charles Waldstein, three lectures on recent excavations at Argive Heræum (in Greece); Lord Rayleigh, six lectures on polarised light. The Friday evening meetings will begin on January 19, when a discourse will be given by Lord Rayleigh, on flight; succeeding discourses will probably be given by the Hon. C. A. Parsons, Prof. J. Reynolds Green, Mr. H. Warington Smyth, Prof. J. H. Poynting, Major Ronald Ross, Prof. Frank Clowes, Sir Benjamin Stone, M.P., Prof. J. Arthur Thomson, Sir A. Noble, Prof. Dewar, and other gentlemen.

AN agricultural conference for the West Indies will be held at Barbados on January 6 and 8, 1900. His Excellency, Sir James Hay, K.C.M.G., the Governor of Barbados, has promised to meet the representatives at Bridgetown on Saturday morning, January 6, and offer them a welcome to the island. Immediately after, the President (Dr. D. Morris, C.M.G.) will deliver the opening address, and the business of the conference will begin. A characteristic of the conference will be the presence of representatives of the leading agricultural societies in the West Indies. By this means it is anticipated that the conference will act as an educative agent of great value, and by enlisting the co-operation of those practically engaged in agriculture, its deliberations will have wider scope, and the influence of the conference will be more widely recognised. The list of subjects to be dealt with covers practically every branch of West Indian agriculture.

ORNITHOLOGY has suffered a severe loss by the death of Arthur Cowell Stark, M.B., who was killed by a Boer shell at Ladysmith on November 18. Dr. Stark was an ardent naturalist, and specially conversant with South African ornithology, having devoted many years to the study of the birds of the Cape Colony and adjoining countries. At the time of his death he had just completed for the Press the first volume of a work on South African birds, which is to form a portion of Mr. W. L. Sclater's "Fauna of South Africa." Dr. Stark was in England during the past summer engaged in the preparation of his book, but returned to the Cape in September last, and proceeded to Natal in order to continue his collections in that colony. When war broke out he offered his services as a volunteer on the Medical Staff, and was sent up to Ladysmith by the last train that passed the Boer army. Standing at the door of the Royal Hotel in Ladysmith, on November 18, he was struck by an exploded shell, and died shortly afterwards. Dr. Stark was a graduate of the University of Edinburgh, and a well-known member of the British Ornithologists' Union.

A CONGRÈS international des sciences ethnographiques will be held in connection with the Paris Exposition, on August 26–September 1, 1900. There will be seven sections, dealing respectively with general ethnology, sociology, and ethics; ethnographical psychology; religious sciences; linguistics and palæography; sciences, arts, and industries; descriptive ethnography. The treasurer of the organising committee is M. Leclère, rue Lecourbe, 54, Paris, and the general secretary, M. Greverath, rue d'Athènes 3 bis, to which address foreign correspondence should be sent.

THE essay on the scientific work of Lord Kelvin, contributed by Prof. G. F. Fitzgerald to an elegant volume just published by Messrs. James MacLehose and Sons, Glasgow, is a masterpiece of appreciative writing. The volume contains a complete account of the celebrations on the occasion of Lord Kelvin's jubilee as professor of natural philosophy in the University of Glasgow; it is thus of particular interest to the many friends who took part in the ceremonies, and to the scientific bodies who sent delegates and messages of congratulation. Preceding this report is Prof. Fitzgerald's essay, in which the nature and significance of Lord Kelvin's contributions to science are described with such remarkable lucidity that every one interested in the progress of natural knowledge would do well to read it. A striking photogravure of Lord Kelvin, from a portrait taken in 1898, forms the frontispiece, and a portrait is given engraved from a photograph taken in 1846. The volume will doubtless be treasured by Lord Kelvin's many admirers, as a slight tribute of regard for the versatility of his genius.

THE *British Medical Journal* announces that Dr. Yersin, whose name is well known for his researches on the plague, has been charged by the Government of Cochin China with a special mission to Java.

IT is reported in *Science* that the Russian Astronomical Society has finally given up its attempt to revise the Julian calendar. The reason assigned for its failure by the Society is "the impossibility of establishing an agreement between the dates of the religious festivals appearing in both calendars."

IN connection with the Institution of Electrical Engineers, a number of local centres are being established where papers will be read and discussed at the same time, or shortly after, their reading in London. In Cape Town these informal meetings have been held for some time past, and advance copies of the Institution's papers have been read at them. A meeting for the formation of a north-eastern centre was to be held yesterday at the Durham College of Science, and the Council have received a petition for the establishment of a similar organisation in Dublin.

WE regret to see the announcement of the death of Mr. N. E. Green, F.R.A.S. An artist by profession, Mr. Green was well known for his admirable astronomical drawings—especially those of Jupiter and Mars. On the occasion of the opposition of the latter planet in 1877 he went to Madeira, where he made a fine series of drawings, a selection from which was published in vol. xliv. of the *Memoirs* of the Royal Astronomical Society. A number of his drawings of Jupiter were reproduced in vol. xlix. of the same publication, and he left behind him a long series of unpublished lunar and planetary drawings. Mr. Green was President of the British Astronomical Association in 1897–98.

THE Institution of Electrical Engineers held their annual dinner on Wednesday, December 6, in the Hotel Cecil, Prof. Silvanus Thompson in the chair. Among the speakers was Lord Kelvin who proposed the toast of "Science." In the course of his remarks, he said:—When the electric telegraph came into practical existence in 1837, when ten years or so later the first submarine cables connected England and the Continent of Europe, and when another ten years or so saw the first Atlantic cable laid, electrical science in all the Universities of Europe was in a very backward state compared with the position in which it is now. A very great stimulus indeed was given to its study from its application to electric telegraphs, and especially to the great system of electric measurements which is so valuable now in pure science—a system which originated certainly not among practical engineers, but among University professors. Gauss and Weber gave from Germany the foundation of the system of electric measurements, the benefits of which are now enjoyed, and the first practical use of which was made in connection with submarine cables.

A PAPER on the manufacture of artificial silk or lustrocellulose was read by Mr. Joseph Cash at a meeting of the Society of Arts on December 6, and is printed in the *Journal* of the Society. A public company for the manufacture of this material by the Chardonnet process has been formed in England, and the factory will be capable when filled with machinery of producing 7000 lbs. of artificial silk per week. The first stage of manufacture is the nitration of cotton or wood pulp producing pyroxyline, discovered by Pelouze in 1838. The greatest care must be employed in conducting this operation, as it is the most important one in the whole process; mistakes sometimes even occur at the long-established factory at Besançon, in France. The process of nitration of cellulose is the displacement of a few molecules of hydrogen by nitric peroxide. There are several varieties of pyroxyline which are obtained by using different mixtures of acid. When the pyroxyline has been obtained, it is placed in a cylinder with a mixture of alcohol and ether; the cylinder is then slowly revolved for twelve hours, with the result that the pyroxyline is dissolved and collodion is produced. After filtration by forcing it through a sheet of cotton-wool between calico, under a pressure of fifteen atmospheres, the collodion is ready for use.

FOR the manufacture of artificial silk a pressure of forty to forty-five atmospheres is required to force the collodion from the reservoirs to the spinning machines, which are constructed with pipes running on each side. Into these pipes are screwed a number of taps with a glass capillary tube fixed on the end, called a silk-worm, through which the collodion is forced; immediately it comes into contact with the air it solidifies, enabling the operative to take hold of the thread or silk, as it can now be called, and convey it to the bobbin. From twelve to twenty-four of these threads are run together on to one bobbin, according to the size of silk required, as is the case with natural silk. After the silk has been dried it is very inflammable and quite unfit for use in textile goods; therefore, a process called denitration is next carried out, which reconverts the product into cellulose. One of the uses of the material is for mantles for the incandescent gas light, it being found that the salts of the rare metals can be mixed with the collodion with greater economy than with any other thread. Large works are in operation at Besançon, in France, producing 7000 lbs. weight per week; but the demand is so great that extensions of the works are being made in order to enable them next January to produce 2000 lbs. per day. The production at Sprietenbach is 600 lbs. daily. Other factories are about to be established in Belgium and Germany.

MENTION is made in *Science Abstracts* of a method of thawing water service pipes by means of electricity, successfully used in Canada. The frozen pipes are thawed by passing alternating currents through them. A pressure of twenty to fifty volts is used, obtained from a portable transformer connected with the street mains. A current of 200 to 300 amperes is passed through the frozen pipe until the water flows freely, which usually takes place in a few minutes.

IN 1894, Prof. van der Waals found a remarkable property of the molecular potential function occurring in his theory of capillarity, namely, that if a constant coefficient be left out of account the potential of a homogeneous sphere at an external point is the same function of the distance from the centre of the sphere as if the whole mass were concentrated at the centre. Dr. G. Bakker, writing in the *Proceedings* of the Royal Academy of Sciences of Amsterdam, now investigates the most general form of potential function possessing this property, and he obtains for the potential at distance r the form

$$\phi(r) = \frac{Ae^{-qr} + Be^{qr}}{r} + C.$$

For the potential function required in the theory of capillarity Dr. Bakker remarks that $B = 0$. The author further investigates whether it is possible to obtain a potential differing in form from the Newtonian potential and satisfying the further condition that the potential is constant throughout the interior of a spherical shell. It is found that a solution exists, but as the expression for the potential function involves the radius of the shell, the result is in no way contradictory to Laplace's conclusion that the Newtonian potential is the only potential which is constant throughout the interior of a spherical shell, *irrespective of the size of its radius.*

WE have recently received the annual report for 1898–99 of the Bacteriologist of the Government of India. The report deals chiefly with experiments on Rinderpest carried on in the laboratory at Muktesar, a preliminary note of which appears. The methods of protective inoculation that are used in South Africa are not convenient for a country like India; Koch's method of using bile from an animal just killed, requiring the slaughter of mai ‐ ‐nimals, is contrary to the religious susceptiilities of the people. The disease, which has been in India for centuries, seems to be of an endemic character, and not liable to spread with the same alarming rapidity as it does in South Africa, so it does not seem all-important to produce a very lasting immunity to check the disease in any particular locality. Since the disease will probably have been going on for some time in a place before measures can be adopted, a rapidly immunising agent is desirable. The serum method seemed to be the most fitted to the purpose, and it is this that is being tried. It is a great loss that the laboratory at Muktesar, the only Government laboratory anything like properly equipped, has recently been burnt down, but we trust no time will be lost in rebuilding it; India at the present time can ill-afford to do without laboratories.

WHETHER ants can hear is a question which has for some time been engaging the attention of Mr. Weld, of the Iowa University, who has published an account of some of his experiments, and the conclusions he draws from the same, in *Science* of November 24. He states that for many years it has been the accepted opinion amongst naturalists that these insects are not endowed with an acoustic sense, at least within the range of sounds perceptible to the human ear. This opinion is based upon the failure of experiments to show that even the loudest and shrillest noises produce the slightest effects on ants subjected to their influence. This, however, is not the result of Mr. Weld's experiments upon several American species of these insects. In one case an ant confined in a test-tube was brought near a milled disc rotating in the air. At each sound from this apparatus the ant showed unmistakable signs of agitation, quickly moving its head and antennæ. Again, when shrill sounds were produced close to a colony protected under glass, the ants instantly showed by their rapid movements signs of excitement and alarm. This leads the experimenter to conclude that at least some (and possibly only American) species of ants are capable of perceiving vibrations, conducted through the air or other media, which are audible as sound to the human ear. He is, however, careful to add that this does not necessarily demonstrate that they hear in the strict sense of the word, but merely that they are capable of perceiving ordinary sound vibrations.

IN the course of an article on the late Mr. P. H. Gosse, published in the March number of the *Journal of the Jamaica Institute*, Mr. Duerden has some interesting observations on recent changes in the fauna of that island. He first of all states that in spite of its being less abundant around country residences, the Indian mungoose appears to be as common as ever in the island, over 1400 head having been trapped on two estates in eight weeks. His next subject is ticks, which have become a terrible plague in certain districts. Although they always existed, originally there appears to have been but one species in the island, but many others have been introduced on foreign cattle and sheep. A few years ago a virulent disease broke out in the cattle, which was at first diagnosed as being allied to the well-known "Texas fever." Subsequently the characteristic symptons of that disease were found to be absent, as were the well-known parasitic organisms by which it is accompanied; but there still seems no doubt that the bovine epidemic is in some way connected with the presence of myriads of introduced ticks.

IN a second communication to the same journal, Mr. Duerden gives the results of the attempts to improve the sea-fisheries of Jamaica. Unfortunately these attempts have not met with the success that was hoped for. The two chief reasons for the failure—and they are amply sufficient—are, firstly, the amount of coral on the sea-bottom, which renders trawling impracticable; and, secondly, a general scarcity of fish, especially those of the valuable flat-fish group (*Pleuronectidae*) On one place where trawling is practicable, it was considered a remarkable feat that a dozen small soles were taken in a day. There are no shoals of fish corresponding to those of the herring, mackerel, and cod of other seas; so that the whole outlook is gloomy in the extreme.

THE *American Naturalist* for November contains the fifth instalment of Messrs. Cowstock and Needham's important contributions to the study of the structure of the wings of insects, for the details of which we must refer our readers to the memoir itself.

MESSRS. FRIEDLÄNDER AND SON, Berlin, have just issued a catalogue (No. 439) containing classified lists of books and papers on crystallography.

MESSRS. DAWBARN AND WARD have published the third edition of Dr. P. H. Emerson's "Naturalistic Photography." The first part is concerned with the æsthetic side of photography, but in the second part technique and practice are treated, and from it both amateur and professional photographers may derive sound philosophy and serviceable hints.

IN the part just received (1899, 1te Hälfte) of the *Sitzungsberichte* of the Niederrheinische Gesellschaft für Natur und Heilkunde zu Bonn, the most important papers are by Dr. Max Koernicke on the spiral thickening bands in the conducting tubes of plants; and by Prof. W. Voigt on artificial regeneration in Planaria.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus*, ♀) from India, presented by Mr. F. G. Stenning; a Lesser White-nosed Monkey (*Cercopithecus petaurista*) from West Africa, presented by Mr. R. Caton Woodville; two Hobbys (*Falco subbuteo*), captured in the Indian Ocean, presented by Mr. J. H. Ingram; a Fieldfare (*Turdus pilaris*), British, presented by Mr. Herbert Goodchild; a Delaland's Gecko (*Tarentola delalandii*) from Teneriffe, presented by Mr. J. Chappell; a Mozambique Monkey (*Cercopithecus pygerythrus*) from East Africa, a Bee-eater (*Merops apiaster*). a Partridge (*Perdix cinerea*), European; two Brown's Parrakeets (*Platycercus browni*) from North Australia, a —— Tortoise (*Testudo nigrita*) from the Galapagos Islands, three Blanding's Terrapins (*Emys blandingi*) from North America, deposited; a Yellow-footed Squirrel (*Sciurus ludovicianus*) from Texas, a Tufted Duck (*Fuligula cristata*), European; two Common Scoters (*Œdemia nigra*), British, purchased.

OUR ASTRONOMICAL COLUMN.

ORBIT OF FIFTH SATELLITE OF JUPITER.—Prof. E. E. Barnard has had the fifth satellite of Jupiter under close observation for some considerable time during the oppositions of 1898 and 1899. Although the increasing southerly declination and the bad season in which the oppositions now occur make the satellite a difficult object, good measures have been secured on several dates. Tisserand having drawn attention to the fact that the measures previously given provided evidence of the eccentricity of the satellite's orbit (*Comptes rendus*, vol. cxix., October 8, 1894), Prof. Barnard decided to observe it as continuously as possible, to settle this question. Tisserand's results indicated that the line of apsides of the satellite's orbit should also have a motion of + 882° a year, or + 2°·42 daily, giving a complete revolution in five months. From the Lick measures he computed the semi-major axis of the orbit to be 47″·906, the eccentricity 0·0073, and longitude of Perijove for 1892, November 1, = –4°. Prof. Barnard's more recent measures enable him to revise these values, and his results are contained in the *Astronomical Journal*, No. 472. On calculating the position of the satellite from Tisserand's value of the motion, a considerable error is found, and the daily motion of the apse line is probably more nearly +2°·465 or 900° yearly, giving a complete revolution of the orbit in 4·9 months.

An interesting question that may also be settled by continued observation of the satellite is the distribution of matter at the equator of Jupiter itself, as the motion of the perijove of the satellite does not agree with that deduced from the actual polar compression of the planet.

During the whole of the measures half the field of view was covered with a piece of smoked mica, through which the bright limb of the planet was observed, and the distances measured from the limb afterwards reduced to the centre by previous measures of the planet's diameter with the same instrument. The increased number of elongations measured gives a much more correct value of the period. The value now given is

11h. 57m. 22·647s.,

which Prof. Barnard considers correct to one-hundredth part of a second.

PARTIAL ECLIPSE OF THE MOON, DECEMBER 16.—There will be a partial eclipse of the moon, visible at Greenwich, during the early morning of Sunday next, in respect to which the following particulars apply:—

First contact with penumbra = 10h. 33·7m.; with shadow = 11h. 44·6m.

Second contact with penumbra = 16h. 18·1m.; with shadow = 15h. 17·2m.

Magnitude of eclipse (moon's diameter = 1) = 0·995.

First contact with shadow occurs at a point 66° from the north point towards the east, measured along the moon's limb.

Last contact with shadow at a point 59° from north point towards the west.

The eclipse is visible in Western Asia, throughout Europe and Africa, and in Eastern America.

OCCULTATION OF NEPTUNE, DECEMBER 16.—There will be another occultation of Neptune during the early morning of Sunday, while the moon is still in the penumbra of the earth's shadow after the partial eclipse. The following are the particulars for observers near London:—

	Sidereal time.	Mean time.	Angle from North Point.	Angle from Vertex.
	h. m.	h. m.	°	°
Disappearance...	9 18	15 36	158	118
Reappearance ...	9 53	16 11	222	180

Greenwich Mean Time of conjunction in R.A.... } 1899 December 16d. 14h. 53m. 15s.

Limits of latitude, 90° N. to 30° N.

Neptune passes the meridian of Greenwich at 13h. 40m., so that it will be well situated for observation of the occultation.

MERIDIAN OF UNIVERSAL TIME.—In the *Revue Scientifique*, Ser. 4, vol. 12, p. 526, M. C. Tondini di Quarenghi summarises most of the evidence in favour of and against the adoption of the meridian of Greenwich as the initial meridian for universal time. The chief objection is cited as a physical one, viz., the extreme uncertainty of the meteorological conditions, rendering celestial observations impossible on a large proportion of the days and nights throughout the year. The advantages of the site at Jerusalem suggested by the Italian Government are the superior observing conditions and the possibility of the district being declared neutral ground, thus ensuring the permanence of the station irrespective of political changes. A further advantage would be the possibility of establishing other subsidiary stations at intervals along the meridian.

THE DEVELOPMENT OF GANGLION-CELLS AND NERVES.[1]

THE results of this memoir largely are in keeping with certain revolutionary changes in embryological doctrine, with which the names of Klaatsch, Miss Julia Platt, Goronowitsch and others are identified. According to their views certain vertebrate structures, which have hitherto been genetically referred wholly or in part to the mesoderm, such as scales, certain cartilages, and even bones, are in fact directly or indirectly products of the outer layer of the embryo, the ectoderm or epiblast. This is only a brief and very general statement of the tendency of their lines of research, and it may be added that as to the details there exist important differences between the different observers. It will not be needful to review all their conclusions here. Our concern is solely with the aspect of the question presented to us by Dr. Goronowitsch in his memoir.

Researches on the development of nerves and ganglia date back to Remak, whose conclusions as to their mesoblastic origin from the protovertebræ or mesoblastic somites were commonly held as recently as twenty-five years ago. About then date the researches of Balfour and Marshall, who maintained that these structures arose as outgrowths of the central nervous system, and that therefore they were epiblastic in origin.

Later on their conclusions were somewhat modified by Beard, in the discovery that the posterior root-ganglia, both cranial and spinal, did not develop as actual outgrowths from the central organ, but that their foundations were to be traced to the deeper portions of the epiblast outside the limits of the future brain and spinal cord. It was also demonstrated that the cranial ganglia received additions from special regions of sensory epiblast, since termed by Kupffer "placodes," on the level of the notochord and above the gill-clefts. Thus, for the sensory portion of each cranial ganglion, two sources of origin could be identified, and the parts so derived were termed neural and lateral respectively. A few years ago Kupffer added a third source, and described an "epibranchial" ganglionic foundation as arising from it. Kupffer's results were obtained in the lamprey, unquestionably one of the most difficult forms among vertebrate animals for the study of organogeny. His results have never been confirmed by any other observer, either in the lamprey or in any other vertebrate.

Whilst it is certain that his epibranchial ganglia have no existence in Elasmobranch fishes, it is also in embryos of these easily demonstrated how Kupffer fell into the error of supposing their presence. In fine, had his researches been carried to sufficiently early "stages" or phases he would have seen that his lateral and epibranchial ganglia merge into one, the foundation of a lateral ganglion.

Since Kupffer's researches were fully published in 1894–5, embryological investigation of the development of cranial and spinal nerves and ganglia has been put somewhat in the shade by brilliant researches into their comparative anatomy at the hands of Allis, Dixon, Ewart, Fürbringer, Haller, Strong and F. J. Cole. Pages and pages might be filled in review of these, along with a critical digest of numerous other papers, embryological and morphological, issued since 1885. Controversies have been waged as to the morphological nature of certain nerves and ganglia, as to their mode or modes of development, and as to the way—apparently a simple problem, but by no means such—in which nerve-fibres arise.

The work under review is only in a minor degree a contribution to a knowledge of the morphological nature of nerves, *i.e.* in so far as it relates to the olfactory and auditory nerves. On the other hand, it emphatically claims to furnish decisive replies to the two latter questions, as to the mode or modes of development of ganglia and of nerve-fibres. If the conclusions drawn by Goronowitsch from his researches can be upheld, it would seem to follow that the investigations of the past twenty-five years—except those of Sedgwick—have been largely in vain.

According to Dr. Goronowitsch, what Balfour and Marshall regarded as outgrowths of the central nervous system, and termed "the neural ridges," have nothing to do with the development of the cranial ganglia. The existence of these "ridges" of cells he does not dispute, but he maintains that the component cells become resolved into the surrounding meso-

[1] Untersuchungen über die erste Anlage der Kranialnerven bei *Salmo fario*." By N. Goronowitsch. Nouveaux Mémoires de la Société impériale des Naturalistes de Moscou, T. xvi. L. 1, pp. 1-55, 3 plates.

blast. The cranial ganglia take their entire origin from Froriep's "Kiemenspaltenorganen." These structures were first discovered by Froriep, and independently by Beard, who identified them as the foundations of the lateral sense organs, and termed them, because of their genetic relations to the gill-clefts, the "branchial sense-organs." Moreover, as previously stated, these patches of sensory epithelium, the "placodes" of Kupffer, were shown to be the sources of ganglionic elements, forming the lateral ganglia. Goronowitsch has now, therefore, endeavoured to limit the cranial ganglia in their origin to these lateral sources alone.

Peculiar, though not confined to himself, are the views maintained by Dr. Goronowitsch as to the mode of attachment of the ganglion with the central organ, and as to the formation of nerve-fibre in general.

In the solutions offered of these problems—which, of course, are really one and the same, to wit, that of the development of nerve—he places himself entirely on the side of A. Sedgwick.

The latter zoologist has maintained, without thus far illustrating his thesis by figures, that nerve-fibres arise *in situ* in the mesodermic reticulum, connecting together the various portions of the developing embryo and filling all the spaces between skin and central nervous system.

The logical conclusion attaching to this view is that nerve is mesodermal in origin. This conclusion Goronowitsch does not hesitate to draw. In his own words in literal translation he says (*inter alia* on p. 40) "the nerve-forming tissue of the complex nerve-trunk is furnished by axial mesoderm."

Incidentally he, like Sedgwick, rejects the doctrines of His, Golgi and their followers, that nerve-fibres arise as processes of ganglion-cells. Naturally! The two views are mutually exclusive. If nerve-fibres arise in a reticulum of mesoderm or mesenchyme, they cannot also be processes of ganglion-cells.

Whatever is to be said for the full acceptance of the process-theory of His and Golgi, and whatever the ultimate fate of the germ-layer theory, no fact in vertebrate embryology stands on a firmer basis than the origin of all nervous structures from the outer layer, the ectoderm or skin, and to fall back upon the mesoderm or its reticulum as the source of nerve appears to us a retrograde step to the embryological standpoint of thirty years ago.

While readily and willingly acknowledging Goronowitsch's industry and zeal in working out this memoir, evidenced by the detailed and laborious description, the carefully drawn and beautifully lithographed plates, his main thesis must remain in abeyance until proof further and more convincing, that this is so for representative members of each of the great vertebrate classes, can be brought forward.

THE UTILITY OF KNOWLEDGE-MAKING AS A MEANS OF LIBERAL TRAINING.[1]

THE subject on which I wish to address a few remarks to you to-day, by way of opening the fortieth session of our College, is the utility of knowledge-making as a means of liberal training.

That the main work of the highest of educational institutions should consist of original research, and that ability to make additions to knowledge should form the chief test of qualification for the highest academic distinction, may be said to have received world-wide recognition; but the value of research work in institutions or departments of a lower grade has not been similarly recognised, and the tests for lower academic degrees and certificates do not, in general, at least formally, include a research test. I wish to bring to your notice some considerations which go to show that the work of all educational institutions, from the highest to the lowest, should be, to a considerable extent, at least, of the nature of original research—understanding by that term, however, the effort to make additions to our own knowledge, not necessarily to the knowledge of the race.

In this sense we have all been engaged more or less in original research from our earliest years; and we probably attained greater success in infancy than in youth or in later life. The young child is completely cut off from all external sources of information; and it could acquire no knowledge beyond a remembrance of confused sensations, if it did not possess the power of "putting that and that together" and finding things out for itself. By applying this power, however, the child succeeds in bringing a large measure of order out of the chaos of sensations which it experiences. The method which it uses is the scientific or knowledge-making method. It finds out the usage of a word, for example, by putting together various instances of its use, constructing a theory as to the meaning of the word, testing the theory by subsequent observation, and modifying the theory as experience widens—in fact, by subjecting its experience to imagination, induction and deduction, and thus, as the logicians would say, generalising such experience. How exactly the process is carried out, even the New Psychology has not yet told us. But it certainly gets carried out somehow; and the result is a series of brilliant, though possibly to some extent sub-conscious, discoveries. The evolutionist would tell us, perhaps, in his learned phraseology, that this phenomenon is a case of the ontogenetic recapitulation of phylogeny, by which he would mean that the young animal in learning its mother-tongue passes in a few months or years through an epitome of the course of development for which the race required as many æons. Even so, the phenomenon does not lose its suggestiveness from our present point of view.

Whether it be because, when the mother-tongue has been acquired, the period of octogenetic recapitulation is complete, and the child brought thereby up to date, or because it is then brought into communication with encyclopædic friends, I cannot say; but certainly once the child is able to question its mysterious neighbours and to understand their answers, its power of applying the scientific method rapidly diminishes, becoming weakened apparently because of the readiness with which information may now be obtained by simple appeal to authority. But though weakened the power is not wholly lost; for it exhibits itself, more or less, in the study both of language and of natural phenomena, during the period of tutelage between early childhood and incipient manhood, and it comes into greater or smaller activity when the young man goes forth to engage in the work of life. And what his degree of success is to be in such work as his hand may find to do will depend, in no small measure, upon his power of putting that and that together and making knowledge for himself from his own experience.

The value of experience in the direction of the work of life does not need to be established by argument. It has become proverbial. But the connection of its value as a directing agency with the making of knowledge may need a few words of exposition. That the mental process which enables us to learn by experience in later life is a knowledge-making process—the same as that used by the child in acquiring its mother-tongue, though perhaps more consciously performed—becomes obvious if we consider any particular kind of work in which men engage. The merchant, to take a single case, in order that he may be able to foresee what kinds and qualities of the many articles in which he deals it will be desirable for him to have in stock, must watch the purchases of his customers, and make mental note of their satisfaction or discontent. The transactions are too numerous to be carried in the memory or to admit of written memoranda. If he is to make progress in judging as to what his stock should include, he must put related experiences together, weld the lessons he learns from them into general rules, and make these rules more and more accurate as time goes on. And the same is true of many other questions which he must settle for himself. Unless, in fact, he can generalise his mercantile experience, as a child generalises its linguistic experience, he must continue to buy and sell with no greater intelligence than he did at the outset of his business career.

> "Till old experience do attain
> To something like prophetic strain,"

as Milton puts it, he can have no complete success.

A similar statement may be made with respect to the physician, the farmer, the investigator, the housewife, the artisan, the politician, the clerk,—with respect, in fact, to all classes of workers, whatever the form of work in which they may be engaged. It may be made also, not only in regard to their main work, but in so far as they may in addition be engaged in athletic, literary, artistic, political, social, religious, or any other effort, and whether that effort take the form of work or play. In short, it is applicable to a greater or smaller extent to at least the great bulk of the various forms of activity of which the lives of most of us are made up. The subject-matter of experience, the material with which we must deal, is different in different cases; but there is one condition

[1] Inaugural address delivered at the opening of the fortieth session of Dalhousie College, Halifax, Nova Scotia, on September 13, by Prof. J. G. Macgregor.

of success which is common to them all,—the possession of the power of foreseeing; and there is one method of acquiring foresight,—the making of knowledge for ourselves from our own experience.

If this be so, it is obvious that this power of knowledge-making should be raised to as high a pitch of efficiency as possible before we enter upon the active work of life. Its growth, like that of all intellectual faculties, is slow; and the facility of its initial cultivation diminishes with advancing years. It is hazardous, therefore, to postpone its cultivation until we are face to face with the problems of life, or even until we enter upon the special study of the main work of life in the technical or professional school. It should be cultivated, and cultivated with especial care, during the whole period of tutelage, whether it be spent at the school only or in part in a department of liberal training of the college. And in order that it may be cultivated, it must be kept in continual exercise.

I do not know that provision for the exercise of this faculty has ever been generally made, with full consciousness, in either school or college; but it can readily be shown that it was given far more exercise in the educational institutions of two or three generations ago, than it is in general in those of the present day.

The curriculum of the old schools, which is also that of the old-fashioned conservative school of our time, consisted largely of classics and mathematical science (including natural philosophy), its backbone being the study of classics; and while the study of mathematics, though an admirable discipline, is for the most part deductive in character, and thus gives only a limited exercise to the power under consideration, the study of language, and especially the study of Latin and Greek, gives it very abundant exercise. Even if the study of a language is carried out with the aid of a grammar and a lexicon, *i.e.* with frequent appeal to authority, it involves continual putting together of instances of the usage of words and phrases which have come to our notice, formation of hypotheses as to their usage, and repeated modification of such hypotheses, after they have been brought to the touchstone of experience. The lexicon, especially the lexicon of the old school, would give little more than a clue in many cases to the English equivalents of say, Latin words, the exact equivalents, whether words or phrases, being determinable only by a study of the context and a fruitful drawing upon experience. And when we think how large is the number of words and phrases and constructions, of the usage of which the student of a language is gradually forming more and more accurate conceptions, we see at once how abundant is the exercise which this study provides of the putting of that and that together. The material on which the knowledge-making power is thus exercised, is of course of one kind, and therefore in general of a kind quite different from the material on which it must be exercised in after life. The exercise afforded is thus one-sided and by no means complete. But it is nevertheless exercise of the same intellectual power which we must later on apply to the more varied and complex material which life will afford.

While the study of the classics gave the student under the old régime considerable experience in the making of knowledge, the curriculum as a whole gave him both the key to his own literature and the literatures of Greece and Rome, and an introduction to the principles of the systems of knowledge which existed at the time. His stock of information we should now consider small; but it bore a great ratio to the whole body of available information. And it should be noted that such knowledge as the student had acquired, had been acquired in a leisurely, thoughtful way, and largely by his own effort, and would thus have become a permanent possession.

The men of the schools, therefore, in those days, had acquired, besides facility of access to the great storehouses of human wisdom, two things of direct importance for success in the work of life—an outfit of knowledge and the power of adding to it from their own experience. They were consequently men of power, and were recognised as such. And as it was the knowledge they possessed that was the only readily recognisable part of their outfit, their knowledge came naturally to be regarded as the secret of their power.

It appears to be Bacon to whom the credit belongs, of having coined the aphorism: "Knowledge is power." If so, to Bacon also must attach the opprobrium of having perpetuated a false and vicious generalisation. However important knowledge may be, it is not *the* essential condition of power. It is only one of the conditions. A second, perhaps the first, is the ability to make knowledge, which *may* be developed in the acquisition of knowledge, but also may not. No knowledge, no power: would have been sound doctrine; Knowledge *is* power: was false doctrine.

And while the possession of knowledge is essential to power, it is not the possession of an outfit of knowledge at the beginning of active life that is essential, but the possession of such outfit when it is wanted. In the old days the world's whole stock of knowledge was so comparatively small, that it was possible in the period of tutelage to get an outfit of its principles at least. At the present day the world's stock is so large, that the school and college can no longer furnish a corresponding outfit. Yet the men of the present day are at little disadvantage on that account. For as the volume of knowledge has increased, its accessibility has increased also. And thus, provided the student of to-day has been trained to acquire knowledge, has been taught, in fact, the most important of the three R's, the art of reading, with all that the art of reading involves, he can readily provide himself at any time with such information as he may require. Thus, nowadays, it is not so much knowledge that is even one of the conditions of success, as a well developed power of acquiring knowledge.

It was largely on the basis of Bacon's false generalisation that the fight was waged in later years between classics and the rapidly growing sciences. The advocates of the introduction of science into the curriculum of the school and college, based their demand mainly on the importance for success in life and for general culture, of a knowledge of the laws of natural phenomena. And their opponents, though relying largely on the excellence of the results achieved under the old system, met the utilitarian arguments of men of science by urging various minor utilities involved in the study of Latin and Greek. Neither party seems to have realised, at least fully, the more profound utility which might be involved in both kinds of study.

The introduction of science into the curriculum under this mistaken conviction could not but have unfortunate results. Its primary effect on the study of classics was to diminish the time devoted to it. But there was a more serious secondary effect; for, since knowledge was power, and as much knowledge of Latin and Greek must therefore be acquired, if possible, as before, the student had to be subjected to a forcing process. Helps of all kinds consequently developed a vigorous, nay a rank, growth—elaborate grammars full of detailed information, lexicons giving all the shades of meaning that words might have, annotated texts removing all difficulties from the student's path, even translations, fitly described in college slang as *cribs* and *ponies*. Power of translating was acquired by the aid of such educationally illegitimate helps; but it was acquired to a smaller extent than formerly, by the student's generalising his own experience and to a greater extent by the use of information derived from authority. The study of the classics consequently, first because of the diminution of time, and secondly because the time was no longer so well employed, came to provide a doubly diminished exercise of the knowledge-making power. The command of the classical languages, too, which was thus acquired, became for these reasons a less permanent possession; and the study of them no longer served to open up to the student, to the extent to which it had previously, the great literatures of the past.

Nor did the science study itself atone for the deterioration which its introduction involved in the study of classics. I need hardly point out that the method which is used in the making of knowledge in any branch of science, is the same as the method we must apply in making knowledge from the experience of everyday life. Indeed, it gets the name of the scientific method, because, though it had been used by men in all ages in the learning of languages and in learning by experience of all kinds, it was first brought to the notice of logicians by the rapid development of science, which resulted from its systematic application to the study of natural phenomena. Any single science, therefore, may be studied as any language may, so as to afford practice in knowledge-making. Language study has the advantage of affording a larger number of simple problems on the material of which the student has the widest experience. A science has the advantage of presenting problems with a greater range of difficulty on a material which is in general more complex. A group of sciences has the further advantage over even a group of languages, of affording a greater variety of subject-matter for the exercise of the knowledge-making power, and consequently giving the student practice in learning from experience under such different conditions as to fit him more completely for using his experience under the conditions of actual life.

The combination of linguistic and scientific study, therefore, if both had been conducted by knowledge making methods, might have been expected to produce better results in the cultivation of the knowledge-making power, than the study of either singly. But under the domination of the conviction that knowledge is power, science could not be studied in this way. The main object for which it had been introduced into the curriculum was the provision of an outfit of useful information, and the study must be carried on, so as to provide as large an outfit as possible. The obvious means of furnishing this outfit was the synoptic text-book, an epitome of the latest results in any branch of science; and all that the student had to do, in order to possess himself of it, was to get up the book. Clearly with this as his method he could not learn to use his own experience, but must become

"Deep versed in books and shallow in himself."

It is true, that when, after a time, the new science study was found to have become a mere getting up of books, the cry of "Back to nature!" was raised. As Wordsworth put it:

"Come forth into the light of things,
Let Nature be your teacher."

As a result, experimental demonstrations were tried; but they were found insufficient. And now laboratory work has been introduced into school and college, and students are made, themselves, to carry out many scientific processes. They are taught to use the balance, to verify Boyle's law, to measure electric currents, to prepare gases, to analyse solutions, to dissect frogs to classify insects, to use the microscope, to hunt out the names of plants. But they are always shown how to do the things required of them. And thus, from our present point of view, this mode of coming into the light of things can be of little avail. For while it makes the student's conceptions more vivid and the knowledge acquired more accurate and less transitory, and while it affords subsidiary training, *e.g.* of the hand and the eye, it gives but little additional opportunity of acquiring power in the making of knowledge. Even such additional opportunity as was at first afforded, when the student had no book to follow and was thrown to a certain extent upon his own resources, has now been withdrawn. For it was soon perceived that a greater amount of ground could be covered if he spent no time in working things out for himself. And so the text-book of laboratory work was devised, telling him exactly what to do and exactly how to do it. "Back to nature!" has thus meant: Back to books! And it could not have been otherwise. For under the conviction that it is knowledge that is power, practice in the putting of that and that together must appear to involve a waste of precious time.

There is another influence which has tended to strip the study of science of the high educational value which it might possess, viz., the influence of the written examination. Men of knowledge under the old régime having been found to be men of power, it became desirable that they should be certified by competent bodies. The degree and the diploma thus came into prominence; and the tests applied to candidates for them, when the candidates became numerous, took generally the form of written examinations. Now it is quite possible to test in this way the possession of command over a language, of deductive power in such subjects as mathematics or philosophy, and of information on any subject. But it is impossible to test by examinations of this kind, directly, the possession of the knowledge-making power. The making of knowledge, even in its humbler forms, is a creative process. It occurs only when the flash of imagination lights up the storehouses of experience and reveals the relations of its accumulated observations. And as the wind bloweth where it listeth, so imagination does not become luminous at command. Put even such men as Faraday or Darwin into the examination hall and tell them to spend an hour in exhibiting on paper their ability to find things out for themselves, and they must almost inevitably fail. It would, in fact, be no more absurd to ask a poet to exhibit true poetic inspiration, at a given date, than to ask a knowledge-maker to make knowledge.

If, therefore, the possession of knowledge-making power is to be tested at all by written examinations, it must be tested indirectly. And in some cases it can. The exercise of this power in the study of a language, besides strengthening the power itself, produces a command of the language which is not otherwise attainable. And consequently it is possible to test the acquisition of this power in linguistic study, indirectly, by a skilful testing of the candidate's command of the language. Its exercise in science study, however, produces in addition to increase of the power itself, nothing but a stock of information, which is much more readily obtainable from books. The acquisition of the knowledge-making power in science study cannot therefore be even indirectly tested by the written examination.

Now written examinations, when used either as the only tests, or as the chief tests, for a degree or a certificate, must tend to encourage the acquisition of what they are capable of testing and to discourage the acquisition of what they cannot test. For candidates soon find out what kind of work will pay, and they naturally confine themselves to it. Hence if such examinations are used as tests for degrees, while they may encourage the cultivation of the knowledge making power in linguistic study, they must discourage and repress it in the study of science.

And if this is the effect of written examinations generally, the effect is of course intensified when they are conducted by a central examining body. For the central examiner, who sets a paper for, say, the schools of a district, can obviously find out even less about the knowledge-making power of candidates than the examiner who can adapt his paper to the work done in a particular school. Centralised examining has serious evil effects of its own. But apart from such effects, which it would be foreign to my subject to discuss now, it must exert a specially strong influence in repressing the cultivation of the knowledge-making power, and in transforming the student into Pope's

"bookful blockhead, ignorantly read,
With loads of learned lumber in his head."

A third difficulty with which the sound teaching of science has met, arises from the complex character of its subject-matter. To compare different usages of words, for example, one has but to turn over the leaves of a book; to compare instances of the occurrence of natural phenomena, the phenomena must be watched for or reproduced under varying conditions. Knowledge-making, therefore, especially in its early stages, finds more difficult problems in science than in language; and the young investigator meets with greater hindrances to progress. The early investigators felt this difficulty, and banded themselves together in societies in order to enjoy the suggestions and criticism of their fellows. The science student of course needs the helping hand still more; and the teacher must be able to give the requisite aid in a judicious way. He must be a knowledge-maker himself, must have sufficient experience in the subject he is teaching, and must be largely endowed with tact and common sense. Unfortunately the old curriculum furnished men with practically no experience of science, the new curriculum furnished men with little knowledge-making power, and no curriculum could furnish the tact and common sense. The available teachers have thus in general been incompetent. And in the making of scientific knowledge, a pupil under an incompetent teacher must stick fast.

Competent teachers in classics, on the other hand, have always been more readily obtainable. And—what is of more importance—in the making of linguistic knowledge, a pupil under an incompetent teacher does not stick fast. He has the experience of his childhood to help him, is capable of exercising the knowledge-making power, without the teacher's aid, on the familiar material which language affords, and in his effort to make progress, cannot help exercising it to a greater or smaller extent. Let me draw special attention to this point; for the fact that in the study of language, exercise of the knowledge-making power is not only possible, but in a large measure inevitable, even under an incompetent teacher, gives to language study a great advantage over science study, as a means of discipline in all educational institutions, but especially in those of lower grade, in which, owing to their large number, the difficulty of securing competent teachers is especially great.

The conclusions we have now reached may be summarised thus:—(1) Few of the subjects of the old curriculum could be studied without exercise of the knowledge-making power;—

many of the subjects of the new curriculum can. (2) The demand for useful information did not affect the old curriculum;—it seriously diminished the exercise of the knowledge-making power in the new. (3) Written examinations might stimulate such exercise in the old curriculum;—they could not but repress it in the new. (4) Competent teachers could readily be secured for the old curriculum;—they have not generally been available for the new. (5) Incompetent teachers could not largely exclude practice in knowledge-making under the old curriculum;—they could not fail to exclude it largely under the new. Obviously, therefore, the more intensely modern the curriculum has become, *i.e.* the more linguistic study has been excluded and science study introduced, the less efficient in general must the curriculum have become, so far as practice in knowledge-making is concerned.

If the above discussion is sound, any system such as our modern system, from which the method of investigation is largely excluded, must be distinctly inferior, as a means of preparing young people for the work of life, to a system such as the one which has become old-fashioned, in which it is given abundant exercise. It is difficult, however, to establish an inferiority in a case of this kind from experience. For in any trial that may be made of the two systems there must always be extraneous circumstances on which the burden of any observed inferiority may be laid. On the present occasion I cannot take time even to summarise such evidence as goes to show that the inferiority which is to be expected has been found to be actual. I must content myself with a mere reference to the result of what is perhaps the most decisive of all the trials which have been made, viz., that made in Prussia as to the relative educational efficiency of the Gymnasium, with its largely classical course, and the Realschule, with its largely scientific course. Both institutions had been conducted with characteristic German thoroughness with respect to the training of teachers and the provision of equipment, and the written examination system had been applied in a non-centralised form. Except in so far as tradition and the wider privileges of Gymnasium graduates may have led the more promising men to enter the Gymnasium, the two institutions seem to have worked under equally favourable conditions. Yet when in 1880, after a trial of more than ten years, the question of continuing to admit graduates of the Realschule to certain courses of the University of Berlin came up for discussion, even the scientific professors testified that for the work of their departments, mainly scientific research, the men nurtured in the Gymnasium had been found better qualified than those who had come up from the Realschule. The effect of tradition and privilege may have had much to do with this result; and the means of instruction in science twenty years ago were of course not so elaborate as they are now. But it is significant, that in the light of the present discussion, it was to be expected that for success even in scientific research, *i.e.* the making of new knowledge of natural phenomena, power of knowledge-making, though cultivated on linguistic study only, would be of greater importance than the stock of scientific knowledge which it is the aim of the modern curriculum to afford.

Our own experience in Nova Scotia is less definite. We have not had the two systems running side by side, and can only compare the present state of things with the past; and the comparison is complicated by the fact that the present state of things is in many respects in advance of the past. But there is no doubt that the country is full of a deep and growing discontent, which, though it finds vent at times in ill-grounded criticism, rests in the main on a solid basis. The farmer, to take a single example, finds that the boys he sends to the High School rarely return to the farm. He blames the school, with its Latin and its multiplicity of sciences, and demands the provision of something more practical, such as the teaching of agriculture. There are probably many reasons why the farmer's boy does not return to the farm; but there can be little doubt, if my position is sound, not merely that he is not fitted, but that he is actually unfitted, by his High School course, for the farmer's work. The farmer must, above all things, be able to learn quickly and accurately from his own experience. His boy, after passing through an intensely modern curriculum, under the pressure of a centralised examining system, and under the guidance of teachers in whom, for the most part, the colleges have failed to develop the investigating spirit and power, must almost inevitably be less able to make knowledge for himself out of his own experience, than he would have been, had he remained on the farm; while even that part of his large stock of acquired knowledge which bears upon agriculture must consist in general of inaccurate and ill-digested epitomes of sciences, in which he has little, if any, genuine interest. The farmer's discontent is therefore probably justified; but he is wrong in the details of his criticism. With the teachers who are at present available, Latin is the subject from which his boy will acquire, more than from any other, the essential power of putting that and that together. Although it is true that the usual synoptic study of the whole circle of the sciences will make his boy neither a farmer nor anything else, it is also true that a more informal study, a knowledge-making as distinguished from a mere information-supplying study, of bodies and the changes they undergo, and of plants and animals, rocks and soils, would cultivate in him the power of using his experience, give him, not much perhaps, but certainly some real knowledge bearing on agriculture, give him the scientific experience requisite for the reading of agricultural books, and give him a living interest in all the operations of the farm. Fruitful teaching in agriculture, however, is impossible. The teacher could teach it only if he were a somewhat experienced farmer himself; and even if he were, he could not teach it adequately to beings with such limited experience as boys.

Nor is the farmer the only exponent of discontent. The feeling of dissatisfaction is general. And if my position is sound it might be expected to be general. For if our school discipline fails to cultivate in our youth the power of learning by experience, it fails to give them what is at least one great essential of success, not in farming merely, but in whatever form of work they may be called upon to undertake.

There is one other educational experience, perhaps specially characteristic of our time, to which I should like to refer, viz., the frequency of the success of the self-made man. His success is usually attributed to innate ability, organising power, push, knowledge of men, and what not. To my mind it is largely due to a well developed power of learning by experience; and he owes that in great measure to the school of practical life in which he has had his training. This school provides an entirely different curriculum from the one we have been considering. It furnishes its pupils with no outfit of information whatever; but compels them to hunt out for themselves such information as they may require. And instead of devising cunning ways of stopping the putting of that and that together, it compels its pupils, by sending them early into active life, to cultivate that power for themselves. Many of them of course go down; for no helping hand is extended to them, and the method is rough. But many manage to obtain the knowledge they require, learn how to put the that and that of their experience together, and graduate, often, as we should say, with high honours, in one or other of the departments of active work. They may not have been brought into contact with much that makes for sweetness and light, and may thus be deficient in literary and general culture; but for all forms of activity that demand the generalising of experience, their rough school has given them a training which is, in some respects at least, admirable. Can we wonder then that the practical man, who rightly regards ability to tackle the main work of life as the most important component of a complete culture, and who sees daily the comparative helplessness of the products of the modern curriculum, decides to send his son as early as possible to the school of practical life?

If, notwithstanding the imperfect manner in which I have presented the value of the knowledge-making power, you are convinced of its great importance, you cannot fail to be interested in the question: How are we to secure its cultivation in the school and college?

We may dismiss at once the proposal suggested by what has been said as to the efficiency of the old-fashioned school, that we should return to the classical curriculum, or, at any rate, to language, as the chief means of educational discipline. Such harking back, even looked at from our present point of view only, would be bad policy, for two reasons, (1) because a combination of language and science study, if both are properly carried out, affords a far better training in knowledge-making than either singly, and (2) because, though an outfit of knowledge of science, adequate for use in the work of life, is no longer capable of being provided beforehand as part of a course of liberal training, the acquisition of power of acquiring knowledge demands considerable scientific experience. A curriculum of which science is an important component, therefore, should be retained, provided the science as well as the language be studied by knowledge-making methods.

Nor need we stop to consider the assertion, made by eminent educational authorities, that in the school at least, such methods cannot be employed in science, or that they have been tried and have failed. Both assertions are sufficiently met by the fact that under favourable conditions, they have been tried and have succeeded.[1] But it must be admitted that knowledge-making methods could not be introduced generally with success, under the prevalent conditions of the present day. For so long as a large body of varied information is an essential condition of academic distinction, so long as the written examination is used as the main test of proficiency, and so long as teachers themselves have not had the investigating spirit developed in them, the school cannot cultivate the knowledge-making power in any large measure.

Reform, to be radical, therefore, must begin with the universities, and with the leading universities. They only can make the conditions for degrees what they please, and they only can hold the examiner completely in check. The smaller universities and colleges must, in the interests of their students, follow more or less the lead of their bigger sisters; and though Councils of Public Instruction and other bodies which govern schools may be largely free to modify their curricula and to regulate their examinations, they cannot secure the services of teachers who are imbued with the investigating spirit, until that spirit has become embodied in the universities.

But while radical reform may not be possible at present, partial reform can be carried out even by a college such as ours, by its steering a middle course between encouraging the use of knowledge-making methods and supplying the information demanded by the larger universities, and by thus cultivating the power and the spirit of investigation to as great an extent as may be possible under present conditions. And the reform thus inaugurated may be extended to the schools of its district, through the teachers supplied by the college, if the governing body of the schools is willing to co-operate. . . . . . .

It is true that as the early investigators in science made progress without the complex and therefore costly appliances which the investigator of to-day in general requires, so students can get an astonishingly large amount of practice in knowledge-making with very simple materials, and that consequently a knowledge-making equipment involves much smaller expenditure than that which is required by the up-to-date course. Nevertheless, even for practice in the making of knowledge which was made by others long ago, not to speak of the making of knowledge of a later date, or of new knowlege, our equipment is entirely inadequate.

There is still another aspect in which we are deficient, viz., in the working facilities afforded to professors. That the professor of a scientific subject may cultivate the knowledge-making power in his students, he must be a knowledge-maker himself; and to do so in full measure he must be enabled to prosecute original research under favourable conditions. His work may be humble, and its value may be comparatively small; but provided its value is real, it will help him to kindle in his students the enthusiasm which springs from the conviction that the subject they are studying is a growing subject, and that it is possible for them to assist in its growth. It is not therefore in the interest of the professors, but in the interest of their students, that I hold it to be the duty of the college to give professors both the time and the necessary outfit for research. Giving them the requisite time means the provision of competent assistants. Giving them the requisite outfit means the provision, not necessarily by any means of completely equipped laboratories, but of books and other working appliances sufficient for at least a few lines of research.

At first sight the considerable expenditure which would be required for this purpose, will appear to most of you to be expenditure on luxury; and possibly the benefit which a college derives from the fact that its professors are known as original investigators, although undoubtedly great, may be of the nature of a luxury. But when we reflect on the importance of training all our young people to use their experience, and consequently of stimulating our college students, many of whom are to be the teachers of our youth, to acquire the knowledge-making power in the highest possible degree, it becomes apparent that research facilities for our professors are not a mere luxury, but are necessary for the performance of thoroughly successful educational work.

I have referred so far only to what liberal training requires. In addition, it is desirable, especially from the point of view of the provision of teachers of higher grade, that those of our students who have shown great promise of power in the making of knowledge, should, without leaving their own country, have ready access to the requisite facilities for research in any department in which they may wish to carry on special study. In other words, Canada ought to have at least one university thoroughly equipped for investigation in all the main departments of knowledge—and I say one, because, however desirable such equipment would be in all, with our local art schools and agricultural schools and other technical schools undeveloped, the country cannot probably afford more than one. And this is desirable, not in order that Canada may take her place worthily among other nations by contributing her share to the growth of knowledge, and not because of the material progress that might result from the advance of science, but mainly because the fruitful investigating work that would be conducted at a fully equipped university, would tend to foster the spirit of investigation in all the colleges, and through the teachers they supply, in all the schools, and would thus tend to make even those who never enter a college better knowledge-makers, and therefore more successful men, in whatever department of work they might be engaged.

It is for this reason that the young people of Canada are to be congratulated, even more than the institution immediately concerned, on the great strides which McGill University has recently been enabled to make towards complete equipment; and for the same reason, I may express the hope, in which I know you will all join, that she may soon acquire as thorough an outfit in all departments as she has already acquired in some. If but one of our universities is to receive complete equipment at present, it is fitting that the one having its seat in our commercial metropolis should be selected for the trust. And if McGill University, regarding herself as the trustee of a rich endowment, held for the benefit of the whole Dominion, is able to rise to the level of her opportunity, her influence will, at no distant date, be felt for good in the life work of every Canadian.

The friends of our smaller colleges must therefore rejoice in the rapid enrichment of their more fortunate sister. Nevertheless its first effect upon them has naturally been one of depression. It is obviously impossible for them to do for the colleges in which they are interested, what McGill's benefactors are doing for her. And, although in a country of such magnificent distances as Canada, it is obviously desirable that our young men should have colleges, or at least a college, provided for them in their own section of the Dominion, in order that as many of them as possible may enjoy the advantage of the higher forms of education, and also that their own section may retain their services for its own development, those who have hitherto supported the smaller colleges naturally ask: Is it worth while for us to make any further effort? Indeed, are we justified in encouraging our young people to attend the smaller colleges when a university so much more fully equipped is open to them?

Such questions receive their answer from the present discussion. Liberal training does not demand, as the provision of encyclopædic knowledge does, that students should be supplied with all the books and all the latest contrivances in all departments of knowledge, or even in any department. It demands only, so far as subjects requiring costly equipment are concerned, that they should have access to such equipment in the chief departments as will enable them to have sufficient and sufficiently varied exercise of the knowledge-making power. Complete equipment is requisite only in an institution which aims at furnishing opportunity for original research on all lines, in fact, at the making of specialists rather than the making of men. Only a small part of such an equipment is necessary for, or can be used in, even the most thorough liberal training.

It follows that the small college with incomplete equipment can furnish quite as sound and thorough liberal training as the completely equipped university, provided it is not too small to supply the important training which college life affords, and provided its equipment, though comparatively small, is adequate; and consequently, that if both these conditions are fulfilled, it is completely justified in inviting students to trust their training to its care.

[1] See Armstrong: "The Heuristic Method of Teaching: Special Reports on Educational Subjects," vol. ii. (London: Education Department, 1898.)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—A statute will be promulgated early next term with the intention of instituting degrees of Doctor of Letters and Doctor of Science. The present statutes provide for the degree of Bachelor of Letters and Bachelor of Science, for which a course of special study or research, and a residence of two years, are required. Several of these research degrees have been granted during the last four years. It is now proposed that the Doctorate should be instituted, for which a candidate shall submit published papers or books containing an original contribution to the advancement of learning or science. A candidate for the degree of Doctor of Science must either be a Bachelor of Science of twenty-six terms standing, or a Master of Arts of thirty-nine terms standing.

The B.Sc. degree has been granted to Mr. H. N. Dickson, of New College; his dissertation consisted of a chemical and physical examination of the surface waters of the North Atlantic collected during 1896 and 1897, and contained 4000 estimations of the salinity.

The lecture list announced for next term contains those to be delivered under the newly instituted School of Geography.

Dr. John Scott Haldane has been reappointed lecturer in physiology for a period of three years.

The newly instituted John Locke scholarship in mental philosophy has not been awarded.

The following alternative subjects are recommended for the Johnson Memorial Prize in 1903: (1) periodic orbits; (2) meteors; (3) an investigation of the image of a star in a telescope as affected by the physical properties of light.

Dr. J. A H. Murray, editor of the "New English Dictionary," has been appointed Romanes lecturer for 1900.

The annual grant of 300*l.* to the chemistry department of the University Museum has been renewed for five years, and the sum of 170*l.* is to be spent on cases for the Pitt-Rivers Museum.

CAMBRIDGE.—Prof. Marshall Ward has been elected a member of the General Board of Studies.

Mr. Timothy Holmes and Prof. W. Burnside, F.R.S., have been elected Honorary Fellows of Pembroke College.

A Shuttleworth Scholarship in Botany and Comparative Anatomy will be awarded at Caius College in March next. The value is 55*l.* a year for three years, and candidates must be medical students of the university of not less than eight terms' standing. Application is to be made to the senior tutor before March 1.

MR. R. T. GLAZEBROOK'S successor as principal of University College, Liverpool, is Mr. A. W. W. Dale, Fellow and Tutor of Trinity Hall, Cambridge.

SIR WILLIAM C. MACDONALD, of Montreal, has founded a Chair of Geology for McGill University in that city, as a memorial of the late Sir William Dawson. According to the terms of the gift, the income of the endowment will be paid to Lady Dawson during her lifetime, and on her death will become available for the maintenance of the new Chair.

AT University College, London, a course of eight lectures dealing with the methods of spectroscopy especially in connection with the photography of the spectrum will be given on Friday evenings, at 5.30, by Mr. E. C. C. Baly, commencing on January 19, 1900. Among the subjects to be treated and illustrated by experiments are:—The history of the determination of the modern standards of wave lengths; the comparison of spectra and determination of wave lengths visually and photographically with prism apparatus; the determination of wave lengths with the grating; and methods of producing emission and absorption spectra.

A COPY of the special report on the new department of agricultural chemistry of the University College of Wales, Aberystwyth, recently submitted to the Court of Governors, has been received. The work of this promising department of the College is carried on in premises specially designed for the purpose. This accounts for the convenient arrangements for access and inter-communication shown upon the plan which accompanies the report. The rooms and the laboratory fittings give evidence that much care has been taken to design arrangements which will conserve the energies of the staff, and give facilities for good practical work by the students.

ON Thursday last, upon the occasion of the distribution of prizes and certificates to the successful students of the Goldsmiths' Company's Technical and Recreative Institute, New Cross, Mr Asquith made a few remarks on the work of polytechnic institutes in London. He pointed out that in the metropolitan area, north and south of the Thames, there are no less than eleven institutions of this kind, with four or five subsidiary branches, upon which a capital expenditure of no less than 500,000*l.*, at the least, has been made, with an annual expense to those who promoted them of something like 130,000*l.*, and with an attendance of no less than 50,000 students. The Goldsmiths' Institute is not only one of the most flourishing among London polytechnic institutions, but in some respects it is unique. Unlike every other institution of the kind in London, it does not receive grants of money either from the Technical Board of the London County Council or from the Central Parochial Foundation of the City of London. The whole cost, except the comparatively insignificant sum received from the students' fees, is defrayed out of the funds of the Goldsmiths' Company.

THE *Times* reports that the executive committee of the Agricultural Education Committee has recently passed a series of resolutions including the following:—(1) That, in view of the importance of concentrating the control of agricultural and rural education in the hands of one Government department, it is expedient that all the educational work of the Board of Agriculture should be transferred to the new Board of Education; (2) that the staff of the new Board should include an adequate number of inspectors, well acquainted with the needs of the agricultural classes and the conditions of country life; (3) that the Board's inspectors should be instructed to see that the curricula of rural schools are differentiated from those of urban schools. With regard to training, the committee think that provision should at once be made at certain of the teachers' training colleges for giving those students who desire it practical as well as theoretical instruction in subjects bearing on agriculture and horticulture; and that a special rural teachers' certificate should be awarded to those teachers who have gone through a full course of instruction, practical and scientific, in agricultural subjects. As to higher agricultural instruction, it is suggested that the Board of Education should encourage those county authorities, who have not yet done so, to provide, or to contribute to, school and experimental farms, and should inspect and report annually on such farms; that no more certificates for proficiency in the "principles of agriculture" should be granted to persons who have not completed an adequate course of practical instruction; and that the courses for Schools of Science situate in country districts should be differentiated from those of urban schools of science by substituting instruction in agricultural science and experimental agriculture for that in other subjects. Another resolution suggests that, with a view to interest agricultural societies in the work of agricultural education, they should be supplied with leaflets, reports, &c., to distribute among their members, who should be invited to visit agricultural schools and experimental plots in their neighbourhood, and to discuss them at their meetings.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, December 8.—Prof. G. Carey Foster, F.R.S., Vice-President, in the chair.—Prof. S. P. Thompson read a paper on obliquely crossed cylindrical lenses. Any two cylindrical lenses crossed obliquely are optically equivalent to two other cylindrical lenses crossed rectangularly, and hence to a sphero-cylindrical lens. Owing to the difficulty of manufacturing cylindrical lenses with the axes of the opposite faces in different directions, it becomes of importance to the optician to be able to calculate the constants of the equivalent but more easily ground sphero-cylindrical lens. To a first approximation a surface of radius of curvature "r" will impress upon a plane wave a curvature of $\frac{\mu - 1}{r}$ where "μ" is the refractive index of the material. If we suppose an equiconvex cylindrical lens cut by two planes at right angles, the line of intersection of the planes passing normally through the centre of the lens, then the sections of the lens will in general be portions of ellipses. It is possible, therefore, to write down in terms of the angle which one of these planes makes with the axis, the convergivity which would be impressed by the lens upon plane waves travelling in these planes. The effect of a second lens crossing the first obliquely can also be written down with respect to the same two planes. The joint effect of the two lenses can then be resolved along any two lines at right angles. Differentiating the expressions for these effects and equating to zero, we get the directions of maximum and minimum cylindricity. These directions are at right angles, and represent two lenses crossed rectangularly, which are the optical equivalent of the original pair considered. The sphero-cylindrical lens is then easily obtained. From the mathematical expressions Prof. Thompson has deduced a graphical solution of the problem. The author exhibited a convenient combination of two cylindrical lenses for giving varying degrees of cylindricity. Let two lenses be ground, each being a mixed equi-cylinder consisting of a concave and convex ground at right angles to one another on the opposite faces of the glass. Two such mixed cylinders, if rotated with equal motion in opposite directions, will give a varying cylindricity of fixed direction in space. With the axes of positive cylindricity coincident they give the maximum; but when each is rotated 45°, their resultant is zero. When rotated beyond 45°, the resultant axis of cylindricity is negative in the fixed direction in which it was formerly positive.—Mr. T. H. Blakesley read a paper on exact formulæ for lenses. In this paper the author makes use of the definition of focal length with respect to magnifying power, which he has described in the *Proceedings* of the Physical Society for November 1897. By this method the focal length of a lens combination is simply a line and not the distance between two definite points. Following the methods of his previous paper, Mr. Blakesley showed how it was possible to determine accurately the constants of lens combinations, and pointed out practical applications to the racking of telescopes for camera work, the determination of refractive indices of liquids, &c.—Prof. W. E. Dalby exhibited a friction dynamometer. The torque to be measured produces a twist in a spiral spring, and the object is to determine the amount of this twist. Side by side upon the shaft are two pulleys, one keyed to the shaft and the other fastened to the end of the spring. The lead of one pulley upon the other, therefore, measures the twist. Two other pulleys are mounted upon a slide, and are joined up to the first ones by means of a continuous band similar to a Weston's differential pulley block. When the shaft is at rest, the two pulleys on the slide are touching; but any motion of the shaft produces a twist in the spring, and therefore a lead of one of the shaft pulleys on the other. This produces a separation of the slide pulleys, which is proportional to the lead, and therefore to the torque, and so from a knowledge of the constants of the dynamometer and its number of revolutions per second the power transmitted is at once determined.—Prof. S. P. Thompson read a note on an organic compound of great double refraction. This substance is crystallised naphthaline, and it is 60 per cent. more doubly refracting than Iceland spar. It is exceedingly brittle, and therefore difficult to work into prisms. Any worked surface must be at once covered with glass to prevent sublimation.—The Society then adjourned until January 26, 1900.

Zoological Society, November 28.—Dr. Henry Woodward, F.R.S., Vice-President, in the chair.—Mr. Lydekker exhibited (on behalf of Messrs. Rowland Ward, Ltd.) and remarked on a headless skin of a kob-like antelope from Lake Mweru, which he proposed to call *Cobus smithemani*, after its discoverer, Mr. F. Smitheman. He likewise exhibited the skull and horns of another kob, belonging to Sir E. G. Loder, for which the name *C. vardoni loderi* was suggested.—Mr. Oldfield Thomas exhibited the skull of a baboon recently obtained at Aden by Messrs. Percival and Dodson. It appeared to represent a new species allied to *Papio hamadryas*, but distinguished by its small size, the row of upper cheek-teeth being only 41·5 mm. in length. It was proposed to be named *Papio arabicus*.—Mr. W. Saville-Kent exhibited, with the aid of the lantern, a series of slides demonstrating the utility of trichromatic photography as applied to the correct colour-registration of biological subjects. Photographic transparencies representing various species of plants and animals were included in the series —Mr. J. S. Budgett gave a general account, illustrated with lantern-slides, of his recent expedition to the Gambia Colony and Protectorate, undertaken primarily for the study of the habits of *Polypterus*. Some living and spirit specimens of this fish were exhibited, and remarks were made upon it, as also upon *Protopterus*, of which examples were likewise obtained. Special reference was made to the antelopes met with during a trip up the Gambia River to the end of its navigable waters, and specimens of the heads of those obtained were laid on the table. A collection of Gambian birds was also exhibited.—A communication was read from Mr. L. A. Borradaile, in which it was shown that both genera (*Coenobita* and *Birgus*) of the Pagurine land-crabs (*Coenobitidae*) are hatched in the *Zoaea*-stage.—Dr. W. G. Ridewood read a paper on the relations of the efferent branchial blood-vessels to the *circulus cephalicus* in the Teleostean fishes, based upon an examination of specimens of sixty-one species. He demonstrated the great variation that is met with in the arrangement of the efferent vessels, and discussed the possibility of utilising the characters as a means of arriving at a natural classification of the group.—Mr. G. A. Boulenger, F.R.S., read a paper on the reptiles, batrachians and fishes collected by the late Mr. John Whitehead in the interior of Hainan. The collection contained specimens of fifteen species, embracing four species of reptiles, six of batrachians, and five of fishes. Of these, two species of reptiles, three of batrachians, and three of fishes were described as new.—A communication was read from Dr. A. G. Butler on a collection of butterflies made by Mr. Richard Crawshay in British East Africa. Sixty-eight species were enumerated and remarked upon, of which four were described as new.—A second communication from Dr. Butler contained a list of a small collection of butterflies made by Captain Hobart, of the Grenadier Guards, in the Nandi District of the Uganda Protectorate. Of the seventeen species represented in the collection, one (*Cymothoe hobarti*) was described as new.—A communication was read from Mr. J. Y. Johnson, containing a note on the habit and mode of growth of the corals belonging to the genus *Pleurocorallium*.—Mr. W. E. de Winton made some supplementary remarks to those published in the *Proceedings* for 1898 (p. 900), on the moulting of the King Penguin (*Aptenodytes pennanti*) now living in the Society's Gardens.

Entomological Society, November 15.—Mr. G. H. Verrall, President, in the chair.—The President announced the death of Dr. C. G. Thomson, one of the honorary fellows of the Society.—Mr. J. J. Walker exhibited four examples of a species of Curculionidæ—*Cleonus sulcirostris*, taken on red sandy soil at Barr's Hill, near Oxford. These examples, he pointed out, were of a reddish tint, harmonising with the colour of the soil on which they were found, and in marked contrast to that of normal grey specimens, some of which, taken at Deal and Reading, he showed for comparison.—The President exhibited specimens of *Chersodromia hirta*, which were found under sea-weed at Brora in August 1899.—Mr G. W. Kirkaldy exhibited two species of Hemiptera of economic interest, one a Pyrrochorid—*Dysdercus cingulatus* (Fabr.), sent by Mr. E. E. Green from Ceylon, where it was found appearing in abundance on the cotton plants, the other a Psyllid—*Aleyrodicus dugesii* Cockl., forwarded by M. A Dugès, who stated that it is attacking the white mulberries in Mexico.—Mr. J. H. Leech contributed part iii. of his paper on Lepidoptera Heterocera from Northern China, Japan, and Corea.

CAMBRIDGE.

Philosophical Society, November 13.—Mr. Larmor, President, in the chair.—Intumescences on *Hibiscus vitifolius*, by Miss E. Dale. *Hibiscus vitifolius* is a plant which is common in the hotter parts of Asia, Africa and Australia. It is usually very hairy, but the hairiness is subject to considerable variation, and the hairs are of several different kinds. On plants grown in greenhouses there are formed abnormal outgrowths of the epidermal and the subepidermal tissue of the stems and leaves. These emergences, especially on the leaves, usually bear stomata at their apices, and those on the stem are characterised by the formation of a cork-cambium at the base of each, which cuts off the older outgrowths. No traces of fungi or mites have been found, but experiments show that these outgrowths are not formed on plants in the open, where transpiration is more freely promoted. Seedlings and cuttings from such plants devoid of outgrowths, when placed in a greenhouse, develop outgrowths, while seedlings from plants provided with them, and which themselves have developed them, lose them if transferred to the open. It seems therefore probable that growth under glass may promote the production of some actively osmotic body in the young cells, and that the over-turgescence is expressed in the abnormal protrusions. Hence the application of the name "Intumescences."—Note on the name *Balanoglossus*, by Dr. Harmer. It was suggested that the species which belong to *Balanoglossus* as restricted by Spengel should be placed in a new genus *Balanocephalus*, whose type-species would be *B. kupfferi*. *Balanoglossus* should be dropped as a generic name, but may conveniently be retained as a semi-popular designation in cases where it is not desired to restrict a statement to any particular genus of the Enteropneusta.—The skeleton of *Astrosclera* compared with that of the Pharetronid sponges, by J. J. Lister. The structure of *Astrosclera willeyana*, the representative of a new family of sponges, obtained by Dr. Willey in the Loyalty Islands, was described, and attention was drawn to the resemblance between its skeleton and that of some members of the *Pharetrones*, a group of sponges which are found as fossils in formations ranging from the Carboniferous to the Cretaceous period. It was pointed out that the resemblance between the skeletal elements formed within the living protoplasm of *Astrosclera* and the bodies formed by purely physical processes in the St. Cassian fossils may have a bearing on the problem of the mode of origin of sponge spicules.—Note on hypotheses as to the origin of the paired limbs of Vertebrates, by J. Graham Kerr. In a paper on hypotheses as to the origin of the paired limbs of Vertebrates, which was taken as read, Mr. J. Graham Kerr referred first to the two hypotheses which were predominant at the present time as explaining the origin of the paired limbs—that which derives them from portions of a once continuous lateral finfold, and that which derives them from the septa between adjacent gill-clefts. The first portion of the paper consisted of a brief statement of these two views together with the fundamental facts upon which they rest, followed by a critical examination of them in the light of modern research. The author came to the conclusion that both views must be looked upon rather as suggestive hypotheses than as scientific theories of the facts as at present known to us. He therefore ventured to bring forward a third view, confessedly a mere hypothesis, which seemed to him to have received very inadequate attention—that the paired limbs are homodynamous with the somatic or true external gills.—Observations upon Polypterus and Protopterus, by J. S. Budgett. Two distinct species of Polypterus occur in the Gambia, *Polypterus lapradii* and *Polypterus senegalus*; the latter was observed in captivity and also in the wild state. The pectoral fins are distinctly organs of propulsion and not as in Teleosts almost exclusively balancers. Polypteros uses its bilobed air bladder as a lung, and can survive an exposure to a damp atmosphere of twenty-four hours. The spiracle is used to emit the excess of air in the pharynx but not for the passage of water. Both species migrate from the river to the flooded meadows in June and July and, spawning in August and September, return to the river in October and November.

EDINBURGH.

Royal Society, December 4.—Lord Kelvin in the chair. As usual at the first meeting of the session, the President gave a brief sketch of the work accomplished last session. Lord Kelvin then proceeded to discuss two physical problems, namely, the problem of the spinning top, and the question as to the manner in which ether is affected by the motion through it of attracting and repelling points. Many mathematicians of the highest order had attacked the problem of the rotation of a rigid body of which one point is fixed; but the peculiarity of the spinning top was that no point was fixed until it settled into the so-called "sleeping" condition. Mr. Archibald Smith, in a paper published in the first volume of the *Cambridge Math. Journ.* (1837), seems to have been the first to have correctly considered the question, Why does a spinning top rise to the sleeping state and then fall away again? And no later mathematician seems to have taken up this question at all. Lord Kelvin had recently worked out a simple case in which the centre of gravity was constrained to move in a vertical line. The minimum angular velocity, for which the upright "sleeping" motion was stable, depended in a simple way upon the curvature of the assumed hemispherical apex on which the top spun. The second problem was a fresh attempt to reconcile the apparently opposite properties of ether which render it so mobile to mass motions through it and yet so sensitive to rapid molecular vibrations. Briefly stated, the idea was to have an intermediate link between the molecule and ether in the form of a "doublet feeler." This doublet consisted of repelling and attracting points, which produced appropriate strains in the ether when themselves set in vibration by the vibrating molecule. The idea, however, gave no clue as to the nature of electricity and magnetism.—In a paper on the rectal gland of the Elasmobranchs, Dr. J. Crawford gave an account of an investigation into the structure and function of this appendage in the dog-fish and skate. The evidence was in favour of its being an excretory organ of the nature of a kidney.—An obituary notice of Dr. Charles Hayes Higgins, prepared by Dr. Sydney Marsden, was read.—Dr. Noel Paton gave an account of further investigations of the life history of the salmon in fresh water. This second instalment dealt chiefly with the fish taken in the months February, March and April, and the general conclusions agreed with those already drawn, the chief result being that the migration of the salmon is regulated wholly by the question of nutrition. The comparative scarcity of male fish caught prevented any certain conclusions being drawn in regard to them. From a comparative study of the pigments Miss Newbiggin had collected strong evidence in favour of Sir John Murray's view that the colour of the salmon was derived from the pigments in the Crustacea, which supplied directly or indirectly the chief food for these fish.—Dr. Thomas Muir communicated a paper on the eliminant of a set of general ternary quadrics, Part ii.

Mathematical Society, December 8.—Mr. R. F. Muirhead, President, in the chair. The following papers were read:—On the evaluation of a certain determinant, by Prof. Crawford.—A special case of the dissection of any two triangles into mutually similar pairs of triangles, by Mr. Alex. D. Russell.—Elementary proof of the potential theorems regarding uniform spherical shells, by Dr. Peddie.

PARIS.

Academy of Sciences, December 4.—M. van Tieghem in the chair. Justification of Fermat's principle on the economy of time in the transmission of a luminous movement through a heterogeneous transparent isotropic medium, by M. J. Boussinesq. Researches on the phenomena of phosphorescence produced by the radiation of radium, by M. Henri Becquerel. The rays given off by some milligrams of barium chloride containing radium were allowed to fall upon various substances, such as calcium and strontium sulphides, rubies, diamond, calc spar, fluorite, and hexagonal blende, in a Becquerel phosphoroscope. When placed first in the dark, and then brought up to within a few millimetres of the radiating substance, all those minerals which became luminous under the influence of the X-rays, also became luminous under the radium rays; but ruby and calc spar, which only become phosphorescent under luminous rays, remained dark. There are, however, differences between the X-rays and these new radiations. Thus a specimen of diamond which was brilliantly luminous under the action of radium did not become luminous when exposed to the radiation from a focus tube, and similar differences were noted for other substances. The whole of the facts observed show that there is really a continuous giving out of energy by radio-active bodies.—On the metallic compound radicals: mercury derivatives, by M. Berthélot. Measurements of the heat of combustion and formation of mercury-methyl, mercury-ethyl, and mercury-phenyl.—Lactic acid, by MM. Berthélot and Delépine. A thermochemical study of lactic acid, and lactones derived from it.—On the explosion of potassium chlorate, by M. Berthélot. If potassium chlorate is introduced suddenly into a vessel which has been previously heated to a temperature much above that at which decomposition commences, an explosion takes place, as with picric acid under similar conditions, although under a slow heating potassium chlorate shows no explosive properties. The explosion produced is clear and sharp, although a little prolonged, resembling a slow powder. These facts give a probable explanation of the recent explosion of chlorate at St. Helens.—On the normal existence of arsenic in animals, and its localisation in certain organs, by M. Armand Gautier. From a consideration of the use of arsenical compounds as a specific in certain diseases, especially in anæmia and Basedow's disease, the author came to the conclusion that the activity of arsenic in such diseases must be to its forming a constituent part of some organs, more particularly the thyroid gland. A search for arsenic showed that it is present as a normal constituent of the thyroid gland in weighable amounts in herbivora, carnivora, and in man. It is also present in smaller quantities in some other organs. In the normal state, there would appear to be about 1 milligram of arsenic in 127 grams of thyroid gland. Further research showed that if the gland is slowly digested at 38° in presence of acidulated pepsine solution, the peptone formed contained no arsenic, the whole being concentrated in the residue of cellular nuclei.—Research and estimation of minimal quantities of arsenic in the organs, by M. Armand Gautier. The tissues are warmed with pure nitric acid (containing about one per cent. of sulphuric acid) until the whole is liquefied, then strong sulphuric acid is added and heat again applied, the oxidation being completed by the addition of nitric acid in small quantities. The liquid is diluted largely with water, sulphurous acid added, and hydrogen sulphide passed for some hours. After purification, the arsenic sulphide is oxidised and poured into a Marsh's apparatus.—M. Georges Lemoine was elected a Member in the Section of Chemistry in the place of the late M. Friedel.—Particulars of a destructive earthquake in the Moluccas on September 30, by the French Consul at Batavia.—Remarks by M. Lœwy on the "Annales de l'Observatoire de Toulouse."—Observations of the Leonids and Biélids made at Athens, November 1899, by M. D. Éginitis.—On some properties of certain systems of circles and spheres, by M. C. Guichard.—On the theory of groups, by M. R. Baire.—On differential equations of the second order with fixed critical points, by M. Paul Painlevé.—Generalisation of a formula of Gauss, by M. E. Busche.—On the transformation of Abelian functions, by M. G. Humbert.—Influence of the X-rays upon the electrical resistance of selenium, by M. Perreau. The X-rays were found to reduce the resistance of selenium in a similar manner to light rays, the reduction caused by the Chabaud tube used being nearly the same as that caused by diffused daylight, or a gas flame at 1·5 metres.—On the proof of the fluorescence of aluminium and magnesium in water and in alcohol under the action of the currents from an induction coil, by M. Thomas Tommasina.—Dissociation of potassium and ammonium iodomercurates by water, by M. Maurice Francois. The decomposition of $(NH_4)I.HgI_2.H_2O$ and of $KI.HgI_2.5H_2O$ is a limited one, and is reversible. When the state of equilibrium is attained, the amount of alkaline iodide present in the liquid is constant for a given temperature.—On the heats of partial neutralisation of carbonyl-ferrocyanic acid compared with those of ferrocyanic acid, by M. J. A. Muller. Carbonyl-ferrocyanic and ferrocyanic acids are of the same order of strength.—On some new combinations of benzene with phosphoric anhydride, by M. H. Giran.—Preparation of tetrachloro- and tetrabromo-orthoquinones starting from the corresponding tetrahaloid derivatives of guiacol and veratrol, by M. H. Cousin. The tetrachloro-derivatives of guiacol and veratrol are first hydrolysed by nitric acid, and the resulting pyrocatechols oxidised to the corresponding quinones.—On a case of hysterical hemiplegia cured by hypnotic suggestion and studied by chronophotography, by M. G. Marinesco.—Biological observations on *Peripatus capensis*, by M. E. L. Bouvier.—On the hybrid fertilisation of the albumen, by M. Hugo de Vries.—The Cretaceous minerals of Aquitaine, by M. Ph. Glangeaud.—On the history of the Jiu valley, in the Central Carpathians, by M. E. de Martonne.—On the vestiges of an ancient vitrified stronghold in the upper valley of the Dore (Puy-de-Dôme), by M. J. Uselade.

NEW SOUTH WALES.

Royal Society, September 6.—The President, W. M. Hamlet, in the chair.—"Sailing birds are dependent on wave-power," by L. Hargrave. The author points out that sailing birds passed most of their time over the face or rising side of waves, and that by so doing they abstracted power from the moving water as the progress of the wave raised the air above it at a velocity proportional to its speed and slope. He used Prof. S. P. Langley's results to show that the uplift of a moderate swell was amply sufficient to support a plane and keep it moving at about thirty-five miles per hour in a calm.—"Some applications and developments of the prismoidal formula," by G. H. Knibbs. Starting with a demonstration that the prismoidal formula was rigorously applicable to solids with parallel plane ends, whose mantles were ruled surfaces, the paper showed how the volumes of series of longitudinally contiguous solids, with plane ends, and skew or warped—ruled quadric—surfaces on the other sides, could most conveniently be calculated. The determination of the volumes of solids whose longitudinal axes were plane-curves, or curves of double curvature, was also considered, and it was shown that the prismoidal formula was also rigorously applicable to circularly warped solids, the centre of gravity in such changing its position linearly with the distance along the curved longitudinal axis. When the change of the centre of gravity of a right section is a non-linear function of the distance along the curved axis, or when the radius of curvature is not constant, the prismoidal formula is not rigorously applicable. The paper closed with suggestions as to the application of the formulæ.—Among the exhibits were twenty-four mounted photographs, including a series of photographs of aboriginals representing two types, male and female, a few illustrative of camp life and corroborrees, and a special series illustrating some of the details of an aboriginal Bora ceremony. The photographs were taken and exhibited by Mr. Chas. H. Kerry, and afterwards presented to the Society.

Royal Society, October 4.—Prof. T. W. E. David, Vice-President, in the chair.—Current Papers, No. 4, by H. C. Russell, C.M.G., F.R.S. This paper began by calling attention to the fact that during the years 1896 and 1897 the prevalent winds over Australia and the Indian Ocean were north-west, and that as a result, comparatively few current papers were received, because the wind forced the bottles carrying current papers towards the south, and in this way prevented them from resting in the Australian Bight, the great dumping ground for bottles. It was also shown that during the past year north-west winds had been few and light, while southerly winds had been frequent, and, as a consequence, current papers had been frequently received. On many days they came in pairs, and on one day three current papers had been seen, which is the maximum for one day, and during the past year 105 had been received. Referring to the drift of the disabled steamer *Perthshire*, it was shown that the direction the steamer took was just that which the author had found to be the course of bottle-papers, and that although the *Perthshire* was driven by many winds, it would appear that the final result did not produce any deviation from the drift-line of that part of the Tasman Sea. Reference was made to the unusual number of breaks in propeller shafts, and to the greater speed of current papers and the great number of violent storms, which the author thought all pointed to unusual energy in the sea and atmosphere, which may have caused the unusual strains on propeller shafts.—Note on the occurrence of Glaciated Pebbles in the Permo-Carboniferous Coal-field near Lochinvar, New South Wales, by Prof. T. W. E. David. These glaciated pebbles occur on a geological horizon over 1000 feet below the level of the Greta Coal-seams, whereas the horizons, where Mr. W. G. Woolnough and Mr. R. D. Oldham discovered their glacial pebbles, are from 1500 to about 2000 feet above the level of the Greta Coal-seams. These glacial beds at Lochinvar are at the very base of the Permo-Carboniferous System, and in general appearance closely resemble the Bacchus Marsh Glacial beds of Victoria, a locality where there is evidence of ice action on a grand scale over a wide area. These last belong probably to about the same geological age as the beds near Lochinvar. The height of the glacial beds at Lochinvar is about 200 feet above the sea, and the thickness of the beds probably not less than 200 feet. The pebbles were probably transported by floating ice. Those at Lochinvar were carried to their present resting place before the Greta Coal-seams were formed, and those at Branxton some time subsequent to the formation of the Greta Coal, in either case at times when this part of the Hunter Coal-field was submerged under the sea, as marine shells of Permo-Carboniferous age occur immediately above the glacial beds.

AMSTERDAM.

Royal Academy of Sciences, October 28.—Prof. Stokvis in the chair.—Prof. Martin reported on behalf of Prof. Behrens and himself on a treatise by Mr. Fritz Noetling, entitled "The miocene of Burma." The conclusion of this report was adopted, viz. to insert this treatise in the *Transactions* of the Academy.—Mr. H. E. de Bruyn read a paper on the relation between the mean sea level and the height of half tide. The author proved that various causes, such as (1) the height of the flood tide, (2) the average sea level, (3) the time of year, (4) the presence of drift ice, influence the difference between the above two averages, and he determined the amount of this influence in the case of the sea level at Delfzyl.—Prof. Bakhuis Roozeboom presented Dr. H. J. Hissink's dissertation, entitled "On mixed crystals of sodium nitrate with potassium nitrate and of sodium nitrate with silver nitrate," and made a communication on the subject. He also read a paper on the nature of inactive carvoxime.—Prof. Behrens read a paper on Isomorphous compounds of gold and mercury. The following communications were presented for insertion in the *Proceedings*: by Prof. Kamerlingh Onnes, on behalf of Dr. E. van Everdingen, jun., a paper on the Hall effect and the increase of magnetic resistance in bismuth at very low temperatures; by Prof. Van der Waals, a paper of Dr. G. Bakker, entitled "Observations on Van der Waals' molecular potential function"; by Dr. J. P. Van der Stok, a paper on tidal constants in the Lampong and Sabargbay; by Prof. Jan de Vries, a paper by Prof. L. Gegenbauer of Vienna, entitled "Neue Sätze über die Wurzeln der Functionen $C_n^v(x)$.

Göttingen.

Royal Society of Sciences.—The *Nachrichten* (Mathematico-physical Section), Part 2, contains the following memoirs contributed to the Society:—

March 11.—Eduard Riecke: Free electricity on the surface of Crookes' tubes.

May 6.—H. T. Simon: The law of action of the Wehnelt interruptor; and on rapid spark-discharges.

May 13.—O. Wallach: Researches (vii.) from the University Chemical Laboratory. (1) On substituted cyanamides and thiocarbamides. (2) On phenyl- and tolyl-butyric acid. (3) Conversion of pentacyclic into azotised hexacyclic compounds. (4) On mixed diazoamido-compounds.—H. Liebmann: Proof of two theorems on the determination of "ovaloids" by the measure of curvature or the mean curvature for all normal directions.

June 24.—J. Orth: Researches from the Göttingen Pathological Institute.

July 22.—Eduard Riecke: On the pressure within certain radiometers.—A. Schönflies: On the distribution of stationary and non-stationary points in certain functions of a real variable.—E. Wiechert: Seismometric observations in the Göttingen Geophysical Institute.

August 13.—O. Wallach: Researches (viii.) from the University Chemical Laboratory. (1) On the oxidation of pinene. (2) On compounds of the fenchone-series. (3) Condensation products from hydro-rubeane, aldehydes and secondary bases.

August 28.—C. Hartlaub: Preliminary communication on the genera *Margelopsis* and *Nemopsis*.

DIARY OF SOCIETIES.

THURSDAY, December 14.

Royal Society, at 4.30.—The Piscian Stars: Sir Norman Lockyer, K.C.B., F.R.S. On the Origin of certain Unknown Lines in the Spectra of Stars of the β Crucis Type, and on the Spectrum of Silicon: Joseph Lunt.—A Note on the Electrical Resistivity of Electrolytic Nickel: Prof. J. A. Fleming, F.R.S.—Investigations on Platinum Thermometry at Kew Observatory: Dr. C. Chree, F.R.S.—Observations on the Morphology of the Blastomycetes found in Carcinomata: Dr. K. W. Monsarrat.

Society of Arts, at 4.30.—Round about the Andamans and Nicobars: Colonel R. C. Temple.

Mathematical Society, at 8.—Sums of Greatest Integers: G. B. Mathews, F.R.S.—Note on Circular Cubics: A. B. Basset, F.R.S.—Formulæ involving Central Differences; and their Application to the Calculation and Extension of Mathematical Tables: W. F. Sheppard.—On the Expression of Spherical Harmonics as Fractional Differential Coefficients: J. Rose-Innes.—The Genesis of the Double Gamma Functions: E. W. Barnes.—The Theorem of Residuation, being a General Treatment of the Intersections of Plane Curves at Multiple Points: Dr. F. S. Macaulay.

Institution of Electrical Engineers, at 8.—Discussion on Mr. Crompton's and Mr. John Holloway's Papers.—Electrical Time Service: F. Hope-Jones.

FRIDAY, December 15.

Epidemiological Society, at 8.30.—Precautions against Plague and Cholera at the Quarantine Station at El Tor: Dr. Armand Ruffer.—The Behaviour of Plague at Oporto: Dr. Arthur Shadwell.—The Control of Plague in India by the Medical Inspection of Railway Passengers: Dr. Spencer Low.

Institution of Civil Engineers, at 8.—On Sludge: Blamey Stevens.

MONDAY, December 18.

Royal Statistical Society, at 5.30—Some Notes on Makeham's Formula for the Force of Mortality: H. P. Calderon.

TUESDAY, December 19.

Zoological Society, at 8.30.—General Remarks on the Mammal-fauna of South Africa: W. L. Sclater.—Contributions to the Osteology of Birds. Part IV. Pygopodes: W. P. Pycraft.—On the Myology of the Edentata, Part II.: B. C. A. Windle and F. G. Parsons.

Institution of Civil Engineers, at 8.—*Paper to be further discussed*: Combined Refuse-destructors and Power-plants: C. Newton Russell.—*Papers to be read, time permitting*: The Purification of Water after its Use in Manufactories: Reginald A. Tatton.—Experiments on the Purification of Waste-Water from Factories: W. O. E. Meade-King.

Royal Statistical Society, at 5.—Some Statistics relating to Working-Class Progress since 1860: G. H. Wood.

Royal Photographic Society, at 8.—Negatives for Three-colour Work: Captain W. de W. Abney, C.B., F.R.S.

WEDNESDAY, December 20.

Society of Arts, at 8.—Bi-Manual Training by Blackboard Drawing: H. Bloomfield Bare.

Geological Society, at 8.—On some Effects of Earth-Movements in the Carboniferous Volcanic Rocks of the Isle of Man: G. W. Lamplugh.—The Zonal Classification of the Wenlock Shales of the Welsh Borderland: Miss G. L. Elles.—On an Intrusion of Diabase into Permo-Carboniferous Rocks at Frederick Henry Bay (Tasmania): T. Stephens.

Royal Meteorological Society, at 7.30.—The Climatic Conditions necessary for the Propagation and Spread of Plague: Baldwin Latham.—Note on a Remarkable Dust Haze experienced at Teneriffe, Canary Islands, February, 1898: Dr. Robert H. Scott, F.R.S.

Royal Microscopical Society, at 8.—A Review of Photo-micrography, and its Different Methods: Edmund J. Spitta.

THURSDAY, December 21.

Linnean Society, at 8.—The Air-bladder and its Connection with the Auditory Organ in the Notopteridæ: Prof. Thos. W. Bridge.—On some New and Interesting Foraminifera from the Funafuti Atol, Ellice Islands: F. Chapman.

Chemical Society, at 8.—The Condensation of Glycollic Aldehyde and Formation of α and β Acrose: H. Jackson.—On Brasilin and Hæmatoxylin, Part III. A. W. Gilbody and W. H. Perkin, jun.—The Action of Alcoholic Potash on Monobromoglutaric Ester: N. E. Bowtell and W. H. Perkin, jun.—(1) Mercurous Iodide; (2) On the Interaction of Mercurous Nitrite and Ethyl Iodide: Dr. P. C. Rây.

CONTENTS.

THURSDAY, DECEMBER 21, 1899.

THE COMING WHEAT SCARCITY.

The Wheat Problem. Based on remarks made in the Presidential Address to the British Association at Bristol in 1898. Revised, with an answer to various critics. By Sir William Crookes, F.R.S. (London: John Murray, 1899.)

THIS essay by Sir William Crookes, as will be remembered, called forth much criticism when it was delivered as the Presidential Address at the Bristol meeting of the British Association. Now that it is reprinted with additions, it may demand a more careful review than was possible at the time. The general idea, it may be said, is by no means novel, and it is one which approved itself to common sense. The population of the world and of different races in the world increases at rates which are more or less ascertainable. The means of supplying its wants, either in the shape of coal, or metals, or food, is also limited, either by the amount of the accumulated stocks, or the means of working them, or the extent of the earth's surface available for producing the food. What more natural then than to calculate, as has been done by Malthus, as to food generally, by other statisticians as to food in particular districts, such as India at the present time, by Jevons as to coal in England, by Prof. Cairnes as to metals generally, and by Prof. Suess, an Austrian geologist and statistician, as to gold specially, that at a given date in future the supply must run short, and then a crisis arrive? Sir William Crookes applies specially to the study of wheat production this leading idea. The consumers of wheat, he tells us, are a little over 500 millions at the present time, having increased to that figure from about 370 millions in 1870, while the quantity of the earth's surface available for wheat is itself limited both by the capacity of the soil and the necessity for cultivating other products. He calculates accordingly that by the year 1931, if population increases as it has done, the supply of wheat will be seriously short, and he suggests that chemistry should come to the rescue by devising means to fix the nitrogen of the atmosphere so as to permit the growth of more wheat on the same soil.

In all this argument, except as to the last suggestion, Sir William Crookes is plainly on the common ground of men of science and philosophers. He may be right or wrong as to details, such, for instance, as fixing 1931 for the time when the "shortage" of wheat will be felt; but given the initial hypotheses, there must be in time a deficiency of the supply to meet the demand for wheat—as well as for other food articles, it may be added—if present conditions of growth of population, and growth of wealth per head in that population, continue.

But at this point I fear the main commendation of Sir William Crookes' essay must stop. His attempt to give precision to the prospect as regards wheat (and the whole gist of his paper is to emphasise the precision of the forecast) appears to me rather to fail, while he does not handle statistical data in the skilled, scientific manner we should expect from a man of his eminence even in a field which he does not usually cultivate. Above all, instead of confining himself to the forecast that a certain position will be arrived at at a future date, if present conditions continue, the conclusion to which expert statisticians now confine themselves, he assumes the continuance of the conditions, and argues for practical measures to meet the apprehended difficulty. In other words, although the general idea of the essay is sound, the execution appears to be somewhat wanting, and the result is not altogether what we should expect from a man of science so distinguished as Sir William Crookes.

To take first the last point mentioned, the failure to recognise the necessary limitation of all such speculations in consequence of the assumption that must be made that present conditions continue unaltered. I hold this to be a capital error on the part of Sir William Crookes. There has been much experience of these discussions since the time of Malthus, and the whole effect of the experience is that, as yet, we are either too far away from the limits when shortness of supply of food and raw materials, which men of science and philosophers anticipate, will be felt, to engage in a precise discussion, or that we know too little as to the ultimate causes of existing conditions to be able to predict whether they will be soon changed or not. The forecasts of Malthus regarding England and the older countries of Europe that the supply of food would run short have not yet come true, because an outlet in the shape of emigration to new countries has been provided, with the double effect that the multitudes who were expected by Malthus to live in the old countries and press on the narrow supplies there are now largely settled in new countries, and are not only growing food for themselves, but for some of the multitudes remaining in the old countries as well, this last condition being rendered possible by the entirely new developments of means of communication which have taken place since Malthus wrote. Since Malthus wrote, also, there has been a general and vast improvement in the art of cultivating the soil. Similarly, as regards coal, the growth of the demand has by no means continued at the rate which Jevons found in existence when he wrote, while the influence of the price of coal as a factor in production has diminished in consequence of the greater effectiveness of the machinery which coal is used to drive. The scarcity of the supply of gold, which the Austrian geologist anticipated, seems also to be deferred indefinitely by the discoveries in the Transvaal, Western Australia, and the Klondyke; while as to the demand for gold, it is equally plain that nothing is more uncertain than the continuance of the present condition of an overwhelming desire by military governments to secure and lock up enormous sums of gold. Experience is thus altogether against making precise forecasts on the lines laid down by Malthus. Consequently, when a new authority takes up a similar subject, we should expect him to be wide-awake to such considerations, as have been found so important in like cases. The conclusions should always be stated with an "if"—a big "if"—and there should be no attempt at precision in the forecasts, against which there are so many chances that they will not, in fact, be realised. The man of science should be content with pointing out that if his previsions are not realised then existing conditions must change, and the future inquirer should be vigilant in observing the changes. Sir William Crookes has not done this, but has assumed that present conditions will continue, and that his prophecy must come true almost to the letter, which places the discussion altogether on a wrong basis.

The handling of the statistical data also, as I have said, is not what one should have expected from Sir William Crookes. To begin with, the relative place of wheat as an article of food supply to the Caucasian race appears to be very much exaggerated. Sir William Crookes, though he does not say so explicitly, really speaks of wheat as the principal food.

"My chief subject," he says, "is of interest to the whole world—to every race—to every human being. It is of urgent importance to-day, and it is a life and death question for generations to come. I mean the question of food supply. Many of my statements you may think are of the alarmist order. Certainly they are depressing; but they are founded on stubborn facts. They show that England and all civilised nations stand in deadly peril of not having enough to eat. As mouths multiply food resources dwindle. Land is a limited quantity, and the land that will grow wheat is absolutely dependent on difficult and capricious natural phenomena."

And more to the same effect. The identification of "wheat" in particular with "food" in general without any discussion of the relative importance of wheat among food articles, in the economy of the peoples concerned, is thus complete. The fact is, however, that wheat is only a fractional part of the food of some of the peoples who consume wheat, especially of the European peoples and the people of the United States, who are by far the largest consumers, and that it could be dispensed with and replaced by other articles wholly or in great part if necessity should arise. Take the case of the United Kingdom alone. Our imports of wheat and wheat-flour last year amounted to rather less than thirty-eight millions sterling, and if we allow for home production we may place our national expenditure on wheat at about fifty millions annually at the outside. Our total annual expenditure on food must be about eight times that sum. Our expenditure on imported food alone—meat, cereals, sugar, rice, &c.—was last year over 170 millions sterling, and if we add to that the home production of meat, dairy produce and cereals, we very soon get to a total figure of 400 millions or thereabouts. Sir William Crookes is thus anxious about an article of food on which we depend only to the extent of one-eighth. It may be rejoined that wheat is specially important on physiological grounds, but if so, these grounds should have been stated, and there is certainly no statement in the paper. The money test, the test of actual expenditure, is in any case not an unfair one. It would be the same, we believe, if Sir William Crookes were going farther afield. The people of the United States are very like ourselves as regards food consumption, and, to some extent, the peoples of France and Germany; while among others, whose diet is different from ours, wheat is still relatively unimportant, because, though they do not consume meat as the peoples of this country and the United States do, yet articles like rye and potatoes really constitute their main food, wheat being almost an article of luxury by comparison, and not a principal food. Nowhere, according to Sir William Crookes' own showing, is so much wheat consumed per head as in France, the United Kingdom, and the United States, the very countries in which its relative importance is lowest as an article of diet. It may be suggested, then, that in a scientific inquiry as to the possible shortage of food supplies in the near future the various chief articles of food of the peoples concerned, such as meat, dairy produce, fish, potatoes and sugar, should have been considered, and not merely wheat. There is another reason for this course. Suppose, as I believe to be the case, that a large part of the earth's surface is now used for the production of expensive articles of food like meat and dairy produce with the minimum of cultivation, the most that could happen as supplies became short might be a change of cultivation, involving some addition, but perhaps no great addition, to the cost of production, but resulting in a simultaneous increase of the quantities of meat, dairy produce and cereals produced. The play, then, between different articles of food must be considered. If one article like wheat is taken by itself, it is plainly only a question of price. At a point, the soil now used in growing meat and dairy produce by means of permanent pasturage could easily be taken to produce wheat or other cereals without any diminution, but rather along with an increase, of the production of meat and dairy produce at the same time, though at perhaps rather more cost. At what point will shortage of all supplies, taken together, be felt, and how? are the questions for the man of science and agriculturist, and they are not to be answered by the sort of rule of thumb which is here applied to wheat.

There is yet another serious oversight, in my judgment, when we look at the paper from a purely statistical point of view. Sir William Crookes goes into great detail as to the acreage under wheat in different countries at different periods, but regarding the other side of the comparison, the population of bread-eaters and their rate of growth, he gives no details at all. He confines himself to the following assertion:

"In 1871 the bread-eaters of the world numbered 371,000,000. In 1881 the numbers rose to 416,000,000; in 1891 to 472,600,000; and at the present time they number 516,500,000. The augmentation of the world's bread-eating population in a geometrical ratio is evidenced by the fact that the yearly aggregates grow progressively larger. In the early seventies they rose 4,300,000 per annum, while in the eighties they increased by more than 6,000,000 per annum, necessitating annual additions to the bread supply nearly one-half greater than sufficed twenty-five years ago."

Clearly a statement like this ought not to be made in a scientific paper, where a great deal turns upon the statement, without the details and references enabling any one to verify and appreciate it. Of course, it is quite possible for any one knowing population statistics, and content to classify large populations as bread-eating, without inquiring in detail what proportion in each population is really bread-eating, to make up a statement for himself; but there are cases of difficulty in any such grouping, and we are entitled to know what Sir William Crookes has done. In a scientific question like this he should have been more specific for another reason. As the consumption of wheat per head in different wheat-eating populations varies a good deal, much may turn upon the nature of the increase, whether it is largest among the communities consuming wheat largely, or among the communities who consume little. To comprehend, in fact, the real growth of wheat-consuming power, we must have an average which allows for the different rates of consumption among the wheat-eating peoples, with references to the authorities for the statements as to each people. To set out this was of the essence of the problem Sir William Crookes had before him, and he has omitted it altogether. The nature of the increased consumption in each country should also have been investigated. It is asserted among farmers, for instance, that a considerable quantity of wheat, more than used to be the case, has of late years been taken in England for other purposes than the food of man, the wheat being given to cattle. Every one knows, again, that flour itself in domestic economy is more and more being applied as an element in cooking articles of luxury, and that it is not really used to a large extent as a principal food at all. All this adds to the interest of the problem as to any approaching shortage of wheat, and the means of making it good, because so much may at need be diverted back from other purposes to the primary use as food; and it shows also that the question of wheat consumption is not one that can be studied, for any such purpose as that contemplated by Sir William Crookes, without an infinity of detail. In any case, it was a matter of scientific good faith that he should have given the details and the references for the important statement we have quoted, which he has not done.

I am not making a mere formal objection. It is, of course, difficult to criticise without having before us the details which Sir William Crookes has not given, but I have not the smallest doubt that the largest increase of bread-eaters, which his details would show, is among the peoples consuming little per head, and not mainly among the peoples consuming much. One of the countries where wheat consumption per head is largest is France, and France is stationary in population.

Having made these general observations on the method followed in the essay, I do not feel called upon to go into detail respecting the actual acreage, and possible acreage, of wheat, in different countries, on which Sir William Crookes has so much to say. There is no question really more difficult. The capacity of a given population for agriculture is here just as much in question as the capacity of the soil, and I quite agree in principle with Sir William Crookes, that although additional soil might be available indefinitely for wheat in proper hands, yet as a matter of fact the soil practically available may be strictly limited. But what he fails to take sufficient note of, I believe, is the question of price. Land that would not be available for wheat with the price at 20*s.* to 25*s.* per quarter, might become available in indefinite quantities with the price at 40*s.* to 50*s.*, and even 60*s.*, which are by no means famine prices. But Sir William Crookes has little to say on this factor of pr ce. Altogether, I may suggest, he relies too much on American statisticians, without having himself verified their methods. Mr. Davis for his purpose is not a quotable authority. He should have gone behind Mr. Davis and verified everything for himself.

The point on which the reference is made is rather a side one, but the danger of putting forth a sweeping statistical statement without adequate support is so well illustrated by it, that it may be useful to quote it. Sir William Crookes states, p. 35:

"Taking the cost of producing a given quantity of wheat in the United Kingdom at 100*s.*, the cost for the same amount in the United States is 67*s.*, in India 66*s.*, and in Russia 54*s.*"

Surely it is altogether erroneous statistically to put forward a statement like this without references. How does Sir William Crookes know that England and the United States and the other countries mentioned differ so much as he states? The cost of production he refers to is either a maximum or a minimum, or a mean of two extremes, or an average; but which is it? As he makes the statement it is really unintelligible. If he means an average, as I presume must have been intended, how does he get the average? The statement is not one to be made in a scientific study without references and authorities, and full explanations of what is really meant.

In conclusion, I may express the hope that in some future essay Sir William Crookes will revise his present work, and not only look into his statistics, but inquire into the question of the play among different articles of food in agricultural production and in human consumption, instead of dealing with one article only. As to his suggested remedy for too little wheat, the fixing of the nitrogen of the atmosphere, it is one which may well be disconnected from the paper itself. Whatever may happen to wheat, the problem is one which should be attractive to the chemist on its own merits. It is, perhaps, unfortunate that the suggestion should have been appended to an alarmist statistical paper, instead of being made from the chemical side only, as the statistics seem to give little support to the suggestion.

R. GIFFEN.

THE PHYSICAL ATLAS.

Atlas of Meteorology. A series of over four hundred Maps prepared by J. G. Bartholomew, F.R.S.E., and A. J. Herbertson, Ph.D.; and edited by Alexander Buchan, LL.D., F.R.S. (Westminster: Archibald Constable and Co., 1899.)

OF the making of meteorological observations there is no end, and some, who have only a partial acquaintance with the subject, might be tempted to add, no result. But such a criticism, however smart, is eminently unjust, and as a protest against such an uncharitable opinion it was a wise and happy thought to endeavour to combine the outcome of the labours of many observers into a monumental form, which could appeal to the eye of many untrained in scientific methods, and convince them that time and thought and money had not been lavished in vain on mere childish records, but that earnest endeavour had harvested an abundance of facts, which only needed orderly arrangement and skilful grouping to make them available for instruction and edification. To the scientific mind well versed in such matters this compilation can appeal more strongly and more worthily, for it demonstrates not only what has been successfully accomplished already, but exhibits the deficiencies that demand attention and offer prospects for hopeful exploration. These deficiencies will be mainly of two kinds. One, due to the dearth of information from sparsely inhabited districts in inhospitable climates, or from regions where no well-ordered government obtains. Such lacunæ are regrettable, but will gradually disappear in presence of individual enterprise, employing the same means as those which have been successful in more settled lands. The other is more serious, and may be traced to the want of greater originality in the construction and management of instruments devoted to particular ends. Imitation and repetition have probably been two of the main causes from which meteorology has suffered. We have been too content with the readings of barometers and thermometers in convenient positions, and have made but few attempts to investigate meteorological phenomena at elevated stations above the earth's surface, leading, it may be, to a knowledge of vertical gradients of pressure, temperature, humidity, &c., and suggesting new lines of useful inquiry. It may seem an ungracious remark with this collection of valuable facts before us, but it would appear that we have been too much engaged in recording the results of particular combinations of the atmosphere in particular districts, and too little concerned in the antecedent processes that have produced the effects we are so eager to register.

This existing wealth of meteorological observations makes us gratefully recognise the amount of labour that has been bestowed upon the production of this atlas. The task must have been a leviathan one, and it has been grappled with manfully. The meagre bibliography of four pages attached to the work, and which we cannot help regarding as somewhat unworthy of its place, can only very feebly indicate the sources of information that must have been consulted in the preparation of this record of the climate and the weather of the world. Scattered over many lands and described in various languages are valuable observations and memoirs, which it must have been the object of the compiler and his assistants to weld into this convenient form; and the eminent authorities who have associated themselves with the editor of this undertaking are a sufficient guarantee that all that is serviceable, all that is trustworthy, has been extracted from these hidden journals and memoirs. The general result is a collection of maps which are to a certain extent diagrams or the pictorial representation of much tabular work, and their study affords not only grounds for congratulation, but will tend to prevent unnecessary duplication and suggest the necessity for more strenuous and more scientific application of the methods open to us.

The atlas, consisting in all of thirty-four plates, is arranged to afford information on two distinct objects of meteorological inquiry, climate and weather—that is to say, variations of the atmospheric conditions for short and ong periods. Under the first heading, climate, we have eight subdivisions. These are (1) isotherms, showing the seasonal and annual distribution of temperature over the world generally, and in greater detail for those countries where a sufficient number of observations exists to permit the lines of equal temperature to be drawn with exactness; (2) isobars showing the distribution of atmospheric pressure, and arrows to indicate the prevailing direction of winds; (3) the relations existing between isotherms and isobars; (4, 5, 6) showing respectively the general distribution of sunshine, cloud and rain over the globe; (7) maps of hyetal regions and the seasonal distribution of rain; and (8) isobars and isohyets indicating monthly and annual distribution of barometric pressure and rainfall as related to each other for various countries.

It is impossible to enter here into details of the manner in which each and every of these subdivisions is treated, to discuss the principles which have guided the editor in constructing the maps and in overcoming the difficulties which naturally beset a diagrammatic representation. It goes without saying that the highest authorities have been consulted in the preparation, and, indeed, are to a certain extent responsible for the accuracy of the maps. These are executed in a very admirable manner, though sometimes the very neatness of execution makes it a little difficult to rapidly grasp the detail printed on them. As a rule, successive changes in the climatic element are shown by more intense washes of the same colour; and we could have wished that this rule had been more uniformly observed, since no abrupt change, such as that suggested by a change of colour, distinguishes the gradual variation of climate with latitude. For example, there is no sudden change of temperature to the north or south of an arbitrarily selected isotherm, yet one passes on these maps from red to yellow and from yellow to green with startling suddenness, as though some new feature had been introduced.

The second main division, under the generic title "weather," naturally deals with the atmospheric conditions which have to be taken into account in making a forecast whether for a shorter or longer period. Here possibly there is opportunity for the exercise of greater originality in the selection of the necessary material than in the earlier section, which deals simply with the direct results of observation. For the systematic study of anomalous weather is of comparatively recent growth, and the information, based as it usually is, on shorter series of observations made in districts where observatories are more sparsely scattered, is not so definite nor so precise as that which characterises the older observations made in climates which do not experience those typical storms whose careful study has been attended always with interesting, and generally with beneficial, results. In this section, if anywhere in the volume, some alteration may be necessary hereafter in the detail and arrangement, occasioned either by the deductions from more recent observations, or by greater generalisations due to theoretical application. But it is safe to say that a very admirable use has been made of the information that at present exists, and in the description prefixed to the maps will be found a careful summary, not only of the inquiries instituted by national bureaux, such as that of the United States with its widespread network of stations, but also of the individual researches of such physicists as Hann, Eliot, Van Bebber, Doberck and others whose names are household words.

The sections into which the editor divides the subject of typical and anomalous weather, or the groups under which our present knowledge of this subject can be presented, are five in number. Barometric pressure of necessity plays the principal part in the arrangement and subdivision of the section. The maps are constructed to exhibit the pressure conditions which obtain in abnormally hot and cold seasons and months in differen regions, those which produce recognised types of wind and weather, or accompany typical storms of all kinds. To these are added maps showing the tracks of storms and the distribution of storm frequency, with a final series showing typical distributions of deviations from the normal monthly pressure, upon the study of which the forecasting of the probable weather for a season will be based, as well as the distribution of the mean deviations from these normals. From this description of the contents of the two sections, it will be seen that the atlas is essentially a book of results. It summarises what has been already accomplished by patient effort and long-continued observation, and the result is encouraging. Mr. Buchan, who signs the introduction in his capacity of editor, contends—

"If the present state of the science [of meteorology] as regards the geographical distribution of results be compared with that of the other sciences, such as geology and the biological sciences, it stands second to none. None of these sciences can show such a world-wide distribution of precise results as are collected in this Atlas of Meteorology in illustration of the geographical distribution of temperature pressure, humidity, cloud, rainfall and movements of the atmosphere, with illustrations of their influence over, and inter-relations with each other."

How far this remark is justified must be left to the individual judgment of those who it is hoped will read and digest this first instalment of the Physical Atlas.

W. E. P.

THE NORTH AMERICAN SLIME MOULDS.

The North American Slime Moulds. By Prof. T. H. McBride. Pp. xvii + 231, and plates. (New York: the Macmillan Company. London: Macmillan and Co., Ltd., 1899.)

THE group of organisms known as Myxomycetes, or as Mycetozoa of De Bary and Rostafinski, has of late years received much careful study in the United States. In 1834 Schweinitz published his "Synopsis of North American Fungi," and his large collection of Myxomycetes has been recognised in that country as the standard authority for reference. In 1848 Curtis contributed articles to journals on the subject, and both he and Ravenel made extensive gatherings in the south-eastern States. Since that time American investigators, conspicuous among whom should be mentioned Prof. Peck and the late Dr. G. A. Rex, have done excellent work; new species have been discovered, and large collections have been made in different parts of the States. The professors of botany have brought the Myxomycetes into their course of instruction, and a literature has sprung up founded to a considerable extent on local research.

Prof. McBride, of the University of Iowa, has made an important addition to this literature in the work under notice. In an interesting preface he pays a well-deserved tribute to the labours of Rostafinski, and we are glad to see that he founds his classification on the lines laid down in Rostafinski's monograph of the Mycetozoa, but he prefers the older name Myxomycetes for the designation of the group. In this he follows Dr. Scott in his admirable book on structural botany; at the same time, Prof. McBride fairly discusses, from a botanist's point of view, the claims that have been advanced for including them in the animal kingdom, and sums up by saying—

"Why call them either animals or plants? The Myxomycetes are independent. All that we may attempt is to assert their nearer kindred with one or other of Life's great branches."

From this standpoint, however, we do not think that the adoption of the name "slime moulds" is a happy one. If, as the professor remarks, their position is "a matter of uncertainty, not to say perplexity," and in the face of the high authority of Rostafinski, under De Bary's supervision, for the name Mycetozoa, an English translation of either word seems to be hardly needed.

The question of nomenclature is perhaps a more burning one in the States than it is with us, where De Candolle's law is very much accepted in practice.

Prof. McBride speaks warmly on the subject on p. 10 of the preface. Instead of adopting the earliest published specific name of a species in the genus in which it now stands, and giving as the authority the name of the person who first placed it in that genus (leaving the history of the first describer to be traced in the unfortunately necessary list of synonyms), he aims at giving the earliest published specific name, under whatever genus it appeared, giving as the authority the name of the first describer in brackets, followed by the name of the placer in the present genus. If an important object in appending the authority were to commemorate the name of the first recorder, we should agree with the professor, and as a matter of sentiment there is much to be said in favour of his view; but if the object in quoting the authority be solely to establish the identity of a species, apart from personal considerations, De Candolle's rule has the advantage of simplicity. The ideal conception of a uniform system of classification universally accepted appears to be unattainable, at least in the present generation, considering the strongly-held and diverging views which now prevail; but Prof. McBride has devoted much labour to searching the oldest records, short and incomplete as many of them are and compiled with the aid of imperfect instruments, and we cannot but admire the thoroughness with which he has endeavoured to carry out his principle.

When we bear in mind the wide variation which we find in many species that offer abundant material for observation, as, for example, in *Physarum nutans* Pers., the adoption of a main centre as the type and the description of diverging forms as varieties appears to be in accordance with the actual facts, and is of assistance to students. Prof. McBride, however, avoids the introduction of varieties, and therefore multiplies the species recorded in his work to an extent which may not meet with universal approval; but it is fair to note that in many cases he leaves the specific value an open question.

On the other hand, in those species which have come under his personal observation—and these embrace a very large proportion of the whole—his descriptions are admirable. We read them with the confidence that they are accurate and drawn from nature; they give us new information and a graphic picture of many species which have seldom or never been recorded in Europe, and it is needless to say that the measurement of spores can be entirely relied upon.

To those who are within reach of the University of Iowa, the fact that the species described are represented by type specimens in the herbarium of that institution is of the utmost value; for, however excellent the description, it is to the type itself that we must fall back as the last resource when so much depends on minute microscopical examination.

The physiology of the Myxomycetes does not appear to have received the careful study in Iowa which we may hope for in the future, considering the wealth of material which the region affords. On more than one occasion Prof. McBride refers to formation of spores as preceding that of the capillitium. On p. 108 he says, in speaking of the capillitium:

"It is necessary to recall the fact that in the best case all such structures of the fructification are but forms of the residue after the formation of the spores."

A laboratory experiment of no great difficulty shows, by a series of stained preparations of maturing sporangia, that the capillitium material, together with the calcareous matter when present, is separated from the spore-plasma before the karyokinetic division of the nuclei takes place preparatory to the formation of the spores; thus the capillitium is formed before the spores.

With regard to the systematic part, Prof. McBride's work must take a pre-eminent position as a guide for students in America, and its value will not be confined to those on the other side of the Atlantic. We lay the book down with a refreshing sense that it is a trustworthy history written in a pleasing manner by one who has a wide grasp of his subject.

A NEW MATERIA MEDICA.

An Introduction to the Study of Materia Medica. Being a short account of the more important crude drugs of vegetable and animal origin. By Henry G. Greenish, F.I.C., F.L.S. With 213 illustrations. Pp. xxi + 511. (London: J. and A. Churchill, 1899.)

THE position of Mr. Greenish as Professor of Materia Medica and Pharmacy to the Pharmaceutical Society of Great Britain has enabled him to produce in the book before us a very useful aid to the students attending his lectures, as well as a valuable handbook to the subject for the use of those of riper years. In his preface the author is careful to explain the meaning of the term Materia Medica, and to qualify the meaning of the words "crude drugs" as distinct from those that have been subjected to preparation. In this connection he says:

"The term Materia Medica literally interpreted signifies all remedial agents of whatever kind, but it is more commonly used to designate that department of medicine devoted to the consideration of simple medicinal substances known as 'drugs.' In medicine the term is usually employed in this sense, but in pharmacy it is generally understood to include only those drugs that are derived from the animal and vegetable kingdoms, and have not undergone any process of elaboration whereby their characters have been materially altered; such drugs are termed crude drugs. Thus the poppy capsule is a crude drug, and opium, which consists of the dried latex of the unripe capsule, is also classed as a crude drug; but the alkaloid morphine, which is the chief constituent of opium, and can be extracted from it only by a comparatively elaborate process, is not regarded as such. Similarly the resins, oleo-resins, gum-resins, various dried juices, &c., are included amongst the crude drugs. The term is also extended to certain vegetable extracts imported from distant countries in which alone they are prepared, even if they have been partially purified, as, for instance, Cutch and Gambier, although similar extracts prepared in this country would no longer be considered as crude drugs."

This explanation will serve to show the nature and aim of Mr. Greenish's work, which is carried through with much distinctness, and each subject is treated in the clearest possible manner and on the same system throughout.

The arrangement of the subjects under the headings of leaves, flowers, fruits, seeds, woods, barks, resins, oils, and so on, is a novel one in works of this kind, so far as English publications are concerned, and for students' purposes it is perhaps the best that could be adopted, especially with the aid of the tabular classification according to the natural orders, which Mr. Greenish gives at the end of the book; but we are inclined to think that this classification would have been more useful, especially to those with a botanical knowledge, had it been arranged in scientific sequence rather than alphabetical, and, further, to have separated the plant products from those of animal origin. This classification, however, will be found of much use, inasmuch as one sees at a glance what medicinal plants are included in any given order, together with a statement as to what part of the plant is used and a reference to the page where the description is to be found.

That the arrangement of each individual subject under its special head is the best that could have been devised there can be no possible doubt. Each drug appears first under its English name, as, for instance, Red Rose Petals in large capitals, followed by its Latin equivalent *Petala Rosae Gallicae;* or, again, Foxglove leaves, *Folia digitalis.* Following these are paragraphs under the heads of source, &c., description, constituents, and uses, and, where necessary, substitutes and adulterations. The whole is written in such a clear style, and in such plain language, that there is no difficulty in understanding at once what is intended. Moreover, the summing up of the description and the points to be observed by the student are terse yet sufficient, and being printed in italics at once catch the student's eye. Thus under Chiretta (*Swertia Chirata*) the following occurs:

"The student should observe—
(*a*) The purplish-brown colour of the stem.
(*b*) The large continuous pith.
(*c*) The intensely bitter taste.
(*d*) The opposite leaves.
(*e*) The bicarpellary, unilocular fruits."

The first three characters will suffice to distinguish the genuine drug from other species of *Swertia* which sometimes are mixed with it or substituted for it, as well as from other substitutions that have been occasionally noticed. The last two are characteristic of the natural order Gentianeæ, and are also useful in identifying the drug.

That the book is not without errors and omissions we are not prepared to say. What book, especially in its first edition, can ever be so regarded? Thus, for instance, under the head of capsicum fruits, Mr. Greenish, though mentioning that the plant is cultivated in Eastern Africa, does not mention Zanzibar in particular as one of the commercial kinds known in the British markets, nor does he even allude to Japan as a source of these pungent fruits, though of late large quantities have been imported thence to this country. But with a book so carefully worked out and so thoroughly well got up, it is ungracious to find faults, many of which have no doubt already been observed by its author and noted for correction in a new edition, which will probably not be long before it is called for, as the book is one that must be in the hands of the continuously increasing number of pharmaceutical students.

We had almost forgotten to say that the numerous illustrations add much to the value of the book. They have been carefully selected, and the source from which they are taken is acknowledged beneath each figure.

OUR BOOK SHELF.

Descriptive General Chemistry. By S. E. Tilman. Second Edition. Pp. x+429. (London: Chapman and Hall, Ltd. New York: John Wiley and Sons, 1899.)

THE author of this volume is professor of chemistry, mineralogy and geology in the United States Military Academy, and the book embodies an attempt to present chemical science in a form and compass adapted to special circumstances. Whilst in the opinion of the author "the chemical knowledge most requisite to the average professional soldier differs but little from that essential to other educated men . . . the experience and judgment of the Academic Board and of their military superiors" has limited the course to about two months. From this statement, as well as from the concentration of three sciences in one professor, it would appear that the dogged resistance to the encroachment of science on the art of war which distinguishes the Anglo-Saxon in this country, is well maintained in America. It is evident, also, that the task of the author is no light one. He has discharged it by presenting a tolerably full and very lucid account of the chief principles of chemistry, followed by a considerable amount of descriptive matter, illustrated, and we may say illuminated, where possible, by reference to things of military interest. The outcome is a very readable volume, containing information which, if it could be conveyed under reasonable conditions, would be of great value to the future soldier. But it need hardly be said that a mass of scientific information, however skilfully selected and well written or well spoken, will give in no important measure a scientific habit of mind, or an animate knowledge of science. On the whole, however, Prof. Tilman has probably done the best possible under the circumstances.

Among matters of special interest in the book are the accounts of American metallurgical processes. The descriptions of important chemical industries are also clear and concise. The weakest point to be noticed in the book is the treatment of fuel calorimetry. There is no description of a calorimeter or a pyrometer, and the old misleading formulæ for the calculation of "calorific power" and "calorific intensity" are introduced. The exhaustive experiments of the late Scheurer-Kestner, which showed the uselessness of such formulæ, do not seem to have become as well known as they should be.

A. S.

Zoologia. By Prof. Achille Griffini. Pp. xvi + 384. (Milan: Ulrico Hoepli, 1900.)

THIS book is divided into an introductory part (26 pp.), dealing with the history and scope of zoology, and the broader principles of morphology and physiology of animal forms, followed by a main part (337 pp.), in which the great groups of animals are successively dealt with in a roughly descending order, the whole ending with an "epilogue" (16 pp.), embodying an ambitious classificatory table, and certain philosophic deductions which, in deference to the scruples of his countrymen, the author is willing to let pass unread! It is in places very thin and antiquated, and its illustrations are on the whole the most interesting feature, since they alone proclaim it a text-book mainly begotten of the text-books, with little fresh thought or aim at originality. There are five hundred and five figures in all, many representing animals in a state of nature, at times with theatrical sensationalism, others delineating the facts of anatomy and minute structure, still others schematic. Taken collectively, they are an *omnium gatherum* of an inferior order. Page after page bears the time-worn figures which we find in nearly every text-book under the sun, here reproduced without acknowledgment and in some cases in a disguised form; and when originality is attempted the result is in places ludicrous; as, for example, in the physiological scheme on p. 81, and the figure of the Molluscan nervous system on p. 329. A set of figures is repeatedly introduced in supposed representation of the eggs and larvæ of the frog (*Rana*)—the egg-mass is that of *Pelodytes*, the larvæ are a combination of the old, old figures of Rösel von Rosenhof (which, for that matter, still do duty in current works in our own tongue), of Ecker and others with which we have long been familiar. On p. 224 there is a figure of a presumed *Ascidia*, which, as Huxley would have said, "illustrates, but does not adorn" the text, since it is that of a *Ciona*, curiously enough copied (but with reversal) from Huxley's "Manual of the Invertebrata," in which it is erroneously named *Phallusia mentula*. The figure of a horse (p. 121) simply insults that graceful beast. The author in a lengthy preface deplores, with just cause, the existing methods of teaching natural science in the Italian schools, for which his book is especially designed in accordance with the requirements of the State; and in support of his plea for improvement he cites forcible passages from addresses on the subject by Profs. Emery, Camerano (his teacher) and others. Proceeding to the question of nomenclature, he excuses himself the adoption of its modern rules on the grounds of his having been on a former occasion reproached for writing *Molge* instead of *Triton*. For this, something may perhaps be said from his point of view, but there is no excuse for the elevation of the racial names of mankind to specific rank (*Ex. Homo arcticus*, *H. cafer*, *et sic de caeteris*). Both figures and Latin names of some of the humbler creatures—transcribed from books which are old and out of date—are antiquated, and we deem further comment unnecessary, except to remark that the treatment of many great groups is so meagre that it is well-nigh useless.

G. B. H.

The British Journal Photographic Almanac for 1900. Edited by Thomas Bedding. Pp. 1516. (London: Henry Greenwood and Co., 1899.)

REGULARLY every year we receive this most useful annual, and as regularly we have to record its growth.

This year the volume reaches the grand total of 1516 pages, and is the largest yet issued, exceeding that of last year by about 40 pages. The popularity of such a book can be best judged by its sale, for photographers soon find out which of the numerous books on this subject are suited to their needs. We gather from the *British Journal of Photography* that the 1899 edition of this almanac, an edition which was composed of 20,500 copies, was rapidly disposed of within three months of publication, a fact which speaks for itself. This, the thirty-ninth annual issue, is quite up to, even if it does not exceed in interest, the previous volumes. It will be found an absolute mine of information : we notice a great number of articles dealing with all branches of the art which gives the reader hints for future work, and results of the experience gained by others. Other parts are devoted to a summary of the progress made during the past year, practical notes and suggestions, miscellaneous information, and many other sections of interest. As usual, the advertisements form a great portion of the book.

The almanac is carrying on the crusade of advocating the use of the metric system in all photographic matters, and has great hopes of the practice becoming universal. To further this object the metric equivalents of the British system are given in all tables and formulæ. Much more might be written about the contents of this volume, but it is hoped that sufficient has been said to enable the reader to form the opinion that it ought to find a place in every photographic studio.

The frontispiece is an excellent bromide print by Messrs. Wellington and Ward from a negative by Mr. H. Walter Barnett, and numerous other illustrations will be found intermingled with the text.

The Elements of Blowpipe Analysis. By Frederick Hutton Getman. Pp. 77. (New York : The Macmillan Company. London : Macmillan and Co., Ltd., 1899.)

THE contents of this slight book include the orthodox blowpipe tests such as are found in most books on qualitative analysis, together with an account of the behaviour of some of the principal ores before the blowpipe. A meritorious feature is that the general chemical action of the common fluxes is explained. In other respects it is not easy to find points calling for special praise. An incorporation of some at least of the admirable tests described in Bunsen's "Flammenreactionen" would have made an improvement. The following minor errors are perhaps worth noting. On p. 10, decrepitation is described as "the crackling of a substance due to the sudden expansion of combined water on heating," and incandescence as "the white light emitted by a substance that is infusible when subjected to a high temperature." On pp. 11 and 13, silver oxide is printed AgO. On p. 17, the formulæ of borax and microcosmic salt are given without water of crystallisation—an important omission from the assayer's point of view. On p. 40, the only test for phosphates is that of flame colouration, the reduction with sodium or magnesium being omitted.

The Elements of Euclid. Books i.–vi. By R. Lachlan. New and revised edition. Pp. ix + 489. (London : Edward Arnold, 1899.)

THE editor of these Elements tells us in the preface that he has endeavoured to make the subject as easy as possible for beginners by the use of simple language, and by presenting the argument in the clearest form. Further, he has attempted to embody in the book, and with great success, the additions and improvements in statement and method which twelve years' experience as an examiner and teacher has shown to be desirable. Throughout the book Euclid's sequence of propositions has been maintained, but in many cases several well-known alternative proofs have been substituted for those of Euclid. In places where the student might experience difficulties fuller notes are added ; and attached occasionally to propositions are others which it is important for the beginner to know. The appendix to the last book contains many interesting problems of theorems for more advanced students, and this is followed by a considerable number of miscellaneous exercises. Students and teachers should find this form of the Elements of Euclid in many respects serviceable.

Essais du Commerce et de l'Industrie. By L. Cuniasse and R. Zwilling. Pp. viii + 302. (Paris : Carré and Naud, 1899.)

THE essential features of a book dealing with the subject of commercial analysis, whether intended for student or professional analyst, are careful elaboration and extreme minuteness of detail. As it is impossible for any analyst to have had an experience of more than a limited number of analytical processes, or at least such an experience as would justify him in publishing them, one naturally expects a book on commercial analysis to be devoted to special branches of the subject, unless, of course, a number of writers co-operate in its production. There are many special treatises of the kind relating to assaying, iron and steel analysis, to the analysis of soaps and fats, tanning materials, &c., which supply everything that is needful in this respect. To state that the present volume contains an account of nearly every branch of commercial analysis within the compass of 279 small octavo pages, that the subjects of leather, glue, vinegar, &c., are dismissed in one page, and that the analyses of other products are treated in the same cursory and superficial manner, is a doubtful recommendation.

Dairy Chemistry : a Practical Handbook for Dairy Chemists and others having control of Dairies. By H. Droop Richmond. Pp. xix + 384. (Charles Griffin and Co., 1899.)

THIS is a handbook for the chemist's laboratory, and deals especially with the matters on which his opinion will be asked, and with the methods of examination he may employ. Although of considerable size, it by no means includes the whole subject of dairy chemistry. The relations of the cow's diet to milk production, and its influence on the quality of the milk, and also the chemistry of dairy operations, are not discussed, though some parts of these subjects are referred to by the way. The author has had peculiarly favourable opportunities for becoming a master of his subject, and the book is full of information which will be valuable to the dairy chemist. Nevertheless, it is not unfrequently disappointing. The different parts of the subject are treated with very different degrees of fulness, and the expositions are not always clear. The book will be of most use to those who are already acquainted with the subject.

A Manual of Surgical Treatment. By Prof. W. Watson Cheyne, F.R.S., and F. F. Burghard, F.R.C.S. In six parts. Part ii. Pp. xix + 382. (London : Longmans, Green and Co., 1899.)

THE second part of this manual of surgical treatment fully justifies the good opinion which was recently expressed in these pages of the first part. It deals with deformities, the surgical affections of the skin, nails, lymphatics, bursæ, muscles, tendons, nerves and blood-vessels. The authors prefix to the volume a very proper statement that it is their endeavour to give only the salient points in the symptoms and pathology of surgical diseases, whilst they enter more fully into the question of treatment. The various topics are treated in a clear and concise manner, the information is accurate and modern, and there is an excellent index. If the future parts fulfil the promise of those already issued, the work will take rank as one of the best amongst the many surgical treatises which have recently issued from the English press.

D'A. P.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Stockholm International Conference on the Exploration of the Sea.

MR. KYLE's letter in the current number of NATURE is interesting as an expression of individual opinion as to the proposals of the Stockholm Conference, but it may be doubted whether he succeeds in his aim of conducing to "greater clearness on the points at issue."

I do not know to what extent Mr. Kyle is authorised to represent the British delegates who attended the Conference. They remain silent, while he replies—interpreting their report. In one place he tells us that "this [hydrographical] work was not intended to hinder the further prosecution of strictly biological research"—for which assurance I hope biologists will be duly grateful—and further on he says that "the areas of investigation will assuredly come under re-consideration." Will the delegates endorse that? Re-consideration of certain points was exactly what I asked for (see NATURE, p. 78).

But whether authorised to speak for the delegates or not, Mr. Kyle is certainly not entitled to say that I do not fully appreciate, and have not fully weighed, the Stockholm report. I have weighed it over and over again, and still adhere to my statement that it does not contain a definite programme of biological work. The sections Mr. Kyle quotes and refers me to (I., II., III*a.*, III*b.*, &c.) consist merely of statements of a quite general nature as to what is "desirable"—admirable sentiments which are neither new nor definite, but have been before the public for some years, and are in the main agreed to on all sides. We looked for something more from this Conference under the heading "programme" than pious wishes of the same unexceptionable nature as—that it is desirable to have full information about everything. If Mr. Kyle is satisfied with a "definite programme" of this nature, I am not; and, moreover, I think we have reason to believe that *the delegates themselves are not*. What are we to understand from their ominous silence; and what is the meaning of the following remarkable statement in the protocols of the Committee No. II. (see Report, p. lv.)? "It is thereupon expressly stated on different sides that a more precise and detailed elaboration of the biological programme is desired." And then further on: "such a detailed elaboration of the programme is rejected. This document is agreed to in the more general form in which it has been proposed, in order that *unanimous* acceptance of it may be arrived at." It is evident then that some of the delegates felt the same want of a more precise and detailed programme that I do. It would be interesting to know if the biological delegates played the part of the eleven obstinate jurymen who had to be convinced in order to secure unanimity. At any rate, this reference to the words of the report must effectually dispose of Mr. Kyle's contention that the programme is sufficient. It was evidently *not sufficient* in the eyes of some of the delegates themselves.

Finally, Mr. Kyle asks if I can show a more definite programme. There can be no great difficulty in that, but I would rather it came from those who were officially appointed to draw it up; and I hope that those delegates who evidently had something of the kind in their minds will publish it. It will be too absurd if any idea of official reticence is allowed to deprive independent biologists of such ideas and advice as the delegates can furnish, whether unanimously or no. If, however, our official representatives do not speak, I shall probably publish soon a detailed programme I have had in my mind for some time in connection with the work of the Lancashire Sea Fisheries Committee.

It is unnecessary for me to answer the latter part of Mr. Kyle's letter, which deals with Mr. Allen's criticisms, and contains a curious caricature of the work of the Marine Biological Association. But however much I may differ from the rest of Mr. Kyle's remarks, it gives me pleasure to agree most cordially with the sentiment expressed in his final paragraph.

Liverpool, December 16. W. A. HERDMAN.

Meteorology at the Berlin Geographical Congress.

IN the report of the Geographical Congress at Berlin (NATURE, vol. lx. p. 633), it is said that the last meeting of the Congress was to have been addressed by Prof. Hergesell, but as he had somewhat rashly made an ascent in a balloon the previous day, the Congress had been formally closed before he returned to Berlin.

In justice to my colleague, the President of the International Aeronautical Committee, and to maintain the customary accuracy of NATURE, I beg to correct this statement by saying that although Prof. Hergesell, in my stead, did make a high balloon ascension with Dr. Berson, and so co-operated in the eighth international ascent of balloons on the Continent, yet he also presented his paper to the Congress at the appointed time the next day.

It may be well to explain that with the idea of extending the sphere of geography, it was arranged to have recent results of the exploration of the atmosphere brought before the Congress by members of the Aeronautical Committee. Accordingly, Prof. Hergesell, of Strassburg, spoke of the instructional balloon ascents in Europe, in which, unfortunately, England has not participated; Prof. Assmann, of Berlin, described the scientific balloon ascents executed by the German Aeronautical Society; M. Teisserenc de Bort, of Paris, explained the work that he has been doing with *ballons-sondes* to get information about the high atmosphere; and I myself gave an account of the use of kites in America to study the meteorological conditions of the lower mile or two of air. A. LAWRENCE ROTCH.

Blue Hill Meteorological Observatory, Mass., U.S.A. December 1.

I AM happy to hear that Prof. Hergesell returned to Berlin in time to read his paper. My mistake is due to hearing it officially announced in the morning that it was feared he could not return in time, and to the report in a Berlin newspaper that he had not returned. It was of course impossible for me to attend all the meetings, and in summarising so vast a programme as that of the Seventh International Congress, some mistakes are sure to be made. It is almost unnecessary to add that no aspersion on Prof. Hergesell was intended, the completion of an unexpectedly prolonged experiment is worth more to science than the reading of many papers.

THE WRITER OF THE REPORT.

Shadows of Insects.

I HAVE only just seen the letter of your correspondent (Capt. D. Wilson-Barker) in your issue of the 7th inst. on the subject of "Butterfly Shadows."

The habit he observes in the butterfly of always adjusting its position after alighting, I have also frequently remarked in the ordinary garden fly and bluebottle. They are fond of congregating on shrubs or ivy in bright sunlight, whence they make short excursive flights in the air returning as nearly as possible to the same place; but no matter which way they are turned when they alight, they immediately readjust their position, and will always be found with their heads directed to the same point of the compass.

I have constantly observed this habit of theirs, but have never seen it mentioned in any natural history. It seems hardly likely that in the case of flies the practice can have anything to do with *shadows*. WM. PARKINSON.

Deerhurst, Coventry Park, Streatham, December 15.

Mosquitoes and Malaria.

IT may be of interest to record the fact that though during the months of June, July and August I collected and examined about 300 mosquitoes in this town, I only came across one specimen of the spotted-winged mosquito which is described as the malaria-conveying species by Major Ross. The majority, quite 75 per cent. of the specimens captured, were the harmless grey kind, the rest being chiefly the equally harmless tiger or brindled species. The single spotted-winged specimen I found in my house on a mosquito curtain. The rarity of its occurrence will, according to Major Ross's theory, account for the comparative absence of malaria in Singapore.

An account of this was given in the *Straits Times* of Sept. 4. A selection of the three species caught in the town of Singapore, together with about three other species from the neighbouring jungle, were sent in August to the British Museum, where they await further examination. R. HANITSCH.

Raffles Museum, Singapore, November 24.

THE GREAT PARIS TELESCOPE.

DURING two or three visits to Paris and Nice some years ago, I discussed with many French astronomers, whom I was privileged to count among my personal friends, the question of the large telescopes of the future. Among the conclusions come to, the first was that the glass industry was not in a position to grapple with astronomical requirements, and hence when reflectors of 8 or 10 feet diameter were talked of it was understood that they must be made of porcelain with a glass surface. Other conclusions were that the coudé mounting designed by M. Lœwy, and carried out so far as the optical parts were concerned by the brothers Henry, should be replaced with object-glasses of or about 25 inches by the use of a siderostat.

I subsequently (1884) gave two lectures at the Society of Arts on these and other questions,[1] in which I pointed out what I considered the best way of using an 8-foot reflector, and with regard to refractors I said: "With an object-glass of 30 inches diameter for physical observations I should certainly prefer the siderostat, thus reducing the cost of an instrument of this size to about one-third of the present price."

During the last few years we have heard a great deal of an enormous telescope to be constructed on the

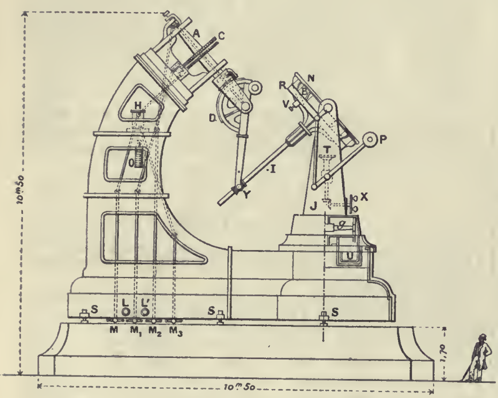


FIG. 1.—The siderostat.

occasion of the Paris Exhibition of 1900; a reflector of 10 feet aperture, such as was discussed in 1875, was indeed spoken of at one time, and renewed one of the old discussions, but it would seem that now as then the glass industry is not able to furnish a disc of this size, for after all it has been determined to construct a refractor, and mount it as I suggested nearly twenty years ago in front of a siderostat.

I have recently received from "Le Conseil d'Administration de la Société l'Optique" details of the scheme which it is proposed to carry out; while information regarding the telescope and siderostat has been given in the *Annuaire du Bureau des Longitudes*, and more recently in the *Scientific American*.

The Council in its memorandum is at some pains to excuse the exaggerations which have been so generally made regarding the power of the new telescope. They state that they hope for such a magnifying power that the surface of the moon will be seen as if our satellite were only 67 kilometres away from us. Under these conditions it was calculated that an object of one metre square might be seen. Hence the short phrase "La lune à un metre," and the consequent nonsense. One of the objects which finally determined the siderostat arrangement was the desirability of having a very long focus, and a focal length of 100 metres (328 feet) has been decided upon.

[1] Cantor Lectures: "Some New Optical Instruments."

M. Deloncle seems to be the chief of the band of astronomical amateurs who have enabled MM. Gautier and Mantois to employ their well-known skill. M. Despret, the Director of the Jeumont Glass Works, has produced the siderostat mirror which has a diameter of 2 metres, a thickness of 30 centimetres, and a weight of 3600 kilos. This certainly could not have been produced with the appliances in use twenty years ago.

The siderostat avoids all the expense of a dome—even if one of 340 feet diameter could be constructed—and saves considerable expenses for installation; it secures greater stability, and saves the astronomer unnecessary fatigue and serious loss of time.

The apparatus constituting the instrument termed a siderostat comprises a pedestal of cast iron, the north part of which supports the polar axis, and the south part the mirror with its frame. The cast iron pedestal, 8 metres long by 8 metres high, is furnished with six screws, which fit in sockets fixed to the stone base 1·70 metres high.

The north part of the pedestal supports the polar axis with its divided and driving circles. This axis is driven by a clock-work movement by means of a tangent screw.

At the lower end of the polar axis a fork is fixed, to which are adjusted the pivots of the declination circle. The toothed declination wheel is set in motion at the foot of the instrument by a handle placed beside that one which produces movement in right ascension; both of these are near the two telescopes which serve for the reading of the two circles.

The mirror, with its cell, has a total weight of 6700 kg. This cell of cast steel is furnished with two pivots; to the back is fixed the directing rod. The interior of the cell is covered entirely with felt, in such a way that the mirror has no point of contact with the metal. Being supported by as great a surface as possible, all deformations are avoided.

The mirror and its cell are kept in equilibrium by a system of levers and counterpoises; the pivots rest on rollers adjusted at the top of the frame, which permits a circular movement by a vertical shaft and a system of independent rollers between two rails.

The base of this frame floats in a cavity two metres in diameter on the south side of the pedestal, containing sufficient mercury to float $\frac{9}{10}$ of the total weight of the movable part, which weighs 15,000 kg.

The clock-work movement is set in action by a weight of 100 kilos. The total weight of the siderostat is 45,000 kg.

To cast the mirror a special furnace was made at the Jeumont Works, capable of holding over twenty tons of glass. This enormous plane mirror was, naturally, the most difficult part of the apparatus to make.

The mould, 2·05 metres in diameter and 0·30 metres in height, was placed on a wagon near the furnace, in order to receive the melted glass coming from the crucible. When the mould was full, the wagon was immediately taken to an annealing oven of the right temperature and then walled up; the cooling lasted a month. The operation of annealing the glass is very difficult to carry out; numerous experiments had to be made; out of twelve discs only two have been successful.

The transportation of such a huge disc of glass to Paris was a difficult matter, and a special train carried it there, and it was conveyed to the optical establishment at night, in order to have a clear roadway.

The disccs for the object-glasses, visual [and photographic, of 1·25 metres in diameter, were cast by M. Mantois; the flint weighs 360 kilos., and the crown 220, and the figuring, polishing and mounting of these enormous discs have been confided to M. Gautier.

The following interesting account of the casting of the glass for the lenses is given in the *Scientific American*:—

"Great attention was paid to the casting of the glass. Specimens of the glass were constantly taken out during the heating and examined with a lens under different conditions of illumination in order to judge of the degree of purity which they have reached. After several specimens have been found to be free from bubbles the temperature is reduced, the glass thickens, the crucible is opened, and a certain portion of the surface is skimmed off to get rid of impurities. The glass is then stirred, and the cooling is allowed to proceed rapidly for five or six hours until the surface of the glass emits a well-defined sound when it is struck with an iron bar. After this step it is necessary to proceed with annealing. The furnace is walled up and a cooling is allowed to proceed, which requires from four to six weeks. When the crucible is opened the glass is found to have been broken into pieces of varying sizes. In order to obtain a 792 pound flint glass lens it is necessary to find a block which weighs nearly 1300 pounds, and such a block having been found among those in the furnace it is removed and placed upon a car. Slabs of glass are sawed from two parallel sides in order to obtain polished surfaces that facilitate a perfect examination of it. The striæ in the surface are removed, and if after this the block exhibits any defects situated at such a depth that they cannot be removed, it is submitted to a moulding which changes its form and brings the chief defects near the surface. The block is placed in a mould of refractory clay and put into a furnace and heated to 800° to 900° Centigrade. By this means it becomes slowly heated and softened until it assumes the form of the mould, but it must not become fused, or the whole operation must be gone over again. If the outcome of the process is successful, the glass is slowly annealed, and is then taken from the mould and examined anew. If any defects deep in the glass are seen, a second operation is begun with a mould of another form. Finally, when the glass is very pure and perfect, another and final moulding produces the plano-convex lens. After this comes another heating and cooling which takes two or three weeks."

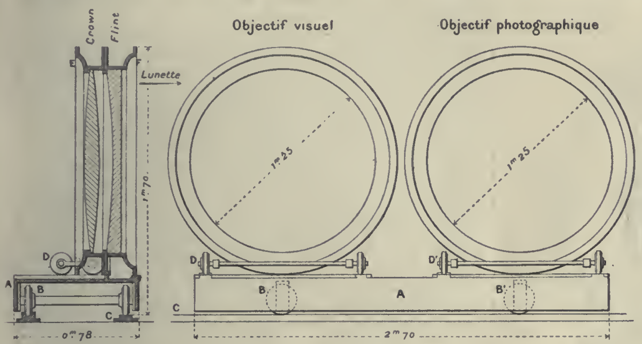


FIG. 2.—The object-glasses.

Telescope.—The telescope tube, which is of sheet steel 2 mm. thick, weighs 21,000 kg.; it is 1·50 metres in diameter, and is composed of twenty-four pieces united by bolts. It rests on eight supports of cast iron resting on stone pillars. In view of expansion, the supports move on rails fixed to the pillars.

I confess this *iron* telescope tube astonishes me.

The two object-glasses are both mounted on the same carriage, which moves on rails in such a manner as to place them easily, the one or the other, at the end of the tube; the weight of each of these object-glasses, without their cell, is about 600 kg., and with the cell 900 kg. Each lens is adjusted in a separate cell; that of the crown is carried on rollers, in order to be able to remove it from the flint and render the cleaning of each disc easy.

The tube carrying the eye-piece is supported by four wheels on rails. It is attached to the telescope tube by an adjusting screw 1·50 metres long, which is used for focussing. In the interior of this tube there is another 1·20 metres in diameter, which can be rotated by clock-work. This carries the adapter for the eye-piece end, which is made to slide in two rectangular directions by means of screws. The eye-piece end can carry either an eye-piece, a micrometer, a photographic plate, or a projecting lens.

By means of the arrangements realised in the eye-piece the observer is rendered independent of the apparent movement of the heavens, and is enabled to follow the object in right ascension and declination.

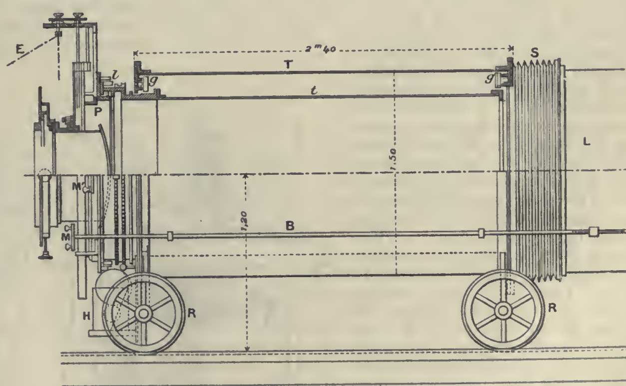


FIG. 3.—The eye-piece and travelling adapter. (Side view.)

It is stated that M. Gautier has been entirely successful, not only with the plane mirror, but with the two object-glasses.

The grinding apparatus consists essentially of a large cast iron plate, *C*, covered with an inch of flannel, upon which the glass disc, A, was carefully laid. The *Scientific American* thus describes it:—

"This plate revolves slowly around a vertical axis by gearing, G, the whole being stepped in a cone. Above

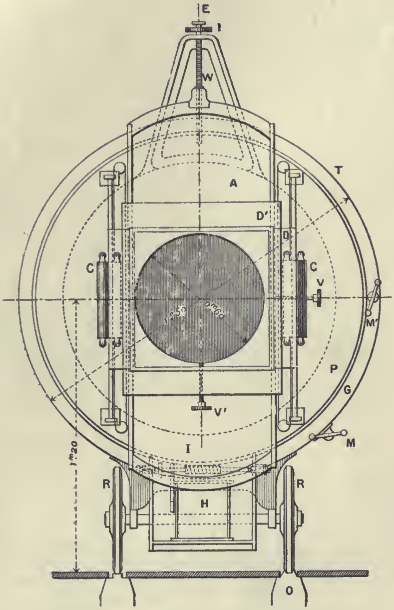


FIG. 4.—Details of the eye-piece. (Front view.)

there is a stationary circular bronze rubber, B, 47¼ inches in diameter, which is given a reciprocating motion by a slider, I, thus passing across the face of the mirror travelling in a circle beneath it. The perfect revolution of the plate and the accurate adjusting of the slides and their parallelism resulted in the production of a perfect mirror. It required three months to adjust the slides alone. The grinding of the mirror was done with a mixture of emery and water. During this operation a workman always stood at a respectful distance from the apparatus so as not to change the temperature of it. From time to time he injected a mixture of emery and water by means of a syringe into a channel running through the grinding plate and ending at the centre. This work was carried on generally from 2 till 5 o'clock in the afternoon, the time of day when the temperature does not change perceptibly. The entire morning was devoted to the cleaning of the machine, and to the verification of the parallelism of the grinding plate with the surface of the mirror, an operation which was performed with four scales which were accurate to $\frac{1}{1000}$ of a millimetre."

"As the grinding proceeded, finer and finer emery was used, and the closer the grinding plate was brought to the surface of the glass. With the finest emery the distance between the plate and the glass was 0·008 inch. The grinding lasted eight months and was followed by the operation of polishing, which required two months The lower surface of the polishing plate was covered with a sheet of albumenised paper like that used in photography, but unsensitised. The workmen spread upon this paper a small quantity of the finest Venetian tripoli and as much as possible was removed with a soft brush. The distance between the rubber and the surface of the glass was 0·0012 of an inch."

"This method of treatment, notwithstanding its delicacy, produces enough heat to render the mirror slightly convex and cause it to draw away more strongly in the centre, so that, upon cooling, it was hollowed at this point. In order to surmount this difficulty the slides were given a curve of which the pitch was 0·4 of an inch. The heat was diminished by operating the machine for a minute and then stopping for a quarter of an hour. When the hand is applied to the mirror, there occurs an extension of 0·0012 of an inch, which is sufficient to distort completely for four or five minutes the image of the flame of a lamp placed at one side of the plate and observed from the other with a small telescope arranged for the purpose. The next operation to be performed is the silvering, and, of course, it will have to be silvered anew from time to time. The mirror protrudes 5·4 inches from its tube or cell, which will be made to swing so as to bring the surface to be silvered underneath. The reservoir containing the bath will be lifted by means of a winch until the mirror enters it at a proper depth. When the operation is finished, the reservoir will be lowered and the silvered surface turned upward and the mirror readjusted in its cell."

I am indebted to M. Gautier for the use of the illustrations, which have already appeared in the *Annuaire Scientifique du Bureau des Longitudes.*

It is the intention of the Syndicate to erect in connection with this telescope a Palais de l'Optique near the Eiffel Tower, containing a hall capable of holding some 4000 persons, and in fine weather images of the various celestial bodies are to be thrown on a screen 20 metres in the side by means of secondary magnifiers. Thus an image of the moon 16 metres in diameter, and of Mars 3·70 metres in diameter, are promised to the abonnés.

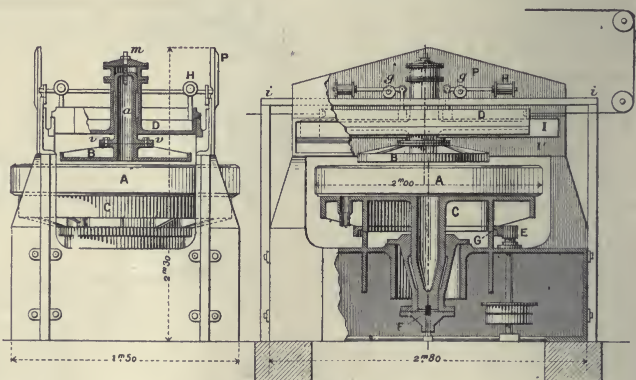


FIG. 5.—The polishing machines.

No doubt the great telescope will be largely capable of advancing science, and this will certainly be taken advantage of by the highly skilled French astronomers. Its erection, therefore, will be a great gain.

Whether the hoped-for 6000 visitors (paying, we presume, a franc each) per half-hour night and day will visit it and help to provide the sinews of war is another matter.

NORMAN LOCKYER.

GEOLOGICAL SURVEY OF THE UNITED KINGDOM.[1]

REPORTS of the progress of the Geological Surveys in India and Canada have already been noticed in NATURE. The report of our home survey has since been issued by the Director-General, Sir Archibald Geikie. It is more voluminous than those of the other countries, and appears rather to be a full record than a "Summary" of the observations made during 1898 by the staff of the Survey. Whatever may be said concerning the state of our knowlege of geology in England and Wales, in Scotland and in Ireland, it cannot be gainsaid that very much remains to be done both from a scientific and a purely economic point of view. The report before us is a striking testimony to this, and when we consider the limited staff and poor equipment of our Survey, it is surprising how much has been done to further the progress of knowledge.

So far as the main field-work of the Geological Survey is concerned, the mapping of entirely new areas has been confined to the mountainous regions of Scotland and to the islands of Arran, Jura and Skye; but it is not in these areas alone that fresh observations of striking importance have been made. Re-surveys are being made of the coal districts of South Wales, North Staffordshire, Leicestershire and South Derbyshire; of the mineral districts of Cornwall and Devon; and of the agricultural districts of the southern and midland counties. In all these cases the work done actually amounts to a new survey, on a larger scale than the original map, and carried out with that attention to minute accuracy which nowadays is absolutely essential. Revisions have also been made in the Silurian areas in Ireland.

A glance at the little index-maps which accompany this report show how much field-work yet remains to be done. Of the 131 sheets of the Scottish one-inch map, fifty-nine only have been published. In England and Wales ninety-nine only of the 360 one-inch new series maps have been published. It has long been recognised that for practical purposes a survey on a scale smaller than six inches to a mile is of little value. The work of the Survey has for many years been conducted on the larger maps, MS. copies of which are deposited for public reference in the Survey Offices in London, Edinburgh and Dublin. In illustration of certain mineral areas and other regions, a number of six-inch maps have been published, but the issue of further maps was some few years ago discontinued, mainly, we believe, on account of the expense of engraving. Cheaper processes, however, are available, and it is to be hoped that the publication of six-inch maps may ere long be resumed. It is not only in mineral areas that these maps are utilised—they are quite as necessary in inquiries relating to water-supply, sanitary engineering, and agriculture. In these important questions the highest attainable accuracy is as necessary as in mining questions. Those who compare the earlier published one-inch maps with the new series of geological maps in England and Wales will recognise the great advances which have been made in the method of mapping, and if these again are compared with the six-inch maps (*e.g.* of the South Wales coal-field) it will be seen how much work is lost or obscured in the small one-inch reproduction. This difference was strikingly shown in the one-inch and six-inch maps of the Durness area in Scotland, published a few years ago.

[1] "Summary of Progress of the Geological Survey of the United Kingdom for 1898." Pp. v + 216. (London: Printed for H.M. Stationery Office, 1899.)

The present "Summary," like the first of the series which was issued a year ago, is arranged stratigraphically, commencing with the Pre-Cambrian and continuing to the Recent deposits; it contains also records of new railway-cuttings and well-borings, and accounts of the microscopic and chemical work carried on in the Petrographical Department and of the varied work performed in the Palæontological Department. Brief notice is also taken of the numerous public and private inquiries made at the offices of the Survey, work which increases from year to year, as help and advice in reference to water-supply, soils, sites for houses, building-materials, various ores and minerals, are as far as possible freely given to those who seek them.

That the field-work of the Survey must be conducted on a strictly scientific basis is not to be questioned. Economic results must follow, and they may not always be apparent at the time of the survey. It is, however, satisfactory to find that discoveries of importance have been made.

The puzzling question of the age and origin of the Highland schists continues to attract a large amount of attention. The evidence gathered tends to show that the "Moine-Schists" of the north-west highlands are metamorphosed arkoses, sandstones, and argillaceous rocks, and that there is unconformity between them and the older (Archæan) gneisses. Associated with the schists are several types of foliated igneous rock, and these in some cases were intruded into the original sediments before their present foliated structures were developed. The Dalradian or so-called Younger Schists of the central highlands have also received much attention, and structures similar to those seen in the Moine Schists have been recognised in these rocks in the Braemar area. What is termed the "hornfels" type of alteration, producing a cordierite-hornfels, has been found where the old granites, such as that of Ben Vuroch, were intruded prior to the movements causing schistosity. This type of metamorphism is not observed in connection with later granitic intrusions, such as those of Cairngorm and Lochnagar. Interesting observations are made on the intrusions of these younger granites, and it is inferred that in the case of Cairngorm the mass, on its southern side, took the form of a cake or sill with vertical or highly inclined edges. The metamorphic changes produced in the bordering rocks by the masses of granite and by various igneous dykes are fully dealt with.

The Cambrian limestones in Skye have yielded a number of fossils which connect them with the Balnakiel and Croisphuil groups of Durness. Several of the species occur also in Newfoundland—and these indicate a horizon below the Arenig formation.

Analyses have been made of Cambrian dolomites from Skye and Durness.

Among the Silurian rocks in Ireland several horizons have been determined by means of Graptolites and other fossils. It is observed that the older rocks of the south-eastern portion of that country have undergone much crushing and deformation, and in the Ribband Series (of Arenig age) the grit-bands are curiously broken up, portions of grit having been pushed into the argillaceous strata so as to produce a brecciated appearance, deceptively like that of a conglomerate; indeed, some of these crush-breccias have actually been described as conglomerates. From the Upper Silurian rocks of Central Scotland a new genus of fishes (*Ateleaspis*) is recorded, and also a new species of *Eurypterus*.

Observations are made on the Old Red Sandstone of Caithness, Ross-shire, the Lorne, and South Wales. In the Lorne district a fish-bed has been discovered on the mainland shore of Kerrera Sound, about three miles south of Oban. The volcanic rocks in the Lower Old Red Sandstone form a conspicuous feature in this region.

Particular attention has been given to the granites of Ben Cruachan and Glen Etive, and it is noted that the porphyrite dykes and sills so numerous in the Cruachan granite are entirely absent from the Glen Etive mass. The evidence tends to show that the chronological order was (1) Ben Cruachan granite, (2) Porphyrite dykes and sills, and (3) Glen Etive granite and quartz-porphyry dykes and sills. It is observed that the huge granitic mass of Ben Cruachan affords special facilities for the study of the phenomena of contact-metamorphism, of which particulars are given. A careful study was made of the Cordierite-bearing rocks which occur among the altered sediments at the back of Loch Awe Hotel, and the discovery in them of Corundum is noted and discussed.

Among the Devonian and older slaty rocks of Devon and Cornwall and the associated eruptive rocks much interesting work is in progress.

In Carboniferous regions the chief work has been done in the coal-fields of South Wales, North Staffordshire and Leicestershire; and there are some new observations on the volcanic rocks in the Carboniferous Limestone of Somerset.

The changes which take place in the Carboniferous Limestone series of Glamorganshire are duly noted, and we have some account of the Millstone Grit and its beds of "silica stone," from which the celebrated Dinas fire-bricks are made. The faulted anticlinal disturbances of the Vale of Neath and Cribarth are described and illustrated. A study of these disturbances is of the highest practical importance, an instance being given where the Pennant escarpment exhibits a gentle and uniform dip, while the soft Lower Coal-measures below are thrown into sharp folds. Explorations are now showing that the lower measures are too much crushed and broken over considerable tracts near the head of the Rhondda valleys for their coals to be workable, though the Pennant rock overlying them is unbroken. Reference is made to the anthracitisation of the coals which proceeds from the eastern side of the South Wales coal-field in a direction somewhat west of north. It is remarked that the lower seams of the north crop in the Vale of Swansea are true anthracites, while one seam becomes a steam-coal at Resolven, and is intermediate between a steam-coal and an anthracite at Crynant. Of the Neath seams, one alone is a house-coal, all the others being steam-coals, although they correspond to the Llantwit group, the most noted house-coals of the coal-field. No connection has been traced between the anthracitisation and the faulting of the district, but the change seems rather to be a form of regional metamorphism dependent upon the temperature to which any part of the coal-field has been subjected during depression, as was suggested many years ago by De la Beche. The results of further investigations on this subject will be looked for with interest, for although much has been done by local observers, the question can only be solved by patient detailed and continuous mapping, and the tabulating of evidence over a large area.

In the North Staffordshire coal-field much has been done to determine and map in detail the main subdivisions of the Coal-measures. The uppermost division, known as the Keele series, comprises a considerable thickness of red sandstones, marls, and occasional bands of cornstone—beds formerly regarded as Permian, but now recognised to be strictly conformable to the Upper Coal-measures. Some of the red marls in this series contain plants of Coal-measure species, and it is remarked that the division cannot be classed with the Permian formation of Lancashire and the north-eastern counties. It remains to be proved how far it corresponds with the Supra-Carboniferous or Permo-Carboniferous division which is engaging much attention on the continent and in other regions abroad. It is remarked that the determination of the horizons in the Coal-measures may prove to have an important industrial and commercial bearing. The fact that the limestone-bands of Newcastle-under-Lyme lie at the base of a group of grey Coal-measures, intercalated between an upper group of red strata (Keele Series) and a lower group of red strata (Etruria Marls), has enabled the survey to detect true Upper Coal-measures in Keele Park, Shutlanehead, and to the west of Leycett; and there seems to be little doubt that the Coal-measures of the Pottery Coal-field lie not far from the surface under Little Madeley and Craddocks Moss. Evidence has been obtained that the strata on the north-west side of the North Staffordshire anticline do not uninterruptedly descend beneath red rocks (so-called Permian) to the west of Leycett, but rise locally westward under Hayes. The effect of this change of inclination is to bring to the surface strata which lie considerably below the unproductive red series, and to bring the principal coals and ironstones within reach further west than might have been expected. Iron-ore has been discovered in the Fenton Park Clay-pits. It is a sphero-siderite yielding 38·7 per cent. of metallic iron. This may prove to be of considerable importance.

A small patch of Carboniferous rocks has been determined at the Bridge of Awe, in the Lorne area, a fact interesting in connection with the discovery, made many years ago by Prof. Judd, of Carboniferous rocks on the east shore of the Sound of Mull, near Ardtornish. Further evidence of Lower Carboniferous rocks in Arran has also been obtained.

Brief observations on Permian rocks in Leicestershire and in Arran are recorded, and there are fuller notes on the Trias (including the Rhætic Beds) in South Wales, and on the Trias of the Midland Counties and Skye. Short notes again are given on the Lias of Glamorganshire, but the only reference to the Oolites is in a note of a deep boring (439 feet) at Oxford. We hope to hear more of this boring, as it is stated to pass from Inferior Oolite into Lower Lias with no evidence of Upper and Middle Lias, which outcrop at Fawler, near Woodstock.

The Cretaceous rocks have received attention in the southern and eastern counties. There are notes on Chalk inliers which form remarkably bold features in the neighbourhood of Cranborne Chase. There are detailed accounts of the Lower Greensand series of Norfolk, but these facts, which convey much new information, have now been printed in full in the Geological Survey memoir on "The Geology of the borders of the Wash." It is mentioned that the name Selbornian, from Selborne in Hampshire, is proposed as a term for the Gault and Upper Greensand, formations which have long been held to be portions of one stage, although it is useful and necessary on geological maps to separate the clayey Gault from the sandy Upper Greensand. The Selbornian stage will include the Red Chalk of Norfolk, Lincolnshire and Yorkshire, as well as the Gault, and the sands Malmstone and Chert-beds of the Upper Greensand. Where fully developed it is divisible into four palæontological zones, in descending order: (4) zone of *Pecten asper* (as usually known), which would more conveniently be called the zone of *Holaster fossarius;* (3) zone of *Ammonites rostratus*, with its local sub-zone of *A. varicosus;* (2) zone characterised by *Ammonites lautus*, *A. denarius*, and *A. interruptus;* (1) the zone of *Ammonites mammillatus*.

The observations on Tertiary strata refer to Bagshot Beds, and to records of new wells at Mundesley and North Walsham which passed through Pliocene strata as well as Glacial Drift. More important are the researches on the volcanic rocks of Skye, which tell of the numerous sills of basalt and diabase which have been intruded into the basaltic lavas. Though the lavas are older, these sills are younger than any of the great plutonic intrusions of gabbro and granophyre. Reference is made also to the presumably Tertiary granite of Arran, whose intrusive character was so clearly appreciated more than a hundred years ago by Hutton.

The Pleistocene notes include some general remarks on the method of investigation of the deposits of this and Recent ages. These notes are followed by an excellent account of the Drifts near Uttoxeter. It is remarked that the prevalent drift of the higher ground is a red sandy loam, or more rarely clay, containing numerous rounded quartzite and other pebbles mainly derived from the Bunter. Evidence was obtained that in spite of its general resemblance to rain-wash the material is the local equivalent of the true boulder clay, and has had a similar derivation from the moving mass of land-ice by which the whole country has been covered. It is remarked that the movement of the ice has not been determined by the shape of the ground in the vicinity, nor by the presence of the elevated Carboniferous Limestone tract of the Weaver Hills, but has been consequent upon the pressure of the great ice-sheet which was piled over the lower ground to the westward and north-westward. The occurrence in new localities of marine shells in the Drift of North Staffordshire is likewise noticed. Further particulars are also given of the Glacial Drift in South Wales. The height to which this extends seems limited only by that of the ground. Not only till with glaciated boulders, but numerous striated rock-surfaces have been observed at heights ranging up to 2000 feet on the Old Red Sandstone. In the Isle of Man the Glacial series has been found by a deep boring to be of unusual thickness, apparently descending to between 470 and 500 feet below sea-level.

From various parts of Scotland observations on the Drifts are recorded. In Aberdeenshire there is evidence of the occurrence of blocks of the Glen Derry diorite on the hillside above Allanmore, at a distance of more than six miles to the south-east of the parent-mass. These blocks could not have been brought to their present position by the later or local glaciation, but must have been transported by the ice-sheet over ridges nearly 3000 feet in height. In Inverness-shire the high-level terraces of fluvio-glacial gravel have been traced to an elevation of 1020 feet. Many observations have been made on the Drifts in Ross-shire and in the Black Isle. Again, in Skye it has been observed that at the epoch of maximum glaciation only the highest summits of the Cuillins stood above the ice. This is true also of Blaven, and probably of the Red Hills, though the crumbling granite of which these latter are composed is not so well fitted as the gabbro to retain evidences of glaciation.

In the southern counties of England, as well as in Scotland and Ireland, various notes have been made on Pleistocene and Recent deposits, on the "Head," clay-with-flints, raised beaches, sand-dunes, peat and other accumulations.

The new railway-cuttings which have been examined are those made by the Great Western Railway Company between Stert, near Devizes, and Westbury, in Wiltshire, and those between Wootton Bassett, in Wiltshire, and Patchway, in Gloucestershire. Cuttings on the Great Eastern Railway between North Walsham and Mundesley are briefly noted.

In this abbreviated account of some of the leading observations recorded in the "Summary of Progress of the Geological Survey for 1898," we have sufficiently indicated the work that is being done, and which we hope will be carried on until the whole country has been mapped as carefully as possible on the six-inch scale. Until that work is accomplished, it can never be considered that the more pressing work of the Survey has been carried out. Regarding this as necessary, and looking to the work already performed, it is not to be denied that a very great deal of the more important work of the Survey has yet to be done. This remark applies, not only to the maps, but to the explanatory memoirs so needful in illustration of each map. The list of publications which is appended to the report before us shows that a number of new memoirs have been issued, while others are in progress; and it is hardly necessary to add that the surveying alone will not supply the public needs if the maps are not accompanied as soon as possible with the memoirs which describe the facts and explain the structures depicted on the maps.

SIR RICHARD THORNE THORNE, K.C.B., F.R.S.

Sanitary science has suffered a severe loss by the death, on Monday, of Sir Richard Thorne Thorne, K.C.B., F.R.S., principal medical officer to the Local Government Board. As a guardian of the public health, he was largely responsible for the security of the United Kingdom against serious epidemics, and for the introduction of sanitary measures which have resulted in a diminution of mortality; and as an investigator he made numerous important contributions to the science of preventive medicine.

Sir Richard Thorne Thorne was born at Leamington on October 13, 1841, and was therefore fifty-eight years of age at the time of his death. From an obituary notice in the *Times* the following particulars concerning his career have been derived. He received his medical education at St. Bartholomew's Hospital, and obtained the membership of the Royal College of Surgeons in 1863. In 1866 he became M.B. of the London University, taking a double first class, and for a short time he held some hospital appointments in London; but about 1870 he accepted office in the Medical Department of the Privy Council, which was afterwards transferred to the Local Government Board. In this capacity he continued for many years to discharge the routine work of the office, in the way of inspections and reports, until 1885, when his mastery of the French language led to his selection as delegate of the British Government at a first International Sanitary Conference, which was held at Rome, and was followed by others at Venice, Dresden and Paris. In these conferences he took from the first a leading part, and was mainly instrumental in convincing the representatives of other Governments of the futility of quarantine and of the facility with which, notwithstanding the presence of infectious disease, commerce might be liberated from vexatious restrictions which had previously hampered it. In this way he became a conspicuous public benefactor, not of this country alone, but of many others; and he was appointed her Majesty's Plenipotentiary for signing the Sanitary Convention of Dresden in 1893 and that of Paris in 1894. He early received the distinction of C.B., and that of K.C.B. was conferred upon him in 1897, soon after he had succeeded the late Sir George Buchanan as the head of his department. He was a Crown member of the General Medical Council, vice-president of the Epidemiological Society, Fellow of the Royal Society and of the Royal College of Physicians, LL.D. of Edinburgh, Doctor of Science of the Royal University of Ireland, and held numerous foreign distinctions. Apart from his many official reports relating to the public health, he was the author of works on the progress of preventive medicine during the Victorian era (1887), the "Milroy" lectures on the natural history and prevention of diphtheria (1891), and of the "Harben" lectures on the administrative control of tuberculosis (1898).

By these and other publications Sir Richard Thorne Thorne assisted scientific progress, and improved the conditions of public health. The influence of his works on national sanitation will long be felt.

NOTES.

At a recent meeting of the Paris Academy of Sciences, M. Berthelot reported that the total amount subscribed for the erection of a statue to Lavoisier was 98,000 francs. M. Barrias has been commissioned to construct the statue and the bas-reliefs for the pedestal. The Municipal Council of Paris has granted a site for the statue in an open space behind the Madeleine Church. The monument will be unveiled when the Paris Exhibition is open, probably some time in July.

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

The Berlin Academy of Sciences will celebrate the second centenary of its foundation on March 19 and 20, 1900.

The annual meeting of the Australasian Association for the Advancement of Science will be opened at Melbourne on January 9, under the presidency of Mr. R. L. J. Ellery.

In the December number of *Natural Science*, the announcement is made that the magazine is to be discontinued, the reason being insufficient support. The journal has always been of interest and value to students of the biological sciences, and it is to be regretted that financial considerations necessitate its withdrawal.

The Council of the Manchester Literary and Philosophical Society have awarded the Wilde Medal for 1900 to Lord Rayleigh, for his contributions to mathematical and experimental physics and to chemistry; a Dalton Medal (struck in 1864) to Sir H. E. Roscoe, for his remarkable original researches in chemistry and for his distinguished services to scientific education; and the Wilde Premium for 1900 to Prof. A. W. Flux for his papers on economic questions read before the Society. The presentation of the medals and the premium will take place at a special meeting in February next, when Lord Rayleigh will deliver the Wilde Lecture for 1900.

A Reuter telegram from St. Petersburg states that the expedition of Baron Toll, organised for the exploration of the New Siberia Islands and Sannikoff Land, will set out in June next from a Norwegian port, whence it will proceed to the mouth of the Lena, on the banks of which river, at a point above the town of Yakutsk, it will pass the winter. During the summer of 1901 the expedition will begin its explorations towards the north, picking up *en route* a detachment which will be sent forward from the main body during March, with a sufficient supply of dogs.

The death of Dr. John Frederick Hodges, professor of agriculture and lecturer on medical jurisprudence in Queen's College, Belfast, is announced in the *Times*. Dr. Hodges was an honorary member of the Academy of Agriculture of Sweden, and of many other scientific societies. He was one of the oldest members of the Chemical Society of London, having been elected a Fellow in 1844—three years after the formation of the Society. Dr. Hodges was the author of the following works:—"First Book of Lessons in Chemistry for Farmers and Teachers" (a work which reached a twelfth edition in 1862), "First Steps in Chemistry," "The Structure and Physiology of the Animals of the Farm," and of several papers published in the proceedings of scientific societies. He was for some years editor of the *Journal* of the Chemico-Agricultural Society of Ulster.

At the international congress on tuberculosis recently held at Berlin (see vol. lx. pp. 108, 154) it was decided to hold a similar congress in England in 1901. A meeting was held in Gray's Inn Hall, on Monday, under the presidency of the Earl of Derby, to make preliminary arrangements for the forthcoming congress. The following resolutions were unanimously adopted:—(1) In view of the fact that tuberculosis, although a preventible disease, still devastates health and destroys lives in all parts of the world, this meeting, consisting of representatives of medical, veterinary, and sanitary science, and also principal officials of municipal and county authorities, is unanimously of opinion that it is desirable to hold a national congress on tuberculosis in the spring of 1901, to which representatives from India and all dependencies of the Empire should be invited, and, in addition, honoured guests from other countries. (2) That this meeting has learned with very great pleasure that H.R.H. the Prince of Wales has graciously consented to preside over the proposed congress, and to open it in person, and desires to convey to his Royal Highness the appreciation of all present of this expression of his sympathy and support. (3) That this meeting heartily approves of the steps already taken by the National Association for the Prevention of Consumption to initiate the undertaking, and earnestly invites the co-operation of representative bodies interested in the public health in carrying out the necessary organisation. (4) That this meeting is of opinion that steps should be at once taken to obtain subscriptions and to open a Congress Fund.

The death is announced of Mr. E. C. C. Stanford, Fellow of the Institute of Chemistry and Chemical Society, and managing director of the British Chemical Company. Mr. Stanford introduced several original methods of chemical manufacture, and prepared a number of new bodies. From the *Chemist and Druggist* we learn that while he was an assistant to the late Prof. Redwood, he began a research on kelp and iodine manufacture; and afterwards delivered lectures on the subject before the Society of Arts. These brought him into notice, and the improved processes of manufacture which he had invented were adopted on a practical scale by Mr. Patterson, of Glasgow, with whom Mr. Stanford became associated, and under his direction the production of iodine at Clydebank became a very profitable industry until the advent of Chilian nitrate crippled it. Mr. Stanford's original idea for the manufacture of iodine was to extract the salts from seaweed by diffusion and without burning it. This was found to be impracticable on a large scale, and therefore he turned his attention to less wasteful production of kelp. Through his efforts the kelp-makers of Ireland and the Hebrides gradually improved the quality of their product, while the Norwegian kelp-makers under Mr. Stanford's instructions have produced a kelp richer in iodides and more suitable for treatment than either Irish or Scotch kelp. The monograph upon the iodine industry in Thorpe's "Dictionary of Applied Chemistry" was written by Mr. Stanford. Arising from his researches on the isolation of iodides from seaweeds by diffusion, he about fifteen years ago introduced into chemistry a new body called algin, the substance which gives seaweed its peculiar texture. This algin is an exceedingly viscous compound, and there appeared to be a future before it as a sizing-agent, but it never succeeded. One of Mr. Stanford's latest researches with the body was the preparation of an iron salt of it which has been found of considerable therapeutic interest, the compound being apparently more readily assimilated by the blood than any other iron compound. His last research was on the active principle of the thyroid gland, and it resulted in the isolation of thyroglandin. The results of this investigation were communicated to the meeting of the British Pharmaceutical Conference at Belfast.

THE Bavarian Government has granted a sum of 6000 marks to Dr. K. Giesenhagen for a botanical investigation of Malacca.

WE learn from the *Botanical Gazette* that Prof. R. von Wettstein, the director of the botanical garden at Vienna, has established a biological experiment station near the Bremerhütte, in the Gschnitzthal, in the Central Tyrolese Alps, at an elevation of 2300 m. The first object of research will be the production of species by direct adaptation.

THE United States Navy Board has issued a report on the results of investigations of the Marconi system of wireless telegraphy. The report is published in full in the *Electrician*, and from it the following statements concerning the efficiency of the system have been taken :—It is well adapted for use in squadron signalling under conditions of rain, fog, darkness and motion of speed. Wind, rain, fog, and other conditions of weather do not affect the transmission through space, but dampness may reduce the range, rapidity, and accuracy by impairing the insulation of the aërial wire and the instruments. Darkness has no effect. When two transmitters are sending at the same time, all the receiving wires within range receive the impulses from transmitters, and the tapes, although unreadable, show unmistakably that such double sending is taking place. In every case, under a great number of varied conditions, the attempted interference was complete. Mr. Marconi, although he stated to the Board before these attempts were made that he could prevent interference, never explained how nor made any attempt to demonstrate that it could be done. Between large ships (heights of masts 130 feet and 140 feet) and a torpedo-boat (height of mast 45 feet), across open water, signals can be read up to seven miles on the torpedo-boat and eighty-five miles on the ship. Communication might be interrupted altogether when tall buildings of iron framing intervene. The rapidity is not greater than twelve words per minute for skilled operators. The sending apparatus and wire would injuriously affect the compass if placed near it. The exact distance is not known, and should be determined by experiment. The system is adapted for use on all vessels of the navy, including torpedo-boats and small vessels, as patrols, scouts, and despatch boats, but it is impracticable in a small boat. For landing parties the only feasible method of use would be to erect a pole on shore and then communicate with the ship. The system could be adapted to the telegraphic determination of differences of longitude in surveying. The Board respectfully recommends that the system be given a trial in the navy.

THE great explosion which occurred in the central crater of Etna, on July 19, is by far the most striking phenomenon exhibited by the volcano since the eruption of 1892. According to Mr. S. Arcidiacono, who describes it in the last *Bollettino* (vol. v., No. 4) of the Italian Seismological Society, it exceeded in violence those which preceded the eruptions of 1886 and 1892. A gigantic "eruptive pine" rose to a height of more than 5000 metres above the summit of the mountain, and was then blown to the south-east into an elongated dark cloud, which covered a large part of the sky and hid the sun. Strangely enough, the great seismometrograph (25·3 metres in length), with which the observatory of Catania is now provided, was absolutely unaffected by the explosion. Three shorter tromometers showed, however, that it was preceded and followed by very slight and rapid vibrations ; and a slight earthquake, accompanied by a prolonged rumbling sound, was felt by a few persons at Zafferana Etnea. Six days later there was a second, but much less violent explosion, which produced no disturbance whatever in the instruments at Catania. The observatory on Mount Etna was unfortunately damaged by falling stones during the first explosion.

A PAPER was read by Mr. C. Newton Russell before the Institution of Civil Engineers on December 12, upon the subject of refuse destruction, particularly in reference to its employment for raising steam. Details were given of ten combined plants, the data of which all tend to prove that a considerable amount of energy in the form of heat may be obtained from the burning of ordinary domestic refuse. At Shoreditch, where the largest of these plants is in operation, the total amount of refuse destroyed during a period of twelve months was about 26,000 tons. The plant consists of six Babcock-Willcox water-tube boilers and twelve refuse-furnaces of the Manlove-Alliot type, each boiler being placed between two refuse-furnaces, the hot gases from which are led into the boiler-tubes through short side-flues, each boiler being provided with a special grate, on which coal might be burned if required. Forced-air draught is supplied to the fires by electrically-driven fans, the pressure in the ashpits being one inch of water. No coal or other fuel is mixed with the refuse, which burns freely ; the maximum temperature observed is 2500° Fahr., and the average, 1500° F. The steam generated in the boilers, at an average pressure of 140 lbs. per square inch, is disposed of mainly by the engines attached to the electric generators, although a small portion of live steam is supplied for clothes-washing purposes to the public baths and washhouses adjoining the electricity works ; exhaust steam is also supplied to the Baths and Free Library, which are entirely heated from the steam produced by the refuse-destructor.

IT may be interesting to some of our readers to know that the U.S. Weather Bureau has just issued a *Bulletin* (No. 27), showing the probable state of the sky along the path of total eclipse of the sun on May 28, 1900, so far as relates to the United States. The track of totality begins on the Pacific Ocean just west of Mexico at sunrise, and leaves the United States near Norfolk (Virginia), and Cape Henry. It then crosses the Atlantic Ocean, and touches Europe at Coimbra, Portugal, takes in Algiers and Northern Africa, and terminates near the northern end of the Red Sea at sunset. This is the third report, and includes the results of observations made in the years 1897–9. The observations are divided into two parts ; (1) the general state of the sky, and (2) the state of the sky near the sun, and show that Central Georgia and Eastern Alabama, about south of Atlanta, is the most favourable part for avoiding the tendency to cloudiness. It is, however, needless to remark that any special cyclonic disturbance on the day in question would seriously modify these calculations as to the mean amount of cloudiness.

IN *Das Wetter* for October, Dr. van Bebber publishes the first part of the results obtained in an interesting discussion on the possibility of scientific weather prediction for several days in advance, with special reference to the requirements of agriculture. Instead of attacking the subject in the usual way of dealing with the more mobile areas of low barometric pressure, he keeps in view the behaviour of the simpler and more persistent areas of high pressure, among which he distinguishes five principal types, in which an anticyclone lies (1) in the neighbourhood of the British Isles (with depressions lying to the eastward); (2) over Germany (with depressions at a considerable distance off); (3) over North or North-East Europe (with depressions to the southward); (4) over East or North-East Europe (with low pressure in the west); (5) over South and South-West Europe (with low pressure to the northward). Tables are given showing the frequency in days of the weather types during twenty years, and of their mean duration. The cases in which the high pressure is situated in the western half of the horizon are much more frequent than those in which it lies to the eastward, especially in the summer season. The distribution of pressure corresponding to type (4) is a winter type, and shows a decided minimum during summer. The occurrence of type (3) in April is very marked, and it is comparatively rare in the summer season. The duration of the different types varies considerably in the twenty years' period, but the average time is about three days. The chief characteristics of the various types is explained; but although these refer more particularly to the weather of the Continent, the lines on which the investigation has been carried out may probably be followed with advantage in other similar discussions.

IN the number of the *Biologisches Centralblatt* for October 1, Dr. L. Reh, of Hamburg, contributes a discussion on symmetry and asymmetry in animals, in the course of which he disputes the correctness of several current views. It has, for instance, been asserted that asymmetry occurs only in land animals of a sluggish disposition and in aquatic creatures. But, observes the author, the majority of fishes are some of the most symmetrical of all animals; while in contrast to the unsymmetrical claws of land-crabs is the symmetry of those of their aquatic cousins. In regard to the occurrence of symmetry in rapidly moving creatures and of asymmetry in those of stationary habits, Dr. Reh admits that, so far as external characters are concerned, the former condition obtains in insects, most fishes and birds, while many tube-dwelling worms, univalve molluscs, and flat-fish are as markedly unsymmetrical. On the other hand, conspicuous asymmetry is met with in the intestines of birds and in the skulls of the toothed whales; while many barnacles, bivalve molluscs, and brachiopods are as distinctly symmetrical.

CAPTAIN GUIDO COUARDE contributes to the *Mittheilungen* of the Vienna Geographical Society an interesting paper on the island of Mayotto, the member of the Comoro group nearest to Madagascar. A short history of the island is given, and notes on its trade, population, climate, flora, and fauna.

PETERMANN'S *Mittheilungen* contains the first part of a detailed study of the geology of Celebes, by Prof. H. Bucking. The region described is that of Minahassa, in the extreme north-west of the island. Minahassa is remarkable for volcanic activity; there are large numbers of active volcanoes, solfataras, mud-volcanoes, and hot springs.

WE have received the first part of the fifty-sixth volume of the *Verhandlungen des naturhistorischen Vereins der Preussischen Rheinlande, Westfalens, und des Reg.-Bezirks Osnabrück*. The general meeting for 1899 was held at Aix-la-Chapelle, and the report contains papers on "Eyes and Industry," by Dr. Thier, oculist in Aix; on the rainfall of the Rhine Province, by Dr. P. Polis; on the geology of volcanic islands, by Paul Grosser; and on the spiders of the Rhine Province, by W. Bosenberg.

THE Hull Scientific and Field Naturalists' Club sends a copy of its *Transactions* for the year 1899. The club wisely confines its publications to local topics. Mr. J. W. Boult contributes a list of Macro-Lepidoptera collected within eight miles of Hull. Mr. Thomas Sheppard deals with the contents and origin of the gravels around Hull. Some of the gravels he regards as Pre-Glacial, although the evidence furnished by the mammalian remains is inconclusive. The mosses of the East Riding form the subject of an article by Mr. J. J. Marshall. Other papers relate to local water-supply, and to "A whale hunt at Goole over thirty years ago."

APPENDIX II. for 1899 of the Kew *Bulletin of Miscellaneous Information* consists of the names and origin of the new garden plants brought for the first time into cultivation during 1898, and the most noteworthy of those which have been re-introduced after being lost from cultivation. The list includes about 300 species.

HERR J. DÖRFLER (Barichgasse 36, Vienna iii.) is about to publish a second edition, revised and enlarged, of his *Botaniker Addressbuch* (Botanical Directory) and asks the co-operation of British botanists, who are requested to send him their full name and address, with their scientific distinctions or appointments, together with the special branch of botany in which they have worked. The price of the Directory will be, to subscribers 7*s*. 6*d*., to non-subscribers, 10*s*. post free.

Bulletin No. 17 of the U.S. Department of Agriculture (Division of Vegetable Physiology and Pathology) consists of a report by Mr. Erwin F. Smith on the "Wilt disease" of cotton, water-melon, and cow-pea (*Vigna sinensis*). It appears to be due to the attacks of a fungus, which is polymorphic, assuming somewhat different forms in the three host-plants. Besides ascospores, it produces three different kinds of conidial reproductive bodies. The fungus has hitherto been known as *Fusarum vasinfectum*, but Mr. Smith regards it as the type of a new genus, *Neocosmospora*, allied to *Cosmospora*.

WE have received a report on the spraying of Charlock and Runch (wild radish) issued conjointly by the Yorkshire College and the East and West Ridings Joint Agricultural Council. The writer, Mr. J. R. Campbell, advocates the destruction of these weeds by a spraying machine, the spray used being either iron sulphate or copper sulphate, preferably the former. It can, however, be used to advantage only in bright, sunny and calm weather. Solutions of the strength of 10 to 15 per cent. iron sulphate have no injurious effects on corn or young seeds, but they are injurious to other cruciferous crops, such as mustard or turnips, and to beans.

EARLY in the New Year Mr. John C. Nimmo will publish the first volume, by Prof. Sayce, of Oxford, of "The Semitic Series," an important new series of standard hand-books intended to present compactly and in popular scientific form a knowledge of the more important facts in the history, religion, government, language, customs, &c., of the Babylonians, Assyrians, and allied Semitic races of ancient history in a way that will be serviceable to the reading public generally, as well as to teachers and masters, students, the clergy, and others. The first volume is "Babylonians and Assyrians—Life and Customs (with special reference to the Contract Tablets and Letters)," by the Rev. A. H. Sayce, Professor of Assyriology at Oxford. Other volumes will follow at regular intervals; each will be complete in itself, and the series, taken as a whole, will neglect no phase of the general result of recent scientific research.

THE additions to the Zoological Society's Gardens during the past week include a Flying Squirrel (*Sciuropterus*, sp. inc.) from Chitral, presented by Captain S. A. Harris, I.M.S.; a Pheasant (*Phasianus colchicus*, ♂) from Russia, presented by the Hon. E. A. Stoner; two Crossed Snakes (*Psammophis crucifer*), two Rhomb-marked Snakes (*Trimerorhinus rhombe-*

atus), two Cape Bucephalus (*Dispholidus typus*), a Puff Adder (*Bitis arietans*) from South Africa, presented by Mr. J. E. Matcham; a Common Rattlesnake (*Crotalus durissus*), two Horrid Rattlesnakes (*Crotalus horridus*) from North America, deposited; four Common Sheldrakes (*Tadorna cornuta*), two White-fronted Geese (*Anser albifrons*), European, purchased; a Harnessed Antelope (*Tragelaphus scripta*, ♀), a Brush-tailed Kangaroo (*Petrogale penicillata*, ♂), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

NEW MINOR PLANET (1899 E.Z.).—Circular No. 25 from the Centralstelle at Kiel contains an ephemeris of the planet observed by Mr. E. F. Coddington in October and November last. Herr Kreutz thinks there seems no doubt that this is identical with the planet found by Dr. J. Palisa (1896 C.O.), and the ephemeris is given with the possibility that more observations may definitely settle the point.

Ephemeris for 12h. Berlin Mean Time.

1899.	R.A. h. m. s.	Decl. ° ′
Dec. 22	0 58 39	−4 59·0
24	1 0 45	4 36·4
26	2 56	4 13·3
28	5 12	3 49·7
30	7 33	3 25·8
Jan. 1 (1900)	1 10 0	−3 1·5

CHANGE IN PUBLICATION OF THE "ASTRONOMISCHE NACHRICHTEN."—We have received a card from Herr H. Kreutz, of the Central Bureau at Kiel, respecting an important alteration in the method of publishing the astronomical information hitherto given in the *Astronomische Nachrichten*, which is one of the most important foreign journals dealing with current astronomical observations. With the beginning of the New Year the original publication will be confined to the recording of general observations, while a separate paper will be issued to contain the ephemerides of comets, planets, &c. The subscription to the new part will be 10 marks yearly. Arrangements are being made for this addition at Kiel, Niemannsweg 103, and subscriptions should be sent there direct.

COMPANION TO THE OBSERVATORY.—We have received the *Companion to the Observatory* for the year 1900. In arrangement this closely resembles those of previous years, giving most of the more important data for the observation of celestial objects. Beginning with one page showing for every week the time of rising and setting of the sun, its declination at noon, mean and sidereal time, and the moon's phases, there follows a calendar, giving for every day in the year the setting, southing, declination of the moon and the longitude of its terminator. Mr. Denning again contributes his list of radiant points of the principal meteor showers during the year. Then follow useful particulars of the R.A., Decl., diameters, times of rising, southing and setting of the planets, with the times of elongation, opposition, conjunction, &c. Occultations, configurations of the satellites of Jupiter, Saturn, Uranus and Neptune occupy the next ten pages. Mr. Crommellin contributes an ephemeris of Eros for the period about the opposition in December. The rest of the book is occupied with an ephemeris for physical observations of the sun, and the mean places and times of maxima and minima, of the more noticeable variable stars.

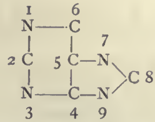
RECENT RESEARCHES ON URIC ACID.

THE uninterrupted stream of new researches which has issued from the laboratory of Prof. Emil Fischer at Berlin since 1895 threatens to bewilder even the careful student of chemistry or physiology. The following brief summary of the results may be found useful.

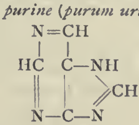
Uric acid is an excretory or waste product of animal life, and is closely related chemically to many substances such as paraxanthine and heteroxanthine, which are associated with it in urine; xanthine, adenine, and guanine, which probably form part of the nucleins of cells, and theobromine, theophylline and caffeine, the physiologically active constituents of tea, coffee and cocoa.

An accurate knowledge of the constitution of these substances is therefore of the first importance to physiologists, whilst a satisfactory process for utilising uric acid—which is a plentiful constituent of guano—in the synthesis of theobromine or caffeine would possess considerable therapeutic interest as well as commercial value. The many difficulties encountered by Prof. Fischer in the solution of these problems have been met with his accustomed skill and resource, which are the admiration and despair of the present-day chemist, and we are now not only in possession of a clear and complete knowledge of the relationship which exists between these complex products of animal and plant life, but we may anticipate before long their appearance as commercial products.

Fischer has shown that in all these compounds the same atomic framework is present and may be represented as follows, the relative position of the atoms being denoted by the numbers 1 to 9.

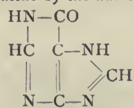


If the four additional hydrogen atoms necessary to satisfy the valencies of the carbon and nitrogen atoms be now added, the structure of the mother substance of the whole series is obtained, a compound which has been actually prepared by Fischer, and named *purine* (*purum uricum*).

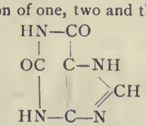


Purine.

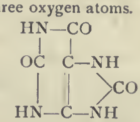
Hypoxanthine, xanthine and uric acid may be derived from purine by the addition of one, two and three oxygen atoms.



Hypoxanthine (6-oxypurine).

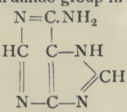


Xanthine (2:6-dioxypurine).

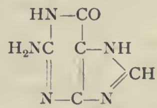


Uric acid (2:6:8-trioxypurine).

Adenine is purine in which the hydrogen atom in position 6 is replaced by an amido-group, whilst guanine is hypoxanthine with an amido-group in position 2.

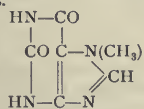


Adenine.

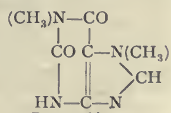


Guanine.

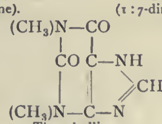
Heteroxanthine, theophylline, paraxanthine, theobromine and caffeine are respectively mono-, di- and tri-methyl xanthines.



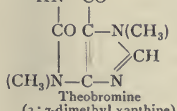
Heteroxanthine (7-methyl xanthine).



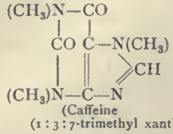
Paraxanthine (1:7-dimethyl xanthine).



Theophylline (1:3-dimethyl xanthine.)



Theobromine (3:7-dimethyl xanthine).



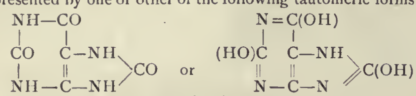
(Caffeine (1:3:7-trimethyl xanthine).

Although most of the natural products are represented in the foregoing formulæ, the list of purine derivatives is not exhausted; for, as in the case of the sugars, the natural products have been supplemented by an even longer list of artificial compounds. Thus 4 monomethyl, 5 dimethyl and 2 trimethyl xanthines are possible, and most of them are known, and all the fifteen theoretically possible methyl derivatives of uric acid have been prepared together with an additional one, whose existence has not yet been accounted for.

Even this does not complete the list of purine derivatives, for there remain methyl purines, methyl adenines and methyl hypoxanthines still to record, as well as an 8-oxypurine isomeric with hypoxanthine and a 6:8-dioxypurine isomeric with xanthine, and many others.

It now remains to indicate the manner in which the constitution of these substances has been determined and their synthesis effected.

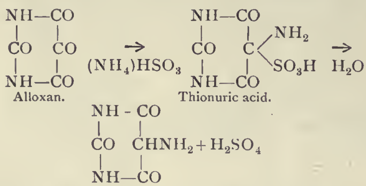
The structure of uric acid was pretty clearly established in the year 1884 by Fischer's discovery of a second methyl uric acid, in addition to the one obtained by Hill, both of which are formed simultaneously by treating the lead salt of uric acid with methyl iodide. Since one of these compounds gives on oxidation methyl alloxan and urea, and the other by similar treatment alloxan and methyl urea, the formula of uric acid must be represented by the fusion of an alloxan and a urea nucleus, so as to form an unsymmetrical grouping after the manner proposed by Medicus. The complete methylation of uric acid yields a tetramethyl derivative from which all the nitrogen is removable in the form of methylamine. It follows, therefore, that the four methyl groups in tetramethyluric acid, and probably therefore the four hydrogen atoms in uric acid itself, are linked to nitrogen. The structure of uric acid is represented by one or other of the following tautomeric forms:—



Uric acid.

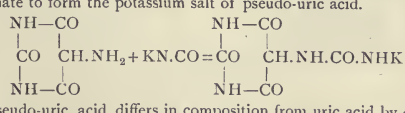
This structure is confirmed by its synthesis from uramil, a synthesis which, it may be interesting to remember, was first suggested by Liebig and Wöhler, then carried forward a step by v. Baeyer's discovery of pseudo-uric acid, and finally realised by Fischer in 1895.

Uramil was first obtained by Liebig and Wöhler from alloxan and ammonium sulphite, which form together thionuric acid, the latter decomposing on boiling with hydrochloric acid into uramil.

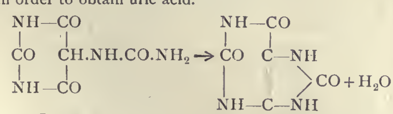


Alloxan. Thionuric acid. Uramil.

Uramil, as v. Baeyer showed, combines with potassium cyanate to form the potassium salt of pseudo-uric acid.



Pseudo-uric acid differs in composition from uric acid by one molecule of water. To effect its removal, which the usual dehydrating agents fail to do, Fischer found that it is only necessary to heat the compound with 20 per cent. hydrochloric acid in order to obtain uric acid.



Pseudo-uric acid. Uric acid.

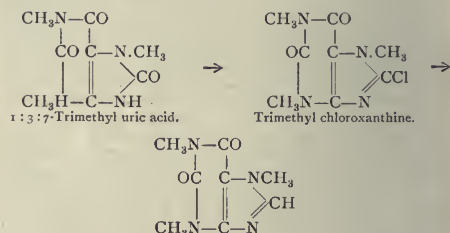
If in place of uramil its methyl derivatives are employed, various methyl uric acids are obtained; an important point, since the positions of the methyl groups in the acid are thereby determined.

Thus from 1 and 7-monomethyl uramil, 1 and 7 methyl uric acid have been obtained; 1:3- and 1:7-dimethyl uramil yield 1:3- and 1:7-dimethyl uric acid; 1:3:7-trimethyl uramil can be converted into trimethyl uric acid, whilst the imido-pseudo-uric acid of Traube is converted into an amido-uric acid.

Having then established the structure of uric acid and the methyl uric acids as hydroxy-derivatives of xanthine, guanine, theobromine, theophylline and caffeine, &c., the question arises, How can these various compounds be obtained from the single raw material, uric acid? Since xanthine can be methylated and converted into theobromine, as Strecker first showed by treating the silver salt with methyl iodide, and since theobromine and theophylline, by a repetition of the same process, can be converted into caffeine, there are several ways in which the above problem might be attacked.

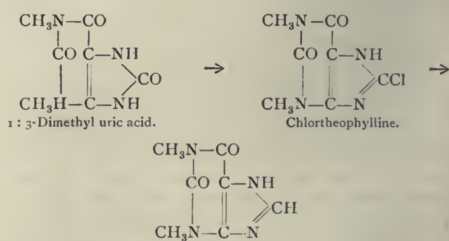
Uric acid might be reduced to xanthine and the xanthine methylated, or uric acid might be converted into monomethyl uric acid, then reduced to monomethyl xanthine and further methylated; or, finally, the di- and tri-methyl uric acids might be first prepared and then reduced to the corresponding di- and tri-methyl xanthines. All three methods have been utilised in turn by Fischer and carried to a successful issue; and since the process is similar in each case, one or two examples may suffice by way of illustration.

When 1:3:7-trimethyl uric acid is heated with a mixture of pentachloride and oxychloride of phosphorus, it yields trimethyl chloroxanthine. Tetramethyl uric acid yields the same product by the elimination of a methyl group in the form of methyl chloride. Trimethylchloroxanthine is then reduced with strong hydriodic acid to caffeine.



1:3:7-Trimethyl uric acid. Trimethyl chloroxanthine. Caffeine.

1:3-Dimethyl uric acid behaves similarly and forms theophylline.

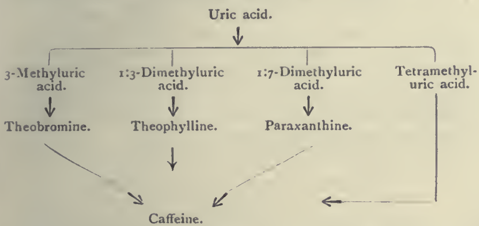


1:3-Dimethyl uric acid. Chlortheophylline. Theophylline.

This process cannot, however, be applied to uric acid in order to obtain xanthine, or to 3 or 7 monomethyl or 3:7-dimethyl uric acid, which might lead to the synthesis of theobromine; since in the first case the substance is destroyed, and in the other cases the chlorine atom replaces the wrong oxygen atom, *i.e.* instead of replacing it in position 8, which is essential to the success of the operation, it enters position 6.

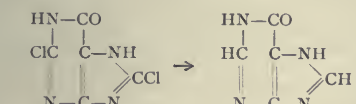
The happy idea of employing phosphorus oxychloride alone in place of the mixture of pentachloride and oxychloride has overcome this unforeseen difficulty, and given a fortunate turn to the investigation.

By this modification 3 : 7-dimethyl uric acid may be made to yield chlorotheobromine and theobromine, or better still, 3-methyl uric acid, which can be obtained by the direct methylation of uric acid, may be converted successively into 3-methyl-8-chloroxanthine, which may be either methylated with methyl iodide in presence of caustic potash to chlorotheobromine and chlorocaffeine, and then reduced, or first reduced to 3-methyl xanthine and then methylated. As a rule, however, the methylation of the chlorine compound is more easily effected than that of the reduced product. Paraxanthine (1 : 7-dimethylxanthine) may be obtained from 1 : 7-dimethy luric acid in a similar manner and also converted by methylation into caffeine. The following scheme will make clear the various directions in which the synthesis of caffeine has been accomplished:—

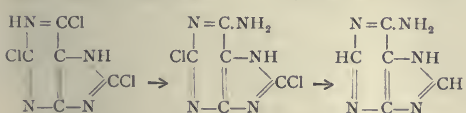


Heteroxanthine (7-methyl xanthine) has been obtained by the action of phosphorus oxychloride on theobromine, which by the elimination of one methyl group forms 7-methyl dichloropurine. By boiling this substance with hydrochloric acid, 7-methyl xanthine is formed. Xanthine cannot be prepared in so direct and simple a manner as the above from uric acid, even when phosphorus oxychloride alone is used, for the first product obtained in this way is 8-oxy-2 : 6-dichloropurine instead of 8-chloro-2 : 6-dioxypurine; but by the action of a large excess of phosphorus oxychloride uric acid may be made to part with its last atom of oxygen. Trichloropurine is then produced, and this compound has served for the synthesis of xanthine and its more nearly related derivatives hypoxanthine, adenine and guanine.

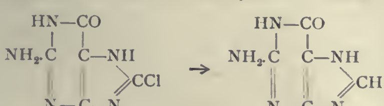
When trichloropurine is treated with aqueous potash it yields 6-oxy-2 : 8-dichloropurine. The latter compound may be directly reduced with hydriodic acid to hypoxanthine, or converted with alcoholic ammonia into chloroguanine, which on reduction forms guanine. Aqueous ammonia converts trichloropurine into 6-amino-2 : 8-dichloropurine, which yields adenine on reduction.



6-oxy-2:8-dichloropurine. Hypoxanthine.

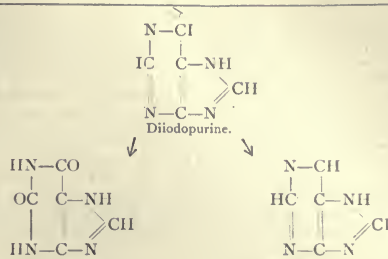


Trichloropurine. 6-amino-2:8-dichloropurine. Adenine.



Chloroguanine. Guanine.

With strong hydriodic acid, trichloropurine is converted into diiodopurine, which yields, on the one hand, with hydrochloric acid xanthine, and with zinc dust and water purine, the mother substance of the whole group of compounds. Though neutral to litmus, purine forms salts, the nitrate and picrate being the most characteristic of these compounds.



Diiodopurine.

Xanthine. Purine.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

MR. FRANK LENEY, of the Geological Department of the British Museum (Natural History), who has been trained under Mr. Smith Woodward, has been appointed Assistant Curator of the Norwich Museum.

MR. A. RENDLE SHORT, a student of University College, Bristol, was awarded the scholarship in physiology at the recent final B.Sc. examination of London University. The scholarship is of the value of 50*l.* per annum for two years.

DR. J. W. GREGORY has been appointed professor of geology and mineralogy in the University of Melbourne, in succession to Sir Frederick M'Coy, F.R.S. Dr. Gregory has been an assistant in the geological department of the British Museum (Natural History) for several years, and is a member of the council of the Geological Society. He has been engaged in very successful explorations—notably in British East Africa in 1892–93, and in Spitsbergen in 1896—and has, in addition, contributed more than fifty papers to scientific societies. The salary attached to the post to which he has been appointed is 1000*l.* a year.

THE London Technical Education Committee have arranged for a second conference of science teachers to be held during the forthcoming Christmas vacation. Meetings will be held on Wednesday, January 10, and Thursday, January 11, 1900, in the morning and afternoon of each day. On the first day the meetings will be held in the conference room of the English Education Exhibition at the Imperial Institute, when the Rt. Hon. Sir John Lubbock, F.R.S., will preside at the morning meetings, and Sir Henry Roscoe, F.R.S., at the afternoon gatherings. The second day's proceedings will take place at the Shoreditch Technical Institute, Pitfield-street, Hoxton. The following addresses will be delivered:—Wednesday at 11 a.m., "Teaching of Botany in Schools," by Prof. L. C. Miall, F.R.S., and "Object Lessons in Botany," by Miss Von Wyss; at 2 o'clock, on "Juvenile Research," by Prof. H. E. Armstrong, F.R.S., this address will be illustrated with lantern slides and experiments by juvenile assistants; on Thursday at 11 a.m., on "Teaching of Natural History in Schools," by Prof. Woods Hutchinson, and on "Object Lessons in Natural History," by Mr. J. W. Tutt; at 2 o'clock, "Metal Work as a Form of Manual Instruction in Schools," by Prof. W. Ripper. Free admission will be granted to as many teachers as the conference rooms will accommodate. Applications for tickets of admission should be made to Dr. Kimmins, Bermondsey Settlement Lodge, S.E., or to Mr. C. E. Buckmaster, 16, Heathfield-road, Mill Hill Park, W.

THE following gifts to science and education in the United States are announced in *Science*:—The money, amounting to 11,400,000 dollars, obtained by Mrs. Jane Stanford for her 285,000 shares of Southern Pacific stock, which she sold recently, will at once be made available for the use of the Stanford University.—Mr. James Jennings McComb, of New York, one of the founders of the South-western Presbyterian University at Clarksville, Tenn., has given 70,000 dollars to the endowment fund, making his contributions amount in all to 100,000 dollars.—Brown University has received an unconditional gift of 10,000 dollars from the heirs of the late Lucian Sharpe.—The Rev. John Pike has left the reversion of half his property to found two scholarships in Bowdoin College.—Mr. Thomas Armstrong, of Plattsburg, New York State, who died in 1897, left his property, amounting to 300,000 dollars, to Union College, Schenectady. Suit was brought on behalf of his wife and children, and half of the estate has been awarded to them, while the remaining 150,000 dollars goes to Union College.—Vassar College has received a gift of 5,000 dollars towards the proposed biological laboratory, for which 25,000 dollars has been promised on condition that an equal additional sum shall be raised.—The University of Pennsylvania has received a gift of 250,000 dollars for the construction and equipment of a laboratory of physics.—Wesleyan University has received a gift of 38,000 dollars from Miss Elizabeth A. Mead, subject to an annuity during her lifetime.—St. Lawrence University has received 34,000 dollars from various sources.

SCIENTIFIC SERIALS.

American Journal of Science, December.—The highest aim of the physicist, by H. A. Rowland. Physics is the science above all sciences which deals with the foundation of the universe, with the constitution of matter from which everything in the universe is made, and with the ether of space by which alone the various portions of matter forming the universe affect each other, even at the greatest distances. He who makes two blades of grass grow where one grew before is the benefactor of mankind; but he who obscurely works to find the laws of such growth is the intellectual superior as well as the greater benefactor of the two.—Notice of an aerolite that recently fell at Allegan, Michigan, by H. L. Ward. The mass in question, about 20 inches long and 10 or 12 inches thick, was seen to fall, and dug up a few minutes after it was buried. It was reported to be hot all through, and not cold at the centre as might have been suspected. The stone is very chondritic in structure. It is of a light ash-grey colour, and exceedingly friable, with a black crust averaging 1 mm. in thickness. Optical examination reveals the presence of enstatite, chrysolite, felspar, troilite and iron, the two last being distributed evenly and thickly as small irregularly shaped grains.—A new meteoric iron found near Iredell, Bosque County, Texas, by W. M. Foote. The meteoritic iron in question was not seen to fall. The three best instances of cleavage are exhibited in one specimen. These are three pairs of perfect adjacent planes forming angles of 120°. The fracture presents a glistening tin-white finely crystalline surface. Grains and plates as much as 2 mm. thick, of a brittle magnetic mineral of pyritiferous aspect are common. A qualitative examination showed the presence of iron, phosphorus and nickel, indicating it to be schreibersite.—Some of the results of the international cloud work for the United States, by F. H. Bigelow. The penetration of ordinary cyclones into the higher regions of the atmosphere is slight. They are only two or three miles deep. Hurricanes are five or six miles deep. The anticyclonic and cyclonic areas are hardly to be considered as centres of motion except in the very lowest strata, since currents of air blow directly across them from west to east, even in the cumulus region of the Rocky Mountain districts. The ordinary circulation theory does not hold good. In each stratum from the surface to the cirrus level about as much air moves north as south, for there are enormous counter currents passing by each other at the same level, and not over one another at different elevations. This puts a new aspect upon the entire problem of the general circulation.

Wiedemann's Annalen der Physik und Chemie, No. 11.—Moving bodies in the electric field, and the electric conductivity of air, by A. Heydweiller. If a sphere rotates uniformly in a medium of different conductivity and in an electric field, and the conductivity of the medium is negligible in comparison with that of the sphere, a couple acts upon the sphere tending to stop its motion. If the conductivities are reversed, the couple tends to accelerate the motion. The author shows that this may account for the stoppage of the moon's original rotation.—Ratio of the electric charge of kathode particles to their mass, by S. Simon. Using Kaufmann's method of magnetic deflection, the author determined the ratio e/m as accurately as possible. He found it to be $1 \cdot 865 \times 10^7$ C.G.S. units, or slightly higher than Kaufmann's value.—On the highest audible and inaudible notes, by R. König. The author investigates notes of pitches ranging from 4096 to 90,000 vibrations per second, produced by bowed tuning-forks. The method of beats is useful for estimating pitches up to the limits of audibility, but the method of Kundt's dust figures is available up to the highest pitches, and is easy to apply and to deduce results from.—Origin of frictional electricity, by C. Christiansen. A mercury jet was surrounded by twelve jets of zinc amalgam, and both were made to fall side by side through oxygen. As long as the oxygen was somewhat moist, the normal difference of potential of 0·88 volt was indicated between the amalgam and the mercury. But when the moisture was gradually reduced the difference of potential steadily decreased, and finally was reversed in sign at a point where the vapour pressure was about 0·5 mm.—Influence of Becquerel rays upon electric sparks and brushes, by J. Elster and H. Geitel. A spark gap 1 cm. wide, between a positive knob and a negative disc, was exposed to the influence of a radium preparation. The sparks or brushes were immediately converted into a glow dicharge, a violet glow surrounding the knob. When the disc was made of cardboard instead of metal, the gap became so sensitive that the radium affected the discharge at a distance of over a metre.—Behaviour of the brush discharge in a magnetic field, by Mr. Toepler. The stratification of the brush discharge is considerably modified by a strong magnetic field. The latter has the effect of crowding the stratifications together, and also of displacing them laterally with respect to each other. An unstable brush discharge is converted into a spark discharge.

SOCIETIES AND ACADEMIES.

LONDON.

Chemical Society, December 7.—Prof. Thorpe, President, in the chair.—The following papers were read.—The oxidation of certain organic acids in presence of ferrous salts, by H. J. H. Fenton and H. O. Jones. The authors have examined the oxidation products of a number of carboxylic acids and of picric acid by hydrogen peroxide in presence of ferrous salts.—Oxalacetic acid, by H. J. H. Fenton and H. O. Jones. Free oxalacetic acid, $C_4H_4O_5$, is obtained on oxidising malic acid in presence of ferrous salts.—Determination of the constitution of fatty acids (Part ii.), by A. W. Crossley and H. R. Le Sueur. Ethylisopropylmalonic acid yields ethylisopropylacetic acid,

$$C_2H_5.CH(C_3H_2).COOH$$

by elimination of carbon dioxide. Ethylic α-bromethylisopropylacetate yields, on treatment with diethylaniline, a mixture of ethylic dimethylethylacrylate and ethylic methylisopropylacrylate.—The reaction between sulphuric acid and potassium ferrocyanide, by R. H. Adie and K. C. Browning. The action of acid of the composition H_2SO_4 or H_2SO_4,H_2O upon potassium ferrocyanide consists in the formation of potassium sulphate and hydroferrocyanic acid and in a partial evolution of carbon monoxide; all the cyanogen in potassium ferrocyanide is converted into carbon monoxide by acid of the composition $H_2SO_4,2H_2O$. Acid of the composition $H_2SO_4,4H_2O$ to $H_2SO_4,10H_2O$ similarly converts the salt into hydrocyanic acid and Everitt's salt, $K_2Fe_2Cy_6$ —The sulphates of bismuth, by R. H. Adie. By the action of sulphuric acid of different concentrations, the author has obtained solid salts of the following compositions:

$$5Bi_2O_3,11SO_3,17H_2O\ ;\ Bi_2O_3,4SO_3,7H_2O\ ;\ Bi_2O_3,4SO_3,3H_2O\ ;\ Bi_2O_3,4SO_3,H_2O\ ;\ Bi_2O_3,4SO_3,10H_2O.$$

—On sulphates of the form $R_2SO_4,2MSO_4$, especially those of isometric crystallisation, by F. R. Mallet. By fusing the constituent salts together, the author has obtained cubic double salts of the following compositions:

$$K_2SO_4,2MgSO_4\ ;\ K_2SO_4,2ZnSO_4;\ K_2SO_4,2MnSO_4\ ;\ K_2SO_4,2NiSO_4\ ;\ K_2SO_4,2CoSO_4\ ;\ Rb_2SO_4,2MgSO_4.$$

—Reactions of the so-called dibenzylamarine, by F. R. Japp and J. Moir. The authors describe the chemical behaviour of dibenzylamarine, which they have previously shown to be benzoyl-*s*-dibenzyl-*i*-diphenylethylenediamine.—Note on isoamarine, by H. L. Snape. The author has resolved isoamarine into its optically active components, thus confirming Japp and Moir's view of its constitution.—On the preparation of benzeneazoorthonitrophenol, by J. T. Hewitt. Benzeneazophenol is converted into benzeneazoorthonitrophenol by dilute nitric acid.—Some new osazones and tetrazones, by H. A. Auden.—A series of substituted nitrogen chlorides. Part ii. The trichlorophenylacyl chlorides, by F. D. Chattaway and K. J. P. Orton.—The reaction between cupric sulphate solution and magnesium, zinc and iron, by R. M. Caven.

Geological Society, December 6.—W. Whitaker, F.R.S., President, in the chair.—Dr. Blanford described certain photographs sent by Mr. E. H. L. Schwarz, and representing the Dwyka boulder-bed and the rounded and grooved underlying surface, in the neighbourhood of the Orange River near Hopetown and Prieska. The importance of these photographs lay in the evidence which they afforded on a disputed point. Dr. Sutherland and Mr. Griesbach had called attention to the evidence of ice-action presented by the Dwyka Conglomerate in Natal, and additional evidence had been brought forward by several observers, especially by Mr. Dunn from the Orange Free State and Cape Colony, and recently by Dr. Molengraaff from the Transvaal. Other observers, however, and especially the late Prof. Green, had disputed the glacial origin of the Dwyka beds. The photographs now exhibited would, the speaker thought, convince most geologists that the phenomena presented were due to ice-action. The resemblance to similar photographs shown to the Society in 1896 by Prof. T. W. Edgworth David, and representing the beds corresponding to the Dwyka Conglomerate in South Australia, was noteworthy. Evidence of glacial action in Upper Palæozoic times had gradually accumulated from India, Australia, and South Africa, and there was a probability that similar indications existed in South America.—On the geology and fossil corals and echinids of Somaliland, by Dr. J. W. Gregory. British Somaliland consists of a high plateau, of which the northern scarp is separated from the Gulf of Aden by a belt of low hills and plains known as the Guban. The southern plateau consists of Archæan gneisses, quartzites, amphibolite-schists, chloritic schists, and pegmatites. It is capped by purple grits, red sandstones, and conglomerates, which are covered by limestones of Neocomian, Turonian (? Cenomanian), and Eocene ages. The Neocomian limestone, which may be correlated with that of Singeli described by Rochebrune, occurs at Dobar in the Guban; while a Jurassic limestone, probably of Bathonian date, occurs at Bihendula in the Guban. Fossils collected from these limestones and from raised reefs of Pleistocene age, have been examined by the author, who tabulates a list of corals and echinids. The evidence of the collections is sufficient to show that a Neocomian limestone occurs both on the summit of the Somali plateau and on the floor of the Guban, and that some marine limestones of Lower Tertiary age (probably Eocene) also occur on the plateau. It is therefore evident that the foundering of the Aden Gulf is post-Eocene in age.—Note on drift-gravels at West Wickham (Kent), by George Clinch. The author describes two beds of drift-gravel at West Wickham. The first, occupying the bottom of a dry valley, yields in a section exposed at Gates Green, material derived from the Chalk and the Lower Greensand; and distinct, although perhaps not direct, relation with the denudation of the Weald is claimed for it. The other bed of gravel is of later age, and has yielded many Palæolithic implements and flakes.—On the occurrence in British carboniferous rocks of the Devonian Genus *Palaeoineilo*, with a description of a new species, by Dr. Wheelton Hind. The family Nuculidæ is represented in carboniferous rocks by the genera *Nucula*, *Nuculana*, and *Ctenodonta*, and to these must now be added *Palaeoneilo*, which the author describes from two fine specimens in the Museum of Practical Geology, from carboniferous shale (Yoredale Shale) south of Hammerton Hall, Slaidburn, Yorkshire. It is remarkable that a genus so well developed in Devonian times should be found at the top of the carboniferous limestone series, but not in intermediate beds. Hall's diagnosis of the genus is given, with additional remarks, and a new species is described and contrasted with *Ctenodonta* (*Palaeoneilo*) *lirata*, Phil., from the Devonian of Baggy.

Entomological Society, December 6.—Mr. G. H. Verrall, President, in the chair.—Mr. J. J. Walker exhibited a specimen of *Colias marnoana*, Rogenh., taken at Massowah, on the Red Sea. He considered this form to be only a dwarfed race of *C. hyale*, Linn.; and for comparison with it, he showed specimens of the var. *nilgherriensis*, Feld., from Central India, and of the var. *simoda*, De L'Orza, from Japan.—Dr. Chapman exhibited a series of specimens, selected from various English collections, together with a few foreign examples, to illustrate the English forms found within the genus *Fumea*. He read some notes relating to the genus, and to characters, chiefly drawn from structure, by which the different species may be distinguished.—Mr. Malcolm Burr called attention to Dr. Sharp's paper on the modification and attitude of *Idolum diabolicum*, recently published in the *Proceedings* of the Cambridge Philosophical Society (vol. x. part iii.). He exhibited the plate, drawn after nature by Mr. Muir, which illustrates the paper, pointing out that no drawing of this kind showing a Mantid in its natural colours simulating the petals of a flower, had hitherto been published. He also exhibited species of Mantodea of various genera, to show the different modifications by means of which insects of this group are made to resemble leaves and flowers.—Mr. Kenneth J. Morton communicated a paper entitled "Descriptions of new species of Oriental *Rhyacophilae*."

DUBLIN.

Royal Dublin Society, November 22.—Prof. E. J. McWeeney in the chair.—Prof. T. Johnson read a paper on the yellow blight of the potato-plant, an examination of which he had undertaken at the request of the Congested Districts Board of Ireland. The disease is especially prevalent in the west, but is found throughout Ireland. The two fungi held mainly responsible for the disease, of which an illustrated account was given, are considered to be *Sclerotinia sclerotiorum* (Lib.), Massee, and *Rhizoctonia Solani*, Kühn, the "small-pox" fungus of the potato-tuber. At the Winter Show of the Royal Dublin Society, of several hundred dishes of potatoes there was scarcely a dish with tubers free from the sclerotia and mycelium of *Rhizoctonia*, hitherto not recorded in Ireland.—Mr. G. H. Carpenter read a paper on some Collembola from Franz-Josef Land, collected by Mr. W. S. Bruce, of the Jackson-Harmsworth Expedition in 1896 and 1897. Seven species are represented in the collection, one of which—an Isotoma—is new to science. Mr. Carpenter also presented a paper on Pantopoda from the Arctic Seas, dredged by Mr. Bruce in 1897 and 1898.—Dr. F. T. Trouton, F.R.S., exhibited Caldwell's modification of the electrolytic interrupter, and drew attention to his explanation of the curious transference flow which occurs from one side to the other through the narrow opening or hole in the dividing partition. The direction of the flow being independent of the direction of the current points to a heating effect. When the explosion in the hole occurs through the sudden evolution of vapour liquid is ejected to both sides; but should the position of the explosion in the hole move, through any cause, to one side, more liquid will be thrown to the other. The bubbles of vapour must tend to form on the side of lowest pressure, thus accounting for the phenomenon. In the apparatus shown, the number of breaks per second was about 750, the volume of the hole about ·0011 c.c.; thus the limit to the rate of flow is about ·4 c.c. The maximum observed was about ·3.

Royal Irish Academy, December 11.—Dr. Benjamin Williamson, F.R.S., in the chair.—Dr. Henry H. Dixon read a paper on the first mitosis of the spore-mother cells of lilium. In this paper observations and arguments are adduced in favour of regarding the double twisted condition of the nuclear thread in this mitosis as arising from the folding and twisting together of parts of the dolichonematous thread. The double thread parting transversely forms the chromosomes, which are thus composed of two twisted portions, each a primary chromosome. In the equatorial plate each *primary chromosome* divides longitudinally. A pair of the longitudinal halves forms the V-shaped daughter chromosome. It is also shown that the unravelling of the halves of the twisted primary chromosomes naturally explains the constant V-form of the daughter chromosomes. From this it will be seen that the mitosis is not a "reducing" division in Weismann's sense. The manner of the formation of the chromosomes brings into proximity in the dispirem stage parts of the nuclear thread which were, in the spirem stage, distant from one another.—Prof. C. J. Joly read a paper on some applications of Hamilton's operator ∇ in the calculus of variations. In the case of positional variations, the conditions for a stationary value of the integral $\int f d\rho, f d\rho$ being a linear and distributive function of the vector element $d\rho$ of a curve, may be expressed by the relation $f\delta\rho = 0$ at the limits, and $f\nu\nabla\nu d\rho\delta\rho = 0$ at each point of the curve. In the second equation, ∇ operates on f alone. For surface integrals, $\iint F d\omega$ where $d\omega$ is a directed element of area, the conditions are $F\nabla = 0$ over the surface, and $F\lambda = 0$ over the boundary, λ being normal to a fixed surface on which the boundary lies. Examples were given for the use of these formulæ.

PARIS.

Academy of Sciences, December 11.—M. van Tieghem in the chair.—The perpetual secretary announced the receipt of the last American contribution to the Lavoisier Fund, the total amount received from the United States amounting to 3054 francs.—On the parallax of the sun, by M. Bouquet de la Grye. The Academy of Sciences in 1882 sent out ten parties of astronomers to observe the transit of Venus across the sun, and in the present paper the final results of these observations are given. The mean of the results obtained by Halley's method with the large telescopes is 8″·7996, with all the telescopes 8″·8068; the adopted result is: 8″·80 ± ·01. The calculations of the results from the photographical methods are not yet completed.—Note on the work done on Mt. Blanc in 1899, by M. J. Janssen. The note contains details of work done in two directions, (1) on the losses that an electric cable undergoes when it is placed bare upon the glacier, and (2) on oxygen in the sun. The first work was unfortunately attended by a fatal accident to one of the observers, M. Cauro, who fell on to the glacier on which the experiments were being carried out. The work was finished by M. Lespieau. It was found that naked wires of galvanised iron were quite serviceable for telegraphing between the observatory and points varying from 300 to 1700 metres distant, a 3 mm. iron wire lying on a length of 1700 metres of glacier ice not constituting a telegraphic "earth." As regards the solar oxygen, the photographs of solar spectra obtained during the year will be discussed subsequently.—Influence of the magnetic field upon the radiation of radio-active bodies, by M. Henri Becquerel. In a non-uniform magnetic field, constituted by a powerful electromagnet, the radium rays are bent and concentrated on the poles. The results were most clearly shown by the aid of photography, a horizontal sensitive plate, covered with black paper, being placed between the two poles 45 mm. apart parallel to the field. Before exciting the magnet the radio-active barium chloride was placed upon the plate half-way between the poles. The maximum deviation corresponds to the direction normal to the field. These results have been obtained independently by MM. Meyer and Schweidler by the use of a fluorescent screen.—On a general method for the estimation of some elements contained in organic compounds, by M. Berthelot. By combustions in oxygen in the calorimetric bomb, at a pressure of 25 atmospheres, accurate estimations of carbon, sulphur and phosphorus are readily carried out if suitable precautions are taken, the most important for the two latter elements being the addition of a certain quantity of naphthaline or camphor. The determination of potassium, the alkaline earths, copper, iron, silver, or mercury presents no difficulties.—On the molecular refractions, molecular dispersions and specific rotatory power of some alkylcamphors, by MM. A. Haller and P.-Th. Muller. Measurements are given for benzylidene-, piperonylidene-, cuminyl-, ethylsaligenyl-, metamethoxybenzyl-, and anisyl- camphors, and the results compared with the figures given by the calculations of Bruhl and Conrady; the experimental results are in general higher than the calculated values. The authors suggest the double linkage connecting the camphor and aldehydic residues as the cause of the deviations.—Remarks by M. Duclaux on his treatise on microbiology.—Note on the Bielids observed at Algiers on November 28–29, by M. H. Tarry.—On the theory of discontinuous functions, by M. R. Baire.—Method for determining the mean density of the earth and the constant of gravitation, by M. Al. Gerschun. If a heavy sphere is brought near the free surface of a liquid at rest, this surface takes the form of a surface of equal Newtonian potential, arising from the simultaneous action of the earth and the heavy sphere. The expression $\frac{R}{\rho} = 1 + \frac{d}{\delta}\alpha^3$ is deduced, where R is the earth's radius, d the density of the sphere, δ the mean density of the earth, and α the ratio of radius of the sphere to the distance of its centre from the free liquid surface, and ρ the radius of the osculating surface to the liquid at its highest point. To determine ρ an optical method is employed of great delicacy, given by Foucault for verifying the truth of plane optical surfaces. Some preliminary experiments on the method show that its precision is not less than those previously in use, neither are the experimental difficulties greater.—On the principle of equality of action and reaction, by M. André Broca.—Action of aluminium chloride upon camphoric anhydride, by M. G. Blanc. The chief product of this reaction is isolauronolic acid. The secondary products are a mixture of acids, having formulæ, $C_9H_{14}O_2$ or $C_9H_{10}O_2$ and a lactone $C_9H_{14}O_2$.—Alkalimetry of the amines, by M. A. Astruc. The fatty amines examined ranging from methylamine to diamylamine are monoacid bases with either helianthine or phenolphthalein as indicator. The primary aromatic bases, on the contrary, are neutral to phenolphthalein, but behave as monoacid bases to methylorange.—On the co-existence of a reducing and an oxidising diastase in animal organs, by MM. J. Abelous and E. Gerard. It is shown that in aqueous extracts of the kidney of the horse, two ferments are present, one of which can reduce a nitrate to nitrite, and the other produce the inverse reaction.—On the presence of mannocellulose in the ligneous tissue of gymnosperms, by M. Gabriel Bertrand.—A contribution to the history of intraocular pressure, and to our knowledge of the mechanism of blood pressure in the capillaries, by M. W. Nicati. Measurements of the hardness of the eye show that the blood pressure of the capillaries is proportional to the ratio between the volume of the body and its surface.—New observations of American *Peripatoïdes*, by M. E. L. Bouvier.—On a new pathogenic *Mucor*, by MM. Lucet and Constantin. This fungus was found to be the cause of a disease of the respiratory organs, at first mistaken for tuberculosis. The disease was cured by treatment with arsenic and potassium iodide. The fungus was found to be a new species, differing from the four pathological species previously known. The name proposed by the authors is *Rhizomucor parasiticus*.—On a new mode of formation of the egg in *Piptocephalis*, by M. Matruchot.—On the mountain chain of Chartreuse, by M. H. Révil.—The *facies* and conditions of deposit of the Turonian in Aquitaine, by M. Ph. Glangeaud.—On new subterranean researches in Dévoluy (Hautes-Alpes), and on the deepest natural well known, by M. E. A. Martel. The shaft found has a depth of at least 310 metres, and is probably greater.—Approximate determination of the denudation of Cretaceous rocks on the coasts of Normandy, by M. J. Thoulet.

CONTENTS.

THURSDAY, DECEMBER 28, 1899.

THE PEOPLING OF AUSTRALIA.

Eaglehawk and Crow: a Study of the Australian Aborigines, including an Inquiry into their Origin and a Survey of Australian Languages. By John Mathew, M.A., B.D. Pp. xvi + 288. Five Plates and a Linguistic Map. (London: David Nutt. Melbourne: Melville, Mullen and Slade, 1899.)

A GREAT deal has been written, and has yet to be written, about the origin of the Australian natives. Considering the immense area that they occupy, there is a considerable amount of uniformity both from a physical and a cultural point of view; but it is now recognised that this apparent uniformity does not necessarily imply purity of origin; indeed, a dual or multiple element in the population may be said to be generally accepted.

The latest investigator of this problem is the Rev. John Mathew, who in his "Eaglehawk and Crow" has boldly restated his previous solution that Australia was first occupied by a branch of the Papuan family; these first-comers occupied all the continent, and having spread across to the southern shores, they crossed what is now Bass Strait, and their migration terminated in Tasmania. Then followed a hostile Dravidian invasion. Mr. Mathew thinks that this ingredient of the population first touched on the north-east coast of Queensland, not in one boat-load, but in an unintermittent stream for many years, probably being forced southwards by the attacks of a more powerful race. Finally, a Malay invasion came later, and in a desultory way by detachments at irregular intervals.

The term Papuan is employed by Mr. Mathew as the equivalent of Melanesian, and is meant to include the Tasmanian Aborigines; hence the Tasmanian Papuans are invariably referred to in this volume as the substratum for the present Australian race; that in them there may be a strain of Negrito blood is not questioned, on the contrary, he inclines to that opinion. Dravidian is not to be understood as indicating the direct descent of Australians from Dravidians, but rather that one strong strain of the Australian people is of common origin with the Dravidians of India and their congeners. Malay refers generally to the people of that race to the north of Australia without distinguishing nationality. It is evident that Mr. Mathew uses these three race terms in a very broad sense, and his view on the two first migrations do not materially differ from those of Flower, Howitt and other students. There is reason to believe, with De Quatrefages and Hamy, Garson and Ling Roth, that the Tasmanians are closely allied to the Negritos, and it may be granted that this stock was formerly widely spread in Australia. Keane in his recent work, "Man: Past and Present," places the Australians, with the Tasmanians, as one of his three divisions of the "Oceanic Negroes," the "Negritoes" and "Papuasians" (Papuans and Melanesians) being the other two. He regards the Australians as a highly specialised type of a single ethnical division.

The Melanesian stock is itself either complex, as several anthropologists hold, or very variable, as Dr. A. B. Meyer advocates. So far as British New Guinea is concerned, there appears, speaking in general terms, to be a western group, traces of which also occur in the south-east, of a dark-skinned, frizzly-haired, usually dolichocephalic people, whose language, as Mr. S. H. Ray has pointed out, has a grammatical construction somewhat analogous to that of the Australian languages. To the south-east is a lighter-coloured people, more or less brachycephalic, and with typically frizzly, but also with curly and wavy hair, whose language is essentially similar to that of the Melanesian Archipelago, and allied to Polynesian; indeed, Dr. Codrington regards the latter language as degraded from the former. The ethnology of British New Guinea is more complex than this brief statement implies; but these two main elements in the population must not be overlooked. Unfortunately, Mr. Mathew states that his term "Papuan is applied, not in its narrowest application (dark New Guinean), but as the equivalent of Melanesian" (p. 5), which, as we have just seen, he leaves quite vague. Later on he tries to show that the Victorian speech has more "Papuan" (or Tasmanian) elements than the languages further north, and hence is by inference more Melanesian than other Australian languages. The radical difference between Melanesian and Australian grammar is not thought to be worthy of even an attempted explanation. The languages of the "dark New Guineans" (Kiwai, Bugilai, &c.), which are expressly excluded from Mr. Mathew's "Papuans," have some analogies in grammatical structure with those of Australia.

Mr. Mathew says a good deal about the colour of the skin and character of the hair of the Australians, and points out that numerous observers have recorded considerable differences in these two features. Unfortunately, these statements are general, and we have no direct comparison with recognised standards, and all the observers were by no means equally competent. We must assume that marked variations in colour do occur, and that the hair may be variedly curly, but without corroborative specimens we can scarcely admit that the hair is sometimes straight or woolly. The evidence collected by Mr. Mathew indicates that on the south-eastern and western coasts the hair is more curly than towards the interior. He speaks of "a decided Papuan fringe . . . with a departure from it landwards and in the north."

We must now consider the Dravidian element in Australia. The argument in favour of this view was first stated by Huxley, and it has been generally adopted (Huxley, it must be remembered, considered that the Australians belonged entirely to that ethnic group). The Sarasins in their elaborate monograph on the ethnology of Ceylon admit that the Australians belong to a "Primitive Dravidian" stem. Mr. Mathew makes the following remarks with regard to this migration:

> "Coming as a later offshoot from the first home of humanity, this invading band was of higher intelligence and better equipped for conflict than the indigenes of Australia. Physically, they were more lithe and wiry, and of taller stature. They were lighter in colour, though a dark race; less hirsute; and the hair of their head was perfectly straight" (p. 6).

Several of these statements are open to question. Some of the "Dravidian" peoples are amongst the hairiest of mankind, and perhaps none have perfectly straight hair. Although the present writer agrees with the hypothesis that the Australians arose in part from the same stock as the pre-Dravidians—that is, the indigenous population of Southern India—there are numerous difficulties which have not yet been thoroughly faced. Most writers assume that they arrived by sea, but there is no evidence that the pre-Dravidians were ever seamen; their descendants are not so to-day either in India or Australia. If they came by land, as Howitt suggests, it is strange that no trace of their migration has been noted in the East Indian Archipelago, and there are many other points that require explanation. There is also some ambiguity in the use of the term "Dravidian," as, from the researches of Thurston, it would appear that there is a dark, broad-nose, curly-haired primitive race in Southern India which may for the present be termed the pre-Dravidian race. The typical Dravidians (Telugus, Kanarese, &c.) are regarded by some as a later immigrant people. In his "Man: Past and Present," Keane states that "all attempts to affiliate this group [the Australian languages] to the Dravidian of Southern India, or to any other, have signally failed."

The Malay invasion is supposed to have taken place "also from the north, first with some degree of continuity and then intermittently" (p. 61). "In the extreme north-west, where Malay words might be most naturally expected, very few are distinguishable. . . . It is rather in unexpected places that Malay words turn up" (p. 57). ". . . A track across the centre of Australia from the Gulf of Carpentaria southward is marked by a few Malay words . . . another region where unquestionable Malay lingual traces exist is a tract on the east coast of Queensland, from about 17° to 21° S. lat., and inland to a distance of some two hundred miles" (p. 59). "There is proof positive that the best cave paintings have been executed by people of Malay blood from the island of Sumatra, a strong presumption also that the rite of circumcision was derived from the same people and place, and I am disposed to think that the Australian message-stick is a childish imitation of Malay writing upon bamboo and rattan as practised in Sumatra" (p. 60).

As the author lays great stress on the linguistic side of his investigations, the present writer consulted his friend Mr. L. H. Ray on this very matter in order to obtain the opinion of an expert. Mr. Ray informs me that 'the author's elaborate comparisons of Australian words with Malay and New Hebridean are absurd and misleading, and show that, in spite of his disclaimer on p. 44, Mr. Mathew belongs to that school of Australian pseudo-philologists who believe that a likeness of words in sound and meaning is a proof of common origin. In Chapter iv. we are asked to believe that Malay immigrants, presumably from various parts of the Archipelago, entered Australia from the north, and wandering about the interior scattered "astonishing relics" of the speech (of one of their sections) all over the island continent. They left the words for "father" and "where" in New South Wales and East Queensland, and "hand" in the extreme east. The word for "head" (not the Malay, but Indian) was left on the Hunter River, the terms for "elder brother," "little," and "louse" were scattered from the Gulf of Carpentaria, southward through Central Australia. "Father," "moon," and "rain" were stranded on the east coast of Queensland; there are other "remarkable analogies" which Mr. Mathew uses to support his theories. Philologists will scarcely be inclined to admit the "especially valuable analysis" which derives the Australian word "wenyo" or "wendyo" ('where') from a New Hebridean interrogative "wa" or "we," and the verb "to" ('to stand') (p. 157). Although Mr. Mathew has evidently taken great pains to make his book of real service to students, individual words in the languages quoted are not always accurately given or properly understood by the author, although he uses them as pegs upon which to hang a theory. For example, he regards the "bapa" type of terms for "father" as a mark of Malay descent, and the "mama" type as evidence of Papuan influence. Yet connectives of "mama" are more common in the Malay region than "bapa," and words like "bapa" are found in all kinds of unconnected languages, *e.g.* Dravidian and Tibeto-Burman in Asia, Bantu in South Africa, and in North America. Other examples are seen in the comparison of numerals (pp. 165, 169), where the New Guinea words are explainable compounds. "Ori Kaiza" (p. 67) is mongrel, "ori" ('bird') is Toaripi, Papuan Gulf, and "kaiza" ('big thing') is Saibai, West Torres Straits. Mr. Mathew might have made a stronger case if he had drawn his examples, not from the colloquial Malay of commerce, but from that common root-stock of the languages of the Indian Archipelago, which is undoubtedly akin to that of the Melanesian tongues. It would have been of great advantage to students if uniformity in spelling had been attempted in the numerous languages quoted.'

Mr. Mathew dwells at some length on some remarkable rock paintings discovered in North-West Australia by Grey and by Bradshaw. One of Grey's figures he identifies with Siva of Hindu mythology, the other he identifies as Daibaitch, a deity of the Battas of Sumatra. This identification is based on some marks on the figure which Mr. Mathew compares with specimens of Sumatran writing in Van der Tuuk's "Les Manuscripts Lampongs." Of course this interpretation assumes that Grey copied the painting with perfect accuracy, and that it was in perfect preservation. These two figures copied by Grey certainly have a non-Australian appearance. Bradshaw's figures are more complicated. The author considers

"it is obvious that there has been an attempt to present pictorial fragments of Hindu mythology in the confused form which has been developed by naturalisation in Sumatra."

These rock paintings are certainly very puzzling, and deserve renewed investigation on the spot. Mr. Mathew's interpretation of them strikes the present writer as somewhat far-fetched.

It is to be regretted that Mr. Mathew does not distinguish between the Malays and the taller, light-coloured Indonesian or non-Malayan inhabitants of the Eastern Archipelago. Keane in his "Ethnology" says:

"Dr. Hamy points out that the Battas and other pre-Malay peoples of Malaysia so closely resemble the

Eastern Polynesians that the two groups should be regarded as two branches of an original non-Malay [Indonesian] stock" (p. 326).

According to Mr. Mathew's theory, Indonesian and Malay elements are implicated in his third invasion of Australia.

Mr. Mathew devotes several chapters to a concise account of the handicrafts, institutions, social customs, sorcery and religion of the Australian natives, and one may gain from the book a very good idea of the Australians as a whole; this account is not a mere compilation from published sources, as Mr. Mathew has had practical experience with "black fellows," and numerous original and hitherto unpublished observations are scattered throughout the book. The careful grammatical study and vocabularies of Australian languages, which occupy nearly half the book, will be of great assistance to students of linguistics—the Kabi grammar is an original contribution. The appropriate title of the book is derived from the widely-spread names of the two main clan divisions of the Australians; the author asks (p. 19):—"Is there any better explanation of the facts possible than that the eaglehawk and the crow represent two distinct races of men which once contested for the possession of Australia, the taller, more powerful and more fierce 'eaglehawk' race ["Dravidian"] overcoming and in places exterminating the weaker, more scantily-equipped sable 'crows'?"

The present writer has endeavoured to give a fair summary of the views held by Mr. Mathew, but it appears to him that the author has not fully appreciated the complexity of the problem which he has set himself to solve. It is also evident that Mr. Mathew has not had access to a number of works that bear upon his subject; some excuse in this respect must, however, be granted to students who reside in the Colonies. The author must be credited with a broad grasp of Australian ethnography, and even if his theories do not receive the support of other students, he will have the satisfaction of knowing that he has done some good service, since generalisation is the salt of science. ALFRED C. HADDON.

CYPRIAN ARCHÆOLOGY.

A Catalogue of the Cyprus Museum, with a Chronicle of Excavations undertaken since the British Occupation, and Introductory Notes on Cypriote Archæology. By John L. Myres, M.A., and Max Ohnefalsch-Richter, Ph.D. Pp. xii + 224. With eight plates. 8vo. (Oxford: at the Clarendon Press, 1899.)

THIS work aspires to be at once a scientific catalogue of, and a handy guide to, the contents of the Cyprus Museum. For the latter purpose it is provided with a flexible cloth binding, for the former it is written in a logical and "scientific" manner, although, by the way, prehistoric archæology is not a science, and never will be one: it is simply a body of disconnected observations, from which one or two more or less probable conclusions can be drawn. The authors deal with an enormous mass of material, and the necessity of compressing this into a portable form has made their book resemble more a collection of transcribed shorthand notes than anything else. These notes, which are only rendered intelligible by reference to headings which themselves have sometimes to be elucidated by further headings, will no doubt be of use to the student of Cyprian archæology, but will hardly be understanded of the casual student tourist who essays to visit the Museum with this book in his hand. What, for instance, will he make of the following (p. 169): "6061–6063. Legs and feet. 6061. Colossal. 6062–6069. Sandalled. 6067. Corkscrew curls and diadem with quatrefoils in relief. 6068–6069. Faces." He will not at once realise the fact that for the necessary elucidation of these mysterious fragments he must refer back a page or so to the headings: "XI. TAMASSOS," "B. Statues of deity or votary in native style; colossal, life-size, or smaller: all male," "*a. Terra-cotta; moulded; hollow*," and that similar researches will have to be made whenever he wishes to obtain an intelligible description and explanation of any object which he may be looking at. Only persons with some knowledge of archæology will be able to find their way about this catalogue, and they will often have to complain of the marvellous epigrammatic manner in which many of the objects are described. No. 5569 is described as follows (p. 156): "H. o. 10.' That is all. Nor does the heading "Miscellaneous" lighten our darkness very much. We eventually discover that Nos. 5501–5569 are terra-cottas from Kition, but what kind of miscellaneous terra-cotta No. 5569 is we have not found out yet. And surely such a description as "SILVER VESSELS, &c. 4871–4873. Spoons. Cf. *Bibl. Nat.* 1635–7." (p. 139), is insufficient. Other similar instances might be quoted, but at the same time Mr. Myres' descriptions are often full and careful enough; *e.g.* Nos. 5017, 5048, 5571, or the group 5801–5826.

No doubt the form of the book is extremely logical, but this very characteristic, pushed to its extreme as it is here, makes it quite useless to the casual tourist, unless he has a very considerable knowledge, not only of Greek archæology generally, but also of the current theories on the subject. The two aims of this catalogue are, in fact, mutually exclusive.

Treating the book entirely from the point of view of the archæologist, we still find something to criticise as well as to praise. The commencement of the introduction (up to the middle of p. 16) is clear and good: nothing is more probable in early Greek archæology than the general position of the præ-Mycenæan and Mycenæan culture with relation to the general development of European civilisation; they were the local phases of the general European culture of the Ages of Copper and Bronze. But later on the introduction becomes somewhat wild and therewith also somewhat too dogmatic in tone; all its statements as to the predominant influence of *Cyprian* culture, as distinct from that of the "præ-Mycenæan" lands generally, on that of early Europe, or the derivation of the pottery-types of the Mondsee-area from that of Cyprus and of the Central European knowledge of copper from the same island are stated with very little intimation of the fact that they are one and all purely hypothetical, and are founded on a series of arguments from analogy which are often of doubtful validity. In fact, the whole gospel of the "Typology" of pots and pans, which is nowadays so fashionable, and is relied upon to explain the whole course of the development of early civilisation, probably rests on no firmer bases than do the similar gospels which profess to elucidate man's early history by means of a comparison of his languages or the varying shapes of his skull.

The statements in the latter part of Mr. Myres' introduction are, then, purely hypothetical. Many are probable enough, but they are not proven historical facts. Take, for instance, his reference to the date of the Mycenæan (he prefers the hideous and hybrid form *Mykenaean*) period of Greek culture. Now it seems very probable that the art of the Mycenæan period, marking the culminating point of the Bronze Age culture of Greece, came to an end in Greece proper in consequence of the overthrow of the Achaian hegemony by the Dorians, who very possibly introduced the use of iron and the rude "Geometrical" style of art into Greece about 1000–800 B.C. But this is only a theory. And neither this theory nor the fact that Mycenæan pottery has been found in the remains of King Khuenaten's city at Tell el-Amarna in Egypt (date about 1430 B.C.) justify Mr. Myres in saying (p. 20) that "the Mykenæan Age is placed between 1700 and 900 B.C. by the find-groups in Egypt, Rhodes and Mykenæ," although it is quite true that "this date agrees with the best Greek tradition." All we can say is that the Mycenæan Age *apparently* goes back to at least 1430 B.C., and probably earlier. That it ended in Greece proper about 800 (not 900) B.C. seems very probable, but that it continued in the always backward and conservative island of Cyprus till the beginning of the seventh century at latest seems to be shown by the new discoveries at Kurion and Enkomi, where, in conjunction with Mycenæan remains of a debased type, Babylonian cylinders of the eighth century have been found. Mr. Myres falls foul of this hypothesis (p. 20), as was to have been expected.

In some respects the catalogue is not quite up-to-date. It is a year or two since Prof. Petrie's theory of a "New Race" of "Libyans" was given up, and the true position of the "New Race" remains as those of the prehistoric Egyptians was pointed out by M. de Morgan. Yet in a book published in 1899 we read (p. 16) of

"the Libyan race, discovered in 1895 by Prof. Flinders Petrie in the settlements and tombs at Ballas and Nagáda . . . this civilisation, which fills the gap between the sixth and the eleventh dynasty . . .," &c.

The gap between these dynasties covers the period 3500–3000 B.C.: the remains from Ballas and Nagáda are those of the late Neolithic or "Æneolithic" periods in Egypt, and most certainly date long before 4500 B.C. It is a pity that Mr. Myres did not even at the eleventh hour insert a paragraph in his list of corrigenda noting this fact.

Prof. Petrie connected this "Libyan" culture with the early civilisation of Palestine, which he ascribed to the Amorites, of whom we know nothing more than their name. So Mr. Myres talks of a "Libyo-Amorite culture" (p. 17). Prof. Petrie also closely connected the præ-Mycenæan stage of southern European civilisation with the "Libyo-Amorite culture." But this connection Mr. Myres hesitates to accept, although he admits resemblances of pottery-technique, &c., between the two.

An acceptance of this theory means now an acceptance of the idea that the præ-Mycenæan stage of Greek culture goes back to at least 5000 years B.C., and that it was at that time closely connected with the primitive civilisation of Egypt. It is difficult to imagine how this connection can be maintained to have ever existed. The famous copper sword which was found in the prehistoric tomb 836 at Nagáda is of late præ-Mycenæan type ("quasi-Mykenæan," *teste* Mr. Myres, who also claims it as especially Cyprian in style), and so probably dates *after* 2000 B.C., while the things with which it was found belonged to the half-savage ancestors of the Egyptians of the first dynasty. This is an example of the uncertainties of the archæological method generally. The sword proves no connection. We are by no means inclined to grant the contention that the præ-Mycenæan culture may go back to an indefinite period B.C., and that such swords may have been in use as well 5000 as 2000 B.C. And the other evidence does not allow us to date even the earliest remains of the præ-Mycenæan age, the lowest towns of Hissarlik and Athens, a day earlier than 2500 B.C., so that the prehistoric Egyptian and prehistoric Greek cultures cannot be regarded as contemporaneous. Both were primitive, half-savage; hence the analogies between their artistic methods. To argue a contemporary connection from such analogies is impossible.

And no such connection can be shown to have existed by way of Libya: we cannot say that there is anything particularly Libyan about the prehistoric Egyptian pottery, &c., because we have not the slightest idea of what early Libyan pottery was like. In fact, the "New Race" objects were dubbed "Libyan" on account of their curiously isolated and strange appearance when placed chronologically between two well-defined periods of the regular Egyptian civilisation: it was foreign and barbarous, why not Libyan? (In much the same way every inexplicable object found in Egypt used to be called "Ethiopian," the remains of Mycenæan culture were dubbed Phœnician or Karian, and those of the Assyrizing civilisation of Asia Minor received the now somewhat discredited appellation "Hittite." It is quite true that unless some theory is made to account for inexplicable phenomena, little progress is possible. But such theories ought never to be, as they so often are, regarded as dogmas to be persistently maintained in spite of controverting evidence.) These inexplicable objects being then "Libyan," people began to think about Lake Tritônis and its legends, about the alliance of the Greek "Akaiuasha" (who may quite possibly have been Achaians) with the Libyans (*n.b.* as late as 1250 B.C.), and so the "præ-Mycenæan" culture of the north-eastern coasts of the Mediterranean was connected with the "New Race" culture through the medium of Libya. Even now that we know that the "New Race" culture is at least two thousand years older than Prof. Petrie's first dating, this Libyan-Greek connection seems to be maintained, although there is no need to suppose that the remains from Ballas and Nagáda are Libyan, or anything else than primitive Egyptian. Even those yellow-haired Kabyles from Ballas and Nagáda have been shown by the unenthusiastic Virchow to owe their Indo-Germanic locks to the action of the salt in the soil!

In a list of Egyptian (Naukratite) porcelain charms and ornaments on p. 137, Mr. Myres mentions "4726–4732. Hawk-headed deity with disc on head. . . . 4736–4737. Hippopotamus-headed deity. . . . 4746. Ram-headed deity." We are not informed whether 4746 is Amen or Khnemu, and the names of 4726–4732 (apparently Rā) and 4736–4737 (Taurt) might well have been given. And what is the inscription on the Babylonian cylinder, No. 4501, which, by the way, is not necessarily of early date, about? The "hieroglyphic inscriptions" on the scarabs (Nos. 4541, 4547–4549; p. 135) are ignored.

Turning to a comparatively unimportant detail, we note a frequent occurrence of the hideous Germanism, "snow-man technique." Cannot some better term than this be devised for the style of what are merely rude hand-made figures?

The labour of correcting misprints in such a work must have been colossal; but the result is extremely good. We only notice Ra-men-kepher for Ra-men-kheper on p. 135. To Mr. H. B. Walters, who read the proofs through, much praise is due. He is also responsible for the annexed reports on excavations at Kurion, Salamis and Maroni, from which a good idea of the marvellous mixture which the average Cyprian tomb contains may be obtained. We are still far from being able to dogmatise with regard to Cyprian archæology!

The indices also deserve praise, but the mistaken aim of making the book serve as a traveller's guide has, by restricting its size, sadly curtailed the number and size of the plates.

Generally speaking, the book will be to the "wayfaring man" (p. viii.) of little use, but to the archæologist it will no doubt prove valuable. Although, we expect, that if he already knows the collection, he will often find it difficult to recognise the objects from Mr. Myres' and "O-R"'s somewhat meagre descriptions of them, yet the care with which the known *provenance* of all objects is noted, and vague statements on the subject are sifted and verified by the authors, will be of great assistance to him. He will know how far Mr. Myres' archæological theories will be of service to him. If archæology is to be constructive, if it seeks to explain its discoveries, it must formulate hypotheses. These hypotheses are often suggestive, often really explain things in a manner which, as far as we can know, is perfectly satisfactory; but as often they are mere *ballons d'essai*, improbable and unsatisfactory. Hypotheses of both kinds occur in the introduction to the *Cyprus Museum Catalogue*: the archæologist will be able to distinguish between them, but the "wayfaring man" has no means of separating the wheat from the chaff. On him, therefore, it cannot be too strongly impressed that the whole story of the development of human civilisation in Cyprus and the Ægean basin before the 8th century B.C. is still merely a collection of hypotheses, sometimes agreeing, more often disagreeing, with one another, and therefore that any description of "Early Man" in Greece or in Cyprus is not a statement of historical facts, but a simple expression of the individual opinion of its author on the subject.

TEXT-BOOK ON THE STRENGTH OF MATERIALS.

The Strength of Materials. By Prof. J. A. Ewing, F.R.S. Pp. xii + 246. (Cambridge University Press, 1899.)

ALL teachers and students of applied mechanics will heartily welcome this book. It is based on the author's article, "Strength of Materials," which appears in the ninth edition of the *Encyclopædia Britannica*. As in his book on the "Steam Engine," the present book is characterised by Prof. Ewing's excellent style and clearness of exposition. The subject matter includes those portions of the subject which are usually taught at the higher colleges.

The author wastes no time in plunging into his subject. The first two chapters are devoted to a general analysis between stress and strain, and the relation between the three elastic coefficients in an isotropic body. Probably many teachers would prefer to postpone the consideration of part of these two chapters—particularly the contents of the second—to a later stage of the book, and this can readily be done without interfering with the usefulness of the book as a text-book. Chapter iii. deals with non-elastic strain, a part of the subject on which Prof. Ewing is particularly qualified to speak. A concise account is given of some of the recent experiments of Mr. Muir on the effect of heating in facilitating recovery of elasticity after overstraining, and it is to be hoped that in any future editions the author will give a full account of the very recent experiments by Mr. Rosenhain and himself on the crystalline structure of metals—a subject which, in the present edition, is merely referred to. The fourth chapter will be found exceedingly valuable to the teacher, dealing, as it does, with the testing of materials, and containing photographs of several pieces of self-contained apparatus designed (by the author) to determine the various elastic constants, and which have been proved to be serviceable in the author's laboratory at Cambridge. Chapters v. and vi. deal with uniformly-varying distributions of stress, and the bending and shearing stresses induced in beams. On page 98 will be found some interesting remarks on the variation of stress over different sections of a tie-rod. In dealing with this subject it is interesting to notice that in a uniformly strained piece of any shape whatever having parallel sides, the distribution of stress over any section might be graphically determined by Prof. Hele-Shaw's method of the flow of a viscous fluid between two parallel plates placed very near together, the boundaries having the same shape as the piece considered. The stress at any point will then be inversely as the distance between adjacent stream-lines, the stream-lines being supposed spaced at equal distances apart at a section where the stress is uniformly distributed. The deflection of beams and the question of continuous girders are discussed in Chapter vii., whilst in Chapter ix. will be found a luminous treatment of struts and columns. Chapter x. is devoted to a consideration of the torsion of shafts and of springs, whilst in Chapter xi. the stresses induced in thin and thick cylinders due to internal or external pressure, and in a thin rotating disc are treated in an exceedingly lucid manner. A valuable addition to the contents of these chapters would be an analysis of the stresses induced in the different parts of high speed connecting rods and crank shafts. Finally, Chapters viii. and xii. are devoted to a very concise discussion of frames, hanging chains and arched ribs.

In the preface, the author states that the book is only intended to be a lecture-room treatment of the subject, which to be effective must be supplemented by laboratory and drawing office work. We venture to think that the work usually done in the drawing office is, in many cases, of such a special and routine character that it only serves to illustrate a very few branches of the subject. It is, of course, true that a properly equipped laboratory, such as the one at Cambridge, enables the student to provide himself with examples which illustrate a very considerable portion of the subject, but some teachers of applied mechanics—fortunately few in number—do not possess a laboratory, and even many of those who do find it desirable to still further supplement the work done in it by means of tutorial classes. The complete absence of any numerical examples will be consequently much felt, and the author would considerably increase the value of his books as *class-room* text-books if he would add, at the end of them, a set of judiciously selected numerical examples which would forcibly illustrate the different points raised in the text.

A word of praise should be given to the Cambridge University Press for the excellent manner in which the book is printed and arranged. It is to be hoped that the present book, together with the same author's "Steam Engine," are intended to form the nucleus of a library of text-books dealing with engineering subjects.

S. D.

A NEW WORK ON LEAD.

Metallurgy of Lead and Silver. Part I. By Henry F. Collins. Pp. xvi + 368. (London: C. Griffin and Co., Ltd., 1899.)

THIS work is one of a series of metallurgical treatises edited by Sir W. C. Roberts-Austen, F.R.S., and written by one of his former pupils, who, besides having gone through a course of training at the Royal College of Science with distinguished success, has had a large amount of practical experience in mines and metallurgical works, which renders him well qualified to successfully undertake the compilation of a work on lead smelting. In these days of great metallurgical enterprises it is of the utmost importance that we should be kept acquainted with the up-to-date methods of our competitors all over the world; and although there are several good books in existence dealing with the metallurgy of lead, the present one is a welcome addition.

The author starts with methods of assaying lead and silver ores, which is a necessary part of the process, and gives valuable information on the method of correct sampling; he also points out those methods of assaying which yield the best results by the wet and dry ways. A very admirable feature of the book is the abundant reference to authority, in which he follows the notable example of his distinguished editor. With the object of economising space, as well as facilitating reference and comparison, details of the practice in particular localities have been thrown into the form of tabular statements and these should prove useful for reference.

It is much to be regretted that so many errors have been allowed to remain in the text and referred to in the table of errata, when by a little more care they might have been avoided. The section on alloys of lead is very meagre, and chiefly compiled from the writings of other metallurgists. Such loose statements as "No definite alloys of lead and antimony are known" (p. 24) are entirely misleading, as several varieties of lead-antimony alloys are used for type metal. The properties of lead as used in trade with the various defects experienced in practical work, such as plumbing, would have formed a valuable adjunct, as many persons are interested in lead-working who care little about the smelting of ores.

The chapter on lead ores, although somewhat condensed, contains the chief information required for practical purposes. The greater part of the book is devoted to lead smelting. It is treated in a sufficiently full manner, the information is reliable, and the language explicit. We are sorry to learn that the various forms of mechanical roasters are not more generally applicable, and that the hand-rabbled reverberatories, with the enormous cost of manual labour, are still in extensive use on account of the scarcity of skilled labour in many localities, mechanical furnaces only being adopted in the larger works where the required skill is available. Various kinds of roasting furnaces are carefully described and their merits discussed. The chemical side of the question is admirably dealt with, and greatly adds to the value of the book for scientific readers.

The principles of blast furnace practice here given forms the most prominent and important part of the work, and should be extremely useful to those engaged in the lead-smelting industry. A correct knowledge of the scientific basis of the processes has not been attained in the past by those responsible for *some* of our works, and possibly this method of treatment may enable some of our closed mines to be reopened and profitably worked. At any rate, we commend the suggestion to those concerned. The author has brought a wide range of knowledge to bear on the subject, and gives useful data for correct blast furnace practice. The nature of fluxes and composition of slags, with their proper chemical formulæ, are here given in considerable detail, and indicate a complete grasp of the subject.

Chapter ix. commences with some recognised methods of analysing ores and slags, so as to enable the operator to properly apportion the constituents of the charge. This is followed by instructions as to the method of calculating the charge, which is somewhat complicated in large works, dealing with a variety of complex ores. Chapter x. deals with blast furnace products, and as these may consist of lead speiss, regulus, slag and secondary products, which have to be separately dealt with, it will be seen how important their consideration to the lead smelter must be. It also contains a considerable number of analyses of mattes, speisses and slags very valuable for purposes of reference.

The subject of flue-dust, its composition, collection and treatment, is discussed in a clear and instructive manner. The difficulties met with in smelting mixed ores of lead and zinc, and the various processes, dry and wet, proposed from time to time by different authorities, are here discussed, and indicate how much more scientific most metallurgical processes are becoming.

The last part of the book deals with the highly important subject of desilverisation, and is written in no way inferior to the preceding pages. Altogether the author has succeeded in producing a trustworthy and fairly comprehensive treatise on the metallurgy of lead, and we trust his enterprise may be rewarded by a deservedly large sale.

OUR BOOK SHELF.

Zur Stereochemie des fünfwertigen Stickstoffes mit besonderer Berücksichtigung des asymmetrichen Stickstoffes in der aromatischen Reihe. By Edgar Wedekind. Pp. 126. (Leipzig: Veit, 1899.)

ALTHOUGH nearly fifty years have passed since Hofmann succeeded in preparing methylethylamylphenylammonium chloride—a compound in which the nitrogen atom is directly united with five different groups or atoms—very little progress has been made with the study of the stereochemistry of pentavalent nitrogen. It is true, no doubt, that the first and the most important step in advance was made nearly nine years ago by Le Bel, who succeeded in preparing an optically active liquid from a solution of methylethylpropylisobutylammonium chloride, but until quite recently, when Pope accomplished the resolution into its optically active isomerides of Wedekind's benzylphenylallylmethylammonium iodide, Le Bel's work afforded the only evidence which we had of optical activity due to pentavalent nitrogen. The number of known compounds which contain such an asymmetric nitrogen atom, and which might possibly be resolved into optically active components, was also comparatively limited.

In these circumstances it might seem a little premature to write a book on the stereochemistry of pentavalent nitrogen, since the facts to be dealt with are few in number, and the theories which have been advanced to explain them—although nearly as numerous as the facts themselves—still require a groundwork of experimental confirmation.

This difficulty of the lack of material no doubt forced itself upon the author, whose book is not merely an historical review of our present knowledge of the stereochemistry of pentavalent nitrogen; this portion of his subject is, in fact, disposed of within the limits of the first seventeen pages, and by far the largest part (ninety-five pages) of the book consists of an account of the work which the author himself has published during the current year in the *Berichte;* the remaining thirteen pages are devoted to a discussion of the theoretical conclusions to be drawn from the results of his experiments.

As the discussion or criticism of the author's investigations—interesting and important though they are—is a task which does not lie within the scope of this review, little remains to be said except that the whole book is written in much the same way as if it were a paper intended for publication in Liebig's *Annalen;* consequently it contains a great many experimental details, including even the results of many analyses, and this rather detracts from its value as a literary effort. Those, however, who take a particular interest in the stereochemistry of pentavalent nitrogen will certainly welcome the book, and principally on account of its historical survey and theoretical conclusions, for here they will find the scattered literature of the subject conveniently collected and discussed in the light of the author's own important observations. F. S. K.

Handbook of Metallurgy. By Dr. Carl Schnabel. Translated by Henry Louis. Two vols. Vol. i. Pp. xvi + 871; Vol. ii. Pp. xiv + 732; 927 Figures in the text. (London: Macmillan and Co., Ltd. 1898.)

BERGRATH DR. CARL SCHNABEL is professor of metallurgy and chemical technology at the Royal Academy of Mines at Clausthal, and his work has long enjoyed a well-deserved reputation. Prof. Henry Louis, who translates it, points out that it is a curious fact that there does not exist in the English language a single complete treatise on metallurgy. Dr. Percy's treatises remain only splendid fragments. Dr. C. Schnabel's object has been to give a complete account of the metallurgical treatment of all the metals ordinarily employed, together with all the recent improvements in the art. The two volumes before us are, however, incomplete, as neither they nor the original work deal with the vast section of metallurgy which includes iron and steel.

Prof. Louis modestly says that his chief object has been to present a faithful interpretation of the original. In this he has admirably succeeded. With the full consent of Dr. Schnabel, the translator has introduced brief rules of any new processes, or improvements on old ones, that have been brought out since the German original was produced. It is a pity, therefore, that the additions made by Prof. Louis are not distinguishable from the rest of the text. In a compressed work of this kind space is, of course, valuable; but it appears to have been in more than one case unequally allotted. The Augustin process, for instance, is now but little used, and is, in fact, nearly obsolete, but it has ten pages devoted to it, while the cyanide process for the extraction of gold from "tailings," which is now the most important wet process in the whole range of metallurgy, has only thirteen pages. The wet process for extracting copper, which does admit of brief statement, has no less than forty-nine pages. Many of the illustrations, from their freshness and originality, will be a great boon to students. In a second edition it would be well to devote more care to the illustrations; at present, though they give a good general idea of the processes or machines they illustrate, they are seldom drawn to scale. The writer of this notice has found general diagrammatic schemes of processes to be of great value to students, and some might well have been introduced into the present work. The sections devoted to the metallurgy of zinc and of aluminium may be mentioned as, considering the size of the volume, being singularly complete and conscientious. Viewed as a whole, the book is very accurate and trustworthy, and in welcoming this addition to metallurgical literature Prof. Louis is to be congratulated on the translation.

W. C. ROBERTS-AUSTEN.

La Philosophie Naturelle. By Dr. W. Nicati. Pp. xi + 308. (Paris: Giard and Brière, 1900.)

DR. NICATI has, it seems, published books on medicine, on physiology proper, and on psychology. A sense of incompleteness has led him at last to make a raid upon philosophy.

An uncompromisingly positive mind, which does its own thinking *en amateur*, is rarely uninteresting. And Dr. Nicati has ideas upon Rabelais and Zola, upon art and politics in general, on immortality and evolution, on the ultimate formulæ for matter and life. His art-criticisms and his political discourses with a socialist leaning are often readable and sometimes suggestive. A reduction of the idea of responsibility to causation does not lack ingenuity. Unfortunately, any further worth in the book it is impossible to discover, save as it reveals the writer's very abnormal psychosis. "Architectonic" faculty united with incoherence, naivety mostly seen in etymologies, but also in bizarre analogies as of existence to a tricycle, are salient faults of the book. But Dr. Nicati's obsession by what may be called the fallacy of the graphic formula is its dominant characteristic. In the logical calculus "it is atrociously done," has its adverb expressed by the radical sign; the anti-Dreyfusard admits fluxional considerations. In *l'energétique*, life is formulated by Cae decorated with arrows, because it arises in the decomposition of matter which has cohesion and other qualities. Pictures on p. 250 are quite exciting.

This sort of inanity throughout makes the writer's charge upon Kant, that he lacks logic in speaking of "empty space," and his attack upon evolution, with a view to substitute "a theory simply evolutionarist," quite devoid of weight. The index is quite excellent.

H. W. B.

Kleiner Leitfaden der Practischen Physik. Dr. F. Kohlrausch. Pp. xix + 260. (Leipzig: Teubner, 1900.)

EVERY physicist is familiar with Dr. Kohlrausch's "Text-book of Physical Measurements," either in the original or in its English translation. It is not too much to say that it was the foundation of the numerous text-books of practical physics which have since appeared. Owing to the successive additions that have been made, Dr. Kohlrausch feels that it has lost its original character, and now fails to be suitable, as formerly, to the needs of a beginner. This feeling has induced him to prepare the present "Kleiner Leitfaden" by selecting from and otherwise modifying the larger volume.

In what sense can this new volume be regarded as a book for beginners? One of the most difficult questions for a teacher to solve is: How far ought a student be left to work out his own salvation? No answer can be given which would be applicable to all students. A youth of keen intelligence only requires outline directions: the details he learns best by finding them out for himself. But such men are exceptions in any laboratory. The more ordinary student will miss a point unless it is explicitly brought before his notice. We think it is to the former class that this book will be most useful. Dr. Kohlrausch has certainly not erred on the side of superabundance of instruction. We think, for example, that it might be found better fitted as a general laboratory manual if a larger number of fully worked out numerical examples were supplied. But as for ourselves, we have only admiration for the dignified restraint which is everywhere displayed. This is no cram-book intended to meet the temporary requirements of an examining board; but it is what the author has aimed to make it—an aid to general culture.

Further, the volume is well and accurately printed. We have read it through, and only detect one small error. The G Fraunhofer line is, in the diagram on p. 133, apparently identified with the third line in the hydrogen spectrum; the difference between them would only be about a millimetre in the diagram; but it is a difference which ought to be exaggerated rather than diminished, in order to prevent a student running away with a wrong idea.

A. W. P.

Elementary Algebra. By C. H. French and G. Osborn. Pp. vii + 349. (London: J. and A. Churchill, 1899.)

THIS book has been purposely written to help elementary students who have to do much of their study privately, and with this aim in view the authors have avoided as far as possible all technical terms in the explanation of the various theorems. It is possible that there may be a tendency to leave too little for the student to think out for himself by this procedure, but that is matter for individual opinion. Apart from this, the treatise is excellent in its numerous selections of examples and for the clear arrangement of the various sections.

Magnetism and Electricity for Beginners. By H. E. Hadley. Pp. viii + 327. (London: Macmillan and Co., Ltd., 1899.)

THIS little manual is written specially to meet the requirements of students preparing for the annual examination of the Science and Art Department, and consequently it follows to a considerable extent the lines of the syllabus provided. In many details, however, it very ably satisfies the desirability of providing fuller treatment, while a conspicuous and commendable feature is the insertion of many original diagrams and photographs of actual experimental apparatus.

The general arrangement is to give certain facts or definitions, followed by one or more experiments to be performed for their complete verification, so that in this respect the book may serve very well as an introduction to the electrical side of practical physics.

The apparatus described is almost entirely simple enough for the average reader to make readily, and the very generous number of illustrations (197) will be very helpful to the clear understanding of the statements made.

Part i., on magnetism, occupies 103 pages, and all the chief phenomena are illustrated by facsimile reproductions of the fields of force as shown by iron filings or small magnetometers. The explanation of electrical screening is very simply and clearly stated; in fact, the text is brought up to date as far as is possible in an elementary manual.

Part ii., statical electricity (106 pages), is specially noticeable for the way in which the usual difficulty of dealing with potential is met by geometrical interpretations; potential-diagrams being given for fields of force, electroscopes, condensers, electrical machines and contact electricity.

Part iii., voltaic electricity (93 pages), is somewhat terse in style, probably necessarily owing to the number of matters in this part of the subject which need description, but the fundamental points in all the sections are well brought forward. The book is certainly an excellent one for elementary students, and is also likely to form a sound basis on which a teacher may frame his course of lessons.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Racial Aspect of Voluntary Enlistment.

THERE is one aspect of our voluntary enlistment system which has never been touched upon so far as I know. It is that by our method the most brave and warlike men of each generation are exposed to far more than the ordinary risks of life, and generally at an age when they have left no descendants. A process of selection has, therefore, been going on in the nation for centuries by which, in the long run, the non-fighters, such as commercial classes, luxurious people, and any cowards, have more descendants proportionally than the brave and warlike. So that the average opinion is growing more and more unwarlike, less brave, and more inclined for peace at any price. The above selection is brought home to us if we consider that of those soldiers killed during the last few weeks how few have left two descendants. I foresee two remedies for this state of things, but will not ask for any more of your valuable space.

R. C. T. EVANS.

9 Heathcote Street, Gray's Inn Road, W.C.

The Wind during Eclipses of the Sun.

I WOULD like to draw attention to the importance of observations of the wind in and near the path of a total eclipse of the sun.

At the Indian eclipse of 1898 I employed at Sahdol, in

Central India, a simple arrangement for observing the strength and direction of the wind. On the morning of the eclipse, as on previous days, the wind was blowing strongly from the north-north-east with frequent gusts of greater force. As totality approached it diminished in strength and became a steady draught of air almost imperceptible to the senses. At the same time it shifted a little to the east. Before the moon had quite left the sun's disk it was again blowing in the same manner as at the beginning of the eclipse. Subsequently, as the sun approached the horizon, the wind diminished and blew with exactly the same force, direction, and uniform character as during totality.

Apparently the normal wind in the daytime at Sahdol contained two elements, one due to the distribution of pressure over Central and Southern Asia and the Indian Ocean, the other the result of comparatively local causes. The latter was suppressed by the eclipse, and the former was represented by the steady movement of the air that remained.

The total eclipse of 1900 does not present such simple conditions, but I believe that much might be learnt from similar observations. JOHN W. EVANS.

Royal College of Science for Ireland, Dublin,
December 16.

THE APPROACHING TOTAL ECLIPSE OF THE SUN.

THE astronomers of both Europe and America are now busy in making arrangements to observe the total eclipse of the sun which will occur on the 28th of next May. As usual, our American cousins are better off than we are, for they can observe the eclipse without going out of their own country. British astronomers will have to travel to Spain or Portugal. The eclipse path stretches from the west of New Orleans to Algiers and N. Africa on the east. The local times and conditions at certain points along this path are thus given in the "Local Particulars" published by the *Nautical Almanac* Office :—

Position W. of New Orleans.
Long. 90° 6′ W., Lat. 30° 4′ N.

	Local Mean Times. d. h. m. s.	Central Standard Mean Times d. h. m. s.	Sun's Altitude.
Eclipse begins	May 27 18 26 13	May 27 18 26 37	18°
Totality begins	,, 27 19 29 42	,, 27 19 30 6	30
Totality ends	,, 27 19 31 0	,, 27 19 31 24	
Eclipse ends	,, 27 20 43 10	,, 27 20 43 34	46

Duration of Totality, 1m. 17·8s.

Angle, from N. point, of	first contact, 104° towards the W.	for *direct* image.
	last contact, 76° towards the E.	
Angle, from Vertex, of	first contact, 40° towards the W.	
	last contact, 145° towards the E.	

Position near Union Point, Georgia.
Long. 83° 5′ W., Lat. 33° 29′ N.

	Local Mean Times. d. h. m. s.	Central Standard Mean Times. d. h. m. s.	Sun's Altitude.
Eclipse begins	May 27 19 0 25	May 27 18 32 45	25°
Totality begins	,, 27 20 7 52	,, 27 19 40 12	39°
Totality ends	,, 27 20 9 24	,, 27 19 41 44	
Eclipse ends	,, 27 21 26 16	,, 27 20 58 36	55

Duration of Totality, 1m. 32·0s.

Angle, from N. point, of	first contact, 104° towards the W.	for *direct* image.
	last contact, 76° towards the E.	
Angle, from Vertex, of	first contact, 41° towards the W.	
	last contact, 139° towards the E.	

Map of the Eclipse track across Spain and Portugal, 28 May, 1900.

Position South of Cape Henry, Virginia.
Long. 76° 5′ W., Lat. 36° 42′ N.

	Local Mean Times. d. h. m. s.	Eastern Standard Mean Times. d. h. m. s.	Sun's Altitude.
Eclipse begins	May 27 19 36 35	May 27 19 40 55	33°
Totality begins	,, 27 20 48 7	,, 27 20 52 27	47°
Totality ends	,, 27 20 49 53	,, 27 20 54 13	
Eclipse ends	,, 27 22 11 2	,, 27 22 15 22	62°

Duration of Totality, 1m. 45·6s.

Angle, from N. point, of	first contact, 103° towards the W.	for *direct* image.
	last contact, 78° towards the E.	
Angle, from Vertex, of	first contact, 44° towards the W.	
	last contact, 130° towards the E.	

Position near Ovar (Portugal)—Long. 8° 38′ W., Lat. 40° 50′ N.

	Local Mean Times. d. h. m. s.	Greenwich Mean Times. d. h. m. s.	Sun's Altitude.
Eclipse begins	May 28 2 8 35	May 28 2 43 7	56°
Totality begins	,, 28 3 27 10	,, 28 4 1 42	42°
Totality ends	,, 28 3 28 43	,, 28 4 3 15	
Eclipse ends	,, 28 4 38 42	,, 28 5 13 14	30°

Duration of Totality, 1m. 33·6s.

Angle, from N. point, of	first contact, 89° towards the W.	for *direct* image.
	last contact, 93° towards the E.	
Angle, from Vertex, of	first contact, 137° towards the W.	
	last contact, 38° towards the E.	

Position S.W. of Talavera de la Reina (Spain)—
Long. 5° 10′ W., Lat. 39° 47′ N.

	Local Mean Times. d. h. m. s.	Greenwich Mean Times. d. h. m. s.	Sun's Altitude.
Eclipse begins	May 28 2 29 18	May 28 2 49 58	53°
Totality begins	,, 28 3 46 2	,, 28 4 6 42	39°
Totality ends	,, 28 3 47 29	,, 28 4 8 9	
Eclipse ends	,, 28 4 55 38	,, 28 5 16 18	26°

Duration of Totality, 1m. 27·4s.

Angle, from N. point, of	first contact, 88° towards the W.	for *direct* image.
	last contact, 94° towards the E.	
Angle, from Vertex, of	first contact, 140° towards the W.	
	last contact, 38° towards the E.	

Position West of Puerto del Infierno (Spain)—
Long. 1° 43′ W., Lat. 38° 38′ N.

	Local Mean Times. d. h. m. s.	Greenwich Mean Times. d. h. m. s.	Sun's Altitude.
Eclipse begins	May 28 2 49 40	May 28 2 56 32	49°
Totality begins	,, 28 4 4 28	,, 28 4 11 20	35°
Totality ends	,, 28 4 5 49	,, 28 4 12 41	
Eclipse ends	,, 28 5 12 9	,, 28 5 19 1	23°

Duration of Totality, 1m. 21·5s.

Angle, from N. point, of	first contact, 87° towards the W.	for *direct* image.
	last contact, 94° towards the E.	
Angle, from Vertex, of	first contact, 143° towards the W.	
	last contact, 38° towards the E.	

Cape De Sta. Pola (Alicante), Spain—
Long. 0° 30′ W., Lat. 38° 13′ N.

	Local Mean Times. d. h. m. s.	Greenwich Mean Times. d. h. m. s.	Sun's Altitude.
Eclipse begins	May 28 2 56 47	May 28 2 58 47	48°
Totality begins	,, 28 4 10 52	,, 28 4 12 52	34°
Totality ends	,, 28 4 12 11	,, 28 4 14 11	
Eclipse ends	,, 28 5 17 55	,, 28 5 19 55	21°

Duration of Totality, 1m. 19·4s.

Angle, from N. point, of	first contact, 87° towards the W.	for *direct* image.
	last contact, 94° towards the E.	
Angle, from Vertex, of	first contact, 144° towards the W.	
	last contact, 38° towards the E.	

The accompanying map of the line of totality will show the parts of Spain and Portugal from which this eclipse can be observed. It will be seen that the track, after leaving Spain near Alicante, crosses the Mediterranean and enters Africa close to Algiers.

We may be perfectly certain that the astronomers of the United States and France will man the beginning and the end of the line quite efficiently. It is clear, therefore, that the attention of British astronomers with serious work to do will be directed to the observing stations in Spain and Portugal.

The weather chances were stated by Prof. Arcimis in a former number of NATURE,[1] and may be considered excellent.

There are many branches of work, such as securing photographs of the corona, in which amateurs may do good service. For them the well-found steamers leaving Marseilles may make the coast near Algiers more convenient.

[1] Vol. lix. p. 439.

HERO OF ALEXANDRIA.[1]

THE reputation of Hero of Alexandria has always been somewhat doubtful, and some difficulty has been felt in apportioning to him his proper place among the scientific worthies of the past. Mr. Schmidt, however, in the communication mentioned below, has attempted to do justice to his reputation, and to resuscitate the memory of him whom most of us remember only through the well-known experiment of Hero's fountain. In another place Mr. Schmidt has endeavoured to fix the approximate date of his career, and by his intimate acquaintance with the various MSS. and authorities, to do something to clear away the doubts that linger around a Hero the younger and some other anonymous writers. Mr. Schmidt may be said to have taken Hero under his particular care, and though, of course, it is unfortunate that many of the original writings are not extant, and that others have not been printed yet, Mr. Schmidt, by a careful study of the remnants, has probably placed himself in a better position to reconstruct the history of this ancient philosopher than any other commentator.

But though Mr. Schmidt attempts to place the object of his study in the most favourable light, to make us see in him one as influential as Euclid, we cannot say that

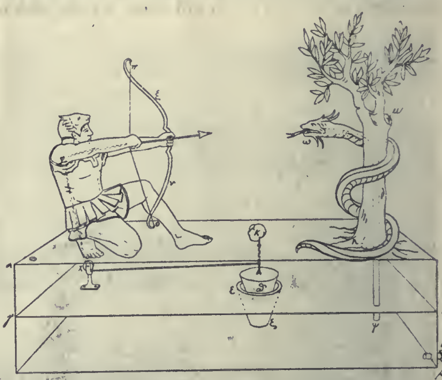


FIG. 1.—Hercules shooting at the apple.

we think the steps he has taken are the most judicious or the most successful. Instead of a philosopher we perceive rather an able artificer and an expert mechanician. The points selected for elaborate illustration are not those which exhibit Hero in the most capable light. There can be no doubt but that Hero successfully solved the problem of determining the area of a triangle from the three sides, and it would have been very interesting to see the method he employed set out in detail, but the author passes over this feat with a bare mention, although the treatment of such a problem appeals more potently to modern students, and bespeaks a higher position in the intellectual scale, than the skilful manipulation of automatic figures over the details of which Mr. Schmidt lovingly lingers. Again, we have indistinct ideas of his experiments on the elasticity of air and steam, and we should like to know whether he made any approach to a knowledge of Boyle's law, and in any way anticipated its enunciation by that philosopher. Of course it may be urged that these are among the best-known results of Hero's life and writings, and that as such they do not need the aid of a commentator, but

[1] "Heron von Alexandria." By W. Schmidt. Sonder abdruck aus den neuen Jahrbüchern für das Klassische Altertum Geschichte und Deutsche Litteratur. (Leipzig: B. G. Teubner, 1899.)

that on the other hand his numerous mechanical devices need to be insisted upon in order to obtain an adequate idea of his varied capacity. But the result is, nevertheless, to present Hero simply as the maker of philosophic toys.

Mr. Schmidt sketches for us, but without sufficient explanation, the devices by which fountains were made to flow, and doors to open by unseen mechanical agency, but one's enthusiasm is scarcely roused though Hercules may shoot at an apple and a serpent be made to hiss his discontent with the arrangement (Fig. 1). But the author does ample justice to the description of the automatic marionettes, whose behaviour and contortions afforded

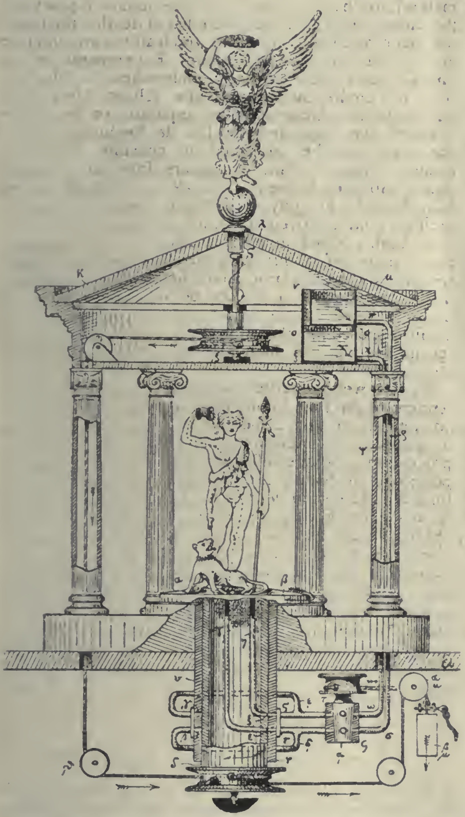


FIG. 2.—Showing the machinery for moving the Bacchante, &c.

sincere delight to the spectator. Two of these automatic theatres, in which some attempt at dramatic action was made, are described in detail, and we learn how the fire was suddenly kindled on the altar of Dionysius, while from the Thyrsus cup spouted respectively milk and wine, the Bacchantes urging their wild career at the same time (Fig. 2). The legend, too, of Nauplius seems to have been illustrated with great care and nicety in a succession of scenes, in which were represented the departure of the Greek ships, the rising of a storm, and the luring of the ill-fated Greeks by lighted torches to the dangerous promontory of Caphareus where they suffered shipwreck. All this tale is told, with the proper accompaniment of lightning and thunder, by means of moving and hidden machinery. Even Ajax is made to swim towards the land, and subsequently to perish in one of various ways according to the fancy of the stage manager. That Hero should devote himself to the construction of the necessary tricks, required to reproduce these scenes, when he seemed clearly capable of higher intellectual flight, does not increase our respect for his memory; but Mr. Schmidt, whose philological tastes seem to be in advance of his scientific, seems to think it would be worth while to reconstruct the machinery, and play the little drama over again to a select audience. He admits the difficulties, both in following the original MSS. and in filling up some necessary lacunæ, but considers the labour would be well spent, since it would illustrate in a most realistic manner the amusements of the ancient inhabitants of Alexandria.

THE SITUATION OF OPHIR.

A REUTER'S correspondent has had an interview with Dr. Carl Peters on the subject of the re-discovery and identification of the ancient gold-bearing site now so well known by the name of Ophir. According to the eminent German traveller, this much discussed locality is situated on or near the Zambesi river, and he is confident that the theories which would place Ophir either in India or in Arabia are both wrong. Dr. Peters is not the first who has convinced himself that Ophir lay somewhere on the east coast of Africa, for the late Mr. Bent and other recent writers believed that they had identified the famous emporium whence Solomon, the king of Israel, obtained gold for the temple at Jerusalem. It must, of course, be admitted that remains of extensive gold workings undoubtedly exist in the locality, and that these possess considerable antiquity cannot be denied. It is, however, open to discussion whether the ruins and workings are "of undoubtedly Semitic type," and also whether the emblems which Dr. Peters identifies as phallic are really connected with "the ancient Semitic sun worship." Until Dr. Peters distinctly states his case in print, and gives his reasons for the faith which is in him, we can do little more than point out that up to the present the theory which would place Ophir, or Aphar, or Sôphir (1 Kings ix. 28; x. 11; 2 Chron. viii. 18; ix. 10) the great metropolis of the Sabeans, which is described in the "Periplus" attributed to Arrian, on the Gulf of Akabah, has not been disproved. The theory which would place Ophir in India, on the banks of the Indus, has much in its favour, and when it is remembered that the precious stones and *almug* trees, which are mentioned with the gold of Ophir, are the peculiar products of India, it is a little difficult not to accept it without more ado. On the other hand, the apes and peacocks (or parrots as some would translate the word *tukkiyyîm*), which were brought to Solomon from the neighbourhood of Ophir, indicate that its site was nearer Palestine than India; for it is well known that peacocks would not survive a long voyage which must have lasted several months, and must also have been made in an open boat. The fact is that many places can produce, and must always have produced, gold in great abundance, and we are driven irresistibly to the conclusion that more than one place bore the name of Ophir.

It is not necessary for the Ophir, whence Solomon obtained gold, to have been situated as near as the northern end of the Red Sea, for it is most likely that the seamen, who traded through Hiram, with him obtained the goods which they had to sell from the larger boats which sailed through Bâb el-Mandeb either to India, or to ports on the north-east and east coasts of Africa. Meanwhile Dr. Peter's claim to the discovery of the Ophir mentioned in the Bible will evoke consider able interest, and we must hope that he will lose no time in bringing before the world the important facts which he must have collected, and the evidence which would connect the phallic rites and worship of the Northern Semites (which have been so carefully described by old John Selden in his "De Diis Syris") with the nature worshippers on the east coast of Africa.

FORMALIN AS A PRESERVATIVE.

ALTHOUGH as a preservative medium for perishable zoological specimens, formalin has scarcely realised all the expectations entertained on its introduction, yet there can be little doubt that it has a great future before it, and that for certain purposes it is likely to prove invaluable. It has, however, many undoubted disadvantages; and in the minds of some museum officials these disadvantages appear to outweigh its manifest valuable properties, so that an unfavourable opinion is entertained of it in general. On the other hand, those who weigh more carefully the *pros* and *cons*, realise that, under proper conditions and restrictions, its value is really very great.

As regards its disadvantages, it must be admitted that it is unsuitable for the permanent preservation of specimens that are likely to be manipulated, as not only are its effects on the hands of the worker most unpleasant, but in many cases it renders the tissues of the specimens themselves so hard that they are practically unworkable. Then, again, it is quite unsuited for all specimens containing calcareous matter, such as molluscs, echinoderms, and crustaceans; while unsatisfactory results appear to have been obtained in the case of certain insects and myriapods. Moreover, it does not seem to be well suited for the preservation of reptiles; and it is said to deteriorate the colours of bird-skins.

Turning to its advantages as a permanent preserving fluid, it is acknowledged to be unrivalled for specimens of watery and "flabby" animals, such as jelly-fish, rendering them more coherent and less likely to disintegrate than any other known medium. Apart from this group, it does not, however, appear to be at present used to any great extent in the exhibition series in the British Museum; although we have reason to believe that its possibilities are occupying the serious attention of the officials. In the series of worms, all the more valuable specimens that were received in formalin have been transferred to spirit, and only the commoner forms left in the original medium. Of the six specimens of eggs, embryos, and larvæ of *Lepidosiren paradoxa* recently added to the exhibition series from Mr. Graham Kerr's Paraguay collection, three are in alcohol and three in formalin; the latter having been sent home in that fluid, and it being thought not advisable that the medium should be changed. If these six specimens are carefully watched, they will afford a test-case of the comparative value of the media. At present, we believe, none of the exhibits in the "Index Museum" are in formalin.

For sterilising freshly killed specimens of mammals and birds, as well as eggs, that have to be sent some distance to a museum in the flesh, there can be no doubt that formalin is invaluable. And it is no less valuable to the field-collector of mammals, not only on account of the small bulk a sufficiency of the fluid occupies, but also from the marvellous preservative power of the fluid itself. According to Mr. O. Thomas (who reports very favourably of it for this purpose), commercial formalin, which is itself 40 per cent. under proof, must be diluted with no less than twenty-five times its own bulk of water before use. Moreover, whereas when mammals are preserved in spirit it is necessary to allow a very large amount of fluid to each specimen, when formalin is employed the vessel may be crammed as full as possible with specimens, which are preserved without exhibiting the slightest traces of putrefaction. When received at the British Museum all such specimens are, however, immediately transferred to alcohol, on account of their unsuitability for handling when in the original medium.

The foregoing instances suffice to show that for certain specific purposes formalin has advantages as a preservative medium not shared by alcohol. But, as many of our readers are aware, another application of formalin has been recently proposed by Dr. G. de Rechter, of the Brussels University, who, in the twelfth volume of the *Annales de l'Institut Pasteur* (1898), has advocated the use of currents of formalin vapour for the preservation of animal specimens. The advantages claimed for this method are that it preserves the specimens in practically the same condition as they were left at death; the tissues not being hardened, while hair and feathers are uninjured alike in texture and in colour. Experiments in this method have been recently undertaken in Mauritius by Mr. Camille Sumeire, of the Albion Dock Company, who has constructed an apparatus on the general lines of one suggested by Dr. de Rechter, in which specimens can be subjected to constant currents of formalin vapour. And it appears from an illustrated report published in the *Bulletin de la Société Médicale de l'Ile Maurice* for July 18, that the results of these experiments have proved eminently satisfactory.

A freshly killed guinea-pig placed in the apparatus for a period of twenty days was found to be in a perfect state of preservation, and when exposed in the open in the museum for a further period of eight days, was likewise found to be intact. Moreover, a culture of bacilli exposed in the apparatus at the same time as the guinea-pig was found to have become completely sterilised.

As was well remarked by Dr. de Grandpré, superintendent of the Port Louis Medical Museum, the potential advantages of such a method of preservation are likely to prove very important. And it is urged that the process may be specially valuable in cases of suspected poisoning, as bodies can be preserved for any length of time in a state suitable for examination. From a natural history point of view the invention has likewise almost unlimited possibilities; and Mr. Sumeire hopes to be able shortly to supply the museums of Europe with examples of the animals of Mauritius as fresh as when alive, instead of in the condition of ordinary spirit-specimens. Indeed, negotiations are already opened with the director of the Paris Museum for the transmission of such formalined specimens to the institution under his charge. We wish all success to the new venture. R. L.

A GREAT SALT LAKE PROBLEM.

AN alluring possibility has for a long time attached itself to the economic resources of Great Salt Lake, in the Western United States, in the way of establishing in its waters, as permanent residents, forms of marine life of commercial importance. The United States Fish Commission recently made an examination of the lake with a view to determining the feasibility of such a plan. The work was undertaken by Mr. H. F. Moore, of the Commission, who finds in the peculiarly interesting conditions which prevail in this unique body of water a decisive answer.

Crustacea, insect larvæ, and the lower plant-life abound in its fresher parts, but for the ordinary inhabitants of the sea the salinity is much too great in the main body of the lake. Great Salt Lake is a remnant of the prehistoric Lake Bonneville, which was fresh, or nearly so, until its drainage basin became isolated by climatic and other changes, its salinity then increasing by evaporation. Brackish springs are common in the vicinity, and these, with the salts of the feeding streams, still contribute to the accumulation of saline matter. On the authority of the United States Geological Survey, the present rate of accumulation will charge the lake with common salt within a period of 25,000 years. The present density is about 1·168, while that of the ocean is but 1·025. It appears that it is not the nature of the saline materials, but their excessive quantity alone, that makes the water unfit for ocean life; for the relative proportions of the solids in solution do not differ materially in the lake-water and sea-water. Three-fourths of these solids are common salt in both cases. The lake, while strongly salt, is not alkaline, and would presumably support the higher organisms of the ocean if properly diluted. Diatoms have been grown experimentally in the diluted Salt Lake water, and, indeed, have been found native in the lake, together with other low plant and animal life, in its brackish parts.

On account of the removal for commercial purposes of large quantities of salt, many have looked forward to a day when the consequent freshening process shall have reduced the density of the water sufficiently to make it an inhabitable medium. About 42,000 tons of common salt are removed annually, while 16,000 tons, according to the calculation of the 25,000 year period required to saturate the lake, enter it each year. From the present density, 1·168, the lake must now hold about 400,000,000 tons of salt, and with these figures as a basis, it appears that in 14,000 years—the processes continuing at the present rate—the lake-water will reach the density of sea-water. As this is a far cry into the future, some would believe that the solution of the problem was to be found in acclimatisation of marine forms to the present briny waters. There is no evidence that this is feasible or remotely possible; the oyster has the best possible opportunity to adapt itself to salt or fresh water, but clings to an intermediate brackish zone of a density between 1·010 and 1·020. The plan which seemed to offer the only possibility of success concerned the oyster, and the location, near the mouths of the fresh streams that feed the lake, of water-zones of a degree of brackishness favourable to oyster growth. The conditions which were found to exist were such as to show conclusively that there is no hope for the utilisation of the lake in this way. The favourable zones, which are narrow at best—in no case over three hundred yards—are subject to great fluctuations in position due to the wind and to seasonal changes. The variation in the volume of water carried by the inflowing streams is remarkable. In one of them the ratio of the greatest flow to the least was as 28 to 1. When they are flushed with the melting of snow in spring the oyster zone is carried lakeward, and during the period of minimum flow in autumn it travels up the mouth of the stream in which it is located. The wind alone sometimes makes a change of level of several feet, and a consequent change of density from 1·009 to 1·014 within five minutes has been observed. Moreover, the deltas of the streams, which must of necessity be the location of the oyster beds, are subject to deposits of silt in amounts fatal to oysters. All these conditions in conjunction make the difficulties of successful oyster culture insuperable.

The brackish springs characteristic of the Bonneville bed have a low density, none exceeding 1·005, and suggest a plan by which they might be utilised. By making them the sources of artificial ponds the evaporation, which is greater than the rainfall, would raise the density to the desired point at which it could be maintained by a proper regulation of the brackish inflow and outflow. On a commercial scale, however, the experiment would be expensive, and might or might not justify itself.

PAUL KNUTH.

BORN on November 20, 1854, Paul Erich Otto Wilhelm Knuth, Professor at the Oberrealschule of Kiel, was only in his forty-sixth year at his death on October 30. After graduating at Griefswald in 1876, he was engaged in teaching at Iserlohn in Westphalia, and from 1881 at Kiel. His first scientific investigations were in the realm of organic chemistry, his chief works a Handbook of Flower-Biology, a Flora of Schleswig-Holstein, and a series of short papers upon the botany of the islands off the German coast—Rügen, Heligoland, Sylt, &c.

The "Handbuch der Blütenbiologie" is based on the English edition of Hermann Müller's "Befruchtung der Blumen," and is destined to replace it. Increasing knowledge has swelled the literature-list from 825 entries to 2871, and Knuth's plan allowed for three volumes in the place of the single one issued in English in 1883; of these the last, designed to contain all we know of the fertilisation of flowers in lands outside Europe, remains unpublished. There is hope that the work may yet be completed. Knuth's own observations in Java, Japan, and California, made in 1898 and 1899, were made to add to the rather meagre knowledge available for this unpublished volume.

His observations on the flora of the North Friesian Islands, of Heligoland and of Rügen, demonstrate how the winds that blow over sea-girt islets, inimical to insect life, impose a limit to the distribution of plants whose highly specialised flowers need insect aid for their fecundation. The lesser the island the greater the influence. Rügen is large, and it is not evident; the Halligen are small, and it is very apparent. These Halligen are "low-lying, marshy islets, hardly rising more than a metre above high tide, wind-swept, where one wanders hour after hour without taking a single anthophilous insect, save on the rare hot and windless days which coax a few to fly from flower to flower." On them the high-types of floral development are rare.

His Flora of Schleswig-Holstein, named above, was largely a compilation, intended to supply a real need, and was followed by a History of Botany in the double province. These, however, as the first steps towards his botanical work, have their own interest. I. H. B.

NOTES.

SOME particulars concerning the vessel which is being built at the Howaldt Shipbuilding Yard at Kiel, for the German Antarctic expedition, are given by the Berlin correspondent of the *Times*. The ship will be built of wood, the only material strong and elastic enough to resist the pressure of the ice. In form she will be somewhat rounder than the *Fram*, and will not fall away towards the keel in the same manner. The length of the ship will be about 46 metres, the breadth between 10 and 11 metres, and the draught about 5 metres. She will be constructed to carry coal and other stores sufficient for three years, and will contain accommodation for five scientific observers, five officers, and a crew of about twenty men. Each of the observers, and each of the officers, will have his own cabin. The centre of the ship will be occupied by the rooms for scientific work, and the forecastle will contain space for fifty Arctic dogs. The ship will be rigged as a three masted schooner. Two steam winches will serve the anchor and will also be used for scientific purposes. The ship will be illuminated throughout with electric light. The Howaldt Shipbuilding Yard, which is under a contract to have the ship built by May 1, 1901, and fitted out not later than the end of August, 1901, has already begun the construction. A model of the vessel will be shown at the Paris Exhibition.

THE *British Medical Journal* states that the Italian Parliament has voted a sum of 1,300,000 lire for the erection of new buildings in the University of Bologna. The work will be begun next spring.

WE learn from the *Times* that M. Raphael Bischoffsheim has presented to the Paris University his observatory at Nice worth 2,700,000f., and 2,500,000f. the interest of which is to cover its expenses.

M. T. Ribot, professor of psychology at the College de France, has been elected a member of the Paris Academy of Moral Sciences in succession to the late M. Nourrisson.

GENERAL GALLIENI, Governor of Madagascar, has been elected a correspondant of the Paris Academy of Sciences. The Academy has also elected M. Méray as correspondant of the section of geometry, and M. Rosenbusch as a member of the section of mineralogy.

A SPECIAL correspondent of the *Times* reports: "six Marconi wireless telegraphy instruments intended for the Boers have been captured at Cape Town. The experiments at Orange River have been highly successful. The communication with De Aar, seventy miles distant, is perfect."

MR. C. VERNON BOYS, F.R.S., will deliver the first of a course of six Christmas lectures specially adapted for young people, at the Royal Institution this afternoon. The subject will be "Fluids in Motion and at Rest" (experimentally illustrated). The remaining lectures will be on December 30 and January 2, 4, 6, 9, 1900.

THE two astronomers whose names have been submitted to the French Minister of Public Instruction, who will select one to fill the vacancy in the Bureau des Longitudes caused by the death of M. Tisserand, are M. Radau and M. Bigourdan.

AN exhibition of food, clothing, medicines, and other articles suitable for travellers in uncivilised and unhealthy regions of the globe, will be held at St. Martin's Town Hall, Charing Cross, on January 1–5, under the title of the "Livingstone Exhibition." A loan collection of Livingstone relics and of objects of interest connected with the work of other travellers will be on view.

AN interesting account of experiments on the growth and regeneration of the tails of tadpoles, conducted by means of Born's method of grafting, is given by Mr. R. G. Harrison in the October number of the *Bulletin* of the Johns Hopkins Hospital. In the neighbourhood of Baltimore there occur two species of frogs whose embryos differ so markedly in colouration from one another, that in any case where parts derived from each are united by grafting into a single organism it is easy to follow in the living specimen, as development proceeds, the change in position of any group of cells in respect to the original line of section. During the development of the tail after grafting it was noticed that a remarkable shifting of the epidermis over the underlying organs took place; so that after a time the epidermis properly belonging to the tail was restricted to the terminal third of that appendage. Now it is well known that the cutaneous nerves of the trunk and tail of the full-grown larvæ and frogs, in passing from the vertebral column to their termination in the skin, pursue an oblique course; and this is obviously due to the above-mentioned backward shifting of the epidermis. Certain other interesting features were also brought to light in the course of the experiments.

WITH the view to ascertain what displacement, vertically or horizontally, took place in the Khási and Gáro Hills during the Indian earthquake of June 1897, a revision of the principal triangulations in the district was made by officers of the Survey of India Department during 1898, and the results are referred to in the report just issued. Horizontal and vertical observations were taken at thirteen stations, fixing the positions of twenty-two and the heights of twenty-five old stations, embracing an area of 1020 square miles. The results show that the whole of this area lay within the region affected by the earthquake, so it is impossible to state how much any one station has been displaced in comparison with the unaffected area outside, but apparently all have suffered more or less. The average horizontal displacement appears to be about 7 feet, whilst the changes in height vary from a subsidence of 4·3 feet to an upheaval of 24 feet; these, however, for the reasons already mentioned, cannot be considered as absolute, but only relative changes. The general apparent effect is that the area has been both widened and raised. If possible, the revision work should be continued and extended, with instruments of equal calibre to those employed in the original triangulation; for accurate measurements of the movement of the earth's crust due to a large earthquake are of deep scientific interest.

THE Antiquity of Man in America is an important problem, and it is well that Mr. W. H. Holmes should revise, as he has done in the *American Anthropologist* (N.S., I., 1899, p. 614), the evidence relating to Auriferous Gravel Man in California. He discusses this special aspect of the question in a full, lucid and judicial spirit. His conclusion is that the testimony furnished is greatly weakened by the facts (1) that the finds on which it was based were made almost wholly by inexpert observers, and (2) that all were recorded at second hand. Affidavits cannot redeem it. Nothing short of expert testimony, amply verified and vigorously stated, will convince the critical mind that a Tertiary race of men, using symmetrically-shaped and beautiful implements, wearing necklaces of wampum and polished beads of marble or travertine bored accurately with revolving drills, fishing with nets weighted with neatly-grooved stone sinkers, and having a religious system so highly developed that at least two forms of ceremonial stones had been specialised, occupied the American continent long enough to develop this marked degree of culture without leaving numerous and distinctive traces of its existence. All these objects resemble modern implements in every essential respect. They are such as may have fallen in the mines from Indian camp sites or been carried in by the Indians themselves.

AN article upon electrolytic processes in industrial operations, contributed to the *Engineering Magazine* by Dr. W. Borchers, shows some of the remarkable developments of electro-technology during late years. Descriptions are given of the various processes by which industrial products are obtained electrolytically. The Castner process for manufacturing sodium is well known, and several similar devices have recently been introduced. Magnesium is obtained from melted magnesium salts by a process founded upon Bunsen's investigations. For the production of aluminium, the Pittsburg Reduction Company use a mixture of chlorides and fluorides of the metals of the alkalis and alkaline earths as electrolytes and solvent for the aluminum oxide. Copper, nickel, silver, and gold, in so far as electrolysis may be said to be applicable to them, are chiefly obtained in pure form by electrical means from the crude metal produced by the smelter. Gold is also electrolytically deposited from weak solutions obtained by chemical lixiviation processes. Caustic soda, caustic potash, chlorate of potash, and chlorine are obtained by electrolysis from aqueous alkali-chloride solutions. By suitable appliances and working conditions, the chlorine and caustic alkali solution may be carried off separately to produce chloride of lime and solid caustic soda, or they may be made to form a solution of chlorate of potash in the place of caustic potash and chlorine. The methods by which these and other electrolytic products are obtained are briefly described by Dr. Borchers in his interesting paper.

WE have received from Dr. L. Carnera, Voluntary Assistant at the Royal Observatory of Turin, a discussion of the amount of bright sunshine recorded at that Observatory, showing *inter alia* the mean duration of sunshine during the different hours and months of the years 1896–8, together with a comparison with the means obtained in a discussion by Dr. Rizzo of the values of the previous six years. While the variations between the two series show that the period is much too short for the deduction of trustworthy means, the results are valuable owing to the comparative rarity of this important climatic factor; for although observations of barometric pressure, temperature, &c., have been made at that institution for more than a century, a sunshine recorder has only been in use there for the last ten years. In fact, the instrument has only come into general use during the last twenty years, principally owing to improvements made by Sir G. G. Stokes in a recorder devised some years previously by the late Mr. J. F. Campbell.

THE Government Astronomer of Western Australia has sent us a copy of the meteorological observations made at the Perth Observatory and other places in that colony during the year 1898. This is the second of a series of annual publications issued by the Perth Observatory; annual meteorological reports have been published since 1876, but the new series shows a marked improvement. In past years the observers were dependent solely upon written instructions without inspection, and had to find out how to do their duties as best they could. In addition to the usual observations, a set of four Platinum Resistance thermometers have been sunk to various depths at Perth, and daily weather forecasts are now issued, which, on the whole, have been remarkably successful. In the year 1898 there were 31 stations provided with barometers and other instruments, and 213 rain-gauge stations, but the monthly charts show that large tracts are still unrepresented.

THE U.S. Government is pushing on its researches of the economical resources of Porto Rico. *Bulletin* No. 25 of the U.S. Department of Agriculture (Division of Forestry) consists of a report by Mr. Robert F. Hill, of the U.S. Geological Survey, on the forest conditions of the island. He states that the climate and soil are well adapted to the growth of a large number of trees and shrubs of great economical value, and he advocates a reversal of the deforesting policy pursued by the Spaniards. Besides those valuable for timber and constructing purposes, he names, as specially adapted to the climatal conditions, the tamarind, the papaw, the castor-oil plant or "palma Christi," the all-spice, the lime, a large number of edible fruits, as the orange, citron, lemon, guava, anona, mango, banana, and many others whose names are less known in this country. The coffee cultivated is of a superior quality. There are comparatively few harmful animals or poisonous plants.

PROF. W. B. SCOTT (*Trans.* Wagner Free Inst. of Science Philadelphia, vol. vi.) describes and figures a series of Ungulate Mammals from the Uinta and White River formations (Oligocene) of Utah and Colorado in North America. The mammals belong to the sub-order of "Selenodont Artiodactyls," and they include two groups; the first comprises forms generically identical with, or clearly related to, Old World anthracotheres and true ruminants, which reached the American continent by migration; the second group includes forms indigenous to America, the successive stages of whose descent may be traced through several of the Tertiary formations.

THE ninth volume of the Iowa Geological Survey (1899) contains the Annual Report for 1898, with accompanying papers. Statistics of mineral productions, including coal, clay, stone, lead and zinc, are contributed by Mr. S. W. Beyer. There are also reports on the Counties of Caroll, Humbolt, Story, Muscatine, and Scott, accompanied by colour-printed maps, and followed by an account of the Artesian Wells of the Belle Plaine Area. The county reports contain concise accounts of the various formations including Silurian, Devonian, Carboniferous, Cretaceous, Pliocene, Glacial and more recent deposits, together with notes on their economic products. In Muscatine county the Devonian rocks afford many points of special interest, and they have yielded a number of fossils.

THE *Mittheilungen* of the Vienna Geographical Society contains an excellent abstract of a paper by Dr. Eduard Richter, published by the Swiss Geological Society at the end of last year, on the advance and retreat of the glaciers in the Alps during the Ice Age. Dr. Richter arrives at the important result that the variation of climate was probably much smaller than has been supposed, because the resistance to the outflow of the ice increases with its quantity in a rapid ratio, and the level of the snowfields would therefore rise quickly to levels where the temperature was lower. The variations of level due to this cause would themselves give rise to sudden and irregular changes in the glaciers according as the ice-surface rose above, or fell below, the snow-line. They also account for the enormous amount of moraine detritus carried by these glaciers; each was made up of a large number of small ice-streams, and the debris was not carried as a ground moraine, but in the body of the ice.

THE *Biologisches Centralbatt* for November 1 contains an article by Dr. L. Kathariner on the influence of light on the colours of the pupæ of butterflies, in which many interesting points are recorded.

THE following lectures will be delivered at the Royal Victoria Hall, Waterloo Road, S.E., on Tuesday evenings during January:—January 2: "Chronicles of a Clay Cliff," by W. H. Shrubsole; January 9: "A Peep Behind the Scenes," by Metcalfe Wood; January 16: "Birds at Home and Abroad," by Mrs. Lemon; January 23: "Plants of Long Ago," by A. C. Seward, Esq., F.R.S.; January 30: "The Fathers of Geology," by F. W. Rudler.

THE *Journal* of the Franklin Institute for December contains several additional addresses delivered on the occasion of the recent celebration of the seventy-fifth anniversary of the Institute. Dr. C. F. Himes describes the history of photographic discovery from the time of Daguerre and Niépce; Mr. C. Kirchhoff surveys the achievements in mining and metallurgy during the past three-quarters of a century; and Mr. J. Fritz gives some reminiscences of the development of iron manufacture in the United States in the same period.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN JANUARY, 1900.

January 2–3.	Epoch of January meteors (radiant $230° + 53°$).
3.	4h. Venus in conjunction with the moon (Venus 6° S.).
6.	7h. 12m. to 8h. 10m. Occultation of 19 Piscium (mag. 5·2) by the moon.
8.	17h. 32m. Jupiter's Sat. IV. in conjunction N. of planet.
10.	7h. 1m. to 7h. 59m. Occultation of τ^2 Arietis (mag. 5·2) by the moon.
10.	7h. 55m. to 9h. 1m. Occultation of 65 Arietis (mag. 5·6) by the moon.
11.	10h. 27m. to 11h. 34m. Occultation of κ^1 Tauri (mag. 4·6) by the moon.
11.	10h. 40m. to 11h. 23m. Occultation of κ^2 Tauri (mag. 5·5) by the moon.

January 13. 10h. 1m. Minimum of Algol (β Persei).
15. Venus. Illuminated portion of disc = 0·873.
16. 6h. 50m. Minimum of Algol (β Persei).
16. 17h. 17m. to 17h. 50m. Occultation of α Cancri (mag. 4·3) by the moon.
20 12h. 46m. to 13h. 46m. Occultation of B.A.C. 4006 (mag. 5·7) by the moon.
21. 11h. 22m. to 12h. 26m. Occultation of q Virginis (mag. 5·7) by the moon.
23. 15h 35m. to 16h. 45m. Occultation of B.A.C. 4722 (mag. 5·5).
26. 1h. Conjunction of Jupiter and the moon (Jupiter 2° 3′ N.).
26. 15h. 40m. Transit of Jupiter's Sat. III. (Egress).

ASTRONOMICAL AND ASTROPHYSICAL SOCIETY OF AMERICA.—Prof. E. B. Frost, of the Yerkes Observatory, contributes to *Science* a full account of the proceedings at the first meeting of this new society, which is the permanent outcome of the two congresses of astronomers and astrophysicists held in the past two years. The following notes are from the report:—

Prof. S. J. Brown discussed his measures of the changes in the orbit of the satellite of Neptune, in order to determine the position of the polar axis and flattening of the planet. This flattening is found to be $e = \frac{1}{102\cdot2}$, an amount corresponding to only 0″·03 between the polar and equatorial diameters.

The period of the revolution of the pole of the satellite's orbit is 531·75 years.

Prof. A. S. Flint described the new Repsold transit micrometer of the Washburn Observatory.

Mr. Kurt Laves read a paper on the "Determination of the constant of nutation from heliometer measures of Eros." The opposition of this planet at the end of 1900 will offer special facilities for this purpose.

An account was given of a proposed new "Harvard Photometry." In the original work all stars were included of sixth or brighter magnitude, as obtained from the principal catalogues then extant; but it has been found in the course of the work that in this way many have been included which are fainter than mag. 6·2. The stars of the Photometry were again observed in 1892–94, and, including special series of measures, there are now prepared *seven* photometric catalogues, giving measures by different observers with different instruments, but all made on the same plan. It is therefore proposed to issue a catalogue of all the stars from the north to the south pole, showing the brightness given by the meridian photometer in all seven catalogues, and to call the work the "Revised Harvard Photometry." As much reference information to other catalogues will be given as is possible, and it is thought a quantitative measure of the colour will be furnished by giving the type of spectrum and photographic magnitude.

Prof. G. C. Comstock described his experiments of placing a very coarse grating before the object glass of a telescope, and measuring the distance between the mean centres of the pairs of star spectra formed on each side of the central image. He finds incidentally that the mean refrangibility of the light of Mars is marked by *less* than that of any red stars yet examined. He has also examined the satellites of Jupiter in this way, and finds different values from those adopted by Michelson and Hamy.

Mr. F. L. Chase has taken heliometer observations of red stars, &c., in order to determine the possibility of there being a slight difference of refraction between these and white stars, thus introducing a disturbing element into measures of parallax. In all his experience, however, he was unable to detect any difference whatever.

Prof. S. I. Bailey said that out of the 900 stars counted in the cluster M.5., eighty-five were variable. Detailed examination of the light curves and periods of many of them showed a remarkable similarity both in the magnitude and range of variation. The periods vary from 10h. 48m. to 14h. 59m. The uniformity of period, magnitude, and light curve among so many variables, points to a common origin and cause of variability.

DAY NUMBERS OF "NAUTICAL ALMANAC."—We have received a pamphlet giving the separate day numbers for use with the tables for finding star constants for the years 1900, 1901, 1902. From the past three years' experience, Prof. Turner says that his restriction of the tables to three figures has been followed by no loss of accuracy, and therefore their publication is continued. In accordance with the decisions of the Conference of Superintendents of Ephemerides held at Paris in 1896, the constants of aberration, precession, and nutation have been altered from the commencement of 1901; but, for the convenience of observers still desiring to use the Struve-Peter's constants, both have been included in the present tables.

"POPULAR ASTRONOMY" FOR DECEMBER.—The issue of *Popular Astronomy* for this month contains, among much generally interesting matter, two useful articles by Profs. H. C. Wilson and W. H. Pickering. The former describes a photograph of the nebula of Andromeda obtained by him at Goodsell Observatory, using the 8-inch Clarke refractor, with an exposure of twelve hours given on three nights. Reproductions of the picture accompany the paper, and the minute structure of the many spirals first photographed by Roberts are magnificently shown.

Prof. Pickering writes to keep up hopes of the meteor shower still being observable. He has examined the times of appearance of the maximum from 902 more minutely, and finds they occurred at regular 100 years' intervals until 1698, when there was a perturbation of four years. Since then thirty-four years would appear to more closely satisfy the period, so that 1901–2 may still be the maximum year.

THE SOUTH-WESTERN POLYTECHNIC.

ONE of the best equipped and most intelligently governed of the London polytechnics is that built at a cost of 55,000*l.*, and located at Manresa Road, Chelsea. Situated as it is in the midst of a densely-populated district, its work, which a large staff of lecturers and demonstrators, under the able guidance of Prof. H. Tomlinson, F.R.S., the Principal, are year by year steadily accomplishing, cannot be overestimated. The work of the polytechnic is carried on in a fine suite of buildings placed within a stone's throw of the Chelsea Town Hall, and the institution is provided with laboratories and lecture-rooms for each of the many departments of science and technology which its work comprises. It is designed more especially to meet the educational needs of the inhabitants of Chelsea, Fulham, Kensington, St. George's (Hanover Square), and Westminster, though students from other parishes are admitted if accommodation is available and other circumstances permit.

Financial Position.—The financial outlook of the South-Western Polytechnic may certainly be regarded as hopeful. Both the fees received from the students and members and the grants earned last session from the Science and Art Department showed a very large increase. The total annual income received from the Technical Education Board of the London County Council amounts to over 4000*l.*, and the annual subsidy from the Charity Commissioners is 1500*l.* The inadequate accommodation which the already extensive buildings offer the increasing number of students to be provided for, has necessitated a further extension, and the governing body are now spending some 7000*l.* on new buildings.

Departments.—The operations of the institution are divided into two distinct portions—day classes and evening classes. In the day classes are included (1) a Day College for men; (2) a Day College for women; (3) a School of Art; (4) a School of Science for boys and girls; and (5) a School of Domestic Economy for girls. The evening classes embrace the following sections: (1) Mathematics; (2) Physics and Electrical Engineering; (3) Mechanical Engineering and Building Trades; (4) Chemistry; (5) Natural Sciences; (6) Languages; (7) Commerce; (8) Domestic Economy; (9) Art; (10) Music; (11) Miscellaneous; (12) Recreation.

Numbers of Students.—The most notable fact, and one of the most encouraging features of the work of the South-Western Polytechnic, is the regular and substantial increase from year to year in the numbers of students attending the different departments. The number of students in the day classes during the session 1897–8 was nearly half as many again as that during 1896–7. Taking all the day classes for both sexes together, the number of individuals attending during the present session is about 30 per cent. greater than for the last school year, the number undergoing instruction at the present time being about 900.

The number of individual students in all evening classes together is about 2000 for the current session, during 1897–8 it was 1844, and the preceding year, 1896-7, 1520. The relative popularity of the different departments among evening class students can be seen at a glance from the number of class entries during the session 1897-8, which was as follows :—

Mathematics	85
Physics and Electrical Engineering... ...	578
Mechanical Engineering and Building Trades	942
Chemistry	185
Natural Sciences	137
Languages	246
Commerce	342
Domestic Economy	233
Art	287
Music	455
Gymnastics	306
Miscellaneous	233

The trades and industries of the evening class students show great variety, and indicate graphically the widespread influence which a polytechnic is able to exert. Of the 1844 students attending evening classes during 1897-8, 304 were clerks, 192 teachers of one kind or another, 183 were salesmen and shop-assistants, 175 apprentices, 65 servants, 59 carpenters and joiners, 42 artists, 37 electricians, 37 painters, 34 builders' clerks, 32 civil servants, and 31 telegraphists. In addition to these, rather smaller numbers of bricklayers, plumbers, fitters, engineers, draughtsmen, dressmakers, milliners were in attendance, while doctors, architects, and merchants were represented ; one or two postmen, porters, and others were also reaping the benefits of education.

Day College for Men.

This college is intended for males above the age of fifteen, and is at the present time attended by over a hundred students, whose ages range from fifteen to forty. It comprises two departments—one technical, the other general. The courses of instruction in the former are arranged to occupy at least two years. On entering, the student is expected to state whether he wishes to be trained as a mechanical or electrical engineer, whether he wishes to be educated with a view to some branch of chemical industry or of the building trade, or whether he desires to study applied art. Except in the last contingency, complete courses of study have been arranged, involving laboratory instruction, tutorial work, attendance at lectures, mathematical exercises, drawing, and workshop instruction.

The general department of the day college, on the other hand, aims at giving either a good all-round education or special training in each of its various sections.

Students admitted to a regular and fully prescribed course of study in the technical department are first required to pass an elementary examination in mathematics and to give evidence of possessing a fair knowledge of English. In the general department the students are not required to pass any entrance examination. Students in the technical department who successfully work through the second year's course may compete for a college diploma.

A few words about the different courses of instruction in the technical department will best indicate the nature of the work in this part of the day college for men. The full scheme of work is :—

FIG. 1.—The Chemical Laboratory, South-Western Polytechnic.

(*a*) *The Mechanical Engineering and Architecture Section* is spread over two years, and aims at providing progressive instruction of a theoretical and practical nature, suitable for students just leaving school and who intend in the near future entering the works of an engineer or the office of an architect. At the same time it is designed to be of service to those who have already spent three or more years in a workshop, and who require a course of technical instruction to fit them for positions of greater responsibility.

(*b*) *The Civil Engineering and Surveying Section* also takes up two years, and trains young men who will hereafter be engaged in surveying, civil engineering, constructional work of any kind, or who propose to proceed to the colonies.

(*c*) *The Electrical Engineering and Applied Physics Section* is intended to familiarise students with methods of accurate measurement and observation, as well as to give a sound knowledge of physical laws and their application to industrial and engineering operations. The laboratories are capable of accommodating fifty students at one time, and are equipped throughout with the most recent apparatus for the study of physics.

(*d*) *The Chemistry Section* is arranged to assist students who intend carrying on work involving the applications of chemistry as industrial, consulting, or analytical chemists. The course includes other subjects required by technical chemists, and students who wish to do more advanced work can only complete the course in three years.

DAY COLLEGE FOR WOMEN.

This college is the counterpart of the day college for men, and the Principal is aided in its direction by a lady superintendent. It is at the present time attended by 200 students. The aim of the college is to provide women with a thorough and liberal education, not only in art, science, literature, and commerce, but also in domestic economy and physical training. While it is a little difficult to make selections where the whole work is so satisfactory, the training offered for lady secretaries and the training college for gymnastic teachers call for special mention. The growing demand for ladies to act as secretaries or confidential clerks renders the question of the competent training of candidates for such posts one of great practical importance, and there is no doubt that the arrangements which have been made at Chelsea to provide a complete course of study for those wishing to obtain employment as secretaries or clerks will have a very beneficial effect.

The training college for gymnastic teachers is under the direction of Fräulein Wilke. The complete course of training extends over two years, and the fee for the whole time is seventy-two guineas. A noteworthy feature of the method of instruction adopted is that the candidates are taught each of the systems of gymnastics, German, Swedish, and English, and are consequently not handicapped like students in many similar colleges where one system only is taught. The instruction is both practical and theoretical, and the most careful precautions are taken to ensure the physical well-being of the embryo instructors.

EVENING CLASSES.

The time table of the evening classes at this polytechnic gives the impression that it would be difficult to name a subject which is not included. There are classes in all branches of pure and applied science, languages and literature, domestic science, commercial subjects, art, music, and many other subjects. The fees are low, and the classes well attended, while the examination results show that the students make substantial progress.

HIGHER SCIENTIFIC INSTRUCTION AND WORK IN RESEARCH.

A special characteristic of the work of the South-Western Polytechnic is the higher instruction in science and the interesting development of education in the methods of research, to which reference has already been made in these columns (No. 1523, p. 236). Both in the day and evening classes great attention is given to electrical engineering. The following table shows the number of individual students attending the more important classes in this section :—

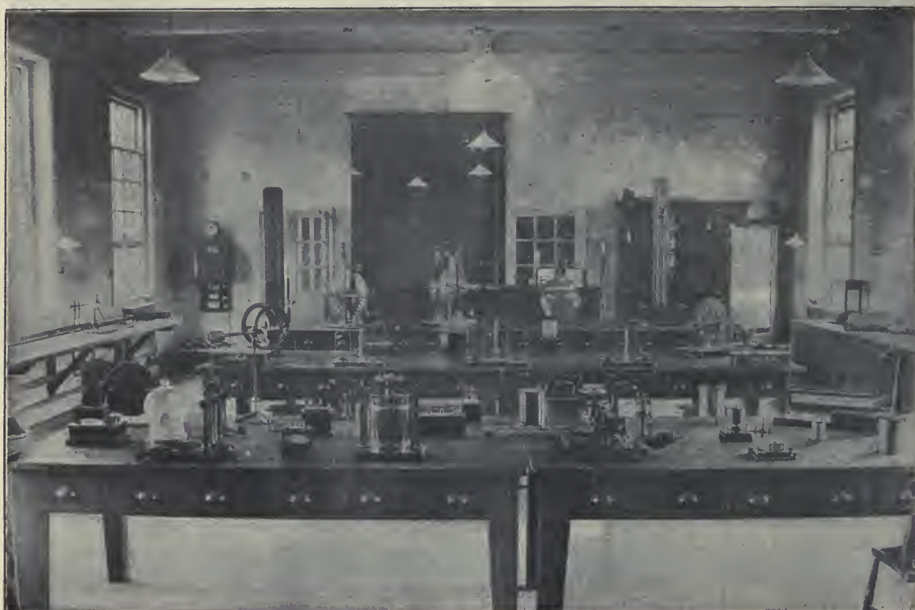


FIG. 2.—The Physical Laboratory, South-Western Polytechnic.

Advanced Electrical Engineering	58
Elementary Electrical Engineering	55
Alternating and Polyphase Currents	24
Calculus for Electrical Engineers	21
Electric Wiring and Fitting	69
B.Sc. Physics for London University	20
Telegraphy	14

The equipment of the laboratories for this work contains some interesting apparatus and machines. The polyphase generator, which consists of three small alternators of identical construction mounted on one bed plate and coupled together with graduated couplings, which admit of any given phase difference being produced between any of the alternators, deserves particular mention. There are also examples of the most recent continental three-phase and induction motors, on which careful tests are now being made. There is an ingenious combination of motor generators, which can be driven either mechanically or electrically. The switchboard and starting appliances for this combination of motor generators were designed and made in the institute.

A small workshop, with electrically driven tools, affords a good scope for the construction of original apparatus. Only typical instruments and standards have been purchased for the physical and electrical laboratories; the great bulk of the instruments and fittings have been both designed and made up in the polytechnic itself. Among the more recent pieces of original apparatus of home manufacture may be mentioned (1) a modified form of Michelson's interferometer, and another adaptation of the same for measuring to a millionth of an inch, and (2) an electro-magnetic speed indicator for use with dynamos and motors. Examples of original apparatus made at the South-Western Polytechnic have been exhibited at the Royal Society, the Royal Institution, and the Institution of Civil Engineers.

Good research work has been accomplished, including a series of tests on insulating materials, investigations on selenium cells, the effects of repeated heating and cooling on the magnetic properties of wrought iron, the relation between the thickness of metallic surfaces and the phase change of the reflected beam, tests with the Nernst lamp, and the negative resistance offered by certain metallic oxides. The results in the last piece of work have been published in the *Electrician*.

OTHER POINTS OF INTEREST.

Several general considerations must be taken into account before the educational position of the South-Western Polytechnic can be rightly estimated. The recreative side of the polytechnic is not considered of prime importance, and the tendency seems to be to minimise its influence. In this respect it departs somewhat from the general type of polytechnic in the metropolis. There is also a laudable desire to initiate new departments as the need for them becomes evident, so that the institution may keep in touch with all the needs of the inhabitants in its neighbourhood. In this connection may be cited the work now being done on the women's side of the institute in the direction of offering ladies of the middle classes such instruction in domestic science as will make them independent of servants. Finally, it should be borne in mind that in more than one department the work being done is of quite as advanced a character as that in some university colleges.

A. T. SIMMONS.

PRIZE LIST OF THE PARIS ACADEMY OF SCIENCES.

AT the Annual Meeting of the Academy, held on December 18, M. von Tieghem gave his Presidential Address, and announced the prizes awarded for 1899. In his address, the President reviewed the scientific progress for the year, and then gave a short account of the life-work of the Members, Foreign Associates, and Correspondents who have died during the past year, MM. Naudin, Friedel, Frankland, Bunsen, Richards, Wiedemann, Marsh, Flower, and Riggenbach.

The prizes were awarded as follows: in Geometry—the Bordin Prize is not awarded, but M. Jules Drach receives an honourable mention, the Francœur Prize to M. Le Cordier, with an honourable mention to M. Le Roy, the Poncelet Prize to M. Cosserat, for the whole of his contributions to geometry and mechanics.

In Mechanics: the Extraordinary Prize of 6,000 francs to M. Bailles for his treatise on the Geometry of indicator diagrams, MM. Charbonnier and Galy-Aché, and Perrin, receiving supplementary prizes, the Montyon Prize to M. Partiot, the Plumey Prize to M. Bonjour for his inventions in connection with steam engines, and the Fourneyron Prize to M. A. Rateau for his theoretical and experimental researches on the theory of pumps.

In Astronomy: the Lalande Prize is awarded to Mr. W. R. Brooks for his important discoveries in connection with comets, and the Valz Prize to M. Nyrén, of Pulkova, for his work in sidereal astronomy.

In Physics: M. Blondlot receives the La Caze Prize for the whole of his researches in experimental physics.

In Statistics: the Montyon Prize is divided equally between the Office central des Œuvres de Bienfaisance, for the memoirs entitled "La France Charitable" and "Paris Charitable," and MM. Dumesnil and Mangenot, for a complete economic study of the trades, income, and mode of living of the inhabitants of Pointe d'Ivry.

In Chemistry: the Jecker Prize is given to M. Maurice Hanriot for the whole of his contributions to organic chemistry, the Wilde Prize to Dr. P. Zeeman for his important discoveries of the relations between the magnetic field and the nature and polarisation of light rays, and the La Caze Prize to M. Engel.

In Mineralogy and Geology: the Delesse Prize is awarded to M. Kilian for his studies in the French Alps, and the Fontanne Prize to M. Émile Haug for his palæontological studies.

In Botany: M. l'Abbé Hue receives the Desmazières Prize for his work on the anatomy and classification of the Lichens, M. Leuduger-Fortmorel an honorable mention for his memoir on the diatoms of the East Coast of Africa, MM. Jules Cardot and Hériband Joseph Montagne Prizes, the Thore Prize being divided between MM. Parmentier and Bouilhac.

In Anatomy and Zoology: the Grand Prize of the Physical Sciences is not awarded; the Bordin Prize is accorded to M. Viré for his memoir on the subterranean fauna of France, and the Savigny Prize to M. Guillaume Grandidier for his researches in Madagascar.

In Medicine and Surgery: Montyon Prizes are given to MM. Nocard and Leclainche for their book on microbial diseases, to Prof. Mayet for his "Treatise on Medical Diagnosis," and to M. A. B. Marfan for his work on the treatment and feeding of young infants. MM. Lejars, Fournier and Garnier receive mentions, and MM. Guillemonat and Labbé citations. The Barbier Prize is divided between MM. Houdas and Joanin, Lapicque, and Schlagdenhauffen. Since no work has been received meriting the Bréant Prize for cure or treatment of Asiatic cholera, the Commission has decided to divide the sum accumulated (6000 francs) between M. Vaillard, and MM. Courmont and Doyon for important work on the pathogeny and pathology of tetanus, MM. H. de Brun, Ch. Besnoit, and J. Guillé receiving mentions. The Godard Prize is awarded to M. Pasteau, the Serres Prize to M. Roule, with honourable mention to Prof. J. Beard, M. Maurice Caullery, and M. Félix Mesnil, the Chaussier Prize to M. Charrin, the Mège Prize to MM. Félix Terrier and Marcel Baudoin for their memoir on intestinal suture, the Baron Larrey Prize to MM. Arnaud and Lafeuille for their memoir on Tuberculosis in the Army, the Bellion Prize being divided between M. Cestan and MM. Crespin and Sergent.

In Physiology: the Montyon Prize for Experimental Physiology is given to Prof. Le Hello for his studies on the locomotion of the horse, M. Quinton receiving honourable mention, the La Caze Prize (Physiology) to Prof. Morat for his contributions to Experimental Physiology, and the Pourat Prize to MM. Weiss and Carvalho for their paper on the specific characters of muscular contraction in the animal series, the Philipeaux Prize not being awarded this year. In Physical Geography, M. Albert Vayssière receives the Gay Prize.

Of the General Prizes, the Arago Medal was awarded to Sir G. G. Stokes on the occasion of his jubilee at Cambridge. The Montyon Prize (unhealthy trades) is given to M. E. Collin for his memoir on the microscopy of foods of vegetable origin, M. P. Razous receiving a mention. M. Louis Ducos de Hauron is awarded the Trémont Prize for his invention of photography in colours by the method of superposed coloured images, M. Vaschy, the Gegner Prize, M. Moutard, the Petit D'Ormoy Prize (Mathematics), M. Alfred Giard, the Petit D'Ormoy Prize (Natural Sciences), M. Verbeck, the Tchihatchef Prize, M. Maurice Leblanc, the Gaston Planté Prize, M. René Metzner, the Cahours Prize, M. Lecaillon, the Saintour Prize, the Pasteur Institute, the Jean-Jacques Berger Prize, M. J. P. Siegler, the Prize founded by Mme. la Marquise De Laplace, the Prize founded by M. Félix Rivot being divided between MM. Siegler, Heurteau, Aron, and Becquerel.

RESULTS OF RECENT SOUNDINGS IN THE PACIFIC.[1]

CAPT. MOSER and I decided not to make any soundings nor do any deep-sea work until we had passed beyond the lines of soundings already run by the *Albatross* and *Thetis* between California and the Hawaiian Islands.

[1] Abridged from a letter received by the U.S. Fish Commission from Prof. Alexander Agassiz, and published n *Science* of December 8.

In latitude 31° 10′ N., and longitude 125° W., we made our first sounding in 1955 fathoms, about 320 miles from Point Conception, the nearest land. We occupied 26 stations until we reached the northern edge of the plateau from which rise the Marquesas Islands, having run from station No. 1, a distance of 3800 miles, in a straight line.

At station No. 2 the depth had increased to 2368 fathoms, the nearest land, Guadeloupe Island, being about 450 miles, and Point Conception nearly 500 miles distant. The depth gradually increased to 2628, 2740, 2810, 2881, 3003, and 3088 fathoms, the last in lat. 16° 38′ N., long. 130° 14′ W., the deepest sounding we obtained thus far in the unexplored part of the Pacific through which we are passing. From that point the depths varied from 2883 to 2690 and 2776, diminishing to 2583, and gradually passing to 2440, 2463, and 2475 fathoms, until off the Marquesas, in lat. 7° 58′ S., long. 139° 08′ W., the depth became 2287 fathoms. It then passed to 1929, 1802, and 1040 fathoms, in lat. 8° 41′ S., long. 139° 46′ W., Nukuhiva Island being about 30 miles distant. Between Nukuhiva and Houa-Houna (Ua-Huka) islands we obtained 830 fathoms, and 5 miles south of Nukuhiva 687 fathoms. When leaving Nukuhiva for the Paumotus we sounded in 1284 fathoms about 9 miles south of that island. These soundings seem to show that this part of the Marquesas rises from a plateau having a depth of 2000 fathoms, and about 50 miles in width, as at station No. 29 we obtained 1932 fathoms.

The deep basin developed by our soundings between lat. 24° 30′ N., and lat. 6° 25′ S., varying in depth from nearly 3100 fathoms to a little less than 2500 fathoms, is probably the western extension of a deep basin indicated by two soundings on the charts, to the eastward of our line, in longitudes 125° and 120° W., and latitudes 9° and 11° N., one of over 3100 fathoms, the other of more than 2550 fathoms, showing this part of the Pacific to be of considerable depth, and to form a uniformly deep basin of great extent, continuing westward probably, judging from the soundings, for a long distance.

I would propose, in accordance with the practice adopted for naming such well-defined basins of the ocean, that this large depression of the Central Pacific, extending for nearly 30° of latitude, be named Moser Basin.

The character of the bottom of this basin is most interesting. The haul of the trawl made at station No. 2, lat. 28° 23′ N., long. 126° 57′ W., brought up the bag full of red clay and manganese nodules with sharks' teeth and cetacean ear-bones; and at nearly all our stations we had indications of manganese nodules. At station No. 13, in 2690 fathoms, lat. 9° 57′ N., long. 137° 47′ W., we again obtained a fine trawl haul of manganese nodules and red clay; there must have been at least enough to fill a 40-gallon barrel.

The nodules of our first haul were either slabs from 6 to 18 inches in length and 4 to 6 inches in thickness, or small nodules ranging in size from that of a walnut to a lentil or less; while those brought up at station No. 13 consisted mainly of nodules looking like mammilated cannon balls varying from 4½ to 6 inches in diameter, the largest being 6½ inches. We again brought up manganese nodules at the Equator in about longitude 138° W., and subsequently—until within sight of Tahiti—we occasionally got manganese nodules.

As had been noticed by Sir John Murray in the *Challenger*, these manganese nodules occur in a part of the Pacific most distant from continental areas. Our experience has been similar to that of the *Challenger*, only I am inclined to think that these nodules range over a far greater area of the Central Pacific than had been supposed, and that this peculiar manganese-nodule bottom characterises a great portion of the deep parts of the Central Pacific where it cannot be affected by the deposit of globigerina, pteropods, or telluric ooze; in the region characterised also by red-clay deposits. For in the track of the great equatorial currents there occur deposits of globigerina ooze in over 2400 fathoms for a distance of over 300 miles in latitude.

Manganese nodules we found south of the Marquesas also, where in 2700 fathoms we obtained, perhaps, the finest specimens of red clay from any of our surroundings. As we approached close to the western Paumotus, and rose upon the plateau from which they rise, globigerina ooze passed gradually to pteropod ooze, then to fine and coarse coral sand. In the channel south of the Paumotus to Tahiti the coral sand passed to volcanic sand mixed with globigerinæ in the deepest parts of the line, and towards Tahiti passed to volcanic mud mixed with globigerinæ, next to fine volcanic sand, and finally, at the last sounding, off Point Venus, to coarse volcanic sand.

We made a few hauls of the trawl on our way, but owing to the great distance we had to steam between San Francisco and the Marquesas (3800 miles) we could not, of course, spend a great deal of time either in trawling or in making tows at intermediate depths. Still the hauls we made with the trawl were most interesting, and confirmed what other deep-sea expeditions have realised: that at great depths, at considerable distances from land and away from any great oceanic current, there is comparatively little animal life to be found. Where manganese nodules were found the hauls were specially poor, a few deep-sea holothurians and ophiurans, and some small actiniæ which had attached themselves to the nodules with a few other invertebrates, seemed to be all that lived at these great depths, 2500 to 2900 fathoms, far away—say from 700 to 1000 miles—from the nearest land.

The bottom temperatures of the deep (Moser) basin varied between 34·6° at 2628 and 2740 fathoms, to 35·2° at 2440 fathoms, and 35° at 2475 fathoms; about 120 miles from the Marquesas. At station No. 23, off the Marquesas, in 1802 fathoms, the temperature was 35·5°.

On our way to Tahiti from the Marquesas we stopped a few days to examine the westernmost atolls of the Paumotus.

It is premature from the examination of the western extremity of the Paumotus to base any general conclusions regarding the mode of formation of these atolls; certainly as far as I have gone there is absolutely nothing to show that the atolls of the Paumotus have not been formed in an area of elevation similar to that of Fiji. The evidence in Rairoa and in the atolls of the western Paumotus is very definite. Makatea is an elevated mass of coralliferous limestone similar in all respects to masses like Vatu Vara, Thithia, and others in Fiji. Like them Makatea is surrounded by a comparatively narrow shore platform cut out from the base of the limestone cliffs and on the seaward extension of which corals grow abundantly to depths of seven to eight fathoms, when they appear to become very much less numerous. So that it is not unnatural, as I am inclined to do, to look upon the area of the Paumotus as one of elevation, the raised and elevated land of which has been affected much in the same way by denudation and erosion as have the masses of elevated coralliferous limestone of Fiji. Only there seems to have been, from the evidence thus far presented, a far greater uniformity in the height of the elevation of the Paumotus. This would render the explanation I have given less evident had I not the experience of the Fiji group to guide me. I am informed that there are other islands and atolls in the Paumotu group, showing traces of this elevation, so that I am at any rate justified in denying that the Paumotus as such are situated in an area of subsidence and that subsidence has been the great factor, as is maintained by Darwin and Dana, in the formation of the characteristic atolls of the group.

It may be well to point out also that the Paumotus, like the Marquesas on one side and the Society Islands on the other, are situated upon a plateau similar to that upon which the last-mentioned groups are placed—this plateau having a depth of from 1200 to 1500 fathoms, and rising from the general oceanic basin which surrounds them, and which has a depth of from 2300 to 2500 fathoms. Furthermore, evidence of this elevation is found at the two extremities of the Paumotu plateau at Makatea, an elevated island consisting of tertiary coralliferous limestone, and at the Gambier Islands, which are volcanic islands of considerable height.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DR. T. E. STANTON, of University College, Liverpool, has been appointed professor of engineering in University College, Bristol, in succession to Prof. Ryan.

DR. EDWARD TAYLOR JONES has been appointed professor of physics in the University College of North Wales, in succession to Prof. A. Gray, F.R.S. The Drapers' Company has made the College a grant of £200 a year for a period of three years towards the maintenance of the department of electrical engineering, pending the establishment of the department on a permanent footing.

SCIENTIFIC SERIAL.

Bulletin of the American Mathematical Society, November.—Dr. G. A. Miller gives a short account of the meeting of the American Association for the Advancement of Science (held August 21–26) as it bore upon the Society, with a short abstract of some of the mathematical papers. A hope is expressed that the Society and the Society for the Promotion of Engineering Education may meet next year with sections A and D respectively of the Association.—Prof. Oskar Bolza reviews Harkness and Morley's introduction to the theory of analytical functions, and Prof. A. S. Hathaway discharges a like office for MacAulay's Octonions. Prof. Bolza considers the former work to be not only of high scientific and pedagogical value, but at the same time of a singular beauty and elegance. A certain freshness and originality pervade the whole, even in places where the authors follow along beaten tracks, and give at every turn evidence of the complete mastery of the subject with which the book is written.—Dr. Lovett gives a *résumé* of five recent theses in mathematics presented for the doctor's degree at the University of Paris. They are: Sur quelques points de la théorie des fonctions, by M. L. Desaint; Sur une classe particulière de groupes hyperabéliens, by M. H. Bourget; Sur l'intégration des équations de la chaleur, by M. E. LeRoy; Les équations différentielles linéaires de la théorie des groupes, by M. F. Marotte; and Essai sur une théorie générale de l'intégration et sur la classification des transcendantes, by M. J. Drach. In the copious mathematical "Notes," an account is given of the mathematical courses of lectures in the winter semester of several Continental and other universities.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, November 16.—"The Medusæ of Millepora." By Sydney J. Hickson, F.R.S.

The male medusæ were discovered in specimens of Millepora from Torres Straits in 1891. Since then no medusæ were seen in any specimens examined except in some from Funafuti collected by Mr. Gardiner, but these were also males and resembled in all essential respects the medusæ previously described. Last year Mr. Duerden sent to the author two consignments of preserved Millepora, one bearing immature and the other mature female medusæ. The immature female medusæ were about 0·4 mm. in diameter; the umbrella is a thin membrane slightly swollen at the margin containing no canals nor cavities of any kind. There is no velum and no tentacles. The umbrella cavity is almost entirely filled with a swollen manubrium bearing a centrally placed mouth and a broad band of ova. The mature female medusæ are 0·6 mm in diameter; three or four ova attain to a size of 0·2 mm. in diameter, the others undergo degeneration or become absorbed into the substance of the large ova. The endoderm of the manubrium is still very thick and vacuolated, but the mouth is usually closed. After the discharge of the medusæ from the corallum the ova become more vacuolated and increase in size to 0·25 mm. in diameter, the general appearance of the eggs being similar to that of the floating eggs of other Cœlenterates.

The medusæ were observed in the living state by Mr. Duerden, who describes them as being sluggish in their movements, feebly pulsating only now and again. Soon after they are set free the eggs are discharged one by one. The whole process, liberation of the medusæ and extrusion of the ova was completed in five or six hours.

Royal Society, December 14.—"The Piscian Stars." By Sir Norman Lockyer, K.C.B., F.R.S.

The classification of the Piscian stars (those in the spectra of which there are dark flutings of carbon) was arrived at nearly ten years ago from the observations of Dunér. The investigation indicated that these stars could be grouped into several distinct species, in the same way as those of Group II. (Antarian stars) which the author had already classified (*Roy. Soc. Proc.*, vol. xliv. p. 65, 1888).

Owing to the want of definite information regarding the line spectrum, the publication of the classification was postponed. Facts bearing on the line spectrum have now been furnished by the recent photographic work of McClean and Hale, and as these do not disturb the classification at which the author had previously arrived, it is unnecessary to further delay the publication of the memoir, which in the main stands as it was written. The original paper is supplemented by reference to the more recent work. The general conclusions arrived at are as follows:—

(1) The undoubted presence of carbon flutings in the sun, including that near *b*, and of solar lines in the Piscian stars, indicates that the Piscian stars are next in order of development to the Arcturian stars.

(2) The stars observed by Dunér may be divided into seven species, beginning with the hottest and ending with the coolest stars.

(3) The reported presence of bright lines in the Piscian stars must be received with caution, as similar evidence of bright lines might be adduced in the case of other classes of stars in which the spectrum is fully explained by dark lines alone.

(4) The redness of the stars increases as we pass from the earlier to the later species of the group.

(5) The variability in this group is less marked than in the Antarian stars, and may perhaps be accounted for by the revolution of secondary bodies of the nature of comets round the stars themselves.

(6) The place on the temperature curve assigned to these stars on the meteoritic hypothesis is fully confirmed by the more detailed inquiry, and the hypothesis is thereby strengthened.

Linnean Society, December 7.—Dr. A. Günther, F.R.S., President, in the chair.—Dr. Otto Stapf, exhibited specimens of Malayan and African species of *Kickxia*, Blume, to show the differences which exist between the two forms. These differences were noticeable in the shape and size of the corolla, the insertion and general relation of the stamens to the tube of the corolla, the placentation, the structure of the fruit, and the general habit of the plants. As the name *Kickxia* would have to be retained for the Malayan species, he proposed the name *Funtumia* for the African species, from *Funtum*, a vernacular name for *F. elastica*. He further pointed out, by means of flowering and fruiting specimens of *F. africana*, Stapf (*Kickxia africana*, Benth.), and of *F. elastica* (*Kickxia elastica*, Preuss), that the latter, and not the former (as was originally assumed), was the source of the so-called Lagos rubber, thus confirming the conclusion to which Dr. Preuss had come with regard to the origin of this rubber.—Dr. Stapf also showed, on behalf of the Director of Kew Gardens, a large infrutescence of *Musa Ensete*, Gmel., lately received from the Azores.—Mr. Gilbert Christy exhibited a preparation of india-rubber by a new process from *Castilloa elastica*, and also specimens of rubber obtained from *Kickxia elastica*.—Mr. A. D. Ferguson exhibited a series of photographic views taken in Demerara.—Mr. J. W. Fawcett read a paper on some vegetable poisons used for the capture of fish by the Aborigines of Australia.—Mr. B. Daydon Jackson pointed out how widespread was the practice of obtaining fish in this way, and gave a brief review of the literature bearing on the subject.—A paper was read by Mr. G. M. Thomson on some Schizopod Crustacea from New Zealand, in which a new genus (*Tenagomysis*) and some new species were described.—Mr. O. A. Walker, in criticising the paper, made some remarks on general distribution, and, in view of the paucity of material which existed, deprecated any attempt being made at present to draw general conclusions.—Mr. H. M. Bernard read a paper on the structure of *Porites*, the smallest of the stony corals.—In a former paper (*Linn. Soc. Journ.*, *Zool.* vol. xxvii. p. 127) he had endeavoured to show that the genus could be deduced from Madreporids as fixed young forms, so young that the skeleton was immature. The small size of the animals, and the fine reticular texture of the skeletal mass, may both be adaptions to their surroundings, for they are most frequently found at the outer edges of the reef and have to bear the full force of the breakers. Since reading his previous paper the author had been fortunate enough to discover the directive plane and the bilateral symmetry of the calicles in *Porites*—very difficult to see, but when once seen recognisable in nearly every specimen. By means of diagrams the variations of the septal system within the genus were described, and the pali were shown to appear in a regular system dependent upon the the fusions of the septa, which fusions always occurred in a definite order.

Mathematical Society, December 14.—Prof. Elliott, F.R.S., Vice-President, in the chair, and subsequently Dr. Macaulay and Dr. Larmor, F.R.S.—The following papers were communicated, in part, by their authors, viz.: (1) A method for extending the accuracy of mathematical formulæ; (2) Central difference formulæ, by Mr. W. F. Sheppard; Circular cubics, by Mr. Basset, F.R.S.; the theorem of residuation, being a general treatment of the intersections of plane curves at multiple points, by Dr. Macaulay.—The remaining papers were communicated by their titles, viz.: The genesis of the double Gamma functions, Mr. E. W. Barnes; on the expression of spherical harmonics as fractional differential co-efficients, Mr. J. Rose-Innes; and sums of greatest integers, by Mr. G. B. Mathews, F.R.S.

Royal Meteorological Society, December 20.—Mr. F. C. Bayard, President, in the chair.—Mr. Baldwin Latham read a paper on the climatic conditions necessary for the propagation and spread of plague. The bubonic plague is primarily due to a specific organism or microbe of infinitesimal size—so small that probably 250 millions of them would be required to cover a square inch of surface. Plague is infectious and contagious, and is greatly influenced by pestilential emanations from polluted and waterlogged soils. The author gives accounts of various outbreaks of plague in this and other countries, including the great plague of London in 1665, when 7165 deaths were recorded in one week in September. Plague is undoubtedly a disease of the poor, and attacks most readily those living on a low diet. The conditions which are conducive to the spread of plague are identical with those which give rise to the escape of malaria from the ground. That the ground itself exercises an enormous influence upon plague is shown by the fact that in all the epidemics persons living on the ground floors suffer to a much greater extent than those who live in the higher storeys of the houses. Mr. Latham says that there cannot be a doubt that the conditions which ordinarily produce evaporation from water or land surfaces are identical with those which produce exhalations from the ground; and these exhalations consist largely of vapour of water carrying matters injurious to health with them. Mr. Latham has discussed the meteorological observations (including the temperature of the soil at the depth of 9, 20, 60 and 132 inches), made at the Colaba Observatory, Bombay, and has compared them with the number of deaths from plague during the recent epidemics in Bombay. He says that if the temperature of the air increases beyond the temperature of the ground, so that its dew-point is above the temperature of the ground, condensation takes place instead of evaporation. To this increased high temperature may be due the sudden stoppage of plague after a certain high temperature has been reached, which, by raising the temperature of the dew-point, stops all exhalation from the ground and may cause condensation to take place instead of evaporation. So also a sudden fall of temperature causes plague to arise; for a fall of temperature means that the temperature of the dew-point must fall, and the tensional difference between a low dew-point and a high ground temperature would at once lead to exhalations escaping in large quantities from the ground, and so lead to the liberation of the plague bacillus from the ground, accompanied with the exhalations necessary for its development.—Dr. R. H. Scott, F.R.S., communicated a note on a remarkable dust haze which was experienced at Teneriffe, Canary Islands, on February 16 to 19, 1898. The haze during this period was exceptionally dense, so much so that a steamer was two days and three nights on a voyage from Teneriffe to Las Palmas, a distance she usually covered in five hours; while the *Tintagel Castle*, of the Donald Currie line, was delayed for thirty hours, and the *Roslin Castle*, homeward bound, had the dust so thick that for 900 miles the sun and stars were obscured, and the ship was delayed two days.

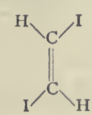
Zoological Society, December 19.—Dr. Henry Woodward, F.R.S., Vice-President, in the chair.—The Secretary read a report on the additions that had been made to the Society's Menagerie during the month of November 1899, and called special attention to two snake-fishes (*Polypterus senegalus*) from the River Gambia, obtained by Mr. J. S. Budgett, F.Z.S., during his recent expedition to the Gambia, and presented by him on November 22. These were believed to be the first examples of this fish ever brought alive to Europe.—On behalf of Mr. G. S. Mackenzie, a photograph was exhibited of two remarkably large tusks of the African Elephant. They each measured, on the outside curve, 10 feet 4 inches in length, and weighed respectively 235 lbs. and 225 lbs.—Mr. Sclater exhibited, on behalf of Mr. Alfred Sharpe, C.B., a portion of the skin of a giraffe which had been shot on the east bank of the Great Loangwa River, British Central Africa, in latitude 13° south, and which, according to Mr. de Winton, who had examined it, was undoubtedly referable to the southern form of this mammal.—Mr. Sclater also exhibited photographs of two young male musk-oxen (*Ovibos moschatus*), now living in the Duke of Bedford's park at Woburn. The animals were stated to have been obtained in Eastern Greenland. They were believed to be the first examples of this species that had reached Europe alive.—Mr. W. E. de Winton exhibited and made remarks upon a specimen of a new mouse of the genus *Dendromys*, obtained by Lord Lovat at Managasha in Southern Abyssinia, for which he proposed the name *Dendromys lovati*.—Mr. R. E. Holding exhibited a series of the horns of the Siberian roebuck (*Capreolus pygargus*) from the Obb River, and made remarks upon the characteristic variation in the horns of this species. Mr. Holding also exhibited a pair of the horns of a stag, from the same district, probably *Cervus eustephanus*, in which the third tine was absent in both horns.—Dr. Forsyth Major exhibited the fœtal skulls of various Malagasy lemurs, showing the development of the osseous tympanic bulla, in which the tympanic ring did not participate. The tertiary *Adapis* in this and other features closely approached the Malagasy lemurs.—He also exhibited an almost complete skull of a new species of *Nesopithecus* (*Globilemur*).—Mr. W. L. Sclater made some remarks on a forthcoming series of volumes which he proposed to issue under the title of "The Fauna of South Africa." The first volume, which was now nearly ready, and would deal with the first half of the Passerine birds, had been undertaken by the late Dr. A. C. Stark. The volume on the mammals, by Mr. Sclater himself, was now in the printer's hands, and would also shortly be issued.—Mr. W. P. Pycraft read the fourth part of his "Contributions to the osteology of birds," which dealt with the grebes and divers (*Pygopodes*). The author considered that the grebes and divers were closely related *inter se*, that they could not be associated with the auks, as had been done by some ornithologists, but were more nearly allied to the tubinares, impennes, and steganopodes. The author also stated that he was of opinion that *Hesperornis* undoubtedly belonged to the suborder pygopodes.—Mr. F. G. Parsons read a second portion of a paper "On the myology of the edentata," prepared by Prof. B. C. A. Windle, F.R.S., and himself. It dealt with the muscles of the hind limb, and also contained a summary of the conclusions that the authors had arrived at respecting the musculature of the order.

CAMBRIDGE.

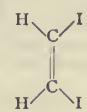
Philosophical Society, November 27.—Mr. Larmor, President, in the chair.—On the influence of temperature, and of various solvents, on the absorption spectra of Didymium and Erbium salts, by Prof. Liveing. Prof. Liveing exhibited a number of photographs prepared to illustrate his paper on the absorption spectra of solutions of salts of Didymium and Erbium in various conditions of dilution and temperature, and in various solvents, which was communicated to the Society at the Stokes Jubilee meeting. These photographs showed that dilution produced no increase of the intensity of the absorptions when the thickness of the absorbent was proportioned to the dilution. In strong solutions of the chlorides a diffuse continuous absorption creeps down the spectrum from the most refrangible end and extends further as the solution is more concentrated. This is not seen with most chlorides, not even with that of aluminium, but is shown by strong solutions of hydrochloric acid in water and in alcohol. The nitrates show a somewhat similar general absorption, and also a widening of some of the bands as the solutions become more concentrated. The effect of acidifying the solutions is to make the absorptions generally more diffuse, but not sensibly to weaken them, and to extend the general absorptions at the most refrangible end. A rise of temperature from about 20° C. to 97° or 98°, also makes the bands more diffuse, but does not increase their intensity. It seems to the author improbable that the metallic atoms should maintain such independence in combination as to have the same absorptions in such different compounds as chloride, nitrate and sulphate, and it is more probable that the common absorptions are due to common products of decomposition. These might be the metallic ions, but the facts that neither dilution nor rise of temperature increase the intensity, and that acidifying does not weaken the intensity of the common absorptions are against that supposition. Ionization implies an electrification of the ions, which again implies a communication of energy to the field, which may probably depend on the circumstances of the encounter when the molecule of salt is broken up, and so some molecules may be broken up without being charged; while there is no reason to suppose that the absorption by a molecule would be altered by its being charged with electricity. The absorptions which are intensified by concentration and also by heat must be ascribed to the condition of the molecules during encounters, which will be more frequent in more concentrated as well as in hotter solutions. The expansion of certain bands with increased concentration by the nitrate, must be ascribed to encounters of molecules derived from the metal with those derived from the acid, which are much more massive than the molecules of water and also than those derived from the chloride. During such encounters the absorbent molecules will be as it were loaded by the influence of the other molecules. This view seems confirmed by the influence which other solvents and other acids have on the absorptions. Didymium chloride in alcohol gives the same bands as the aqueous solution, but generally more diffuse and more or less shifted a little towards the red. The same solution acidified with hydrochloric acid exaggerates greatly these modifications, almost washing out the more refrangible bands and breaking up the very strong band in the yellow into several separate bands. Glycerol as solvent gives modifications similar to, but more strongly marked than, those of alcohol. The acetate in acetic acid and the maleate in water gives similar but much less marked modifications. The tartrate and the citrate in ammoniacal solution also give similar modifications. The borate in solid glass of borax also gives bands which are unmistakably modifications of those produced by the aqueous solution. All these modifications seem to be of the same *character*, though of greater intensity, than the differences between the bands given by nitrate and chloride, and may be attributed to the influence of the comparatively complicated influences of the various molecules during the times of encounter. In such cases as the acid alcoholic solutions there will certainly be at least four chemical compounds mixed in the solvent, which may well produce a complicated modification of the bands without destroying their identity.—"Researches in the Sugar Group," by H. Jackson. A summary is given of the joint researches of Mr. H. J. H. Fenton and the author, which may be conveniently divided into two parts. (α) Oxidation of the more common polyhydric alcohols. The remarkable part which iron plays as a carrier of oxygen was first pointed out by Mr. Fenton in the case of tartaric acid, and has since been extended by him to other hydroxy-compounds. An aqueous solution of the following polyhydric alcohols, glycol, glycerine, erythrite, dulcite, mannite and sorbite, was taken in turn, and after adding a small quantity of ferrous salt to each, hydrogen peroxide was added: in all cases a large evolution of heat took place. The oxidation products in the case of glycol, glycerine and erythrite quickly reduce Fehling's solution in the cold and restore the colour to an alcoholic solution of magenta, which has been decolourised by sulphur dioxide: on treatment with phenyl hydrazine acetate, osazones were obtained which, on analysis, were found to correspond respectively to glycolic aldehyde or diose, glycericaldehyde or triose, and erythrose or tetrose. The oxidation compounds of dulcite, mannite and sorbite do not reduce Fehling's solution in cold, but quickly on warming: they do not give the "magenta" test; facts which serve to distinguish the hexoses from the simpler members of the sugar group. On treatment with phenyl hydrazine acetate there was obtained from dulcite the osazone of inactive galactose, from mannite the hydrazone of mannose, and from sorbite an osazone identical with glucosazone. If an aqueous solution of glycol, glycerine or erythrite, to which a very small quantity of ferrous salt has been added, be exposed for a little time to the action of sunlight in the presence of atmospheric oxygen, it can be shown on examination that a certain amount of the sugar has been formed. These experiments may perhaps give a little support to the theory that iron, which occurs in hæmoglobin and is associated so intimately with chlorophyll, may act as a carrier of atmospheric oxygen. (β) Isolation of diose in a crystalline state and its condensation to a hexose. When dioxymaleic acid, suspended in water, is distilled on the water bath under very diminished pressure and the distillate evaporated to small bulk in a vacuum desiccator, a syrup is left which on standing crystallises out in flat plates of the oblique system. On analysis and examination it is shown to be crystalline diose. A determination of its molecular weight by the depression of the freezing point of water shows the crystal to be bimolecular, but on standing and taking frequent determinations the molecular weight gradually becomes normal and corresponds to the single formula $C_2H_4O_2$, and then remains quite constant. If a dilute aqueous solution of diose be treated with a 1 per cent. solution of soda at the ordinary temperature it quickly turns yellow and finally brown. After standing a few hours it no longer reduces Fehling's solution in the cold, but readily on warming: it no longer gives the "magenta" test: in fact, it has lost all the properties of diose and assumed those of a true hexose. This is confirmed on examining the osazone, which corresponds to a normal hexosazone. The melting point and action towards solvents of the osazone prove its identity with β acrosazone, which Fischer and Tafel isolated from the condensation product of glycerose.—On a new mineral by A. Hutchinson. A colourless transparent crystal of the new mineral was found on a specimen of Axinite from Cornwall in the Carne collection recently acquired by the University. The crystallographic and optical constants of the crystal prove it to belong to the Prismatic system. The results of a quantitative chemical analysis agree well with the formula $CaSn(SiO_3)_3.2H_2O$. The mineral has been named Stokesite in honour of Sir George Gabriel Stokes.—On the condition that five lines in space of four dimensions should lie on a quadric, by H. W. Richmond. In order that five straight lines situated in a space of four dimensions should lie on a surface of the second order a condition must be satisfied. It is here pointed out that the known properties of quadrics in space of five dimensions suggest a simple mode of expressing the necessary condition.

ST. LOUIS.

Academy of Science, December 4.—Dr. Edward H. Keiser described some derivatives of acetylene, exhibiting specimens of the new liquid acetylene iodide discovered by him in January, 1899. He described the methods of making the compounds, and gave an account of its chief physical and chemical properties. The liquid acetylene di-iodide solidifies at $-21°$ C. and boils at 185°. It has the percentage composition and molecular weight represented by the formula $C_2H_2I_2$, and is isomeric with the well-known solid acetylene di-iodide. The speaker announced the discovery of a new method of making the liquid acetylene di-iodide, namely, by heating the solid compound to 260° in a sealed tube. The solid compound is thereby partially converted into the liquid compound. Similarly, if the pure liquid di-iodide be heated to 260° in a sealed tube, on cooling down the liquid will be found to have been partially converted into the solid compound. All the facts known indicate that these two iodides of acetylene are stereoisomers, and that their configuration must be represented by the stereometric formulas



and



Since Dr. Keiser has found that the solid acetylene di-iodide can be converted into fumaric acid, it would follow that the first of the two formulas would represent the solid acetylene di-iodide and the second one the liquid di-iodide. Further experiments upon these compounds are under way, and the attempt will be made to convert the liquid di-iodide into maleic acid.—Dr. K. Bremer demonstrated some tests for glucose by means of aniline dyes, showing that nearly all of the "alkaline" aniline dyes, when rendered basic by the addition of sodium hydrate, become decolourised, or have their colour greatly modified, on heating, in case glucose is present. The reactions shown were especially pretty in the case of methylene blue and safranine.—Prof. Nipher announced that he had nearly completed preparations for the measurement of wind pressures on the sides of the main building of Washington University. The pressures are to be measured at various points along the west end of the building, having a width of about 50 feet, and along the north front, which is something over 200 feet in length. Simultaneous measurements of wind pressure, and wind velocity and direction will be made. The method used is that tested by him on the trains of the Illinois Central Railroad during the summer of

1897. The method was described in No. 1, vol. viii. of the *Transactions* of the Academy of Science of St. Louis. An invitation was extended to members to visit the University and inspect the apparatus.—Prof. H. Aug. Hunicke spoke briefly on some observations which he had recently made on the boiling temperature of hydrocarbons, from which it appeared that when T is the boiling temperature (absolute scale), ρ is radius of gyration of the molecule, and α is a constant, then $T^2 = \alpha\rho$. This holds for the entire series of saturated hydrocarbons, including all isomers.

AMSTERDAM.

Royal Academy of Sciences, November 25.—Prof. Van de Sande Bakhuyzen in the chair.—Prof. Kamerlingh Onnes read, on behalf of Prof. Lorentz and himself, a report on the treatise by Prof. R. Sissingh, entitled "The general properties of the optical image by central rays in a series of centred spherical surfaces." The conclusion, arrived at in the report, viz., to insert the treatise in the *Transactions* of the Academy, was approved. Dr. Hamburger made a communication concerning the absorption of fat and soap in the large and the small intestine. (1) It may now be considered as settled that the large intestine of the dog possesses the power of absorbing fat. (2) Contrary to what has hitherto been assumed, this power is considerable and not even inferior to that of the small intestine. (3) To bring about such a considerable absorption, it is necessary to take an emulsion which will keep a long time in the intestine. The usual Na_2CO_3 is not suitable for preparing such an emulsion, much less NaCl, because both are absorbed quickly and the emulsion consequently soon ceases to exist. A solution of sapo medicatus, however, appears to answer the requirements. (4) As regards the soap solution itself, it appears that it is absorbed, though much more slowly than Na_2CO_3, and that during the absorption it is, partly at least, converted into fat already in the mucosa. This conversion goes on in the severed intestine, nay, it is even effected when the mucosa has been chopped up. Heating to 80°, however, destroys the above mentioned property. (5) As regards the course, taken by fat during absorption in the large intestine, it is very likely that part of it is carried off by the blood capillaries. At any rate in the case of the small intestine, this has been proved beyond a doubt by the above described experiments.—Prof. Cardinaal made a communication concerning an application of the involutions of a higher degree.—Prof. W. Kapteyn made a communication on certain particular cases of Monge's differential equation. All these communications will be inserted in the *Proceedings*. The following were further presented for insertion in the *Proceedings*. (*a*) By Prof. Bakhuis Roozeboom, two papers, by Dr. Ernst Cohen, entitled respectively: (1) The enantiotropy of tin (III.), and (2) The alleged identity of red and yellow mercuric oxide. (*b*) By Prof. Lobry de Bruyn: (1) On behalf of Mr. W. Alberda van Ekenstein and himself, a paper on *d*-sorbinose and *l*-sorbinose (ϕ-tagatose) and their configuration. The inquiry into *d*-sorbose has shown that this ketose possesses the following configuration formula: $CH_2OH—CO—\underset{OH}{\overset{H}{C}}—\underset{H}{\overset{OH}{C}}—\underset{OH}{\overset{H}{C}}—CH_2OH$. On reduction it yields, besides *d*-sorbite, *d*-idite as well; its osazon is identical with idosazon and gulosazon. ϕ-tagatose, a new ketone, which, besides tagatose, is obtained from galactose, under the transforming influence of alkalis, has been found to be the optical antipode of *d*-sorbose, consequently *l*-sorbose with the configuration $CH_2OH—CO—\underset{H}{\overset{OH}{C}}—\underset{OH}{\overset{H}{C}}—\underset{H}{\overset{OH}{C}}—CH_2OH$. A detailed article on this subject will appear in the *Recueil*. (2) On behalf of Mr. J. J. Blanksma, a paper on the action of sodium mono- and disulphides on aromatic nitro compounds. The inquiry has proved that a nitro group of *o*-dinitrobenzol is easily replaceable, and that dithio combinations are formed (also obtained from chlorine nitrobenzol and bromine nitrobenzol), which on oxidation yield sulphonic acids. (*c*) By Prof. J. C. Kapteyn, on behalf of Mr. S. L. Veenstra, a paper on the results of his inquiries into systematical corrections of the stars' own motions in Auwer's Catalogue of Bradley and the coordinates of the apex of the sun's motion. The computations are founded on data, derived from a still unpublished catalogue, compiled by Prof. Kapteyn, which contains, besides the motions of the Bradley stars, a number of auxiliary magnitudes. The result of the computation of the apex does not point to a relative motion of stars of different spectral types. (*d*) By Dr. J. P. van der Stok, a paper on two earthquakes, observed respectively at Batavia and in Europe. (*e*) By Prof. Van der Waals, on behalf of Dr. G. Bakker, a paper on the potential functions $\phi(r) = \frac{Ae^{-qr} + Be^{qr}}{r}$ and $\phi(r) = \frac{A \sin(qr + \alpha)}{r}$, and Van der Waals' potential formula.

DIARY OF SOCIETIES.

THURSDAY, DECEMBER 28.

ROYAL INSTITUTION, at 3.—Fluids in Motion and at Rest: C. V. Boys, F.R.S.

SATURDAY, DECEMBER 30.

ROYAL INSTITUTION, at 3.—Fluids in Motion and at Rest: C. V. Boys, F.R.S.

MONDAY, JANUARY 1.

VICTORIA INSTITUTE, at 4.30.—Sub-Oceanic Terraces and River Valleys: Prof. Lobley.

TUESDAY, JANUARY 2.

ROYAL INSTITUTION, at 3.—Fluids in Motion and at Rest: C. V. Boys, F.R.S.

THURSDAY, JANUARY 4.

ROYAL INSTITUTION, at 3.—Fluids in Motion and at Rest: C. V. Boys, F.R.S.

RÖNTGEN SOCIETY, at 8.—The Interpretation of Skiagrams: Chisholm Williams.

FRIDAY, JANUARY 5.

GEOLOGISTS' ASSOCIATION, at 8.—Our Older Raised Beaches: Address by Sir Archibald Geikie, F.R.S.—A New Rhætic Section at Bristol: W. H. Wickes.

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THURSDAY, JANUARY 4, 1899.

PHYSIOLOGY VERSUS *NATURAL SELECTION: AN UNNATURAL ANTITHESIS.*

Colour in Nature: a Study in Biology. By Marion I. Newbigin, D.Sc. (Lond.). Pp. xii + 344. (London: John Murray, 1898.)

THE authoress states in the preface that her object is "to set forth in systematic order the main facts at present known in regard to the Pigments and Colours of Plants and Animals," and especially to treat the physiological side of the subject, and bring together the scattered literature which deals with it.

The first three chapters are introductory, dealing with general questions of importance for the remainder of the work—such as the differences between pigmental and structural colours, and the classification of both these categories. Colours and pigments are then considered throughout the plant and animal worlds, the subjects treated in consecutive chapters being plants; Protozoa sponges and Cœlentera; worms; Crustacea and Echinodermata; Lepidoptera; insects in general and spiders; Mollusca and invertebrates generally; fish; amphibians and reptiles; birds (occupying two chapters); mammals and the origin of pigments. The concluding chapter "on the relation of facts to theories" contains a general summary and a brief exposition and criticism of various theories as to the origin of colour. The list of references, admitted to be incomplete, will nevertheless be useful, although it is to be hoped that in a future edition mention will be made of Colonel Swinhoe's complete paper "On the Mimetic Forms," &c., in the *Linnean Journal*, instead of to the brief abstract in the *Proc. Roy. Soc.*

The writer again and again protests against the interpretation of colour phenomena by natural selection, and implies that those who incline to accept this interpretation are satisfied with casual suggestions which they make no attempt to test. The present writer believes that the exact opposite is the truth, and that in the whole history of biological thought no theoretical suggestions have been so fruitful of extended and precise observations as those based upon this very hypothesis.

Whenever a writer ventures to suggest such an interpretation, it is assumed by opponents that he is satisfied to leave the matter at this point without the thought of any further investigation by way of confirmation. This is an assumption, and a most unfair assumption. Those who have found natural selection a sure guide to research, who cannot pursue all the varied lines which it indicates, are glad to offer the same inspiration to other workers. "A few magic words upon natural selection" (p. 24) are not intended to "dismiss" any problem in natural history, but rather to suggest lines of research by which it may be attacked.

It is interesting to note that this extremely critical attitude as regards natural selection is not accompanied by any special reticence in the use of other hypotheses. Thus, as regards birds and butterflies, "the fact of the exquisite structural coloration and a wonderful development of structures arising from the cuticle, suggests that the structural colours are merely a result of extreme differentiation of the cuticle, and therefore produced by the same cause which gave rise to this differentiation" (p. 11).

Again, on p. 155, the persistence of green pigments derived from the larval food into the ova (and, in fact, into the young which hatch from them) is quoted from the present writer; and the authoress then proceeds to suggest that the green colour found by Mr. F. Gowland Hopkins in the *Pierinae* is of the same kind. This unsupported suggestion is very probably sound, and had been independently arrived at by the present writer, who is also inclined to extend it to the green pigments doubtless derived from the blood (hæmolymph), which are stored, as in the *Pierinae*, between the two wing membranes, and give rise to the bright green or sometimes blue-green bands or spots in certain *Nymphalinae* (*Colaenis dido*, *Victorina steneles*) and *Papilioninae* (*P. sarpedon*, &c.). Such a suggestion is reasonable, and may well lead to specially directed research; but a similar spur to inquiry, if based on the theory of natural selection, would have been held up to contempt by the authoress.

The freedom with which even flimsy and worthless speculation is indulged in, if only an explanation founded on natural selection can be thereby avoided, is well seen on pages 161 and 162, where the warning colours of *Heliconidae* and the mimetic or convergent *Pierinae* are briefly discussed. The writer suggests that the slow flight and warning colour of *Heliconidae* and their mimics are due to "the relatively low organisation which renders pigmentation by waste products possible, which makes brilliant optical colours impossible."

First, as to "low organisation," the Insecta are admittedly among the most specialised of animals; excepting the Diptera there are no more specialised insects than the Lepidoptera; among Lepidoptera the *Ithomiinae* (Bates' *Danaoid Heliconidae*, Trimen's *Heliconoid Danaidae*) are the most specialised, and the *Heliconinae* proper (Bates' *Acraeoid Heliconidae*) only less so.

Secondly, as to "pigmentation by waste products," Mr. Gowland Hopkins' observations prove that the pigments of the *Heliconidae* are *not* the same as those of the Pierines which resemble them. The latter alone have been shown to possess wing pigments of uric acid or substances allied to it.

Thirdly, as to brilliant optical colours being rendered impossible. There are numerous examples of iridescence in *Ithomiinae*, and some structural blues in the far less numerous *Heliconinae* proper, while in the *Danainae* which are closely related to the former the structural blues of many much-mimicked *Euploeina* are magnificently developed.

The writer is apparently desirous of rejecting an interpretation which explains an immense body of facts, and has led to the discovery of an immense number more, in order to substitute a crude suggestion which, for its mere statement, requires the distortion of many well ascertained facts.

It is only fair to add, however, that the writer recognises and clearly points out the obvious difficulty that the resemblances in pattern are not to be explained by her hypothesis.

Similar bias is shown in the prominence given to unimportant and often partisan statements; while the original evidence on which an opposite conclusion has been based is neglected or barely alluded to.

Thus, referring to the variable coloration of caterpillars, we read on p. 147: "According to recent research, it is not so much the colour of the environment which directly affects the larvæ as the intensity of the light" (see Garbowski). To the conclusive experiments upon which an opposite contention is based no allusion is made, the bias of the writer permitting nothing more than a vague reference to "popular books besides those already mentioned." But, on the strength of the statement quoted above, we are treated with reflections upon the errors of a simple explanation in biology.

Again, on p. 325, in reference to the artifically produced variations in the colours of butterflies, we are told that "competent entomologists (*e.g.* Garbowski) are of opinion that the new colours have little or no phylogenetic importance," without the slightest indication that highly competent authorities have given very good reasons for an opposite conclusion. In fact, if the writer agrees with an authority, it is sufficient to quote his opinion without his reasons, and, above all, without any of the reasons which point in another direction.

The references to Piepers' easily answered and often superficial objections to the theory of mimicry (pp. 316–321) are given at considerable length, and the reader unacquainted with the subject might well suppose, from the writer's concluding remarks, that serious difficulties had been raised.

In a similar spirit the writer speaks of "the (by hypothesis) well-protected *Heliconidae*" (p. 149), thus assuming an assumption on the part of those who seek an interpretation based upon natural selection, and neglecting the considerable body of evidence, direct as well as indirect, which has been brought together.

The use of the contemptuous "so-called" occasionally recalls the jest about the "so-called nineteenth century."

The statement of the procedure of the Darwinian school (p. 306), in attempting to solve the problems of colour, is the merest travesty, quite unworthy of serious comment.

Apart from the obvious bias of the writer in dealing with natural selection, of which numerous other examples might have been adduced, the work is likely to be useful. The most interesting and valuable parts are those dealing with subjects which the authoress has herself investigated, such as the structural colours of birds' feathers. The book is, in fact, not a well-balanced and judicial account of the subject, "Colour in Nature," but an interesting exposition of those parts of her subject with which the authoress is in sympathy, other parts being either distorted or omitted. In the former category would doubtless be placed the interpretation of external colour, as the expression of internal structure, of which a single example is given on p. 226, and it is therefore remarkable that no reference is made to the numerous examples which the late Alfred Tylor was accustomed to explain in this manner.

The book is clearly printed, with few printer's errors, and the small number of simple illustrations sufficiently explain the writer's meaning. E. B. P.

THE GROWTH OF ANIMAL AND VEGETABLE ORGANISMS.

Experimental Morphology. By Charles Benedict Davenport, Ph.D., Instructor in Zoology in Harvard University. Part 2. Pp. xviii + 281 to 508. (New York: Macmillan Company; London: Macmillan and Co., Ltd., 1899.)

THE second part of Dr. Davenport's work—the first part appeared two years ago and was noticed in NATURE, October 14, 1897—deals exclusively with the effect of chemical and physical agents upon the growth of animal and plant organisms. In the preface the author draws attention to the importance of the study of the conditions which affect growth. "The possibility of increasing the human race beyond limits that are not far off depends upon a better knowledge of the conditions of growth. The reader has only to consider that the world's supply of 2500 million bushels of wheat, 2000 million bushels of maize, 90 million tons of potatoes, and its untold millions of tons of beef, pork, and fish are reproduced each year by growth." This importance has recently been emphasised by the remarkable result of Sir William Crookes' researches into the statistics of the world's wheat supply as set forth in his presidential address at the Bristol meeting of the British Association, and the controversy to which that address has given rise. Dr. Davenport selects as his definition of growth "increase in volume," a definition which is by no means safe from criticism. Although we all think we understand what is meant when growth is spoken of, biologists have been by no means in agreement as to how exactly it should be defined. Thus, as the author points out, while Huxley spoke of growth as "increase in size," Sachs regards the volume increase as necessarily intimately associated with change of form, while Pfeffer takes the qualifying part of Sachs' definition, and defines growth as change in form only, and this is accepted by Vines, who adds: "accompanied usually by increase in bulk." To us this definition appears far more satisfactory, even if it is associated with the idea of development, than the more limited definition adopted by Davenport. In the animal organism especially is it difficult to exclude the idea of change of form in association with growth, nor does it seem reasonable to place a mere swelling due to imbibition of water or to distension with gas upon the same footing as a new formation of bioplasm.

The book before us is, however, almost entirely concerned with vegetable organisms, in which, no doubt, the imbibition of water plays a much more important part in the process of growth than it is apt to do in animals. And as a matter of fact the percentage of water in many animal embryos undergoes a steady decrease as development and growth proceed.

With regard to the effect of chemical agents upon growth, one of the most interesting parts of the work is that dealing with the supply of nitrogen to growing plants, whether it be offered to them in the form of a salt (nitrate) added to the soil, or, as occurs in Leguminosæ, in the form of atmospheric nitrogen, fixed for their assimilation by the symbiotic bacteria at their roots.

Chemotropism, or the effect of chemical agents upon the direction of growth, and heliotropism (phototropism), or the effect of light upon the direction of growth, both receive their due share of attention. The effect of water upon growth is treated separately from that of other chemical agents, this amount of attention being accorded it on account of its immense importance—especially in plants—in the process. The effects of contact with solids and that of molar agents in general are duly considered, and the chapter devoted to them includes subjects so diverse as the results upon the growth of bacteria by violently shaking the vessel containing them, the tendency of twining stems and tendrils to grasp the solid objects with which they come in contact, the effect of wounds upon the growth of plants, and even the effect of flowing water in influencing the direction of growth. The effect of gravity upon the growth of sessile organisms (geotropism) and the results obtained by neutralising this effect by the employment of the klinostat is also considered, and illustrated by numerous diagrams. The effect of atmospheric electricity in increasing the rate of growth was supposed to be demonstrated by the experiments of Grandeau, who reared two similar plants—one in the open, and the other with an enclosure of wide-meshed wire netting—with a marked balance in favour of the one which was exposed freely to the influence of any electricity which might be present in the atmosphere; but others have obtained negative or discordant results.

The effect of heat in influencing the growth of organisms is familiar to every biologist, and Dr. Davenport illustrates it by numerous tables and charts taken from observations upon both plants and animals. It is indeed impossible here so much as to enumerate all the different aspects from which the subject of growth has been studied, and to which reference may be found; and although the book does not profess to be anything more than a compilation, and, in fact, contains no matter which is entirely original, it is that sort of compilation which will be of most use to the student of biology, as indicating to him where he may at once come across the work which has been done in each department of the subject of which it treats. That the information yielded should include everything upon so vast a subject is too much to expect in a book of less than five hundred by no means closely printed pages, and, in fact, one occasionally misses a reference to work of no little interest and importance, such as that of Ringer upon the influence of mineral salts upon the growth of tadpoles, and of Romanes upon the comparative effects of flash light and steady light in producing phototropism in seedling plants. Neither is the subject of the influence of drugs considered at anything like the length which its importance seems to deserve. Nevertheless, for the reasons indicated, and because the book is a painstaking and, on the whole, a successful attempt to furnish a connected account of an important branch of experimental morphology, it will be welcomed by the many workers who are devoting themselves to the pursuit of this interesting class of investigation.

A BOOK ON MOUNTAINS.

Die hochgebirge der Erde. Von Robert von Lendenfeld. Mit titelbild in Farbendruck 148 Abbildungen und 15 Karten. Pp. xiv + 532. (Freiburg im Breisgau: Herdersche Verlagshandlung, 1899.)

THIS is a most conscientious piece of bookmaking. The author appears to have read and made a summary of all the more important descriptions of the mountain masses of the globe. Beginning with a sketch of the physiography of mountains, their development and sculpturing, he passes on to describe them chain by chain. As he has himself travelled much, he can often speak from personal experience, while the numerous and generally excellent illustrations enable the reader to realise the different types of scenery. Reproductions of photographs are used in most cases, but occasionally, of course, copies of engravings, variable in quality, were alone available. Some, both of the one and the other, have done duty before, and a few perhaps may be more attractive to the general than to the scientific public. Pictures, for instance, of climbers in a mist seem more appropriate to a book of travels, and some of those representing mountain plants or animals are hardly such as to enhance the value of the book. Attractive also as are all Mr. E. T. Compton's sketches, we cannot but feel that in a treatise of this kind reproductions of photographs would have been better, for accurate delineation is sometimes sacrificed to artistic sensibility. This is especially true of the drawing of the Grivola on p. 128, in which we have not found it easy to make out the topography. These, however, are matters of opinion. The book contains a vast mass of information, brought down to the latest possible date, and collected with a thoroughness and accuracy truly German.

The book also exhibits one or two defects, which perhaps, like its merits, are related to its birth-place. In the treatment of the subject we are conscious of some want of lucid arrangement and of a comprehensive grasp. In regard to the former, a brief outline of the contents may perhaps best indicate our meaning. It begins with a short sketch of mountain building and sculpturing, followed by a glance at the characteristic flora and fauna: a subject so wide that any details can only be fragmentary, and we should have preferred to pass it by in a few paragraphs which stated the general principles by which the life distribution has been determined. The author then commences, at the seventieth page, his special descriptions with the mountains west of the Mediterranean, from the Atlas to the Pyrenees. Thence he passes on to the Alps, which are treated, perhaps not unjustifiably, at rather disproportionate length, and then in another section we jump from Sardinia and Corsica to the Apennines, run along the Carpathians to the Balkans, make a leap to the Caucasus, and finally land with the ark on Ararat. Next comes the radiating group of giant chains in Central Asia, of which some of the less known are very well described. In the next section, after a very brief glance at the northern mountains of Eurasia in general, we are transported to Spitsbergen and Iceland, and then restored to the mainland in Scandinavia and the Urals. After that we wander to Central and Southern Africa, taking flight at last for Arabia and the peninsula of Hindustan. Then, in a long section, we make the circuit of the Pacific together with a digression to Hawaii, and after jumping from Greenland to the Appalachians, and thence to Guiana, finally come to rest on the highlands of Brazil. We find traces, no doubt, of a geographical order in the above, but think that to have kept to continents, while carefully pointing out the relation to ocean basins, would on the whole have produced clearer ideas.

We also feel the want of a concluding chapter, giving a summary of the results which follow from a study of the details contained in the foregoing sections; the principles, if we may so call them, of mountain building and sculpture, and the connection between their forms and materials. The latter was sketched briefly, but accurately so far as it went, by Ruskin years ago in the fourth volume of "Modern Painters," and might now have been elaborated in more detail by Dr. von Lendenfeld from the mass of materials which he has collected. We may illustrate the want of inductive treatment by the case of Monte Rosa. The map, especially if slightly extended eastward, would have given the author an opportunity to discuss an interesting problem leading up to general principles. What causes the extraordinary gap between Monte Rosa and the Strahlhorn? The range of the Mischabelhörner seems to be cut off at the southern face of the latter, while another range, running from the west, terminates even more abruptly in the eastern and northern faces of Monte Rosa. In the intervening gap, some four miles wide, nothing on the edge of the great snow-field rises higher than the hump of the Cima de Jazzi itself, obviously terminating a ridge which extends eastward from the Riffelhorn. What is the explanation of this ridge—also cut off abruptly like the others, and of the gap itself? The map suggests to us a solution of the mystery. Beneath a precipitous descent, seldom less than 6000 feet vertical, lies the head of the Macugnaga valley. Here, as in many other cases in the Alps—it is probably equally true of the Théodule gap west of the Breithorn—the denuding forces have acted with greater potency on the Italian side of the watershed, and they have actually quarried away the mountain centre from which these great ridges once radiated and replaced it by the great amphitheatre into which the Macugnaga glacier now descends.

But while venturing on these criticisms we are thankful for what the book gives us, especially for a glossary to help the unlearned and for an excellent index. We lay it down with something like envy. It is one of a series illustrative of the Earth; it is well and almost profusely illustrated, excellently printed, and its price is 14 marks. We presume then that works of this nature find in Germany a sale sufficiently large to make them remunerative to publishers. But would any English firm be adventurous enough to undertake such a series, or even to publish the volume before us? We fear not. Our German cousins value education more than we do, and apparently desire mental food more solid than halfpenny newspapers, penny dreadfuls, shilling shockers, or even novels with a purpose.

T. G. BONNEY.

OUR BOOK SHELF.

Beginselen der Scheikunde. By Dr. M. C. Schuyten. Pp. 109. (Antwerp: Van Ishoven, 1899.)

THIS is an elementary text-book on qualitative analysis, which aims also at imparting some of the fundamental principles of chemistry. A short introduction explaining the difference between physical and chemical change is followed by a list of the more important elements (iron is omitted) with their symbols. From this we pass on to a brief account of some fourteen elements, which are to furnish material for experimental investigation. The author then selects the unfortunate case of copper and sulphur to illustrate the difference between a mixture and a compound. It is needless to say that a more illogical and false illustration could scarcely be conceived. 6·3 grams of copper powder and 3·2 grams of sulphur are mixed together. The student must puzzle out for himself why these precise quantities are taken. Having satisfied himself by the help of a pocket lens that both substances are still present when they are shaken up, the mixture is heated. The blue-black mass which results is now, we are told, a chemical compound consisting of 63·12 parts of copper and 31·83 parts of sulphur, when the author must be fully aware that it is a non-homogeneous mixture of cuprous and cupric sulphide and free sulphur. One is tempted to suggest another example of the same order. Take 1 lb. of sugar and $\frac{1}{4}$ lb. of butter, and mix them together. The butter and sugar may still be observed with a lens. Proceed to heat them until the required consistency is obtained. The substance is no longer sugar and butter. Consequently, the resulting toffy is not a mixture, but a compound made up of the original ingredients in the proportions taken.

Passing over this unsatisfactory start, the system laid down by the author has much to recommend it. Before the student begins systematic analysis, he is set to perform experiments on the preparation of simple compounds, as well as to study such general reactions as oxidation reduction, the action of acids on metals, &c. The text is interspersed with notes of interrogation, and, in addition, a few questions are appended to each lesson.

Where the book fails is in its attempt to condense a large amount of information into a small compass, and in the lack of sufficient experimental details and adequate illustrations of apparatus.

A beginner, who had no further help than this book affords, would meet with difficulties at every step. No doubt the author's object is to place something in the student's hands which will supplement his own laboratory teaching, and from this point of view its publication may be justified.

Student's Edition of a Standard Dictionary of the English Language. Edited by James C. Fernald. Pp. viii + 915. (New York: Funk and Wagnalls Company, 1898.)

The Standard Intermediate School Dictionary of the English Language. Edited by James C. Fernald. Pp. viii + 533. (New York: Funk and Wagnalls Company, 1899.)

BOTH these dictionaries are based upon Funk and Wagnalls' Standard Dictionary. The student's edition gives the orthography, pronunciation, meaning and etymology of upwards of 60,000 words and phrases. It is furnished with appendices of proper names, foreign phrases, faulty diction, disputed pronunciations and abbreviations, as well as with a number of useful tables, including those of the chemical elements, metric weights and measures and many others. The student's dictionary also contains some 1225 pictorial illustrations. The school edition provides brief and accurate etymologies, and is furnished with as many as 800 pictures. Both volumes are beautifully printed and serviceably bound.

Though the books have only recently been placed upon the British market, they have attained a wide popularity in America, and we shall be much surprised if their attractiveness does not lead to their becoming favourites in this country.

It is always interesting to compare dictionaries, and some of the results of a comparison of those before us with one largely used in English schools will not be out of place. The first word, the meanings of which were placed side by side, was *steelyard*. In the school volume under notice was found "a simple device for weighing, consisting of a scale beam, counterpoise, and hooks," while the book with which it was compared gave "a balance for weighing bodies, consisting of a single weight shifted backwards and forwards on a graduated beam." But it is only fair to add that a small cut, of a not very intelligible kind, illustrates the American definition. The second word looked up in both volumes, this time using the student's edition of the Standard Dictionary, was *nebula*. In the dictionary under review is to be found :—(1) "Any luminous cloud-like object in the sky, as a distant star cluster ; (2) A supposed gaseous body of unorganised stellar substance" ; that in the familiar dictionary on our table :—(1) "An appearance as of light gauzy cloud amongst the stars, usually only seen through a telescope, often resolvable by a powerful instrument into clusters of stars ; (2) A white spot or opacity in the cornea." Neither of the definitions is altogether satisfactory, for a nebula is not a star cluster any more than an amœba is a star-fish.

The new volumes have, however, several commendable characteristics, and will doubtless find a place in schools.

Outlines of Bacteriology. By Dr. L. H. Thoinot and E. J. Masselin. Translated by W. St. Clair Symmers, M.B. Pp. 318. (London: C. Griffin and Co., Ltd., 1899.)

THIS little volume, bound in leather, is evidently calculated to stand hard wear, and is put together in the hopes of becoming a bacteriologist's *vade mecum*. It differs from many such compressed manuals by the introduction of numerous quotations from the original memoirs ; these extracts would have gained in value had the source been acknowledged in all cases instead of in certain instances only, one of the principal advantages of such references being to encourage the intelligent student to consult such memoirs for himself, and so extend his knowledge of the subject beyond the necessarily confined limits of a small text-book.

The authors are medical men, and it is for the medical student that the book has been written, and for this purpose it appears to be admirably suited ; industrial bacteriology is not touched upon, and we think, therefore, the title is somewhat misleading, inasmuch as the authors deal with but one branch of bacteriology. It is clearly printed and copiously illustrated.

Lehrbuch der Experimental Physik. By Adolph Wüllner. Fifth edition, vol. iv., part 2. Pp. xii + 530. (Leipzig: Teubner, 1899.)

A TREATISE on physics which, by the issue of the above part, has now completed its fifth edition must evidently have been found useful ; and it may safely be said that this edition will be found still more useful than its predecessors. The book has been fully revised and considerably enlarged ; the additional matter representing the more recent advances in physics. The section which now lies before us treats of the propagation and perception of light, interference, diffraction, and polarisation phenomena and theories.

The thirty additional photographs in this edition are mainly owing to the advances in the electromagnetic theory of light, and to the increase of our knowledge with regard to the relations between light and magnetism (Zeeman effect, &c.) These and indeed all the parts of the book are treated with great lucidity, thoroughness, and accuracy. We may call particular attention to the chapters dealing with polarisation ; they specially please us. Those diagrams which represent three-dimensional phenomena in the plane of the paper do so in such a manner that the intention of each is evident at a glance ; and the mode of dealing with the optical properties of the crystals selected for illustration of the general theory is such as to give a very complete view of the cited cases, and strikes us when contrasted with the treatment in certain other text-books which might be mentioned. Altogether, although the volume shares the fault of so many German books—viz., that it is not always free from dryness—we recommend it heartily as a thoroughly sound and modern text-book suitable for the use of the senior students in our university colleges. A. W. P.

Proceedings of the Eleventh Annual Meeting of the Association of Economic Entomologists. (*Bulletin* No. 20, New Series, U.S. Department of Agriculture ; Division of Entomology.) Pp. 111. (Washington, 1899.)

THIS publication includes a series of useful and interesting articles on injurious insects, by Profs. Howard, Marlatt, Felt and other well-known entomologists. Fortunately, injurious insects seem to have their day of destructiveness, and then cease to do much mischief ; at least, for a time, owing to natural or artificial checks. Thus, respecting the much-dreaded San José Scale, Prof. Marlatt writes : "It is not especially feared to-day in California, and, in fact, it is looked upon by some of the largest fruit-growers (as I am informed by Prof. Washburn) as having been of positive advantage, the yearly treatment of trees having necessitated a system of regular short pruning, which has greatly improved the quality of the fruit, and much lessened the expense of gathering." He, therefore, argues against undue alarm and excessive preventive measures respecting sudden and perhaps temporary insect attacks. Prof. Howard prints a translation from the Russian, by Dr. Fireman, of a paper by Porchinski, respecting the destruction of Tabanidæ by pouring kerosene into the pools to which they resort to drink. Other articles deal with caprification in California ; the destruction of hairy caterpillars by birds ; the progress of the never-ending campaign against the Gipsy Moth in Massachusetts, &c. W. F. K.

Elementary Dynamics. By W. M. Baker. Ch. xix. Pp. 251. (London: George Bell and Sons, 1899.)

ALTHOUGH necessarily similar in subject matter to the many existing treatises on this subject, the above little work will recommend itself by many convenient minor originalities. The descriptions are exceedingly minute and clear, and are in most cases followed by more worked-out typical examples than usual.

In addition to a set of examples at the end of each chapter, there is a useful compilation of more difficult problems at the end, selected from past examination papers. The scope of subject included has been chosen chiefly for the benefit of students preparing for Woolwich and Sandhurst, or reading for scholarships at the Universities.

Handbook of Physics and Chemistry. By H. E. Corbin and A. M. Stewart. Pp. vi + 424. (London: J. and A. Churchill, 1899.)

WITHOUT attempting any originality of style or subject matter the authors of this work have culled from the many authoritative sources the requisite information necessary for students preparing for the First Examination in physics and chemistry of the Conjoint Board of the Royal Colleges of Physicians and Surgeons. The book will also be useful to those working for the Pharmaceutical Society and the Royal Veterinary College, the syllabuses prescribed by these institutes being fully covered.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Contemporary Meteor-Showers of the Leonid and Bielid Meteor-Periods.

PART I.—*Co-Leonid Showers.*

As a large proportion of the November shooting-stars observed and mapped in 1899 on and near the two chief shower-nights, of November 14th and 15th, were *non-Leonid* meteors emanating from various contemporaneous centres of much less conspicuous star-showers of that month, than the eagerly expected but unfortunately not witnessed great spectacle of the *Leonids* themselves, it may furnish a useful clue to some of the foreign-looking or unconformable meteors' sources of which several bright examples were no doubt mapped by observers in the many able watches kept for the recently expected shower, to mention some radiant-points which were noticed here to be particularly active in about twelve hours of tolerably productive meteor-watching, lasting one or two, to three hours, on each night of November 6th, 8th, 10th, 12th and 13th, in clear dark sky, before the moon had acquired sufficient strength to hide the smaller meteors. Mr. Denning also watched for about four hours on the nights of the 10th, 11th and 13th, seeing four *Leonids* and twenty-four other meteors; and among nine unconformable ones of which he sent me path-positions, three accorded in direction with radiant-points of my present list, and one of these, on November 10th, as well as a second meteor on that night, was simultaneously mapped here, enabling real paths of these two meteors to be concluded from the observations, as represented in this Table.

TABLE I.—*Real Paths of an* e-Taurid, *and of an* ι-Aurigid *Shooting-star, doubly observed at Bristol and Slough, on November* 10*th* 1899.

Hour G.M.T.	Apparent Magnitude.	Height in B.S. Miles, at: Beginning.	Height in B.S. Miles, at: End.	Radiant-point. α δ	Length of Path (Miles); and Duration (Seconds).	Observed, and (Theoretical Parabolic) Speed, Miles p. sec.	Appearance.
h. m. 13 16	2–4	58; over 5 miles S.E. from Cheltenham.	46; over 5 miles S. by E. from Evesham, Worcestershire.	$55°+4°$ *e Tauri* S., 15° W. alt. 42°.	$17\frac{1}{2}$; 0·8	22 ($21\frac{1}{2}$)	Uniformly bright, orange-yellow; no sparks or streak.
13 37	4	77; over 1 mile E. from Godalming, Surrey.	47; over 3 Miles W. from Chertsey, Middlesex.	72+30 *ι Aurigae* Due S., alt. 68°.	$33\frac{1}{2}$; 1·4	24 ($29\frac{1}{2}$)	Near radiant, at Slough, slow, tapered; yellow, with streak-like, red, tapered, spark-tail.

The first true *Leonid* seen here appeared at the close of a short very clouded watch of 30m., at 5h. 59m. a.m., on November 13th; at least as bright as *Sirius*, since it shone through clouds which hid all stars except those of Leo's Sickle, from which its course was directed.[1] In the earlier part, however, of that night, and during all the preceding night of November 11th, the sky here had been completely overcast; but Mr. Denning saw two small *Leonids* and three other meteors in 35m., at Bristol, after 14h. 50m. on the latter night. Two third magnitude *Leonids* were seen here on the following morning of November 14th, among four meteors mapped in a nearly clear hour after 4h. a.m., and Mr. Denning noted a small *Leonid* with two other meteors in about 20m., on that morning, after 5h. a.m.; but the few tracks seen till then showed no great activity yet of the looked for meteoric exhibition. A single bright *Leonid*, at 13h. 33m.,[1] seen here in the half-hour till 2h. a.m. on the morning of November 15th, when the sky for a short while was clear before thick fog and clouds intercepted all view of the sky for the rest of that night and through all the night of the 15th, with only a very partial break's exception for an hour preceding daybreak on the morning of the 16th, when nothing meteoric was seen, was the only view that I could here obtain of any well marked phase of brightness or abundance which the shower was expected to display, and which it did actually display with some small intensity elsewhere, on its two chief predicted nights.

While no rapid rate of appearance of the *Leonids* was yet noted here in the clear half-hour till 2h. a.m. on November 15th, I have learned from my brother, Sir W. J. Herschel, that at Littlemore, near Oxford, he observed, with a small party of watchers, quite an abundance of *Leonids* on that morning, in clear sky, between 1h. 15m. and 6h. 15m. a.m. The total list recorded there in those five hours was 62 *Leonids* and 40 *non-Leonids* or ordinary meteors. To the number of the *Leonids*, besides, should be added six or eight not charted, from their coming too rapidly in one or two minutes at 5h. 25m., and in five minutes after the appearance, at 5h. 40m. a.m., of the brightest meteor of this watch, which will be referred to more particularly below. Including those additions, the numbers of *Leonids* noted in the successive hours before, and half-hours after moon-set at 16h. 50m., were

Hours ending at	14h. 50m.	15h. 50m.	16h. 50m.
Numbers of *Leonids*	6	8	10
And Hourly rates..	6	8	10

Half-hours ending at	17h. 20m.	17h. 50m.	18h. 15m. (25m.)
Number of *Leonids*	14	25	7 (in. 25m.)
And Hourly rates..	28	50	17

The sky was generally clear, and extremely clear in the one dark hour after moon-set. The hourly rates then show a sudden increase; but a very sudden rise occurred also in the second half of that dark hour (from 28 to 50 *Leonids* per hour, very soon arrested then by gradually increasing daylight), much too abrupt and sudden an increase, it seems obvious, to be at all possibly ascribed to fading lunar twilight. These observed rates in the moonless sky seem thus pretty certainly to show that a maximum of the meteor-stream was either fast approaching and very near and imminent, or may perhaps even have been just attained, when a close was put by daylight to my brother's good view of the shower and to his carefully recorded notes of this *Leonid* display's appearance. The proportion of the number of *Leonids* to that of ordinary shooting-stars seen in the watch at Littlemore, 6 or 7 : 4, nearly resembles, although it did not quite attain the proportions noted at Romsey, Hants, and at the University of Pennsylvania, U.S., on the

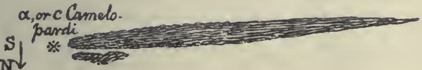
[1] This path was approximately from 99°, + 19° to 83°, + 15°; about 15° in ⅔ second.

[1] This 1st magnitude *Leonid's* path was from 113°, + 37° to 93°, + $39\frac{1}{2}$°; 15° in ⅔ second, leaving a greenish-white streak all the way for about 2 seconds.

following morning of November 16th, which, as reported in the *Times* of November 17th, were both about 2 : 1.[1]

One of the forty unconformable or *non-Leonid* meteors seen at Littlemore, which appeared at 5h. 40m. a.m. on November 15th, was so extremely bright that it could only be termed conventionally an "ordinary" shooting-star, since it was not only brighter than Sirius and than all the other fixed stars, but it left behind it a light streak along its path, the terminal part of which remained visible for five minutes. The general hue of the meteor was yellow, inclining to orange, and it described a path of 35° from *α Ursae Majoris* exactly to *α* (9, or *c*, Bode) *Camelopardi*, or about from 163°, +63° to 72°, +66°, in two, or two and a half seconds. A streak remained on all its long path, which thickened greatly in about the last third part, or last 12° of the flight, and remained shining there with surprising persistency, while on the earlier part of the track it quickly faded out. The light-wisp shortened gradually from behind, its front end remaining constantly near *α* (or *c*) *Camelopardi*; and when it had shrunk to about 8° in length, it grew slightly sinuous, as if windwafted, and its last visible light-trace at the end-point of the flight had drifted about half a degree northwards, altogether, or sideways from the streak's direction, when it disappeared. The first and final appearances which the streak presented near the star *α*, or Bode's *c Camelopardi*, are shown as they were represented by a sketch, in the adjoining Figure (Fig. 1).

Like multitudes of streak-leaving meteors which in the morning hours, on all nights of the year, stream from the neighbourhood of the earth's apex near the east horizon, this bright



Streak of the Meteor of 5h 40m am., November 15th, 1899, as seen at Littlemore, near Oxford.

FIG. 1.

meteor's path diverged from no conspicuously well known ordinary radiant-point of the *Leonid* epoch, but shot from far east of *Leo*, and must have passed about over the northern part of Oxfordshire from some radiant-point not far above the E. by S., or E.S.E. horizon among the stars of *Comae Berenices*, or near *ζ Virginis* and *Spica* which had then just risen in the E.S.E. Should it have been recorded elsewhere, therefore, descriptions of its apparent path at other places to compare with this one would be of special interest and value, as with only one exception, of a centre of five swift meteors leaving streaks, observed by Mr. Denning on the morning of November 16th–17th, 1885, at 190°, +21°, near *q*, or 35 *Comae*, in the southern portion of the constellation [1] (pretty close to which point, through 194°, + 23°, the present meteor's path-line passes backwards), no radiant point of marked activity near the yearly shower-date of the *Leonids*, appears, in Mr. Denning's splendidly comprehensive "General Catalogue of Radiant-points,"[2] to have been hitherto recorded in that quarter of the sky.[3] The altitude of 39° of the latter radiant-point, and its moderate distance, only 45°, from the beginning of the meteor-path, are not entirely inimical to this radiant point's adoption, as although the apparent path was very long for a rather steep-sloped descending real one, it should be noticed that the meteor passed nearly overhead and therefore in such near view at Littlemore that a great apparent length of path may on that ground alone be very readily accounted for, and the thickening and persistence of the streak in only the latter portion of the flight, favours the presumption of a pretty steep descent into the atmosphere, rather than a supposition that the real path was nearly horizontal. The observed speed of flight, 15° or 16° per second, is also too insecure a measurement to serve as an exact or very reliable criterion between a higher and a lower radiant-point position; but as it was not more than half the apparent speed with which one of the *Leonids* would seem to dart along,—about 30° per second,—in a similar position relative to its radiant-point and to the horizon, the slower real meteor-speeds of both the *α–ζ Virginids* and the *q-Comids*,—30-35 miles per second,—owing to their radiant-points' greater elongations from the earth's apex, as compared with that of the *Leonids*, about 43 miles per second, are evidently represented pretty nearly, although as usual in estimates of durations of flights and of apparent path-speeds, only with moderate exactness, by the observed, not very rapid angular velocity of the meteor's motion.

[1] Until 3h. a.m. on the 16th, the weather in the United States of America had been in general very unfavourable for meteor-watching; but from about that hour onwards until daybreak, good numbers of meteors, 102, 64, 59 and 30, were seen at Philadelphia, Harvard College Observatory, Bayport on Long Island, and Chicago; and at Denver, as reported in the *Times* of November 18th, the *Leonids*, after beginning to appear at 1h. a.m., were not very numerous until about 4h. a.m.; 63 were then counted in a quarter of an hour. The number of meteors seen at Romsey, in Hampshire, was 60; and at the Observatories of Madrid and Treptow (Stettin, North Germany), also, good numbers of meteors on the morning of the 16th were recorded. A period of considerable activity of the *Leonid* meteor-stream seems thus to have very distinctly presented itself on each of the two probably predicted mornings, for the shower's return, of November 15th and 16th. A lively shower of 80 or 100 *Leonids* seen on the morning of the 15th by Messrs. Tikhoff and Lespieau in the first of the two balloon ascents made by the astronomers of Meudon and the French Aeronautical Society, on the two foretold shower nights, and a very interesting description by Mr. W. H. Daw, in the *English Mechanic* of November 24th, of a rapid shower of 40 or 50 *Leonids* seen in exceedingly clear sky on Hampstead Heath, in about 40m. between moon-set and daybreak on the earlier one of those two mornings, both perfectly confirm the description given above of a considerably bright *Leonid* display just before daybreak on the morning of November 15th. It must, however, have then very speedily collapsed; for at Princeton, New Jersey, U.S., only about 20 *Leonids* were seen, in clear sky, from soon after midnight (about 5h.-6h. a.m., G.M.T.), until 5h. a.m. (10h. a.m., G.M.T.), by Professor C. A. Young, on the morning of November 15th; ("Popular Astronomy," December 1899, vol. vii. p. 543:—assuming that, in that account of a transitory good view of the *Leonids*, the date of rain and clouded sky given as the "night of Monday–Tuesday, November 14th–15th," may be corrected to November 13th–14th; and that by "Tuesday night," when the sky cleared up soon after midnight and about 20 *Leonids* were seen at Princeton, must no doubt be meant, as the description is regarded here as having been evidently intended to imply, the night of November 14th–15th).

[1] The shower is included in Mr. Denning's excellent list of 50 ordinary meteor showers contemporary with the period of the *Leonids* (which will soon again be more particularly referred to), as No. 43, at 190°, + 21°.

[2] "Memoirs of the Royal Astronomical Society," vol. liii. pp. 203–292.—The 278 showers' numbers in this List, and in its introductory "Index List" of all the showers' average positions and stellar designations, are quoted in the Tables and general matter of this letter, by the symbol D('99), with the showers' successive numbers.

[3] In a letter from Mr. Denning of November 25th, I am informed that he has been able to compute this meteor's real path from some additional observations sent to him by meteor-recording correspondents from Yeovil in Somersetshire, and from Woburn in Bedfordshire, which accorded very well with the data furnished by the above account at Littlemore. These observations he found to be consistent with the supposed direction of flight from the radiant point near *q* or 35 *Comae*, and to give a real path which also exactly corresponds with the above conjectured geographical position of the track; while the vertical height and the length of path agree with the usual results for very bright and slantingly descending meteors. The following are the particulars, in detail, obtained by Mr. Denning, of the meteor's real path.

Height, in miles, at		Length of Path and Velocity.	Radiant Point.		Parabolic Meteor-speed.
Beginning	End.		α	δ	
71 miles over 4 miles south of Buckingham.	42 miles over 3 miles south of Shipston-on-Stour, Warwickshire.	46 miles in 2¼ seconds; 20½ miles per second.	193°	+ 27°; 7° S. of East, altitude 42°; near *q Comae*.	36 miles per second.

The observed duration, of about 2¼ seconds, at Littlemore, gives, as here shown, a real speed, 20½ miles per second, so much slower than the presumptive one of either 36 or 30 miles per second, which should belong to parabolic-moving meteors proceeding from this radiant-point or from one near *Spica*, that the measure of duration and of apparent swiftness or slowness of the meteor's flight was really, as surmised above, in this meteor's case as in so many others, not an exact enough *datum* to be helpful towards a desired, but delicate discrimination of the meteor's radiant-point by astronomical considerations.

A good view of the meteor obtained by Mr. F. H. Wright, in Northamptonshire, is described in the *English Mechanic*, vol. lxx. p. 406, December 15th, 1899; Mr. Wright confirms the great visible duration of the meteor's light-streak, by stating that it appeared to change its position slowly from its original line of flight towards N.W., appearing first to be 5° or perhaps more in length, and that after being watched for four minutes, when it was still visible, it appeared to be directed more nearly towards N.E. The point where it "burst, midway between *Castor* and *Capella*," satisfactorily confirms Mr. Denning's determination of the real height and place of the meteor's end-point; and as regards the earlier portion of the real track which it pursued, although nothing precise enough to establish the radiant-point exactly, was supplied by the general description that the direction of flight was towards N.W. (more nearly in reality towards due W.),—yet this point's real position near *q Comae*, had already been certainly determined, and excellently well-defined at that position, by the exact apparent direction of the meteor's course, in Bedfordshire, supplied to Mr. Denning by Mr. W. C. Tetley.

The important calculations of the perturbations of the *Leonid* meteor-stream by the major planets since the year 1890, recently published by Dr. A. Berberich, of Berlin,[1] in which the effect of those perturbations to alter the form of the stream's orbit and hence the distances from the sun, at their nodes, of those parts of the stream which the earth would encounter, respectively in November of the years 1898 and 1899, led that distinguished German astronomer to the conclusion that inward deflections towards the sun of 0·0163 and 0·0048 earth's orbit-radius, or of about one and a half, and half a million miles respectively, would be produced in the two meteor clusters at their nodes, by the special perturbations exerted upon them respectively by the major planets; and as the orbit of Tempel's comet of 1866, which they may be supposed to have been nearly following, passed already at its node, in January of that year, at 0·0065 earth's orbit-radius, or 604,000 miles inside the earth's orbit, the offing distances of these two clusters' centres on the inside of the earth's track when the earth passed near them in November, 1898 and 1899, would be respectively about two million and one million miles, if they pursued the same orbit as the comet had in 1866, before undergoing the exceptionally strong perturbations; while in their previous revolution they would have been but little more than half a million miles inside the orbit of the earth; and if the meteor clusters passed through in 1866 and 1867 were also moving along the comet's orbit then, and sufficed to produce imposing meteor-showers when the earth approached to within about half a million miles from their stream-centres, it need certainly excite no wonder if no meteor-showers of extraordinary brightness should have happened to occur on the November dates of 1898 and 1899, when the earth approached no nearer than to two million and one million miles from the meteor-current's centre

But Dr. Berberich's investigation really showed what marked differences of effect are produced by the planetary perturbations on different portions of the long meteor-stream, so that instead of any parts of it now following exactly the same orbit as the comet, it must all have become waved and sinuous along a mean orbit path; and no prediction of the showers probable intensity at a new return can be at all based certainly on an apparent centrality and on great brightness of its just previous periodical appearance. The succession of fine showers of 1799, 1832–3, and 1866–7 appears to have been interrupted for the present by some such deformations impressed by past perturbations, during nearly twenty centuries, on the meteor-current. But these may be replaced next year, with equal probability, by new and contrary ones in the portion of the stream which the earth, it may be hoped, will pass through more centrally than seems to have occurred this year, in November, 1900. It may also still be somewhat premature to regard the strength of the November shower as having fallen this year beyond all traces of resemblance below its anticipated brightness, until detailed reports may still for a long time be expected from many anxious meteor-watching stations in the Antipodes, like the great observatories of Australia and the younger, but yet very well equipped meteorological and astronomical observatory at Hong Kong.

The following were the times of observation, (Table II.), and the radiant-point results, (Table III.), of my recent morning views, in clear sky, of 69 *non-Leonid* and five *Leonid* shooting-stars seen in the 12hrs. watch on November 6th–16th. The 74 meteors were for the most part small, only about twenty having surpassed third magnitude stars, and none having exceeded the brightest fixed stars in brightness. Only six or seven unconformable meteors, besides one *Leonid*, left momentary light-streaks; two from the radiant at κ, and two from radiants near π or ρ *Leonis*, and two more from the radiant near the equator at p, 29 *Monocerotis*. A greenish-streaked, 1st magnitude meteor from this latter point, on November 8th, had, in fact, so perfectly the appearance of a true long-pathed, swift *Leonid*, as quite to deceive me, at first, into a supposition that it must surely be a fine and very early harbinger of the coming meteor-shower, until its path was mapped and traced back to its real *Monocerotid* centre.

With the exception of a κ *Leonid* on the morning of November 14th, the thirty-eight meteors grouped under the five *co-Leonid* radiant centres in Table III. were all seen among sixty-four ordinary shooting-stars on November 6th–10th; the four remaining ordinary meteors added to the list in broken watches in the following very clouded star-shower nights, having all belonged to very feeble showers from other ordinary centres. But the five *Leonids* seen then in a few restricted glimpses of the sky, gave a pretty exactly defined radiant-point, which, though obtained from several different nights of observation, might yet, it was thought, be esteemed accurate enough, and of sufficient general interest to be included in the Table.

The paths were all projected on a chart of stars laid down for the epoch A.D. 1900, on the extraordinarily accurate gnomonic polar net drawn to single degrees of right-ascension and declination about a centre of projection in declination 45°, by Prof. Lorenzoni, and published at the astonishingly low price of 0·4 *lira* (about 4*d.*) per large "double-crown"-sized sheet of exquisitely printed zincographic engraving, at the Meteorological Observatory of Fontaniva, Venice, for the use of Italian and other shooting-star observers. The radiant-point positions were thus very accurately extracted, and the unusual precision of the gnomonically ruled map seems to have been very strikingly illustrated by the smallness of the areas from which the tracks referred back to each of the radiant-points diverged. The radii of these circular areas drawn round each radiant, as a centre, of just sufficient width to include the most distant of the path lines regarded as belonging to that radiant, are shown in the third column of the Table. But they sometimes overreached the proper smallness of a focal region, when only one or two very outlying path lines occurred, as happened in the plotted set of ξ *Taurid* paths, among an otherwise well centred group of path-directions. The concluded centre-places were compared with two radiant-lists published by Mr. Denning; one of fifty ordinary meteor-showers visible at about the same time with the *Leonids* (or, about a week later, also with the *Bielid* meteors),[1] and the other his extensive "General Catalogue" above referred to. The first and fourth columns of the Table give the Numbers in those two Lists, of separately accounted "*Co-Leonid*" streams, and of more or less long-enduring ordinary meteor-systems, or "shower-series," with which the present set of showers appeared to be identical; and the average positions of the latter "shower-series," as given with their running numbers in the catalogue, in the "Index-List" of Mr. Denning's "General Catalogue," are added in the fifth column of the Table to the preceding column's Numbers in that General Catalogue, or its Index-List. The agreements found, very closely confirmed the two lists' positions, excepting in the case of the main stream of *Taurids*, which, as I hope to recur to hereafter in a communication of some notes on large *co-Leonid* and *co-Bielid* meteors to supplement this letter, appears on this occasion to have proceeded from a rather outlying centre, rather nearer to α than to ϵ *Tauri*.

A shower centre at ξ, o *Tauri*, very prominent in October and November, apparently reaches its maximum on November 2nd, when Mr. Denning noted its place very exactly, in 1886, by a considerable shower of seventeen meteors, at 55°, +9°. One member of this stream, it has been already mentioned, with a radiant-point at 55°, +4°, was doubly observed at Bristol and Slough this year, on November 10th; and another as early as September 17th, in 1898, by Mr. A. King, at Leicester, and here, brighter than stars of the first magnitude, with a radiant-point at 57°, +7°. The shower was well defined this year by many tracks, very near its mean position in Mr. Denning's "General Radiant Catalogue," although no place seems to have been accorded to it in the select List of Fifty Showers visible at the same time with the *Leonids*. The p, q, or "30 *Monocerotids*" (No. 3), which form a rather weaker shower-series of similar duration to the ξ, or "e *Taurids*," and which furnished a few bright streak-leaving meteors this year from close to their mean centre in the "General Radiant Catalogue," are also missing from, and are no doubt properly passed over in the special *co-Leonid* List, as they not only formed a less plentiful shower than the ξ *Taurids*, in these watches, but they were also not all quite so certainly assignable as were the great majority of the ξ, o *Taurid* tracks, to their adopted centre.

Among many recorded radiant-points near *Leo's* Sickle, only that near κ *Leonis* was found to be distinctly active, presenting itself very sharply before any true-directed "γ *Leonid*" meteor-paths were charted; and though only a slender shower of slightly streaked and rather sparingly bright meteors, it must doubtless produce on ordinary *Leonid* shower nights some of the swift shooting-stars resembling *Leonids* which in yearly watches for the great shower's return, are sometimes seen diverging from a little north of *Leo*. On the morning of November 14th, 1877, a marked abundance of apparently just

[1] *Astronomische Nachrichten*, No. 3526, October; and *The Observatory*, vol. xxi. p. 446, December, 1898.

[1] *Astronomische Nachrichten*, No. 3513; August, 1898.

TABLE II.—*Times of Watch at Slough, November 6th–16th,* 1899; *Numbers of Meteors seen, and State of Sky.*

Date 1899, Nov.	Times of Watch, G.M.T. From	Times of Watch, G.M.T. To	Duration of Watch.	Numbers of Meteors seen. *Non-Leonids.*	Numbers of Meteors seen. *Leonids.*	Apparent Magnitudes. >1	1	2	3	4	5	Hourly Rates of Total Meteors.	Moonlight; and State of the Sky; &c.
	h. m.	h. m.	h. m.										
6	14 0	17 0	3 0	27	—	—	2	4	4	7	10	9·0	No moon; quite clear.
8	13 40	15 40	2 0	18	—	—	3	2	3	7	3	9·0	No moon; very clear and bright.
10	13 0	15 30	2 30	19	—	2	—	1	5	8	3	7·6	No moon; clear, but luminous with thin haze.
12	17 30	18 0	30	1	1 = Sirius	1	—	—	1	—	—	4·0	No moon; very hazy and half overcast.
13	13 30	15 15	1 45	1	—	—	—	1	—	—	—	0·6	¾ moon setting, at first; clear till 14h.; but gradually overcast at last.
13	15 45	17 0	1 15	2	2	—	2	—	2	—	—	3·2	No moon; hazy, and ½ clouded. Two small Leonids, a bright κ *Leonid*, and do. ζ *Draconid.*
14	13 30	14 0	0 30	—	1	—	1	—	—	—	—	2·0	¾ moon hid 4–5th mag. stars: clear till 14h., afterwards overcast until Nov. 16th, 5h. a.m.; in 1h. then, sky $\frac{1}{10}$th clear, no meteor seen.
16	13 30 14 30	14 15 14 45	1 0	1	1	—	—	—	2	—	—	2·0	Full moon bright; clear in two short intervals; one meteor seen in each.
Totals ...			12 30	69	5	3	8	8	17	22	16	8·5; average hourly rate in clear, moonless sky, on November 6th–10th.	

TABLE III.—*Radiant-points of* 37 *out of* 64 Non-Leonid *Meteors seen at Slough on November* 6*th*–10*th*; *and of Five* Leonids, *and one* κ-Leonid *among ten Meteors, on November* 12*th*–16*th*, 1899.

Number in Mr. Denning's Co-Leonid Radiant-list, 1898.	Observed Place of Radiant, in Polar Position, and by neighbouring bright Star. α δ	Radius of Circular Radiant Area.	Corresponding Place and Number, (D('99)), in Mr. Denning's "General Catalogue," 1899. D('99) No.	Position α δ	Numbers of Meteors Mapped.	Dates of Observation of the Meteors; 1899, November.	Apparent Magnitudes of the Meteors.	Average Apparent Length of Path.	Average Apparent Speed; Degrees per Second.	Reference Numbers to the Notes, below.
	° °	°		° °				°		
	52 + 8 ξ, ο *Tauri*	4½	49	53·2 + 7·6 *e Tauri*	10	6666, 888, 10, 10, 10.	4, 1, 2, 3, 4, 2, 1, >1, 4 6	12·8	14·2	1
13	68 + 17 α *Tauri* —	3	53	59·7 + 20·3 (Sub-position, 63 + 22.) ε *Tauri*	6	666, 8, 10, 10	4, 5, 4, 3, 4, 4	7·1	9·4	2
	121 − 1 *p*, and 29 *Monocerotis*	2	96	121·5 − 2·1 30 *Monocerotis*	5	6, 88, 10, 10	5, 1, 4, >1, 5	12·8	22·1	3
31	134 + 67 σ *Ursae Majoris*	2½	105	135·0 + 66·7 σ *Ursae Majoris*	5	666, 88	5, 3, 5, 5, 3	8·0	15·2	4
33	143 + 29 κ *Leonis*	1½	108	142·0 + 28·4 μ *Leonis*	7	666, 88, 10, 13	2, 4, 6, 4, 3, 1	11·4	27·6	5
	150 + 23 γ, ζ *Leonis*	2	115	151 + 22·3 γ, ζ *Leonis*	5	12, 13, 13, 14, 16	>1, 3, 3, 1, 3	11·8	21·4	6

Notes to the above six Showers; regarding the general appearances of their Meteors.

No. 1. ξ, ο *Taurids*:—Rather long-pathed, evenly bright, yellow, or orange, star-like meteors; with slight spark-tails, but leaving no streaks. One, on November 10th, as bright as Sirius, near the south horizon, burst in mid-course with a yellow spark-cloud, projecting a fragment to the right, and itself pursuing a deflected path onwards to sudden disappearance; like the annexed sketch (Fig. 2). This meteor may have been either a ξ, ο, or an ε *Taurid* (from 63°, + 22°), as the path-line prolonged backwards passed nearly through both those radiant-points. About half a minute after its appearance, an equally bright, white, *Sirius*-like *p Monocerotid* shot rapidly, 8° in 0·6 seconds, to very near the north-west horizon across *Lacerta*, leaving a fugitive white streak. These two were the only *non-Leonid* meteors seen in my watch, as bright as *Sirius*; and as they belonged to two entirely distinct meteor-streams, it was a curious coincidence that they should both present themselves, with great resemblance in appearance, within half a minute of each other.

No. 2. α *Taurids*:—Yellow star-like meteors, with sometimes intermittent and rekindling light; no streaks or sparks.

No. 3. *p Monocerotids*:—Swift, yellowish-white, *Leonid*-like meteors, leaving tapered, greenish-white streaks.

No. 4. σ *Ursae Majorids*:—Rather swift yellowish, stellar meteors, without sparks or streaks. An early member, apparently, of this meteor-stream was seen this year on October 5th; when among some meteor-paths mapped in two simultaneous watches, a 2nd magnitude shooting-star was noted here, and at Farnborough (Hants, 15 miles S.S.W. from Slough) by Mr. J. H. Bridger, at 10h. 55m., the two path-descriptions of which were in perfect geometrical accordance, and indicated the meteor's real path and radiant-point with much exactness. By the two mapped path-lines' backward intersection, a little way in rear of both the tracks, the latter point was at 138°, + 64°, close to this present shower's centre at 134°, + 67°, and to σ, τ *Ursae Majoris.* The meteor traversed 14 miles in 0·7 second, from 51 miles over a point near Leighton Buzzard, Bedfordshire, to 44 miles over Little Hampton, near Princes Risborough, Bucks, from a direction N.N.E., altitude 30°; and the speed of 20 miles per second fell much short of the shower's proper parabolic meteor-speed then, of 37 miles per second. But from the shortness of the base-line, affording but little parallactic displacement of the apparent paths, the concluded real height and length of path can scarcely be regarded as very dependable, and the duration of flight, 0·7 second, recorded here, may also very possibly have been somewhat overrated.

No. 5. κ *Leonids*:—Very swift, yellowish-white tapered meteors, leaving slight, white streaks.

No. 6. γ, ζ *Leonids*:—Swift, white or yellow, tapered meteors. (Mostly seen through mist; but one of 1st magnitude, seen in clear sky on November 14th, left a tapered, greenish-white streak for 2 seconds).

these κ *Leonid* meteors was thus observed by Mr. T. W. Backhouse at Sunderland,[1] who found a pretty exact radiant-point near μ *Leonis*, at $146°, +26°$, of seven "Leonids," one as bright as Jupiter, leaving a streak for three seconds, and the rest small; seen with eight other meteors in 1h. 20m. of clear sky during some hours' watch before daybreak on that morning. By an apparently just similar deception, in the bright shower of *Leonids* mapped and assigned here to various *foci* on the morning of November 15th, 1896, a pretty compact region of divergence was noticed north of *Leo*, in *Leo Minor*, of four or five meteor-paths, at about $155°, +35°$,[2] as apparently composed of "Leonid stragglers." But at $154°, +40°$, D('99) 118, there is a strong enduring shower-series of μ *Ursids*, first well recorded in November by Mr. Denning at $155°, +36°$, from about twenty swift white meteors on November 26th–29th, 1876,[3] and observed in late years very frequently on the *Leonid* dates of November 10th–17th, within a few degrees of that position. As it is found to present itself also as an active stationary shower during the preceding and following months of October and December, no very cogent reasons, it would seem, can be admitted to exist for describing this shower's meteors, or those of the contemporary shower near κ *Leonis*, for want of better designations, as stragglers or erratic members of the main meteor-stream of the *Leonids*.

One or two tracks seen here, and some mapped by Mr. Denning, on November 6th–11th, appear to have proceeded from known radiant centres south of the Sickle-stars, near o and π *Leonis*; but with these scarce exceptions no signs of swift-flighted meteors crossing *Leo* from south-eastern centres in *Hydra* and *Virgo* could be noticed with the brightness and abundance which those contemporary showers sometimes present on the yearly shower-nights of the *Leonids*. The main body of the ordinary meteors seen in these earlier nights' watches were pursuing leisurely, mostly short, but sometimes lengthy random

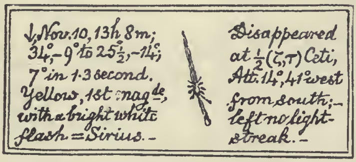


Fig. 2.

courses from many scattered radiant sources of more or less well-known positions among the constellations overhead, and in the north, west and south quarters of the sky. Of all these slow-paced systems, amounting in Mr. Denning's special list to thirty or forty centres of very undiversified looking meteor-flights, only one overhead radiant-point at σ *Ursae Majoris*, and the two south-westerly showers of the α–ϵ and ξ–o *Taurids* were marked abundantly enough by meteor-paths to be perfectly identifiable. A number of other centre-points absorbed the rest of the recorded tracks in single, or at most in two or three connected flights, too few to fix their radiants' real places certainly during the far too restrictedly short starlight time of my three or four fine nights' watch to show more of those scantily-escorted flights or lonesomely projected flashes, and to disclose their focal points and stellar features of appearance properly.

From their persistencies, however, enabling them to be reckoned as belonging to the *Bielid* meteor-period, a projection which I made last year of about 220 observations obtained by different observers in former years, since 1861, of meteors of that yearly period, November 20th–30th,[4] exhibited more fully than the less numerous observations made on earlier November nights this year could do, the relative strengths at that epoch (and therefore probably also in a nearly similar manner at the ten days earlier period of the *Leonid* displays), of several of these zenithal and western streams contained in Mr. Denning's Select List of Fifty ordinary *co-Leonid* Showers. To extend accordingly the illustrations which longer observations would have yielded, of the large array of ordinary showers included in Mr. Denning's Mid-November Radiant List a little further than the limited acquaintance, only with a few of them which this year's observations furnished, it may be useful to supplement this present partial review by a further position-list and some particular descriptions of several ordinary meteor-showers of the Bielid meteor-period, which were found to have been either transiently active or steadily productive during a long series of years, in those rather more comprehensive meteor-path projections.

A. S. Herschel.

[1] "British Association Reports," 1878, pp. 320, and 329.

[2] Nature, vol. lv. p. 175.

[3] "British Association Reports," 1877, pp. 164, 167.

[4] Prepared about this time last year for Dr. A. Hnatek, of Vienna, who has presented to the Vienna Academy of Sciences (*Sitzungs-berichte der kaiserlichen Akademie, Mathem.-Naturw. Classe*, Bd. cvii., Abth. ii.; December, 1898), an elaborate investigation both of the Bielids' radiant-point and of those of ordinary meteor-showers visible at the same time with the Bielids, from a widely amassed collection of meteor-observations for the period November 20th–30th, including among those made in Austria and supplied to him with numerous paths recorded at the Observatory of Vienna by Dr. Weiss, and in addition to similar contributions from Profs. Schiaparelli and Nyiland, and to many paths recorded in the works of Dr. Schmidt, some published by Von Littrow, which were made at the Observatory of Vienna as long ago as the year 1837.

The Royal Society Catalogue and Psychology.

In the original classification of the sciences for the purposes of the projected Royal Society Catalogue of Scientific Literature, Psychology was given an independent place. Recognising this, the International Psychological Congress at Munich, in 1896, appointed an English committee to do what they could to further the scheme in the name of the Congress. Following this, Dr. G. F. Stout, editor of *Mind*, then at Aberdeen, now at Oxford, was asked by Prof. Michael Foster to prepare a schedule for psychology. Dr. Stout sought the collaboration of the present writer, who represented the *Psychological Review* and its annual catalogue the *Psychological Index*. In the meantime, at the suggestion of Prof. Foster to the present writer, the question had come up in America as to the advisability of suspending our Index (which is now common to the *Zeitsch. f. Psychologie*, Berlin, and the *Année Psychologique*, Paris), with the preliminary understanding that if the Royal Society Catalogue issued an adequate list in psychology, it would be advisable to suspend the publication of the Index and support the Catalogue. Dr. Stout submitted the schedule he had prepared.

After a long period, in which no communication of any kind reaches Dr. Stout—nor has it yet!—the printed report of the conference of last June informs us that psychology has been classed under physiology, and the present writer learns from Sir M. Foster that the psychological schedule is to be cut up—if this action be finally confirmed by the Royal Society—and fractions of it inserted where place can be found for them under physiological headings.

Understanding that there is still a chance to reconsider this action, I venture as one of the joint proprietors and editors of the *Psychological Index*, whose existence is in question, and also in behalf of the reputation of psychology, to say:—

(1) If this action relegating Psychology to Physiology is carried out, the *Psychological Index* will continue to be issued and its subscribers retained.

(2) In that case some action is highly probable on the part of the International Congress of Psychologists meeting in Paris in the summer, seeing that they endorsed the former course of the Royal Society in giving the subject an independent schedule. At that congress the representatives of the French and German bibliographies mentioned are also to be in conference, with a result that may readily be foreseen.

(3) The present writer thinks he represents the competent opinion among psychologists in saying that the day is past for this sort of ignoring of the claims of one department of scientific knowledge at the instance of another. This was amply shown by the attitude of psychologists toward Prof. Richet's *Bibliog. Physiol.*, in which a similar treatment of psychology is carried out by one who attends psychological congresses and allows himself to be made prominent in them. It is interesting to know that Prof. Richet has been an active member of the Royal Society Conference.

Psychology is knowledge of the mind, not of the body—whatever method it may adopt to solve its peculiar problems—and to class it under physiology is about as reasonable as to class it under *cheese*—on the ground that cheese is sometimes green, green is a colour, and colour is a mental state!

It may be added that no criticism of the Royal Society

Committee is intended; but it is to be hoped it will adhere to its original classification. J. MARK BALDWIN.

Oxford, December 18.

The Stockholm Fisheries Conference and British Fishery Investigations.

FROM Mr. H. M. Kyle's letter in your issue of December 14, it is clear that he is ignorant of the present position of the British Government with regard to fishery investigations. The great obstacle in the way of such investigations, as every one who has taken any part whatever in their organisation is aware, has always been the want of adequate funds to carry on the researches. The investigations, if properly conducted, are very expensive, involving not only the employment of highly-trained naturalists, but also the equipment of laboratories on shore and of sea-going ships capable of visiting the fishing grounds. The latter item is so costly, that no vessel capable of keeping the sea has yet been systematically employed for scientific fishery work in British waters.

On account of the expense, there is little likelihood of investigations upon an adequate scale being attempted without the use of public money. This is recognised by the Government, and money has been spent by H.M. Treasury for biological and fishery researches in three different directions. In England the Marine Biological Association of the United Kingdom, which was started by private effort in order to promote (to use Prof. Huxley's words) "researches leading to the improvement of zoological and botanical science, and to an increase of our knowledge as regards the food, life-conditions and habits of British food-fishes and molluscs," received in 1885 a Government grant of 5000*l.* towards the cost of the erection of the first laboratory at Plymouth, and has since received an annual grant, which from 1892 has been 1000*l.* Altogether some 13,000*l.* of Government money has been spent, in addition to an equal amount derived from private sources.

In Scotland the Fishery Board receives from the public funds a yearly sum for scientific investigations which amounts, I believe, to about 3000*l.*; whilst in Ireland a single sum of 2,500*l.* has recently been granted to assist the fishery investigations of the Royal Dublin Society.

We may now examine in more detail the position of each of the three bodies entrusted by the Government with the expenditure of money for fishery work in England, Scotland, and Ireland respectively.

At the time of the foundation of the Marine Biological Association, the Government, in making the first grant of money, placed upon the Association the responsibility of doing for England work of the kind done in Scotland by the scientific department of the Fishery Board. Encouraged by the support received from public and private sources, the Association proceeded to lay down the necessary machinery for carrying out both scientific and economic work, and a sum of 12,000*l.* was spent in building and equipping the Laboratory at Plymouth as a first step in that direction.

The foundations of the Association were laid upon a liberal scale, involving the expenditure of a considerable capital, but the superstructure remained to be built. The subsequent yearly financial support was not on a scale commensurate with that given to the Association on its foundation, and it has never been possible to make full use of the machinery provided. By far the greater portion of the income of the Association is necessarily devoted to expenses of establishment and organisation, and only a small sum remains for the employment of naturalists to conduct investigations. The funds have never reached a figure which would render the maintenance of a sea-going vessel with which to reach the fishing grounds a question which could be practically considered. Having regard to the money at its disposal, the Association may fairly claim to have produced a body of work which in quality will compare with that done by any similar organisation elsewhere. It must not be supposed, however, that one man can produce the work of six, and it has never been possible to employ at Plymouth more than one naturalist devoting his attention to fishery work.

When, five years ago, the Council did me the honour of appointing me to the executive office of the Association, I undertook the duties of the post knowing that the justification for the yearly expenditure in maintaining the Laboratory in a state of efficiency lay, not in the amount of work which could be immediately produced, but in the fact that a solid foundation had been laid, which was capable, with an increased income, of producing a very large amount of valuable work. Further experience has confirmed this view, and I have also been forced to admit, perhaps reluctantly, that the only practical method by which the necessary increase of income can be obtained is by the development, on the part of the Government, of the fishery branch of the work. That the work of the Association was never intended to be confined to what can be done at Plymouth is shown not only by its name and the avowed objects of its promoters, but also by the fact that for a number of years the Association maintained a naturalist and kept open a laboratory at Grimsby for the study of North Sea fisheries. The investigations made by Mr. Holt and Mr. Cunningham in this connection will, in usefulness, rank with the best fishery work which has been done in the North Sea, and it was due only to lack of funds that these investigations could not be continued.

Turning now to the Scottish Fishery Board, it will be admitted that, so far as its scientific investigations are concerned, a similar condition of things exists, in a less pronounced degree. For years an urgent appeal for a steamer capable of keeping the sea has been a constantly recurring feature in the Reports of the Board, and the scientific superintendent will be the first to agree with me in saying that the scientific staff is by no means numerically strong enough to carry out the investigations upon the scale which their importance and difficulty demand.

In Ireland, where the Royal Dublin Society is working in close connection with the fishery inspectors, and is supported by Government money, it has also been impossible to provide a proper vessel, and Mr. Holt is working single-handed, except for occasional volunteer help, although he has accommodation for a number of naturalists.

All past experience has shown that the British Government is very reluctant to spend money upon scientific investigations of any kind, and at the present time it is practically certain that any increased expenditure in this direction will be limited in amount. It is of the utmost importance that what money is spent should be put to the best possible use. Under the circumstances described, and considering the amount of public money which has already been expended on organisations and establishments, all of which are awaiting development to produce their full return of work, I cannot see any justification for asking the Government, as a next step, to provide a considerable sum for a new organisation with a new laboratory, which to judge by all that has happened in the past would soon find itself as unable as its predecessors to adequately carry out its schemes, from the want of proper financial support.

The first demand should be for such a slight reorganisation of existing bodies as will bring them into working contact, a rearrangement which could be brought about with little if any increase of expenditure, and a proper provision of ships and naturalists for carrying out the investigations. When this has been obtained the co-ordination of British investigations with those of neighbouring countries will be a matter of no great difficulty, and one which, in my opinion, can be carried out with no such expenditure for organisation as that suggested by the Stockholm Conference.

As Mr. Kyle has seen fit to introduce matters of a somewhat personal nature into his letter, I may, perhaps, be permitted to say that I make no pretence whatever of being a specialist in fishery investigation, my scientific work having for the most part lain in other directions, nor is it my intention to attempt to alter this condition of things. Should the Government see fit to largely develop the work of the Marine Biological Association on the lines I have indicated, I fully realise that they will wish to have in the executive post a specialist in fishery matters, and this is an eventuality which I am prepared to meet. I should also add that the opinions expressed in this letter are entirely of a personal nature, and I am quite unaware whether or not they would be shared by a majority of the members of the Council of the Association. E. J. ALLEN.

The Laboratory, Plymouth, December 16, 1899.

Dr. W. Kobelt and the Mediterranean Fauna.

THE second part of Dr. W. Kobelt's "Studien zur Zoogeographie" has been in my hands since its issue, viz., about a year ago, and I have had ample time to become fully acquainted with its merits and its defects. The subject is one which has a singular interest to me, for I have been working out the fauna of Italy and its dependent seas, especially in relation to Vertebrata, for the last five and twenty years, and have formed a collection in which about 38,000 specimens (25,000 being fish) represent the vertebrate fauna of Italy and the seas which surround it. I soon found that although strong in Mollusca, Dr. Kobelt was weak in the knowledge of other classes of animals, and that along with solid fact" his book also contains a number of grave inaccuracies. Now I am very busy, and find that life is far too short to allow the waste of time caused by polemics; I usually, therefore, avoid them, and should certainly have passed over Dr. Kobelt's errors and omissions had not your reviewer's remarks in No. 1570 of NATURE (page 99) rendered it imperative that I also should ask you to allow me to make a few remarks. NATURE has now fully undertaken the noble task of keeping scientific investigators up to the mark as regards the general progress of knowledge, and it is not fair that it should unwittingly propagate error. Now of the several chapters of Dr. W. Kobelt's book, the poorest and the worst is by far the one (*viertes Kapitel*) which he has devoted to "Das Mittelmeer," the classic ground of the renowned labours of Edward Forbes and of so many before and after him. How ever could a German living in the land of bookworms and patient labourers in bibliography write such a chapter, and come amongst other incorrect and incongruous conclusions, to that pyramidal error that the abyssal parts of the Mediterranean are azoic? Good and learned Dr. Carpenter said something similar about twenty years ago, after the fruitless dredgings of the *Porcupine* and *Shearwater*, but he lived to know that he had been mistaken, and we discussed the very subject together at a dinner at his own house in June 1883.

It was on August 5, 1881, that I sent an express across Asinara to Porto Torres, North Sardinia, bearing a letter to the editor of NATURE in which I gave the first account of the discovery of typical representatives of the North Atlantic deep-sea fauna in the abyssal area off North-west Sardinia; on that occasion specimens of *Polycheles* (Willemœsia), *Brisinga* and *Hyalonema* had been secured with the trawl (NATURE, August 18, 1881, p. 358). A few days later, from depths between 3000 and 1500 metres, I got two new forms of Macrurid fishes, so characteristic of the abyssal fauna, viz., *Chalinura mediterranea* and *Hymenocephalus italicus*; of the former the two specimens then caught are as yet the only ones known. This was the first deep-sea campaign of the *Washington*; we were all new to such work, and yet a few weeks later, at the meeting of the Third International Geographical Congress at Venice, I was able to lay before the savants there assembled a preliminary report, in which the existence of a deep-sea fauna in the Mediterranean, similar to that of the North Atlantic, but evidently with some special features, was fully proven. Our greatest depth was then 3624 metres, between Sardinia and Sicily; thence we dredged up fourteen living animals: an Anomourous Decapod, an Annelid, and several singular small Holothuroids, as yet unstudied. The two following summers, about a month each year, were dedicated to thalassographic researches in the Mediterranean by the Italian man-of-war *Washington*, but the trawl was hardly ever used at the greater depths. The authorities of the navy, and I am sorry to add also those of the Lincei, appeared to have lost all interest in that fertile field of research. Years after, a little deep-sea trawling was done by the Austrians round about Crete; they got some good abyssals, amongst which *Bathypterois*, the singular tentacled fish; they also found the greatest depth yet recorded in the Mediterranean, over 4000 metres. The enlightened Prince of Monaco has also given a trial to some of his wonderful deep-sea traps, always with good results, but his systematic abyssal researches have all been outside our "Mittelmeer" hitherto.

I have never lost any opportunity since 1881 of doing my level best to promote the continuance of those thalassographic and especially abyssal researches, which had been so well begun by the *Washington*; my last appeal was made to the Third Italian Geographical Congress, which met at Florence last year, my proposals were adopted unanimously in the proper section, and I am beginning to hope that they may soon have a practical result.

I have not the slightest doubt that the abyssal fauna of the Mediterranean is a rich one, in which not a few novelties will turn up. I have already in my Italian collection about seventy species of typical abyssal fish—Elasmobranchs and Teleostei—and have, besides those already mentioned, described some very singular forms hitherto unknown, and apparently peculiar, such as *Bathophilus* and *Eretmophorus*.

After all this you will admit that it is rather sad to read in NATURE of November 30, 1899, that "the Mediterranean, as is well known, sinks in places to profoundly abyssal depths; the actually greatest depth appears to be 4400 metres; but here no living organisms have been found. It is purely azoic; the reason for the want of life is, according to the author, the want of oxygen and the abundance of carbonic acid." I should like to see the above assertion proved.

I may add that Dr. Kobelt, who is a specialist in Malacology, appears to be unacquainted with the abyssal molluscs which I dredged up from great depths in the Mediterranean, and which were described (several as new) shortly after by my lamented friend, J. Gwyn Jeffreys. And at p. 105 of his book he says that *Nephrops norvegicus* is not found in the Mediterranean. Now in 1881 I dredged up specimens from depths of 765–823 metres, in that sea, off the west end of Sicily.

Dr. Kobelt has a grim way of disposing of the Cetacea of the Mediterranean. These are much better known than he appears to be aware; I know positively that thirteen species occur, four being *Mystacoceti*; none are peculiar, and could hardly be expected to present that case, but it is of singular interest that the common porpoise (*Phocaena communis*) is certainly absent from the Mediterranean, and said to be common in the Black Sea. Our seal (*Pelagius monachus*) is nearly peculiar to the Mediterranean and Adriatic, where *Phoca vitulina* never occurs. This hardly looks like "an impoverished gulf of the Atlantic," as Dr. Kobelt is pleased to style our "Mittelmeer" as regards mammals. And, turning to terrestrial mammalia, what of the Mediterranean barrier *re* Muflons (*Ovis musimon*) in Corsica and Sardinia; *Cervus corsicanus*, with the same peculiar distribution—these mammals are found in a wild condition nowhere else—and *Cervus dama*, wild only in Sardinia? I will allow the *Inuus ecandatus* as an importation, but hardly as a native product of the "Rock" of Gibraltar!

Certainly I can hardly commend Dr. Kobelt's book to the serious student of zoo-geography; and I cannot help a bitter reflection when I come to compare mentally the favourable review it has had in these pages, where a few weeks earlier a volume, of which one of the co-authors may be styled the father of zoo-geography, and is emphatically one of the most meritorious of England's zoologists, was treated in a very different style (*vide* NATURE, No. 1549, vol. lx., p. 217).

HENRY H. GIGLIOLI.

Royal Zoological Museum, Florence,
December 8, 1899.

PROF. GIGLIOLI appears to blame me for a too favourable review of Dr. Kobelt's recent book. In that review I pointed out some errors, as I thought, of inference as well as of omission; I still think however that Dr. Kobelt has produced an usefully elaborate and painstaking work, and therefore beg for a short space wherein to reply to such of Dr. Giglioli's criticisms as affect my own review.

Dr. Giglioli justly comments upon the fact that many deep-sea animals have been dredged in the Mediterranean. But, as I understand him, Dr. Kobelt does not deny this; he merely observes that the abyssal fauna of the Mediterranean is not special to that sea. Dr. Giglioli himself remarks upon the occurrence of "typical representatives of the North Atlantic deep-sea fauna," which is in accord with what Dr. Kobelt says. That there are some forms peculiar to the Mediterranean does not necessarily invalidate the justice of Dr. Kobelt's generalisation. I do not read Dr. Kobelt as saying that "the abyssal parts of the Mediterranean are azoic." How could I, considering that he gives (p. 115) two lists of deep-sea Mollusca? I understood him to mean that one particular locality of 4400 metres in depth happened to be so. In this matter I simply referred to Dr. Kobelt's statement. I neither dissented nor assented. Dr. Giglioli is no doubt right in asserting that the whales of the Mediterranean are not only not peculiar but could not be expected to be. But if the number with which he is acquainted (13) represent the entire Cetacean fauna of that sea, then Dr. Kobelt is most emphatically right in speaking of it as an impoverished gulf of the Atlantic. THE REVIEWER.

THE ECLIPSE EXPEDITION AT VIZIADURG.

I.

SO much of the material acquired to science by the observations of the last total eclipse of the sun in India has now been published by the Royal and other Societies, that I now propose to give in the columns of NATURE a connected account of the work done and arrangements adopted at Viziadurg.

Four of us left London in the R.M.S. *Lusitania* on December 10, 1897, and that vessel reached Colombo on January 4, 1898. As we steamed into the harbour, about 1 a.m. on the 4th, the first ship we passed was Her Majesty's ship *Melpomene*, many lighted, white painted, her hull appearing phosphorescent in the dark night. Long before the *Lusitania* was moored, Lieut. Colbeck, R.N., of the *Melpomene*, and an officer of the Customs Department were on board, and such complete arrangements had been made that a few minutes after the mails had been put into one lighter, the instruments, which had been brought on deck the day before, were being delicately handled into another. There was therefore no sleep for any of us that night, and early in the morning Captain Chisholm-Batten, R.N., of the *Melpomene*, came on board. Shortly afterwards the eclipse party, with all their gear, were transferred from the mail steamer, after taking leave of Captain Veale and his officers, to the cruiser.

It did not require a keen observer to find out, after a very short time on board, that the Melpomenes had made up their minds to emulate the doings of their comrades on the *Volage*, in connection with the Varanger Fjord eclipse of August 1896, and also that this was in part due to the keen interest taken by Captain Chisholm Batten in all things scientific. He very soon put exactly the same question to me that Captain King-Hall had done two years before on the *Volage*, and I gave him the same reply. He said, "If you will explain to the ship's company what is wanted I will call for volunteers, and then we will see what can be done." I did as I was told.

We left Colombo at 5 p.m. on the same day. On the morning of the 5th (Wednesday) we sighted Cape Comorin, and in the early evening I explained, by means of lantern slides thrown on a screen under the bridge by an eighty-candle glow-lamp, the kind of work done during an eclipse, and how the ship's company of the *Volage* had organised themselves in 1896. When my talk was over, Captain Batten called for volunteers. To my delight and astonishment, and I must say rather alarm, about 120 officers and men at once stepped forward. Now that, of course, meant incessant school till the moment of the eclipse. However, we were all quite prepared for it, although it was evident that the Eclipse party of three had their work cut out for them.

The next delightful thing I found was that three or four of the officers of the ship were just as competent to give instructions on the various lines of work to be attempted as my assistants and myself were, so that the teaching was put into a very big commission.

FIG. 1.—The Fort.

This was an intensely interesting day to me, for while arrangements for the eclipse of 1898 were thus advancing, the *Melpomene* was following the sea-track of the flagship *Glasgow*, which carried the expedition of 1871. Cannamore was first passed, and later on Baikul, where my station was seven-and-twenty years ago. Heigh ho! Why is one not always young and full of energy, and why should the power of doing dwindle as one knows better what to do? But that is another story.

We began our drills the same night. An important part of the work was to get an idea of the outlines of the corona, and for that purpose I had taken out several discs which would hide the more luminous lower parts of it in order to shield the observers' eyes, so that they would be in the best possible position to note the delicate tracery outside. In addition to that, a large party had volunteered for drawing the corona, so we started drawing competitions; we had marks for form and for colour of the corona. For this purpose the ship rigged up a magic-lantern by means of one of the incandescent lights. We found a capital screen on deck in the shape of one of the casings; drawings and photographs (coloured) of the corona were thrown on the screen and copied under eclipse conditions. What do I mean by eclipse conditions? I mean this: experience shows that when the eclipse begins you must tell everybody how many seconds are left, otherwise they will lose time by trying to find out for themselves; if the eclipse is going to last 170 seconds, at the instant of totality we tell them so. After 10 seconds we say, "You have 160 seconds more"; after 20 seconds we tell them they have 150 seconds more, and so on, in as encouraging a way as we can. We adopted this plan in our practising.

The next thing which delighted me was, that not only was every rating in the ship represented two or three times over in the volunteers, but that almost all the men who volunteered to make these drawings had colour-boxes. Where they get them from I do not know, but colour-boxes they had. In the examination we gave 10 marks for colour and 10 for form; several of them got 18 out of a possible 20 marks. I mention that because it gives an idea of the thoroughness with which every part of the work was done.

It was a little over a day's run from Baikul to Viziadurg, where, on the 7th, Captain Batten, after a fine sweep into the bay, chose his station at 3 p.m. navy fashion, that is, pilotless, over the anchor shown on the chart. Soon after this the native pilot, in a boat which had hugged the southern shore, and had, perhaps, for this reason been unnoticed in spite of a tattered blue ensign with a lion in one of the corners, came on board, and after him a boat full of gorgeously-apparelled native officials accompanying Mr. Bomanji, Collector of the district of Ratnagiri, in which Viziadurg is situated, among them an overseer of the Public Works Department, who was on the spot in charge of some most excellent masons and carpenters, picked men from Ratnagiri as we later ascertained, and plenty of material for the construction of the necessary concrete bases and huts.

Mr. Bomanji came on board to report the arrangements which had been made for the expedition by the Government of India. As these were not quite completed, it was necessary for the first few days to return to the ship every evening, but afterwards Mr. Fowler, Dr. Lockyer, and myself took up our quarters at the Dak bungalow inside the fort, close to the instruments. Meals were provided at the Collector's camp, which was also inside the fort.

A party was landed at the fort on the afternoon of our arrival, Saturday, January 8, to inspect the site suggested by Mr. Bomanji, and it was at once evident that it would satisfy all requirements, provided the fluctuations of temperature of the great masses of masonry composing the fort had no disturbing influence on the steadiness of the air. In order to investigate this point a $3\frac{3}{4}$-inch telescope was set up, and observations of the surrounding landscape, and, at dusk, of various stars, were made, from which it appeared that the atmosphere was sufficiently steady for the observations.

We found a considerable number of coolies was also present to do such work as carrying packing-cases, sawing wood, clearing the camp, &c.

In the fort was also a police guard sent from Ratnagiri. The camp was watched both by day and night so effectively by them that no damage to any instrument was reported.

Description of Viziadurg.

Viziadurg, we found, is practically concentrated in its fort. A former collector of the district, Mr. Sinclair, had been good enough to send me a photograph of it. On landing, after the collector's visit, we found that the real thing is certainly far more extensive than the photograph suggested, and more than this, the building and its history are both of very high interest. The fort dates from the fourteenth century, but it was much strengthened in the sixteenth, when the towers and triple walls, the well-preserved ruins of which now encircle it, were added. These towers number twenty-seven; they rise to 100 feet, and, like the massive walls, are built of large blocks of stone, now coloured dark red, and almost black in places. The walls enclose about twenty acres, and within this space are habitable buildings, two wells, and a water reservoir, formerly lined with lead at the bottom and to about 10 feet up the sides, larger than the largest of the celebrated tanks at Aden. From the beginning of the sixteenth century the fort was the headquarters of piracy in the Indian seas. Kanhoji Angria, the admiral of the Maratha fleet, became a renowned corsair, and at his death was ably succeeded by his son, Julaji Angria. These gentlemen seemed to have had it all their own way. They respected no flag, captured many ships, sacked the coast towns, and, worst of all, repelled several expeditions sent against them by the English, Portuguese and Dutch. Julaji only finally surrendered in 1755 to a force of twelve men-of-war with some forty small native armed vessels, commanded by Admiral Watson, supported on land by an army of eight hundred European and six hundred native troops, under Lieut.-Colonel (afterwards Lord) Clive. Angria's fleet was destroyed, fifteen hundred prisoners were taken, and eight Europeans rescued. Two hundred and fifty cannon and eight brass mortars were found, and besides, stores and valuables worth 125,000*l.* After this the fort came under the Peshwa's government, and his admiral, Anandrav Dhulop, establishing himself therein, commenced a successful career, enriched himself, and added much to piratical science, until finally the British took possession of the district in 1818.

If the final cause of the pirates of Viziadurg was, as it seems to have been, the formation of an Eclipse camp, even to providing unexpended bombs for clock weights, the fact that they built the fort exactly where it is, commanding a harbour finer than that familiar to their-to-be *confrères* of Penzance, was evidently also connected with the present visit of the *Melpomene*. Equally sheltered from the fiercest blasts of both the south-west and north-east monsoons, the anchorage is as safe as it is convenient; but it must not at once be taken for granted that under these conditions the water surface is always smooth. The goddesses of meteorology have their smaller as well as their greater festivals, so that what the monsoons are to the year the land and sea breezes are to the day. The sea breeze sets in about noon with marvellous regularity, and is at its height about sun-down; as the night advances everything becomes calm, and at ten o'clock even the rattle of the jalousies in the windows of the fort has entirely ceased.

Precautions and Preparations.

While considering the desirability of establishing a station at Viziadurg, a friend of great Indian experience was loud in his praises of the Konkan as a health resort. He expressed his astonishment that yachtsmen, who generally know what is good for them, so constantly neglect to spend some winter months on a coast so delightful in many ways. Our experiences entirely justified my friend's views. Of course, great precautions have to be taken when so much work has to be done in the sun; but my Baikul experience told me the conditions are much better at Viziadurg than they are in South Canara. The sun's rays were almost always tempered by a breeze; the temperature at 8 a.m. was often about 70 degrees, and on shore 85 degrees was reached later on in the day.

Next morning, Sunday, January 9, the instruments were landed absolutely without the slightest difficulty. With reference to this a few words may be said concerning the preparations for an Eclipse Expedition, since few people have any idea of the labour involved or of the precautions to be taken. In the first place, all the instruments to be taken out must be adjusted for the place chosen for observation; that is, the so-called "Polar axis," on which each instrument turns, must be directed to the position which will be occupied by the pole star at the Eclipse station. Thus, while in London the axis points in a direction of 51½ degrees from the horizontal, in India this direction was about 16½ degrees. The instruments must then be made to work under these new conditions, and each position of all the optical portions which produces the best results must be marked most carefully, either by screwing down or by lines of white paint, so that each can be exactly replaced at the station. Then comes the taking down and packing. On this point I got a lesson in 1882 at Siout, in Egypt, which I shall never forget. It was a question of getting a stand, weighing about 3 cwt., of an equatorial telescope into the Khedive's yacht. There was no tackle, and the thing was got on board by the Egyptian authorities flogging a giant Soudanese up a plank with the stand on his back. Since then, in all the expeditions I have had to do with, all stands have been built upon the spot by filling a wooden and paper model with concrete; and, further, no packing case has weighed more than 60lb.; this enormously simplifies boat service. All mirrors and plates must be hermetically sealed up, parts of different instruments must not be mixed together in the packing cases, and all cases containing pieces of the same instrument must have the same index letter. As a result of this system we took to Viziadurg eighty cases, on which the skilled packers employed at the South Kensington Museum expended infinite care; they were all small and numbered and lettered, so that they could be easily landed the moment the sites for the several instruments were settled. The local labourers, under the efficient superintendence of the Public Works Department, had no difficulty in sorting the cases.

It was important to erect the huts as soon as possible, not only to shelter the instruments but the observers from the sun. Among the precautions taken in the camp I may mention that 10-feet square screens of excellent matting made locally and stiffened with bamboo were temporarily erected to the sunward of every working party, both at morning and evening. When it was necessary to go on with the work at mid-day, the same screens were supported over the workers by bamboos. As each instrument was erected it was permanently protected in the same manner.

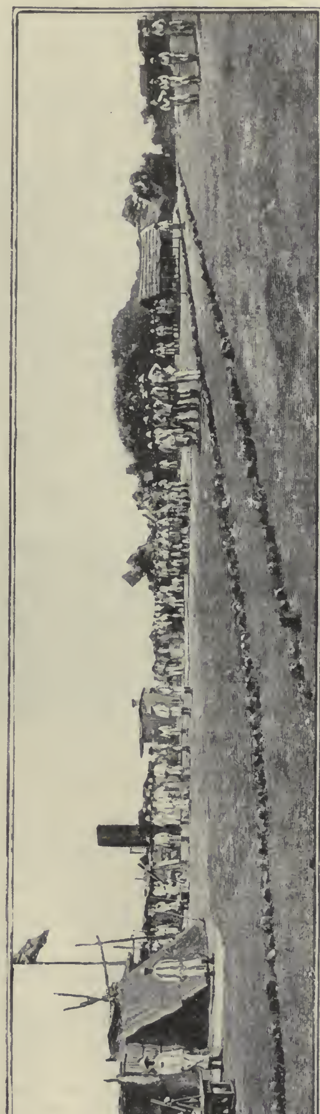


FIG. 2.—General view of camp.

With these precautions, and with such a climate, no one was sick.

The concrete pillars for the instruments were begun the day we landed. The men were brought on shore in the early morning in order to do the drills and erect the various instruments and all sorts of other work which turned up; but we had to knock off in the middle of the day in consequence of the extreme heat. It was very convenient for us that the *Melpomene* could lie at such a short distance from the camp that it did not take more than a quarter of an hour for the various parties to get to work. A signal station was at once established, so that, as at Kiö in Lapland, we could at once communicate with the ship in case anything were wanted.

In camp the work was incessant from sunrise to midnight, excluding the break in the middle of the day.

The instruments were set up as soon as their bases were ready. Mr. Fowler and Dr. Lockyer were enabled to report all the fixed instruments and huts, eight in number, erected and all but the final adjustments made after six days' work. Constant clear skies enabled all the adjustments to be made without difficulty, and by January 17 all the instruments were ready.

Life on Shore.

It became necessary on Tuesday, January 11, to transfer our quarters from the ship to the shore, as the erection of the instruments was by that time advanced to such a stage that it was possible to test the various adjustments by observations of stars. This change of front was accompanied by some difficulty, for many telegrams had been received telling us, now that this, now that that, was the shore arrangement which had been approved by the authorities, in one case of the Supreme Government, in the other of the Government of Bombay. The officials of the Bombay Government, in spite of letter from home of old date stating the exact opposite, were firmly convinced that independently of the supply of material for huts, the organisation of the camp and all the astronomical night-work on shore was a question of a tiffin basket; that it was rather exhilarating than otherwise in the climate of India to remain on shore with the aforesaid basket till one o'clock in the morning, and reach it again at sunrise.

They were also of opinion that a man-of-war of some three thousand tons could lie practically alongside the fort; that there was sleeping and other accommodation in a third-class cruiser for any number of shore hands; and finally, that it was open to anybody to walk on board and claim it.

The phantasmagoria of telegrams ceased on Saturday, and Captain Batten, who had insisted on sending his steward on shore to look after us, was now no longer dependent on the wardroom mess for his meals. As we had no servants and could not get any, he sent two Seedie boys to look after us and see to the lamps at night, which they did most satisfactorily. I was once more in the land of pantomime, and again came to the conclusion that after all spoken language may be a needless survival. The Collector, camping out some little distance away from the observatory, was now our host, and we had to thank him for unceasing forethought and kindness. We lunched and dined with him, and he supplied me with an interpreter, which facilitated matters greatly.

It took us some time to get through all Customs formalities, and the difference between Ceylon and Bombay methods we found curious. At Colombo, before the *Lusitania* had come to her moorings, Mr. Halliday, an officer of the Customs Department, came on board with a letter from Mr. Lionel F. Lee, the principal Collector of Customs, offering all possible assistance in landing and trans-shipping baggage and instruments. The Bombay officials were evidently of the opinion that the *Melpomene*, instead of coming from her station at Calcutta, had arrived straight from home full of contraband. The local official followed me round the camp with a bundle of forms, until at last, in despair, I informed him that, to my regret, I did not know the precise value of each article of wearing apparel brought out, but that all trunks could be opened for inspection on landing, and I would make any payment he might demand.

Our quarters in the fort were not without interest. They were in a building much more modern than the fort itself, and consisted of two rooms and a verandah on the first floor, approached by external stone steps. The ground floor, a little below the general level, we devoted to a dark room and a general store-room for the more delicate parts of the instrumental equipment. In each of the upper rooms, which were white-washed, with sanded floors, there was a bedstead, a chair and a tub; and after all, what more does one really want? I should add that there was also a looking-glass of much more gorgeous make, which did good service by blocking a door of which the fastening had given way. Further, in one of the bed-rooms there was a small table, now used for gastronomic and now for astronomic purposes. But the real furniture, both of rooms and verandah, were the pictures on, or rather in its walls. I mean the views from the windows when the jalousies were opened, especially some little time before sunrise and after sunset. I have never seen such effects of gorgeous, indescribable colours. Why was Lippmann not there to catch these colours, unknown in Europe—the fierce contrasts between the water and the land; between the beautiful river valley and the open sea; between the hard outlines of the gloomy ramparts below and the delicate landscapes which seem to float above them in the gloaming; and, finally, between the pure white of the *Melpomene* and the blue water on which she floated—a blue which at certain times of the day put the blue of the Mediterranean into the shade!

Of mosquitoes there were none; indeed, the absence of insect life was remarkable; of snakes we saw few, though the region has a very bad reputation, so bad that in 1876 the sum of 441*l.* was expended in killing 141,000. Of course, precautions were taken. Dr. Lauder Brunton and Prof. Fraser were good enough to provide me with the latest things in remedies, including *serum antiveneux*, which I handed over to Dr. Nolan, who posted up full instructions as to their use; but as this is a matter where prevention is better than cure, leggings by day and lamps by night were used by everybody.

And now a few words about the growth of the camp. The first shelter erected was for the use of the signalmen, for one of the guiding principles has been that no one need work in the sun unless he likes, and at the very first it was necessary that there should be signalmen to connect the camp with the ship. In relation to this first shelter, an idiosyncrasy of the blue-jacket, which I had a previous opportunity of studying at Kiö, came out. On landing in the morning I found this shelter already christened "Flaggies Villa"; the sailors on the staff of the other instruments were not going to be outdone, and as their shelters went up one got the idea of a village fair, for each carried a sign as I have previously mentioned: the 6-inch equatorial, of which Prof. Pedler arrived to take charge on the 13th, was the "Town Hall"; the 9-inch prismatic camera lived in "Mainsail Hall"; the 6-inch prismatic camera under Mr. Fowler's charge was accommodated in the "Central Hotel." The very much occupied hut which covered the cœlostat and the instruments which it feeds with light, that is, the integrating spectroscope and the two coronagraphs, was named the "Empire Palace." The whole fort was named "Batten's Camp," and the wall on which the discs were placed was called the "Common Hard"—the ship hailed from Portsmouth—and so on. In three or four days there was not a place which had not a name, and a very good name too.

The Lectures and Drills.

The lectures went on steadily from January 5 to 17. They were given by many of the ship's officers as well as by members of the Expedition.

The first drills of the work to be done at the chief instruments during the eclipse took place on the 13th. This statement, perhaps, requires some explanation. When a large instrument is brought out so great a distance to observe a fleeting phenomenon it is natural to try and get out of it the greatest possible amount of work. To secure this the greatest possible division of labour is the first and indeed the chief requirement. This means that many heads and hands must be employed in each of the operations necessary, and this spells drill, unceasing drill.

Now, if this crowd does not work together without the slightest hitch, failure is certain. I do not think I need say more as to the necessity for constant drill, but with regard to the complete operations something more than drill is necessary. With about 120 observers and helpers, on the principle of cutting the coat according to the cloth, a pretty large programme is permissible. When once this is settled, and the volunteers have selected a branch of the work in which they think they can render most efficient help, instruction as to the special points must be imparted. This was done without stint and almost entirely by the officers, and with such a will and skill that my own superfluity on the stage became increasingly obvious day by day. While this set one thinking in one direction along lines not untinged with regrets, in another there was great cause for rejoicing, for it will be a grand day for solar physics when the observations of eclipses will be among the recognised duties of a ship, such as the present one, on the station with a sufficient crew to tackle it.

While the instruments were being set up, one of the chief things accomplished was to organise the whole effort, so that when things were ready everybody could work together. As the number of volunteers was so large, I pointed out to Captain Batten, who had volunteered to aid in a special branch of the work, the importance of his taking charge of the whole camp and giving all the necessary orders for conducting the operations during the general rehearsals and the eclipse itself. He eventually agreed to this, and the procedure and time signals were arranged between us. To me, an old eclipser, it was a beautiful thing shortly afterwards to see the splendid drill commenced in eclipse form, along all lines, going on to the sound of the bugle.

It was found that with such a large number of volunteers we could practically undertake almost every kind of work which had ever been attempted during an eclipse. The

FIG. 3.—Preparing for a rehearsal. Captain Chisholm-Batten and time-party at the eclipse clock.

observers were divided into twenty-two groups, each in charge of a responsible person.

The groups of observers were as follows :—

(1) Time.
(2) 6-inch prismatic camera.
(3) 9-inch ,, ,,
(4) Integrating spectroscope.
(5) 6-inch equatorial.
(6) Coronagraph.
(7) Discs.
(8) Sketches of corona without discs.
(9) 3¾-inch equatorial.
(10) Observations on stars.
(11) Shadow-bands.
(12) Meteorological observations.
(13) Hand spectroscopes.
(14) Prisms for rings.
(15) Polariscope.
(16) Landscape colours.
(17) ,, cameras.
(18) Shadow phenomena.
(19) Kinematograph for eclipse.
(20) Kinematograph for shadow.
(21) Contact observations.
(22) Observations on natives, animals, &c.

NORMAN LOCKYER.

(To be continued.)

NOTES.

THE list of "New Year's Honours" includes the following names of men distinguished by their scientific attainments :—The dignity of a peerage has been conferred upon Sir John Lubbock, Bart. Dr. Lauder Brunton has received the honour of knighthood. Captain Abney has been promoted to a Knight Commandership (K.C.B.) of the Order of the Bath, and Major-General Festing has been created a Companion of the same Order (C.B.). Dr. Patric Manson, medical adviser to the Colonial Office, has been appointed a Companion of the Order of St. Michael and St. George (C.M.G.).

A WELL-ATTENDED meeting of the members of the Palæontographical and Ray Societies was held at the Geological Society's Apartments, Burlington House, on Tuesday, December 19; the Rt. Hon. Sir John Lubbock, Bart., M.P., President of the Ray Society, in the chair. The object of the joint meeting was to present to the Rev. Prof. Wiltshire, the hon. sec. of both the above-named societies, his portrait in oils, an illuminated address, and a cheque for 138*l.*—the balance of the sum subscribed after defraying expenses—in recognition of the services rendered by him to these societies and to palæontology and zoology during a period of more than thirty years. The portrait was executed by Miss Atkinson; the illuminated address by Miss G. M. Woodward. Among those present were Dr. Henry Woodward, F.R.S., President of the Palæontographical Society, the Rt. Rev. Bishop Mitchinson, Master of Pembroke, Oxford, Prof. T. McKenny Hughes, F.R.S., and Prof. W. J. Lewis, the Rev. R. A. Bullen, the Rev. G. F. Whidborne, V.P. Pal. Soc., the Rev. H. H. Winwood, Dr. W. T. Blanford, F.R.S., Mr. John Hopkinson, Prof. T. Rupert Jones, F.R.S., Sir Owen Roberts, Dr. D. H. Scott, F.R.S., Mr. F. W. Rudler, F.G.S., and Mr. A. Strahan; many ladies were also present. The presentation address was made by Sir John Lubbock, and the Rev. Prof. Wiltshire responded. Speeches were also made by Dr. Woodward, Prof. T. McKenny Hughes, Rev. G. F. Whidborne, and the Rev. H. H. Winwood; 132 subscribers took part in the testimonial.

A CONGRÈS d'Histoire des Sciences will be held in connection with the Paris Exhibition. As the development of all branches of scientific knowledge will be considered, the Congress will be of wide interest. Prof. Paul Tannery is the president of the organising committee, and Dr. Sicard de Plauzoles is the secretary. The official address is 10 boulevard Raspail, Paris.

PROF. MILNE-EDWARDS has been elected vice-president of the Paris Academy of Sciences for this year.

THE eighth Pasteur Institute existing in France was opened at Lyons on Monday, the seven others, in order of seniority, being Paris, Algiers, Tunis, Montpellier, Marseilles, Bordeaux and Lille. In connection with this, the *Times* points out that there are six Institutes in Russia, at St. Petersburg, Moscow, Samara, Kharkof, Warsaw and Odessa; five in Italy, at Bologna, Milan, Naples, Palermo and Turin; and two in Austria-Hungary, at Vienna and Budapest; while there are also Institutes at Saragossa, Malta, Bukharest, Constantinople, Aleppo and Tiflis. There are three in North America, at New York, Chicago and Havana, and two in South America, at Rio de Janeiro and Buenos Ayres.

THE important paper which Prof. J. J. Thomson communicated to the British Association meeting at Dover, on the masses of the ions in gases at low pressures, has been published in the December number of the *Philosophical Magazine*.

THE ion is now playing such an important part in physical investigations that many are anxious to become familiar with the work which has brought electrolysis to its present standpoint. An interesting article on electrolysis and the theory of ions has been communicated to *La Revue des deux Mondes* by M. A. Dastre, in which our readers will find the history of the subject fully stated.

WE regret to see the announcement that Sir James Paget, Bart., F.R.S., died on Saturday last, at the age of eighty-five.

THE *Times* states that the Paris Observatory will henceforth in all its publications reckon the day from midnight to midnight, the hours being numbered from 0 to 24. This system of time reckoning has been adopted in our *Nautical Almanac* since 1891.

WE learn from *Science* that Dr. G. A. Dorsey, curator of anthropology, Field Columbian Museum, accompanied by an assistant and the Rev. H. R. Voth, have gone to the Pueblo of Oraibi, Arizona. The object of the expedition is to secure additional ethnological material for the Museum, to witness the winter solstice ceremony just past in order to get suggestions for new groups, and also to start a systematic and somewhat extended excavation in order to strengthen the archæological exhibit from this interesting region. The expenses are covered by Mr. Stanley R. McCormick, of Chicago, who has placed 5000 dollars at the disposal of the Museum in addition to the 10,000 dollars already expended on the Hopis.

THE *Daily Chronicle* recalls that a London paper of the first week of 1800 alluded to the then recent hot disputes in France and England respecting the beginning of the nineteenth century. According to the paragraph, the famous Joseph Jérôme Lefrançais de Lalande, who then occupied the Chair of Astronomy in the University of Paris, had taken an active part in the controversy, and he had pronounced in favour of January 1, 1801. His decision had been generally accepted as correct on both sides of the Channel. The newspaper referred to remarks: "The same ridiculous question was agitated in 1700." So does history repeat itself.

AT the last meeting of the British Astronomical Association, Mr. Maunder made a statement with reference to the arrangements that are being made by the Association for the proposed expedition to Spain and Algeria to view the solar eclipse of May 28. Subject to a sufficient number of passages being actually taken before January 31, the Royal Mail steamer *Tagus*, or a sister vessel, will be engaged, and will start from Southampton on Friday, May 18, at 6 p.m., calling at Cadiz and Alicante, and arriving at Algiers at 6 a.m. on Thursday, the 24th. The vessel will stay there until after the eclipse, leaving at 6 a.m. on Tuesday the 29th, and calling at Alicante, Gibraltar, and Lisbon on the way to Southampton, which will be reached at 7 a.m. on Monday, June 4. It is hoped the members of the Association would divide themselves into three groups—those observing the eclipse (1) in the interior of Spain; (2) at Alicante or neighbourhood, and (3) in Algeria, where the ship will act as hotel for those who may wish to use it in that capacity.

UNDER the auspices of the Albany Institute and the Albany Historical Art Society, the anniversary of the birth of Prof. Joseph Henry was celebrated in that city on December 17th. In opening the meeting President Colvin paid a glowing tribute to Prof. Henry. The *Electrical Review* of New York reports him to have remarked:—"In 1831 Prof. Henry developed his system of magnetic telegraphy, and within these halls (Albany Academy) placed a telegraph wire a mile in length, over which signals were sounded by the self-same magnet and bell which you will hear to-night. The telegraph was now a reality—he would not patent it. Thus here began a greater phase of his character, his unselfishness and his devotion to the public welfare. We are now brought face to face with that noble nature, which as college professor, as director and developer of Smithson's magnificent bequest to the American people, as counsellor of the United States Government in its most important scientific and technical works, as a discoverer in many branches of science, made him great among our greatest—faithful, noble and true." An illustrated account of Henry's work appears in the *Scientific American* of December 23.

PROF. S. W. STRATTON, of the University of Chicago, has recently been appointed Inspector of Standards, Bureau of Weights and Measures. In accepting this position (remarks *Science*) Prof. Stratton takes immediate charge of the United States Office of Weights and Measures at a most opportune time. This Office has long had in its custody the national standards of length and mass, and has done much valuable work for science and the arts, which has been the logical outcome of this custody. Within the last two years the Office has taken up vigorously the matter of standards for electrical measurements, has acquired apparatus and made special studies, and is now ready to do valuable work along that line. It is especially well equipped for measurements of resistance of the highest degree of accuracy.

THE thirty-first volume of the *Zeitschrift für physikalische Chemie* just issued forms a pleasing novelty in scientific publication. This Jubelband, which is published as a whole and not in parts as usual, is dedicated by his pupils to Prof. J. H. van 't Hoff, to celebrate the twenty-fifth anniversary of his taking the degree of Doctor of Philosophy at the University of Utrecht. The introduction to the volume, by Prof. Ostwald, consists of a short biography of the distinguished Dutch Professor, and an appreciative *résumé* of his far-reaching discoveries, together with a complete list, compiled by Dr. E. Cohen, of his published researches. The authors of all the papers are old students of Prof. van 't Hoff, and each paper is written in the author's own language, with the exception of the Polish and Swedish contributors, so that German, English, French and Dutch are represented. As there are twenty-six papers in all, it is hardly possible to give a summary of them here, but the diversity of the subjects treated serves to show the many-sided originality of the author of the modern theory of solution. An excellent portrait of Prof. van 't Hoff in heliogravure is included in the volume.

DR. ROBERT WALLACE has republished as a separate leaflet his letter to the *Times* of November 29, on the African horse-sickness. The disease is a malarial fever produced by a minute fungus which grows during the summer on the *veldt*, but whether in water, on the soil, or as a parasite, is not yet ascertained. Although not contagious, it is contracted by animals exposed to the night air, especially in damp situations. The disease appears annually, but only in certain seasons attains alarming proportions. Its serious character may be gleaned from the statement that some 95 per cent. of the animals afflicted succumb. And unfortunately no effectual system of inoculation has yet been discovered to check its ravages. Certain precautions are, however, mentioned, which render horses less likely to be attacked; and we believe that horses fed on dry fodder, like those of the British cavalry, stand a better chance of escape than grass-fed animals.

AT a recent meeting of the Society of Arts, Mr. F. G. Aflalo read a paper on the necessity for legislative regulation of sea-angling. It was urged that angling from piers on the British coast resulted in a very appreciable diminution of the numbers of certain species of fishes, such spots being favourite feeding-grounds for fish of several descriptions. It was not that each boy that fished did much harm by himself, but the total catch by the entire army of boy-fishers must be very large indeed. And there is one very strong reason why legislation in regard to restoring under-sized fish to the sea should be enforced against the angler rather than against the steam-trawler. This is that while most of such fish are irretrievably injured by the trawler, the majority of those captured by the hook, if carefully removed, are little or none the worse for their temporary sojourn in the air. It is admitted that a large destruction of small fish takes place through trawling; but the only remedy for this would be to stop the industry altogether. On the other hand, the return of small fish captured by the hook to the water is a comparatively easy matter to enforce. The general sense of the meeting supported the author's views.

THE greater portion of the December issue of the *Zoologist* is taken up by the continuation of Mr. Distant's paper on mimicry; the illustration of "active mimicry" forming the subject of this section. Among many instructive examples, we may call attention to one very curious case. During the last decade gardens in Hamburg have been extensively planted with the white-leaved variety of the maple, and the common white butterfly has now accustomed itself to select that shrub on which to settle. Had Hamburg been a *terra incognita*, observes the author, there is little doubt that this practice would have been recorded as a striking instance of passive mimicry. Although not coming under the head of mimicry, we may mention that an analogous change of habit is taking place among many of the Argentine birds, which formerly built on the ground, but, as planting increases, are beginning to nest in trees.

WE learn from the U.S. *Monthly Weather Review* for September last, that the important international cloud work of the Weather Bureau, on which Prof. F. H. Bigelow has been engaged for several years, is now completed, and will be published in the annual report of that department for 1898–99. It will be remembered that about the middle of the year 1896 several meteorological services co-operated in taking a series of simultaneous observations on the height and motion of the ten standard types of clouds which have been defined by the International Cloud Committee, and that the observations were continued for at least a year. Those undertaken by the Weather Bureau were divided into two classes: (1) Those made by means of two theodolites placed at the end of a long base-line. These give the absolute height, velocity, and direction of motion of individual clouds at Washington. (2) Those made with nephoscopes at fourteen stations over the districts east of the Rocky Mountains, giving the relative velocity and direction of motion. The discussion of the data will show the distribution and average height of each type of cloud for every month, and the depth of the zone or horizontal belt in which each type may occur. A very important subject of investigation has been the determination of the direction and velocities of the horizontal motions of the air in each of the eight principal levels, on all sides of the areas of high and low barometric pressures as they move over the United States. This gives definite information regarding storm components, and will enable us to look more closely into the various theories of cyclones and anti-cyclones; it is stated that an attempt to interpret the analytical equations of motion has led to a different idea of the circulation in storms from that commonly taught by meteorologists.

SEVERAL drawings and reproductions of photographs of "the old moon in the young one's arms" are given in the *Bulletin* of the French Astronomical Society for December, 1899, with an article upon the subject of earth-shine, or *la lumière cendrée* as it is termed in France. Curious views have been held as to the reason why the whole dusky ball of

our satellite can be seen near the time of new moon. Posidonius thought that the moon was a diaphanous body, and that the rays of the sun passing through it caused the dull appearance observed. Tycho Brahe suggested that the appearance was produced by the illumination of the moon by Venus, and it was left to Leonard de Vinci to discover the real cause, namely, the reflection by the moon of sunlight reflected from the earth. The accompanying illustration of the phenomenon is from a photograph obtained by M. F. Quénisset.

APPENDIX III. to the Kew *Bulletin of Useful Information* for 1899 consists of a directory of the staffs of the Botanical Departments in these islands, in the colonies, and in India.

THE discovery of several lines in the infra-red spectrum of argon or of some associated gas is announced by Messrs. R. Nasini, F. Anderlini, and R. Salvadori in the *Atti dei Lincei*, viii. (2) 10. The spectrum, of which a photograph is given, was obtained from the residual gas of one of the fumaroli of

Vesuvius, but as it is stated to be perfectly identical in this region with that of argon obtained from air, and this again with the spectra of gases from other fumaroli of Vesuvius, from the rocks in the proximity of the crater, from the Grotta del Cane, from the Acque Albule of Tivoli, from the Bulicame del Viterbo, and from the carbon dioxide emanations of Pergine in Tuscany, the authors think that these lines belong to argon or to some gas accompanying argon in the air. The wave-lengths of the new lines are estimated by exterpolation to be 798, 803, 814, 832, 845, and 857·5, and Signor Anderlini has been able to see the first three lines in the Grotta del Cane gas. It is claimed that the lines in question have not been observed by Crookes, Kayser, Eder, Valenta and others.

IN the *Agricultural Gazette of New South Wales* for September, 1899, are several papers of more than local interest; especially one on the timber trade of New South Wales, by R. Dalrymple-Hay; protective inoculation against anthrax, by Dr. F. Tidswell, and entomological notes for 1898, by W. Froggatt. The last is illustrated by several excellent plates of insects destructive to timber.

WE have received *Bulletin* 175 (July, 1899) of the Michigan State Agricultural College Experiment Station (Entomological Department), edited by Messrs. Barrows and Pettit, and containing notes on about twenty species of insects observed during 1898, including a new moth destructive to peach, *Depressaria persicaeella*, Murtfeldt. The species now dealt with are different from those described in previous reports, and it is intended that future reports shall give a further selection, until all the more interesting or destructive insects of the State have been discussed. The greater part of the figures in this report are original.

WE are glad to notice that the first number of the second series of *The Library* contains a short section dealing with the progress of science, and some helpful notes for librarians on scientific works recently published. The selection of books is by no means complete, nor is it as representative as could be wished, but there seems no reason why this very useful part of an exceptionally interesting magazine should not be developed in future numbers. An excellent photogravure of Dr. Richard Garnett forms a suitable frontispiece to this first number.

DR. J. SANDERSON CHRISTISON'S little book "Crime and Criminals" has reached a second edition. It has been enlarged by the addition of an appendix containing analyses of the "Luetgert" case, which caused so great an excitement in America, and other noted crimes. The book is almost entirely made up of a series of articles on "Jail Types" which originally appeared in the *Chicago Tribune*. The photographs of actual criminals illustrating the volume will be of interest to students of criminology.

THE current number of the *Berichte* contains an important contribution by Dr. R. Scholl to the theory of the constitution of the fulminates. Of the numerous formulæ put forward since the first attempt of Kekulé, the simplest is that proposed by Scholl, and afterwards taken up by Nef, in connection with the views of the latter on divalent carbon, namely, that fulminic acid is carbyloxim, C : N.OH. The fact discovered by Nef, that the mercury salt of nitromethane on standing is partially converted, with loss of water, into mercury fulminate, is in good agreement with the above simple constitution. Further experimental support to this view is now given by Dr. Scholl in the present preliminary note, in which he aims at transferring the oximido group to a stable hydrocarbon radical. Silver fulminate and benzene react together in presence of aluminium chloride, forming benzaldoxim. The conditions necessary for securing good yields require very careful attention, and differ considerably from those generally favourable to the Friedel and Crafts reaction. Thus, with dry materials and freshly prepared aluminium chloride the yield was very bad; but the use of a commercial chloride gave good results. It was then found that the presence of a certain amount of moisture was necessary to obtain good yields, the highest being obtained when a mixture of pure, freshly prepared $AlCl_3$ and crystallised $AlCl_3.6H_2O$ was employed. These results are thus of interest from two points of view, the Friedel and Crafts reaction and the constitution of the fulminates.

THE additions to the Zoological Society's Gardens during the past week include a Black-backed Jackal (*Canis mesomelas*) from South Africa, presented by Mr. J. E. Matcham; a Mozambique Monkey (*Cercopithecus pygerythrus*) from East Africa, a Suricate (*Suricata tetradactyla*) from South Africa, two —— Chelodines (*Chelodina*, sp. inc.) from Australia, three Speckled Terrapins (*Clemmys guttata*) from North America, two Black-headed Terrapins (*Damonia reevesi unicolor*) from China, deposited.

OUR ASTRONOMICAL COLUMN.

HOLMES' COMET (1899 II.).—M. H. J. Zwiers gives a new ephemeris for this comet in the *Astronomische Nachrichten*, No. 3610. The object is getting so faint, however, that an abridgement for every fourth day only is given here.

Ephemeris for 12h. Greenwich Mean Time.

1899.	R.A. h. m. s.	Decl. ° ′ ″
Jan. 4	... 2 10 23·50	... +41 52 40·2
8	... 12 59·30	... 41 25 46·8
12	... 15 58·86	... 41 0 58·5
16	... 19 20·23	... 40 38 16·2
20	... 23 1·71	... 40 17 38·4
24	... 27 1·76	... 39 59 2 0
28	... 31 19·04	... 39 42 23·0
Feb. 1	... 2 35 52·32	... +39 27 36·6

ORBIT OF EROS.—Signor E. Millosevich, of Rome, has communicated to the *Astronomische Nachrichten*, No. 3609, an ephemeris for facilitating observations of the minor planet Eros during the coming opposition at the end of the present year. The ephemeris extends over the period 1900 September 1–1901 January 31, the positions being computed from the following elements:—

Elements for Epoch 1900 *October* 31·5 *Berlin Mean Time.*

$$
\begin{aligned}
M &= 304° \ 23' \ 59''·7 \\
\pi &= 121 \ \ 9 \ \ 22·0 \\
\omega &= 177 \ 38 \ 41·6 \\
\Omega &= 303 \ 30 \ 40·4 \\
\iota &= 10 \ 49 \ 38·9 \\
\phi &= 12 \ 52 \ 48·2 \\
\mu &= 2015''·12740 \text{ (period } 643·14\text{d.)} \\
\log a &= 0·1638027
\end{aligned}
$$

THE SOLAR PARALLAX.—In *Comptes rendus* (vol. 129, pp. 986–993), M. Bouquet de la Grye furnishes the result of his discussion of the facts obtained by the various French expeditions sent out to observe the Transit of Venus in 1882. The reports hitherto published of the expedition have only dealt with the form of the planet's disc and the question of photography. The calculations of the solar parallax from the times of contact of the planet with the sun's limb have occupied several years. The author states that the external contacts are influenced by the size of the objectives of the observing telescopes, but the internal contacts do not show any such connection. Using Halley's method, and combining the observations from the several stations in all possible groups, he finds that:—

From observations with large telescopes $p = 8''·7996$.
,, ,, ,, small ,, $p = 8''·8068$.

and gives *mean parallax* $= 8''·80$ from the visual observations of French parties. A full discussion of the measures of the photographic records obtained will be presented shortly.

PRIZES PROPOSED BY THE PARIS ACADEMY OF SCIENCES FOR 1900.

THE Grand Prix des Sciences Mathematiques will be awarded in 1900 for an improvement, in any important point, of our knowledge of the number of classes of quadratic forms of two unknowns with entire coefficients; the Bordin Prize (3000 francs), for the development and improvement of the theory of surfaces applicable to the paraboloid of revolution; the Francœur Prize (1000 francs), for discoveries useful to the progress of pure or applied mathematics; the Poncelet Prize (2000 francs), for any similar work published during the last ten years.

In Mechanics: the Extraordinary Prize of 6000 francs will be given for any work increasing the efficiency of the French navy; the Montyon Prize (700 francs), for the invention or improvement of instruments useful to the progress of agriculture, the mechanical arts or sciences; the Plumey Prize (2500 francs), for improvements in steam engines or any invention contributing most to the progress of steam navigation.

In Astronomy: the Lalande Prize (540 francs) is offered for the most interesting observations, or work most useful to the progress of astronomy; the Damoiseau Prize (1500 francs), for a memoir on the theory of one of the periodic comets of which several returns have been observed; the Valz Prize, for the author of the most interesting astronomical observation made during the year; the Janssen Prize (a gold medal), for the most important discovery in physical astronomy; and an anonymous prize of 1500 francs, as an encouragement to the calculators of the minor planets, especially those discovered in the Nice Observatory.

In Statistics: a Montyon Prize of 500 francs, for a memoir on questions bearing on French statistics.

In Chemistry: the Jecker Prize (10,000 francs), for organic chemistry, and the Wilde Prize (4000 francs).

In Mineralogy and Geology: the Vaillant Prize (4000 francs) will be awarded in 1900 for a rigorous determination of one or more atomic weights, or for the study of alloys.

In Botany: the Barbier Prize (2000 francs) is intended to recompense whoever makes a valuable discovery in the medical, surgical, or pharmaceutical sciences, or in botany, in relation to the art of healing; the Desmazières Prize (1600 francs), for a memoir on the cryptogams: the Montagne Prizes (1000 francs and 500 francs), for work on the anatomy, physiology, development, or description of the lower cryptogams; and the Thore Prize (200 francs) to the author of the best memoir on the cellular cryptogams of Europe (algæ, mosses, lichens, or fungi), or on the anatomy of any species of European insect.

In Anatomy and Zoology: the Savigny Prize (975 francs), in aid of young travelling zoologists not receiving Government aid, more especially those occupying themselves with the invertebrates of Egypt and Syria; the Da Gama Machado Prize (1200 francs), for the best memoir on the coloured parts of the tegumentary system of animals.

In Medicine and Surgery: a Montyon Prize, for any discovery useful in the art of healing; the Bréant Prize (100,000 francs), for a specific antidote against Asiatic cholera, or for such a discovery of the causes of Asiatic cholera that those causes may be suppressed and the disease stamped out. The interest on the capital sum will be awarded for a rigorous demonstration of the existence in the atmosphere of materials capable of propagating epidemic diseases; the Godard Prize (1000 francs), for the best memoir on the anatomy, physiology, and pathology of the genito-urinary organs; the Parkin Prize (3400 francs), as a recompense for researches upon either the curative effects of carbon and carbon dioxide, or for the effects of volcanic action upon the spreading of epidemic diseases; the Bellion Prize (1400 francs), for works or discoveries especially profitable to the health of man; the Mège Prize, for a study of the causes which have favoured or retarded the progress of medicine; the Dusgate Prize, for the best work on the diagnosis of death, and on the means of preventing premature burial; the Lallemand Prize (1800 francs), for work on the nervous system; and the Baron Larrey Prize (1000 francs), for the best work treating of military medicine, surgery, or hygiene.

In Physiology: a Montyon Prize of 750 francs is offered annually; the Pomat Prize (1400 francs), for a determination of the principal anthropometric data; the Martin-Damourette Prize (1400 francs) and the Philipeaux Prize (890 francs), for work in experimental physiology. In Physical Geography, the Gay Prize (2500 francs), for the application to a portion of France, or a portion of the Alpine Chain, of the analysis of the geological circumstances which have determined the actual conditions of relief and hydrography.

Of the General Prizes, the following may be awarded in 1900: the Arago Medal, the Montyon Prize (unhealthy trades), the Cuvier Prize (1500 francs), the Tremont Prize (1100 francs), the Gegner Prize (4000 francs), the Delalande-Guérineau Prize (1000 francs), the Jérome Ponti Prize (3500 francs), the Tchihatchef Prize (3000 francs), the Boileau Prize (1300 francs), the Houllevigne Prize (5000 francs), the Cahours Prize (3000 francs), and the Saintour Prize (3000 francs).

GEOLOGY OF JAMAICA.[1]

THIRTY years have elapsed since the publication of the "Reports on the Geology of Jamaica," by James G. Sawkins and others, with an appendix by Robert Etheridge; a work published as one of the "Memoirs of the Geological Survey." In the work before us Mr. Robert T. Hill deals anew with the subject, his observations being based upon surveys made for Alexander Agassiz; and he has evidently spared no pains to investigate the geology and physical geography of the island in a thorough manner in accordance with modern knowledge. It is interesting to find him referring to the early paper written by De la Beche for the Geological Society in 1828 as "more in harmony with the conclusions to be presented by us than the subsequent and more extensive reports of the official surveys which supplanted them."

Mr. Hill considers that Jamaica presents a more favourable opportunity for detailed geologic investigation than any other tropical area. Highways, bridle-paths, and railways intersect the land in various directions, to say nothing of the coast-cliffs. Hence there is no lack of geological sections, and the author has had great advantages over those who preceded him. He remarks that the earlier researches "failed to solve the essential problems of the succession and age of the strata," and that the literature of no other region, especially that relating to palæontology, "presents so many erroneous conclusions." Curiously enough the author attributes this stratigraphic confusion, not to incompetence, but "to an act of Providence." It is well known that the original Director of the Jamaican Geological Survey, Lucas Barrett, was drowned in a diving-dress, and it is pointed out that the endeavours to interpret his opinions were the chief sources of subsequent erroneous conclusions. The stratigraphical errors were largely those of correlation, for it is admitted that otherwise the official reports were full of valuable data.

The author now starts afresh in naming and classifying the formations, using geographical terms, rather than those of a lithological or palæontological nature. The island is made up of Cretaceous, Eocene, Oligocene, Pliocene, and younger deposits, together with intrusive rocks. In adopting geographical names it would have been well, if possible, to have avoided the use of those names which are not original to the island, but are familiar elsewhere; to speak of the Jerusalem, Richmond, and Falmouth beds of Jamaica is at least unfortunate. So far as they go the Yallahs, Catadupa, and Manchioneal beds sound more appropriate, and the same may be said of the Bogue Island formation.

Evidence is given to show that locally the Cretaceous, Eocene and Oligocene formations were stratigraphically continuous, and we have a succession upwards from detrital to oceanic deposits. The higher Eocene beds contain *Cerithium*, *Lucina*, and Rudistes.

The white limestones of the Jamaican series are shown to represent several distinct ages, from Cretaceous to Recent, but the main mass belongs to the Oligocene. This mass forms the large plateau region which is really a dissected plain, rising in places to 3000 feet. It is known as "the cock-pit country," on account of the numerous swallow-holes, which vary from shallow circular basins to sink-holes 500 feet in depth. They are characterised by a bright red clayey soil, a residue from the dissolution of the limestone. Dykes of diorite and granitic rock penetrate Cretaceous, Eocene and Oligocene strata. The coastal deposits include various gravels, marls, and reef-beds of later Tertiary and Recent ages.

[1] "The Geology and Physical Geography of Jamaica: Study of a Type of Antillean Development." By Robert T Hill, *Bull. Museum Comp. Zool. Harvard Coll.*, vol. xxxiv., 1899, pp. 256; with 41 plates. (Cambridge Mass.)

The author discusses at some length the changes of physiography in tropical America, in their bearing on the history of the West Indian Islands. In Jurassic times there is evidence of a great expansion of land from the Rocky Mountains eastwards in North America, and over the north-eastern part of South America. "It is probable that the continental mass as a whole, practically equivalent in area to the present one, occupied a position slightly east of its present locus." The American fossiliferous marine Jurassic belonged to the Pacific area, and may have extended as far to the east as Havana. No evidence is recognised for establishing land connection between the islands and North and South American lands in Post-Jurassic time. The first evidence of Antillean lands is found in eruptive rocks of late Cretaceous time, when it is probable there were marine volcanoes. The land débris constituting the Eocene strata proves the pre-existence of extensive Cretaceous land-areas. In late Eocene and early Oligocene times there was a profound regional subsidence, and 3000 feet of purely oceanic deposits were accumulated. A great uplift occurred in late Oligocene or Miocene times, and subsequently many minor movements of elevation and depression have taken place.

In an appendix some Cretaceous and Eocene corals from Jamaica are described by Mr. T. Wayland Vaughan.

H. B. W.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

UNDER the will of Mr. James Brown Thomson, of Kinning Park, Glasgow, the University of Glasgow will receive 10,000*l*., and the Glasgow Technical College, 2000*l*.

MR. W. H. DERRIMAN, assistant lecturer in physics at the Technical College, Huddersfield, has been appointed to a similar post in University College, Liverpool.

Science states that Dr. Jokichi Takamine, of the University of Tokio, Japan, known for his researches on digestive ferments, is at present on a tour of inspection of the larger educational institutions of the United States. He has been sent by the Japanese Government to examine the scientific work and methods of American universities.

AN English Educational Exhibition will be held at the Imperial Institute on January 5-27. The exhibits will comprise students' work, and will refer to primary, secondary, technical, and higher education of both sexes. A series of lectures and conferences on educational subjects and demonstration lessons will be held at the Imperial Institute during the Exhibition. Particulars of the chief science conferences have already been given (p. 189).

THE *University Correspondent* has published its annual crop of amusing mistakes made by schoolboys in answers to examination questions. The following answers, selected from many similar ones, show how easy it is for pupils to receive inaccurate and confused impressions when given didactic instruction, and also how essential it is that examination questions should be explicit:—When would you expect an eclipse of the sun to take place? In the night.—The sun never sets on English possessions, because the sun sets in the west, and our colonies are in the north, south, and east.—The exports of Ceylon are peculiar to any other part of the world. The chief are piano steamers (sc. P. and O. steamers).—A cubic foot of water weighs 64 lbs. : ∴ a squate foot of water weights 16 lb., and a foot of water weights 4 lb.—The three principle parts of the eye are the pupil, the moat, and the beam.—A mariner's compass is a little poast stuck up in the sea, and when people want to know the way, the ships go and look at it.—Many other instances might be given, but those quoted are sufficient to show that there is much room for improvement in the teaching of scientific subjects while such hazy ideas exist in the minds of schoolboys.

SCIENTIFIC SERIAL.

Symons's Monthly Meteorological Magazine, December, 1899.—The aims of meteorology. This is a brief synopsis of a "Report on the Meteorology of Maryland," prepared by direction of the U.S. Weather Bureau. The article on special observations and investigations enumerates twenty-nine heads under which observations are made. While all are useful in different ways, any single service dealing with one-third of them would have little energy left for the improvement of the important work of weather prediction. Mr. Symons considers that the perusal of the work, consisting of about a hundred pages, is not merely instructive as a guide to the future, but also very useful as a record of past progress.—Kites and meteorology, by W. A. Eddy. This is a statement, in chronological order, of the various occasions on which kites have been used in meteorological investigations, from those in 1749, by Wilson and Melvill, near Glasgow, and in 1836 by Admiral Bach in Hudson Strait, in sending up thermometers, to those very successful experiments made in recent years at the Blue Hill Observatory, by means of the Eddy and Hargrave kites.—The same number also contains some interesting notes on damage by lightning, injurious effects of fog on plants, and unusual snow crystals.

SOCIETIES AND ACADEMIES.

EDINBURGH.

Royal Society, December 19, 1899.—Prof. Duns in the chair.—Dr. J. Souttar McKendrick, of Glasgow, read a paper on the zymolysis of tissues, physiological and pathological. After a short bibliographical sketch of the nature and action of enzymes as they exist in the digestive juices, with their methods of extraction, and mention of the observations of Nasse, Brucke, and others who had attempted to demonstrate the presence of ptyalin and pepsin in muscle, the author described in detail his method of procedure. He made glycerine extracts of between sixty and seventy tissues of the rabbit, child, adult, and those obtained post-mortem, and with each tissue extractive he endeavoured to demonstrate the presence or absence of enzymes similar in their action to ptyalin or amylopsin, pepsin, trypsin, inversin and rennin. A series of extractives were also made from certain pathological tissues, namely, carcinomata, sarcomata, tissues from an eclamptic, &c. The results pointed to the presence of pepsin, or a substance analogous to it, in all the tissues, physiological and pathological; to the presence of a diastatic ferment in most of the tissues; to the absence of tripsin except in the pancreas; to the absence of a milk curdling ferment except in those tissues in which it is known to exist; to the absence of an inversive ferment. Malignant tissues were found to have proteolytic and diastatic properties. Though rabbit's blood contained no diastatic enzyme, eclamptic blood contained such an enzyme in large amount; and all eclamptic tissues yielded extracts with markedly diastatic properties. The author in conclusion advocated the similar examination of the blood in all obscure diseases and of carcinomatous and sarcomatous growth.—Prof. Mitchell communicated a paper on the cooling of a body in a steady blast of air, Part II. In the later experiments the air currents had been varied from 10 to nearly 1000 metres per minute, and the temperature had been carried up to 120° C. Newton's law of cooling under these conditions was found to hold with great accuracy, and Newton's original statement, imperfectly quoted by most writers, completely verified. The rate of cooling was shown to be proportional to the difference of temperature for a given strength of blast, and to be proportional (for a given temperature) to the strength of blast up to a value of about 450 metres per minute, but to fall off from the law of proportionality for higher values. This was explained as a result of unsteadiness in the air current at these higher values—Dr. Mahalanobis described a new form of myograph, which consisted essentially of a T-shaped lever, pivoted so as to admit of horizontal movements free from the influence of gravity. The instrument was suitable for obtaining myograms of isometric and isotonic contractions of muscles, and most of the ordinary experiments on fatigue, tetanus, &c. The momentum of the lever during contraction of the muscle was approximately counterbalanced by the slight increase of tension in an elastic band, thus securing a fairly isotonic condition of the muscle.—Dr. C. G. Knott drew attention to the fact that Prof. Swan, of St. Andrews, had in 1859 constructed and used the form of photometer commonly associated with the names of Lummer and Brodhun, who described it in 1889. Swan's own description and figure will be found in the *Trans.* R.S.E., vol. xxii., 1861.—Prof. Tait, in a note on the claim recently made for Gauss to the invention of quaternions, showed that what Prof. Klein, both in the *Mathematische Annalen* and in his (and Sommerfeld's) treatise *Ueber die Theorie des Kreisels* ascribed to Gauss was not the Hamiltonian quaternion at all, but a particular and very limited kind of strain, which consisted of a simple rotation combined with an isotropic expansion, and thus involving four constants only. Klein and Sommerfeld's attempted identification of Gauss' operator with Hamilton's quaternion indicated a curious misapprehension on their part of the real essence of a quaternion.—Dr. C. G. Knott, in a paper on the same subject, gave a detailed criticism of the section in Klein and Sommerfeld's treatise devoted to the discussion of the theory of quaternions.

PARIS.

Academy of Sciences, December 26, 1899.—M. van Tieghem in the chair.—M. H. Milne-Edwards was elected Vice-President of the Academy for the year 1900.—Note on the work contained in the volume of the "Annales de l'Observatoire de Paris de 1897," by M. Lœwy. This volume inaugurates a new series of *Annales*, differing from preceding volumes both in the nature of the work carried out and the form chosen for publication.—On the radiation of radio-active bodies, by M. Henri Becquerel. There would appear to be a fundamental difference between the radiations of radium and polonium salts, in spite of their similar photographic action, as the polonium radiations placed in a magnetic field show no influence of the same order as observed for radium.—Experimental cultures on the adaptation of plants to the Mediterranean climate, by M. Gaston Bonnier. The object of these researches was to find out if plants taken from temperate climates to the Mediterranean could so modify their form and structure as to adapt themselves to their new surroundings. Experiments were carried out with a large number of different species, and nearly all showed, even after one season, notable differences in form, the stems becoming more ligneous, even stems of one year's growth, the leaves larger and thicker with the veins more strongly marked.—Researches on the tautomerism of benzoyl-benzoic acid, by MM. A. Haller and A. Guyot. From its mode of formation from benzene and phthalyl chloride, benzoyl-benzoic acid would appear to have the constitution of an oxylactone, and this view is confirmed by the formation of diphenyl-phthalide from its chloride. But, on the other hand, in many reactions both the chloride and acid exhibit undoubted ketonic properties. It thus appeared to be interesting to see if the tautomeric modifications of this acid could be obtained as methyl ethers. Methyl-*o*-benzyl benzoate was accordingly prepared by five different methods, direct etherification by hydrochloric acid, interaction of methyl iodide and the silver salt, interaction of benzoyl-benzoic anhydride and sodium methylate, action of sodium methylate upon acetyl-benzoyl-benzoic anhydride, and upon benzoyl-benzoic chloride. In all cases the same ether was produced, which would appear to be the true ketonic ether, $C_6H_5.CO.C_6H_4.CO.(OCH_3)$.—Remarks by M. Albert Gaudry, upon a work of M. Erland Nordenskjold.—General Gallieni was elected a correspondent for the Section of Geography and Navigation.—Observation of the eclipse of the moon of December 16, 1899, with the photographic equatorial at Toulouse, by M. Montangerand. Experiments with plates of different degrees of sensitiveness showed that panchromatic plates give better results with a total than a partial eclipse.—Observations of the new planet EY (Charlois), made at the Observatory of Besançon, by M. P. Chofardet.—Organisation of the daily registration of the entire chromosphere of the sun at the Observatory at Meudon. First results, by M. H. Deslandres.—Remarks on the preceding communication, by M. J. Janssen.—On the employment of triphase currents in Radiography, by M. Delézinier.—On the discontinuities produced by the brusque expansion of compressed gases, by M. Paul Vieille. Diaphragms of collodion were constructed capable of standing a pressure up to twenty-seven atmospheres. By the sudden rupture of this diaphragm, an explosive wave was set up, the front of which was more symmetrical than when explosives are used. The mean velocities of propagation of the wave were measured at different distances from the diaphragm. Velocities could thus be obtained of over 600 metres per second, greater than the velocity of sound.—On some phenomena presented by iron, by M. Galy-Aché. The results of the experiments upon a very pure sample of iron are in accord with the views of Osmond and Werth, that there are two allotropic varieties of iron, α-iron, stable at the ordinary temperature, and β-iron, stable at high temperatures.—On the changes in volume accompanying the hardening of hydraulic cements, by M. H. Le Chatelier. The contraction was measured by sealing up the cements in the bulb of a thermometer containing water. The absolute contraction after six months was between 4 c.c. and 5 c.c. per 100 grams of cement. There was at the same time an apparent expansion, sufficient in some cases to burst the bulbs of the thermometers.—On the temperature of transformation of the two varieties, quadratic and orthorhombic, of mercuric iodide, by M. D. Gernez. The transformation-temperature is 126°. The temperature of 75°, found by M. Wyrouboff, is due to an error caused by his working *in vacuo*.—New experiments upon the activity of manganese with respect to the phosphorescence of strontium sulphide, by M. José Rodriguez Mourelo.—On molybdenum silicide, by M. E. Vigouroux. Silicon combines directly with molybdenum in the electric furnace, forming Mo_2Si_3, which is obtained pure with difficulty. It burns in chlorine at 300°, giving silicon tetrachloride and molybdenum perchloride.—On molybdenum disulphide, by M. Marcel Guichard. Of the various methods suggested for the preparation of molybdenum disulphide, two only are satisfactory, the fusion of potassium carbonate and sulphur with molybdenum dioxide, and heating sulphur to a high temperature with ammonium molybdate. The first method gives a crystalline product, the second an amorphous one. By the action of heat a new sesquisulphide is formed, further particulars of which will be given in a subsequent note.—The action of nitrous acid upon the leucobase $C_{18}H_{24}N_2$, by M. A. Trillat.—Heat of neutralisation and acidimetry of cacodylic acid, by M. Henri Hibbert. Cacodylic acid is a feeble monobasic acid, being neutral to helianthine and monobasic to phenol-phthalein.—The hydrate of sodium dioxide and the prepration of hydrogen peroxide, by M. de Forcrand.—On the anhydrous sesquichlorides of rhodium and iridium, by M. E. Leidié. The double chloride $Rh_2Cl_6 6NaCl$. (with $3H_2O$ or $18H_2O$), heated in a current of dry hydrogen chloride up to 440° C gives a mixture of Rh_2Cl_6 and NaCl from which the latter can be removed by washing with water. The hydrogen chloride may advantageously be replaced by chlorine if the double salt is previously dried at 105°–110° C. The corresponding iridium chloride is best obtained by heating $Ir_2Cl_6 6NH_4Cl$ in chlorine at 440° C.—The biochemical oxidation of propylglycol, by M. André Kling. Following up his previous work on this subject, the author has now proved that the reducing body formed by the oxidation of $CH_2(OH)CH(OH)CH_3$ is acetal, $CH_3.CO.CH_2OH$.—On the preparation of the carbazides. Action of the hydrazines upon the phenolic carbonates, by MM. P. Cazeneuve and Moreau. By the interaction of phenyl carbonate and phenyl-hydrazine a good yield of carbohydrazide is obtained. Similarly hydrazine hydrate gives carbazide, $CO(NH.NH_2)_2$. The method appears to be capable of general application.—Combinations of lithium chloride with ethylamine, by M. J. Bonnefoi. From the dissociation pressures of the compounds $LiCl.C_2H_5(NH_2)$, $LiCl.2C_2H_5(NH_2)$, $LiCl.3C_2H_5(NH_2)$, the heats of dissociation are calculated by Clapeyron's formula to be 13·72 cal., 11·09 cal., and 10·50 cal. These numbers were also measured directly in the calorimeter, and found to be 13·83 cal., 10·98 cal., and 10·57 cal. respectively.—On narceine, by M. Émile Leroy. Measurements of the heats of hydration, combustion, and formation of narceine and its salts.—On the evolution of mineral matter during germination, by M. G. André.—On the estimation of the halogens in organic compounds, by M. Amand Valeur. The determination of the halogens in organic compounds can be carried out very rapidly and accurately in the calorimetric bomb, provided that a suitable quantity of naphthalene is burned at the same time. For chlorine and bromine, strong ammonia is placed in the bomb, and this liquid analysed volumetrically either by Mohr's or Volhard's method. The whole analysis can be finished in half an hour. For iodine the ammonia is replaced by potash solution. Tetra-iodo-ethylene, containing 95·5 per cent. of iodine, gave very good results by this method.—On some effects of electric discharges upon the heart of mammals, by MM. J. L. Prevost and F. Battelli. Under the influence of a current of suitable strength, the tremulous vibrations are replaced by true rhythmic contractions of the heart, with restoration of the blood pressure, if the current is applied within fifteen seconds of the appearance of the trembling.—General considerations on the male reproductive organs of the Coleoptera, by M. L. Bordas.—The evolution without heterogony of an Angiostome of the ringed adder, by M. Railliet.—On the pigment of the Arenicolæ, by M. Pierre Fauvel.—Chlorophyllian assimilation in solar light which has traversed leaves, by M. Ed. Griffon. The passage of light through a single leaf causes a notable weakening in the activity of those rays which are required for the chlorophyllian assimilation. The results vary much with the conditions of temperature and lighting.—On a bacterial zooglea of definite form, by M. Radais.—On the elements of limited symmetry, by M. Walleront.—Observations on the structure of the diluvium of the Seine, by M. Stanislas Meunier.—On a new hypothesis on the nature of the physical conditions of smell, by MM. Vaschide and Van Melle. The authors combat the view that the sense of smell is due to the emission of particles from the substance, and suggest that the effect is produced by rays of short wave-length, analogous, but not similar to, light rays, Röntgen rays, &c. They adduce ten arguments in favour of their hypothesis.—On a cranial campylogram, by MM. Blin and Simon. A description of an instrument for measuring the curves of the cranium in the living.—Barometric movements caused on the meridian of the sun by its movement in declination, by M. A. Poincaré.

CAPE TOWN.

South African Philosophical Society, November 29, 1899.—Mr. L. Péringney, President, in the chair.—The President recorded the deciphering, by Mr. Donald Ferguson, of an old stone which has been in the South African Museum since 1855. The stone was known to the late Dr. Atherstone and Mr. C. A. Fairbridge as the Mossel Bay stone. It is a rudely cubical block of sandstone with a cut inscription on one surface, which, however, has been broken across. On the fractured surface, at right angles to the inscribed face, there is a peculiarly shaped cross. Mr. Sclater sent an impression of the inscription to Mr. Ferguson, who translated it as follows:—"Here was lost the ship *Sao Gonzalo* in the year 1630. They made [built] two boats . . . ?" An account of the fleet of which the *Sao Gonzalo* formed a part is given in an old MS. in the British Museum, a transcript and translation of this being sent by Mr. Ferguson. The wreck occurred at Bahia Fermoza, now Plettenberg Bay, and the stone had originally marked the spot. Some of the present inhabitants of Plettenberg Bay remember a stone having been sent to Cape Town, and it is most probably this so-called Mossel Bay stone.—Dr. Gilchrist read a paper on, and showed a specimen of, a new Aplysia. The new species (*Paraplysia Lowii*), found at East London, is the third known one of the group of the Tectibranchiata, characterised chiefly by the peculiar position of the rhinophora. It differs from the other two species, *P. piperata* (Smith) and *P. monhoti* (Gilchrist) in several features which have been supposed to be characteristic of the genus Paraplysia proposed by Pilsbury.—Messrs. Rogers and Schwarz gave an account of the "Orange River Ground Moraine" in the neighbourhood of Prieska. Sections near Prieska show an ancient morainic conglomerate passing underneath the so-called Kimberley shales, and lying unconformably on the older Jasper rocks, quartzites and granite. The conglomerate contains numerous striated boulders, and the underlying rock often presents a rounded, scratched surface, which frequently forms distinct *roches moutonnées*. The ice passed from north to south. The authors could not say certainly what the exact relation of this conglomerate to the Dwyka conglomerate is, but are of opinion that it partially at least represents the land-formed ground moraine of the ancient glacier whose water-borne detritus has elsewhere formed the Dwyka conglomerate. The paper was illustrated by photographs and specimens of the striated boulders and floor.—An account of the earthquake of September 15, 1899, presented by the secretary, was taken as read.

DIARY OF SOCIETIES.

THURSDAY, JANUARY 4.

ROYAL INSTITUTION, at 3.—Fluids in Motion and at Rest: C. V. Boys, F.R.S.
RÖNTGEN SOCIETY, at 8.—The Interpretation of Skiagrams: Chisholm Williams.

FRIDAY, JANUARY 5.

GEOLOGISTS' ASSOCIATION, at 8.—Our Older Raised Beaches: Address by Sir Archibald Geikie, F.R.S.—A New Rhætic Section at Bristol: W. H. Wickes.

SATURDAY, JANUARY 6.

ROYAL INSTITUTION, at 3.—Fluids in Motion and at Rest: C. V Boys, F.R S.

MONDAY, JANUARY 8.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—Colour Photography: J. W. Hinchley.—Cinchona: J. M. Vargas Vergara.—Microscopic Character of Vicunna, Camel-hair, and Alpaca: R. M. Prideaux.

TUESDAY, JANUARY 9.

ROYAL INSTITUTION, at 3.—Fluids in Motion and at Rest: C. V. Boys, F.R.S.
INSTITUTION OF CIVIL ENGINEERS, at 8.—The Purification of Water after its Use in Manufactories: Reginald A. Tatton.—Experiments on the Purification of Waste Water from Factories: W. O. E. Meade-King.
ANTHROPOLOGICAL INSTITUTE, at 8.30.—The Oak and the Thunder God: H. M. Chadwick.—Notes on some Caves in the Zitzikamma, or Outeniqua District, near Knysna, South Africa, and the Objects found therein: Dr. H. D. R. Kingston.—Notes on Skeletons found in the Zitzikamma and Knysna Caves: F. C. Shrubsall.

WEDNESDAY, JANUARY 10.

GEOLOGICAL SOCIETY, at 8.—On a Particular Form of Surface, the Results of Glacial and Subaerial Erosion, seen on Loch Lochy and elsewhere: Dr. W. T. Blanford, F.R.S.—On the Geology of Northern Anglesey, Part II.: C. A. Matley.—The Formation of Dendrites: A. O. Watkins.

THURSDAY, JANUARY 11.

MATHEMATICAL SOCIETY, at 8.—A Problem in Resonance, illustrative of the Mechanical Theory of Selective Absorption: Prof. Lamb, F.R.S.
INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Report of the Institution's Visit to Switzerland. The Report will be taken as read, and the discussion will be opened by Mr. Crompton by a Comparison between British and Continental Practice in Electrical Engineering.

FRIDAY, JANUARY 12.

ROYAL ASTRONOMICAL SOCIETY, at 8.
INSTITUTION OF CIVIL ENGINEERS, at 8.—The Theory of Structures and Strength of Materials: Prof. T. Claxton Fidler.

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THURSDAY, JANUARY 11, 1900.

ASTRONOMICAL AND OPTICAL INSTRUMENTS.

Handbuch der Astronomischen Instrumentenkunde. Von Dr. L. Ambronn. Zwei Bände. Mit 1185 in den Text gedruckten Figuren. Pp. vi + 1276. (Berlin: Julius Springer, 1899.)

Die Optischen Instrumente der Firma R. Fuess deren Beschreibung, Justierung, und Anwendung. Von C. Leiss. Mit 233 Holzschnitten im Text und 3 Lichtdrucktafeln. Pp. xiv + 397. (Leipzig: Wilhelm Engelmann, 1899.)

WHOEVER undertakes to write a manual on astronomical instruments, or indeed on the instruments that the study of any branch of physics demands, engages in a task of no common difficulty. It is impossible to turn over the two handsome and ponderous volumes that Dr. Ambronn has compiled, without being struck with the wealth and variety of material that is submitted to our notice. The successive effects of ingenuity as detailed in these volumes are so bewildering in their extent, that it is quite impossible within the limits of a few paragraphs to do justice to the labour and research to which these volumes are an eloquent witness. We can only hope to sketch the scheme, to suggest the lines on which, in the opinion of the author, a text-book on astronomical instruments should proceed. The lucidity of explanation and the wealth of illustration only make the task the more difficult, by demonstrating the number of points that are worthy of comment and attention.

The history of construction, the gradual evolution of the telescope or equatorial, interesting and inviting as such a subject must be, is not allowed to any extent to interfere with the author's project of presenting before astronomers, and before mechanicians, the devices which have been sanctioned by experience and approved after repeated tests. Historical remarks there must be, the comparison of the work and methods of one maker with another, the growth of convenience and power of instruments necessitates descriptions which illustrate historical progress; but such remarks are incidental, and do not concern the main purpose of the work. The present standpoint of mechanical art and the achievements of workshops of known reputation, of themselves cover an enormous ground, which will be studied with profit alike by those who seek to modify existing instruments in a direction which will make them available for special investigations, and by those to whom are necessarily entrusted the duties of manufacture and the details of arrangement.

The work really consists of seven separate treatises, each fairly complete in itself, and the whole forming an encyclopædia, an invaluable work of reference on astronomical instruments. These seven sections are entitled: (1) Accessory apparatus; (2) clocks; (3) separate parts of instruments; (4) micrometers; (5) instruments devoted to special purposes; (6) complete instruments; (7) observatory buildings. The division is somewhat artificial, and cannot be rigorously maintained. For instance, a heliometer might be described as a complete instrument rather than as a special form of micrometer, and there seems no reason why chronographs should not be treated under clocks. Of course, no confusion can possibly arise from such a method of division, because each instrument serves a definite purpose, and its mode of use is perfectly defined. Simplicity of construction is perhaps the best guide to arrangement, and it may be that which the author has followed. Certainly he is well advised in selecting the screw as the first subject for detailed description, and the effective treatment applied to this simple piece of apparatus, whether as a tool in the hands of a mechanic or in the more delicate application to measurement as a micrometer, assures us that we are in presence of a master. We have many useful and ingenious hints both in construction and use, and it is of special importance to notice, as lifting the book out of the category of merely descriptive works, that the author has added an example of the method of determining the errors of a screw as the problem comes before the practical astronomer. But this, and other perfectly legitimate applications of theory to be met elsewhere in the book, suggest a difficulty which, we feel sure, the author has experienced, and introduce a feature which may be considered not altogether satisfactory. How far should a manual of this character concern itself with the theory of instruments? It was evidently the intention of the author not to supply a descriptive work simply, not a manufacturer's catalogue illustrated by many engravings, but to add also a theoretical treatise which might be useful to the astronomical student. But to enter into the theory with that rigorous detail which characterises many text-books, would evidently carry the author too far, and might add another volume to a work whose length is already sufficiently forbidding. There is, therefore, a constant struggle between the theoretical and descriptive parts, in which the former is usually worsted, and the maintenance of the same high standard of excellence common to both is rendered impossible. For instance, the theory of the sextant is in its way more complete than that of the heliometer, simply because the same actual space is approximately allotted to each. One cannot help feeling that the author has not done himself justice in the matter of theoretical discussion, and we hope that he may be tempted to return to the subject and complete his work by giving a theory as precise and thorough as the descriptive portion is clear and satisfactory.

From the screw it would have seemed natural to have gone at once to the reading microscope and the micrometer; but the author has preferred to interpolate the description of levels, collimators, and other mechanical devices, which are not so much astronomical instruments as aids to adjustment and means for inquiry into the stability of the instrument properly so-called. In the second section, Dr. Ambronn breaks away from his account of space measurement in order to describe clocks and time-recording instruments. The treatment here is mainly conducted from a German point of view, and more attention might have been bestowed on improvements that have been suggested by English authorities. But, of course, one admits readily enough that

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he has to do with a German book, written in German for German students and workpeople, and some allowance must be made for patriotism. What would seem a fault in one longitude may be regarded as a merit in another. In fact, a comparison between rival methods of construction and the effort to apprehend the manner in which merits, fully recognised here, are appreciated abroad, constitute one of the main features of interest in this book. For instance, we should gather that the gravity escapement is not so highly considered in Germany as among ourselves.

The separate parts of the instrument which come under detailed description in the next section are axes, the telescope properly so-called with its optical arrangement, and circles. Each of these sections will be found to contain excellent matter, and though one might point out small omissions, to which accident has possibly directed special attention, it would be ungracious to do so without admitting that the author has also collected numerous facts that one has either forgotten or imperfectly apprehended. Under the heading of circles will be found some very interesting remarks on the subject of dividing engines. Whether the introduction here is legitimate we will not stop to inquire, for it might be urged that a dividing engine is no more an astronomical instrument than a lathe or a screwdriver; but the information is so pertinent, and, as we imagine, rather inaccessible, that we cannot but welcome this slight excursion from the observatory to the workshop.

The second volume opens with an account of the micrometer in all its various forms, with wires and without. Under this second head the author places the heliometer, and does not appear prepared to regard this peculiar device as a complete instrument. But his practical acquaintance with its use not only entitles him to speak authoritatively, but supplies him with instances and examples of the method of determining the corrections. We doubt, however, if the popularity of this form of measurement will increase in this country. The fifth section is the only one to which we are inclined to take any exception. In it we have to do with the modern developments of photography, as applied to astronomy, whether in the determination of stellar positions or the interpretation of spectroscopic results. Photometers, spectroscopes, heliostats, and a variety of other apparatus are dovetailed together into this section, with the result that we miss the minute and varied detail that lends a charm to so much of the work. Neither can we altogether accept the author's excuse that a thorough description would lead him too far from his purpose, or that able authorities like Müller and Scheiner have recently discussed in detail the matter treated in this section. To have compiled an account of the instruments used for the determination of position would have been a perfectly intelligible undertaking, and it is in fact what Dr. Ambronn has accomplished with great skill and elaboration. We think he would have been well advised, considering the completeness on which he had planned his work, to have limited his task to such instruments, and refused to consider those that are more particularly adjuncts to the physical laboratory. But it must be clearly understood, that it is only in comparison with the remainder of the book that we notice any falling off from the high level which is elsewhere uniformly maintained. Some 150 quarto pages with 134 illustrations is in itself a treatise of considerable size and merit, and one which we may accept with gratitude.

Under the heading of "complete instruments" we have descriptions of every kind of Transit Circle and Equatorial that ingenuity has suggested and engineering skill has constructed. Indeed, in some instances, such as the particular form of Transit Circle suggested by Dr. Common, the fertility of resource on the part of the inventor has outrun the makers' capacity to realise. Sextants and Altazimuths; the Almucantar and the Chronodeik are not only illustrated by a profusion of diagrams, but examples of results are added. It is impossible to do justice either to the wealth of information or the judicious arrangement which characterise this section on meridional and extra-meridional telescopes. For the numerous forms of equatorial receive the same share of careful attention and historical illustration as do the transit instruments. From Sissons early experiment down to the latest addition to the Cambridge observatory, one might say that no typical construction has been omitted. The more one studies the pages of this excellent encyclopædia of astronomical instruments, the more convinced will he be that it should find a place on the shelves of every observatory, and in the library of every instrument maker.

The second work placed at the head of this article must of necessity partake of something of the nature of a manufacturer's catalogue, but it is so much in advance of the usual compilations of that character, that a very feeble notion of its aim and contents is gained by such a comparison. The production betokens not only a very considerable amount of enterprise on the part of those who are responsible for its preparation, but it intimates the extent of the demand for high-class instruments in Germany, and shows the manner in which that demand is met and encouraged. In reading the book, or portions of it, we experience the same feeling as in being conducted through a scientific exhibition by the ablest of guides. A constant succession of pleasurable surprises meets one at every turn, in noting how difficulties are smoothed away by ingenious appliances. Dr. Leiss, who is well known from his contributions to the *Zeitschrift für Instrumentenkunde*, plays the part of the guide with a skill which suggests that many of the instruments, with whose adjustments he is so familiar, owe their final form to his ingenious skill. There is no necessity to enumerate the various classes of instruments that here find adequate illustration. All that is needed for the physical laboratory on the side of its optical equipment, whether for education or research, finds its place here. Spectrometers and spectroscopes, goniometers and polarising apparatus in wonderful variety, microscopes with endless accessories, are pictured and described. And not only is the student considered, but the lecturer also, for an excellent chapter on projection apparatus is added. The one fact that stands out clearly from this wonderful display is the progress that has been made in recent years, both in the variety of apparatus and the excellence of workmanship.

WIRELESS TELEGRAPHY.

A History of Wireless Telegraphy, 1838–1899. By J. J. Fahie, M.I.E.E., &c. Pp. xvii + 325. (Edinburgh and London: William Blackwood and Sons, 1899.)

La Télégraphie sans Fils. Par André Broca. Pp. vii + 202. (Paris: Gauthier-Villars et Fils, 1899.)

WIRELESS telegraphy is a subject of absorbing popular interest at the present time. Its sensational possibilities are being gradually demonstrated; and just now a special popular interest arises from its obvious applicability to the amelioration of the state of isolation of our beleaguered garrisons in South Africa. Telegraphy without tangible means of communication has, however, proved an attractive field of inquiry almost since Volta's discovery of the electric current a century ago. And when in later years the submarine cable became a success, the high earning power, and the high cost also, served both to attract and to stimulate many inventors and scientific enthusiasts in their search for a system of telegraphy which would dispense with the costly cable.

The first of the two books here noticed contains matter of great interest, and is written by an authority on the history of telegraphy. Mr. Fahie has unearthed with much diligence a great mass of almost, or quite, forgotten experimental work (largely relating to efforts based on the conducting power of water). This, together with descriptions of the more recent work of Preece, Lodge, Marconi and others, he presents to the reader chiefly in the form of copious extracts from original papers.

One is able to gain an idea from this book of the immense amount of experimental work continually being carried out; to be noticed possibly in the current literature of the day, and then to be forgotten save when some striking practical success, such as that of Marconi, calls forth a historian who will rescue such work from oblivion.

For a frontispiece, the book has a collection of small but excellent portraits of "the arch builders of wireless telegraphy," from Oersted to Marconi; and at the end are gathered a number of extracts embodying the views of Lodge, Henry and Rowland, followed by Prof. Branly's classical paper on the behaviour of imperfect contacts to electrical radiation, and by a most interesting letter to Mr. Fahie by Prof. Hughes, describing his hitherto unpublished work on what are now called "coherers," which he was led to carry out after his invention of the microphone in 1877. The book concludes with a reprint of Marconi's patent of 1896, which shows how extensive his experiments had been before he came to England.

All these appendices are worthy of the most careful reading in the light of recent events. In fact, the book teems with interesting matter from cover to cover.

While the work is certainly opportune, yet a careful perusal brings us to the rather opposite conclusion that it is also premature. It is opportune, for a work on wireless telegraphy from an authority like Mr. Fahie is very welcome now. It is premature, in that the subject is changing so rapidly that a consistent account is impossible. For Marconi's present arrangement, though arrived at after the most careful investigation, yet seems to be still very empirical, as for example in the almost arbitrary choice of the kind of electric waves or of coherers, out of the infinite variety of both which are possible. It is still to be hoped that some other set of waves and some different type of coherer may be found equally available, and furnishing and receiving signals more amenable to projection in any required direction. Success in localising the electric waves is vital to the extended adoption of wireless telegraphy, yet Mr. Fahie is of course unable to include an account of this part of the subject in his book.

The author has adopted a chronological arrangement. No other seems in fact possible. Yet we think that many would prefer the accounts of mere *conduction* experiments to be kept separate from *etheric* telegraphy. Among other anomalies of arrangement we may mention that Lodge's work on wireless telegraphy is described under the general title of "G. Marconi's Method" (pp. 227–235).

Apart from obsolete expressions and unfortunate quotations from public utterances (as, "the Röntgen form of telegraph," p. viii.), the author's own language is not always precise. Thus "a rapidly revolving rheotome which broke up the current into a musical note" (p. 152), though perhaps expressive, is not accurate. Again, the reference to Hertz's "experimental proof of the hitherto theoretical fact" (p. 183), of the identity of the velocity of propagation of light and of electric waves, is hardly felicitous. Some of the author's elucidations of theory, also, are not perhaps as clear as they might be. An edition prepared at greater leisure, however, would no doubt be free from such passages.

The most obvious criticism of the book relates to the disjointed reading which arises from the author's very frequent insertion of extracts. But this criticism Mr. Fahie meets half way, for in his preface he "seems to hear the facetious critic exclaim, 'Why, this is all scissors and paste,'" and he rejoins, "So it is, much of it"; and he further adds that "so is all true history when you delete the fictions with which many historians embellish their facts." If this rather pessimistic view be adopted, then it would seem that a readable history is an impossibility. At all events, we certainly think that the constant change in literary style, both in character and quality, combined with the obsolete scientific expressions in which many of the extracts are couched, does not contribute to make the book readable. Indeed, we would describe the book as an excellent and well arranged store of material for writing a book on wireless telegraphy. It may be, however, that the attempt to render a *history* readable is to be deprecated.

The author has dedicated his work to Sir William Preece. Its later chapters bear witness to the striking way in which a Government department has so consistently and actively encouraged advance and scientific investigation wherever results of importance to its own work were to be hoped for.

There remains to state in conclusion that Mr. Fahie's book is certainly the best, if not the only work of reference which has appeared on the history of wireless telegraphy.

For a lucid and thoughtful exposition of the theory of the propagation of electric waves we can cordially recommend a little book by M. André Broca, "La Télégraphie sans Fils," which has lately been published. Within the compass of two hundred small pages of large print will here be found, first, a description of simple telegraphic apparatus; then a number of chapters which, with the help of hydraulic analogy, serve in an effective and remarkable manner to introduce the electromagnetic theory of light; and, lastly, a good account of the action of the vertical-wire transmitter and of the most recent work on coherers.

M. Broca succeeds in giving in simple scientific language, and without the help of mathematical analysis, an explanation of many abstruse points, such as the flow of electric currents in submarine cables and of electric waves along wires.

The vertical wire, according to him, emits an electric disturbance having an axis of symmetry, the wire itself; and a wave having this quality distributes its energy mostly in a plane perpendicular to the axis, a horizontal plane in this case, the energy diminishing with the square of the cosine of the angle from the vertical axis. It is to this concentration of energy in a horizontal plane that the vertical wire owes its success as a transmitter, but real concentration of messages transmitted by this means is not to be expected. (The employment of two or more wires inclined at different angles in the same vertical plane, but not necessarily close together, might possibly, we think, furnish by the intersection of two or more planes of greatest action, a *line* of reinforced action—a kind of imperfectly *directed* message which might be received by an arrangement similar to the transmitter.)

An appendix gives in a few pages the mathematical theory of the propagation of waves along a conductor.

M. Broca's little book is a valuable addition to the fast accumulating literature of wireless telegraphy, and we shall be glad to see an English translation.

D. K. M.

WORK AND THOUGHT AT WOOD'S HOLL, U.S.A.

Biological Lectures from the Marine Biological Laboratory, Wood's Holl, Massachusetts, 1898. Pp. 343. (Boston: Ginn and Co, 1899.)

THIS volume, like its predecessors, is the joint production of several of the leading biologists of the United States, indicative to a certain extent of the trend of thought and investigation in their midst, and, like its predecessors, it teams with interest and suggestiveness. Of the sixteen lectures reported, the majority are by well-known authors, and the book is remarkable for the extent to which it deals with questions of a cytological and psychological nature, in contradistinction to those of a more strictly morphological, such as we are accustomed to associate with a marine laboratory. Not that the latter have been neglected! for a remarkable essay by A. D. Mead, on the "Cell Origin of the Prototroch," which would seem to justify once more the belief in the ancestral nature of the Trochophore larva, is a thorough-going piece of sea-side work. The subject of "Cell-Lineage and Ancestral Reminiscence," in the hands of Prof. E. B. Wilson, yields fresh support for the theory that homologies only gradually arise during development, and that "the ultimate court of appeal lies in the fate of the cells"; and in a preliminary account of some investigations into the "Structure of Protoplasm" the same author is led to conclude, with von Kölliker, basing his observations of the Echinoderm egg, that "no universal or even general formula for protoplasmic structure can be given, and that the foam-structure of Bütschli is in certain cases at least of secondary origin."

In the course of his work he has done a great service in pointing out that so-called "granules" are often really liquid in nature, and in emphasising the extent to which error has hitherto asisen from the general tendency to regard these as solid bodies.

Among the more recondite problems dealt with are "Adaptation in Cleavage" of the Egg, "Protoplasmic Movement as a Factor of Differentiation," "Equal and Unequal Cleavage in Annelids," and "The Relation of the Axis of the Embryo to the First Cleavage Plane." In the hands of Messrs. F. R. Lillie, E. G. Conklin, A. L. Treadwell and Miss C. M. Clapp, both the practical and philosophic aspects of these and cognate subjects receive adequate consideration. The whole series of essays are well worth reading, and except that the Filose Phenomenon has not come under observation, the present moot points in embryology have been for the most part boldly attacked. Interest amounting to curiosity attaches to the description by Mr. Lillie in *Unio* of what, following Conklin, he terms provisionally a "sphere-substance," said to be "derived entirely from the inner sphere of the second maturation-spindle," and to his allegation, which seems to us none too clear, that it "moves and elongates so as to mark out a definite horizontal plane in the egg, and that the first cleavage-spindle places itself in conformity with this predetermined arrangement."

More sensational, and to our thinking less sound, is a lecture by T. H. Montgomery, jun., on some "Observations on Various Nucleolar Structures in the Cell." Like that on "The Heredity of the Marking in Fish Embryos" (J. Loeb), and on "Injury" to the Lower Animals as concerning "Pain Sensations" (W. W. Norman), this appears to us premature, and the authors would have done well had they given both their observations and reflections fuller consideration. An essay on "Some Problems of Regeneration," by T. H. Morgan, is noteworthy, for the fact that its author emphasises the degree to which it is now becoming evident in the progress of biology, that, as we attempt "to reduce living phenomena to simpler terms," we sooner or later "meet with a factor that defies further physical analysis," with the refrain that "we gain nothing by calling it a vital force, unless we can define what we mean by vitality."

In a lecture on the "Elimination of the Unfit," Dr. H. C. Bumpus deals in an analytical form with the effects of a severe storm on the Introduced Sparrow, and his observations at least serve to remind us that we are perhaps not sufficiently on the alert for evidence of processes in organic evolution obtainable from the study of passing events. Dr. W. M. Wheeler, in an interesting essay on "The Theoria Generationis" of Wolff, justly controverts some adverse criticism by Sachs, and establishes Wolff's position as a pioneer among præformationists—

as the Siegfried who overcame "the monstrous theory of *emboîtement*, not only false in itself, but one jealously guarding the problem of development and preventing all access to it." The author points to an analogy between the rise and progress of præformationist and Darwinian schools, which, agreed in maintaining a transformation of the simpler into the more complex have neither succeeded in demonstrating how that process is achieved.

The three lectures which remain are somewhat more special than the rest. That by Dr. Watasé on phosphorescence gives welcome support to the theory of Quatrefages that this is intimately associated with contractility, and that a common cause would appear to underlie the two processes. Dr. Watasé has been for years engaged upon this fascinating subject. His treatment of it has been no less original than that of other topics upon which he has left his mark, and we sincerely hope, now that he has returned to Japan, he will promptly give us the definitive treatise of which we are expectant. Prof. W. B. Scott, whose patient, consistent work upon the palæontology of the American Artiodactyles has for years been eagerly followed by all interested in mammalian descent, has in the lecture which he contributes to the present volume built up a masterly defence of the principle of convergence—the first comprehensive defence from the palæontological side—by lack of appreciation of which it has long been patent to anatomists that not a few of our accepted classificatory schemes and conceptions of affinity are erroneous. He deals chiefly with recent discoveries in the now famous Uinta formations, and his thesis, like the work upon which it is based, is thoroughly English in method. By contrast to the bulk of the volume before us, it comes as a set off to the too frequent indications of that "Germanising" to which our American brethren appear somewhat prone. His chief deduction that "all the strictly indigenous North American selenodonts are branches of the great tylopodan stem" is replete with interest.

Finally, there is a lengthy lecture by Prof. C. O. Whitman on "Animal Behaviour," setting forth in detail, and with comment which is exemplary in its moderation and cautiousness, a series of experiments on the phenomena of response exhibited by certain American creatures under his hand (especially a *Clepsine*, *Necturus*, and certain pigeons). He frames a thoughtful argument, which leads to the conclusion that "instinct precedes intelligence," and that its primary roots lie in "the constitutional activities of protoplasm," which, as he justly remarks, relieves us of the inconsistencies "involved in the theory of instinct as lapsed intelligence." His aphorism that "organisation shapes behaviour" would seem destined to bear the fate of his truism, "organisation precedes cell formation," now prophetic; and to him, the guiding spirit in the work which necessitated the publication of the present volume, as to all his collaborateurs, we offer our hearty congratulations. A little more work and a little less theory would be acceptable in some cases, but so long as the connection between the two is maintained to the extent exemplified in the present volume, we shall remain content.

The book closes with a series of short obituary notices, which include those of the former Assistant Director at Wood's Holl and of the author of one of the lectures, together with a passing reference to the death of W. R. Harrington, an enthusiastic young American, well known and greatly respected on the European side of the Atlantic, who recently met his death in a second attempt to secure the young of the Bichir (*Polypterus*). G. B. H.

OUR BOOK SHELF.

Darstellung der 32 möglichen Krystallklassen. By Prof. H. Baumhauer. Pp. 36. (Leipzig: Wilhelm Engelmann, 1899.)

PROF. BAUMHAUER discusses the symmetry of crystals in accordance with recent views, and employs the axes of symmetry to distinguish the classes. Weiss and Mohs first recognised that crystals fell into seven groups depending on the relative lengths and inclinations of the crystallographic axes. The older school of crystallographers, following the lead of Naumann, commenced with the class of highest symmetry in each system, and derived the remainder by removing elements of symmetry. The logical method, as was pointed out by Gadolin, is to start with the class of lowest symmetry and add elements of symmetry until the most complicated class is reached. Each class is, in reality, quite independent of any other, even if in the same system. Groth adopted this view in the last edition of his "Physikalische Krystallographie," and rejecting all ideas of hemihedrism, introduced a nomenclature which has been here employed by Prof. Baumhauer. He, however, differs from the Munich professor, but joins Schönflies in dividing the thirty-two classes into groups depending on the axes of symmetry present. This method splits up the monoclinic system, two classes of which join the rhombic system to form the digonal group (*i.e.* the group with at least one axis of two-fold symmetry), whilst the third, which possesses a plane of symmetry only, remains by itself in the monogonal group. The triclinic class, according to the author, forms the anaxial group; Schönflies, on the other hand, splits it up and gives the holohedral class to the digonal group, and the other to the monogonal group. The latter arrangement is certainly more logical, though there is something to be said for Prof. Baumhauer's objection that a "2-zählige Spiegelachse" being in any direction, and therefore not necessarily parallel to a crystallographically possible edge, cannot be said to exist. The author follows Schönflies in placing the classes represented by phenacite and calcite respectively in the hexagonal group, whereas Groth includes them in the trigonal group. These two groups, however, might well be regarded as one.

A word must be said for the excellent diagrams, which show very clearly the symmetry of each class. At the end is given a description of illustrative models, to be obtained from Dr. F. Krantz, of Bonn.

The Essex Naturalist: the Journal of the Essex Field Club. Edited by William Cole. Vols. ix., 1895–6, and x., 1897–8. (Essex Field Club, 1899.)

THE *Essex Naturalist* has long been known as the ably conducted journal of one of the best field clubs in existence. Full accounts of the meetings and excursions of the Essex Field Club are given, and, in addition to these, any observations of interest to naturalists made within the limits of the county are recorded, and when necessary illustrated. The term naturalist is quite properly used in the very widest sense, so that the journal includes meteorological, geological, geographical and anthropological observations, as well as others dealing with ancient marks, boundaries and buildings, customs and trades.

The journal is an excellent example of all that the organ of a field club and county natural history society should be. It fulfils a double function, recording interesting observations which would otherwise have been forgotten, and stimulating its members to make fresh efforts in their own districts. Throughout every county opportunities for observation are continually occurring, opportunities which are often wasted for want of an alert local naturalist. A fresh cutting made on a railway, a new gravel pit opened, an old house pulled down, afford the chance of interesting and often valuable observations when the keen and trained observer is on the spot. The encouragement of such work is of no less importance for the progress of science than the comprehensive papers by acknowledged leaders of their subject which appear in the *Essex Naturalist*. These would be published under any circumstances, whereas the former are rescued from the multitude of observations which might have been.

The journal is exceedingly well printed, and is a model of careful and successful editorship. E. B. P.

Anleitung zur Darstellung chemischer Präparate. Ein Leitfaden für den praktischen Unterricht in der Anorganischen Chemie. Von Prof. Dr. H. Erdmann. Second edition. 92 pp. (Frankfort: H. Bechhold, 1899.)

THE great educational value of a well-chosen set of chemical preparations, as an adjunct to the usual analytical courses, is now generally admitted; it has been, however, usual to select the examples almost wholly from the field of organic chemistry. To Prof. Erdmann is due the credit of showing that a course of inorganic preparations was not only feasible, but on account of the greater variety of difficulties met with in many cases, even preferable for educational purposes to a selection wholly organic. In this second edition several additions have been made to the original text, including the preparation of ammonium perborate, dry aluminium chloride, arsenious oxide, violet chromium sulphate and potassium iodate.

The instructions throughout are very practical, the cost of the material having been borne in mind throughout, many laboratory bye-products or residues being utilised as the raw material for preparations.

In the few instances where the methods given are not the best available, the residues are worked up in other preparations. The book as a whole fills a gap in chemical literature.

The Boyhood of a Naturalist. By Fred Smith. Pp. vi + 227. (London: Blackie and Son, Ltd., 1900.)

THIS genial account of his boyhood by a naturalist, writing under the pseudonym Fred Smith, will afford unlimited interest to any youngster with a love for live things. That Fred Smith did not shine in school, and was only with difficulty made to play cricket fairly regularly, rather adds to his winsomeness. Indirectly, the book should prove useful in demonstrating the educational value of the study of nature at first-hand. Fred's education was unmistakably of the kind which it is at present fashionable to call "heuristic," and his progress in his numerous researches is further evidence of the possibility of a boy, though considered a dunce at school, arriving at manhood educated in the better sense of the term, since his faculties are properly trained and his perceptions keenly alert. As a gift book for a child with a natural proclivity for biological work the volume can be thoroughly recommended; it is both instructive and amusing.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The New Zealand Zoological Region.

IN a paper on "The Geography of Mammals" (*Geographical Journal*, vol. iii. p. 95, and vol. iv. p. 35, 1894), Mr. W. L. Sclater divides the land surface of the earth into three great divisions, Notogœa, Neogœa, and Arctogœa, and these are subdivided into six regions, the Australian region corresponding with the division Notogœa. It seems to me, however, that had Mr. Sclater considered what is natural rather than what is convenient, he would have divided his Notogœa into two regions, separating the New Zealand area from that of Australia, for these two areas are essentially distinct from one another in all their great fundamental zoological characteristics. According to Mr. Sclater, Prof. Huxley and Prof. Newton make the New Zealand area a primary zoological region (I have not seen the "Dictionary of Birds" or Huxley's paper). Mr. Sclater then says: "there is, no doubt, as has just been shown, a good deal to be said for this proposal; but, on the other hand, there are even more valid reasons for retaining New Zealand as a sub-region of the Australian region." Mr. Sclater then states his "more valid regions," which are three in number. The first is that as he is dealing with mammals only it would be absurd to give a small group of islands, which is almost entirely without terrestrial mammals, the rank of a primary region. Had Mr. Sclater therefore left the New Zealand area out of his considerations altogether, as was wisely done by Mr. P. L. Sclater in his lecture "The Geographical Distribution of Mammals" (Manchester Science Lectures, No. 5, Sixth Series, 1874), I should have been entirely in accordance with him, and there would have been no occasion for this paper.

The second reason given is that of "practical convenience." It seems to me, however, that convenience should only be a secondary consideration, and that what is natural is far more important. Mr. Sclater goes on to say that "other small insular areas might with some justice put forward nearly similar claims."

New Zealand, however, stands alone in its very remarkable physical and biological conditions, and presents with those of Australia the strongest contrasts rather than similarities.

It is, however, to Mr. Sclater's third reason that I have more especially to take exception. He says: "Although New Zealand possesses no indigenous terrestrial mammals, yet the fauna, such as it is, shows an unmistakable affinity of various degrees to that of Australia, and more especially to the tropical parts of that continent. It is, indeed, probable that the whole of the fauna of New Zealand has been originally derived from that source."

There are no doubt affinities between the faunas of Australia and New Zealand; but when we consider that in Tertiary times (probably Pliocene) the New Zealand land area extended far to the north and west of its present limits, probably as far as Lord Howe Island, and the facilities for the diffusion of species from the one area to the other were immensely greater than they are at present, the wonder is that these affinities are so slight and insignificant. It has been usual to look for similarities in the faunas, and to attach much importance to the occurrence of the same or representative species in both areas, and the great and essential differences of the faunas as a whole have been largely lost sight of or little understood.

I would first remark that the presence in Australia of a rich mammal fauna (marsupials and monotremes), and its total absence from New Zealand, is certainly significant. But let that pass, and, as Mr. Sclater has himself suggested, to determine the geographical affinities of New Zealand we must take "the fauna such as it is," consisting of birds, reptiles and other lower groups; and when we do this we find that the result is exactly opposite to what Mr. Sclater would lead us to expect.

Prof. Newton has no doubt ably dealt with the affinities of the New Zealand birds in his work, "Dictionary of Birds"; I need not therefore discuss them here, except to remark that one of the most interesting and remarkable features of our bird fauna is the fact that during recent times—at most a few hundred years back—there existed in these lands numerous species of two families of raft-breasted birds, *Dinornithidae* and *Apterygidae*, which are so essentially distinct in structure that they are probably not even distantly related to one another, but have arisen quite independently, and no representatives of these families have been found in any other country. (The supposed finding of *Dinornis* and *Apteryx* remains by Mr. De Vis in Queensland, having been discussed by Captain Hutton and Mr. Lydekker, is now considered to have been a mistake.)

As regards the reptiles, we have the well-known and peculiar Tuatara (*Hatteria punctata*) and a number of lizards, which Messrs. A. H. S. Lucas and C. Frost have recently revised, and they tell us that the New Zealand forms are not related to those of Australia (*Trans.* New Zealand Institute, vol. xxix. p. 264).

The land and fresh-water molluscs have been critically revised by Mr. H. Suter; and Mr. H. Crosse, in his introductory note to Mr. Suter's paper, summarises his conclusions thus:—"Les faunes malacologiques Australienne et Néo-Zélandaise sont, d'ailleurs, à première vue, fort différentes l'une de l'autre, et elles présentent souvent des caractères opposés. . . . En réalité, les Mollusques terrestres et fluviatiles de la Nouvelle-Zélande, et nous comprenons sous cette dénomination, non seulement les deux grandes îles du Nord et du Sud, mais encore les îles Stewart, Auckland, Campbell, et Kermadec, forment un ensemble d'espèces très particulières, toutes, ou à peu près toutes, indigènes, et constituant une faune locale, insulaire et parfaitement caracatérisée.

"Pourtant, à notre avis, il existe un archipel, dans la faune duquel, si originale qu'elle soit, on trouve des affinités marquées et des rapports incontestables avec celle de la Nouvelle-Zélande: c'est la Nouvelle-Calédonie" (*Journal de Conchyliologie*, 1894, vol. xli. pp. 215, 216).

Mr. C. Hedley has also pointed out that the land molluscan fauna of New Zealand is quite distinct from that of Australia, and has affinities rather with the faunas of Lord Howe Island, New Caledonia, Fiji, the New Hebrides, and Solomon Islands (*Records* Australian Museum, vol. i. No. 7, 1891; *Proc.* Linn. Soc. N.S.W., 1892 (2), vol. vii. p. 335; *Ann. and Mag. Nat. Hist.*, 1893 (6), vol. xi. p. 435). This is indeed significant, especially when the form of the "New Zealand Plateau" and the ocean-floor beyond is taken into consideration.

As regards the earthworms, Dr. Benham tells us that they "are very different from those of Australia, on the one hand, and Europe on the other" (*Canterbury Weekly Press*, May 3, 1899). I cannot, however, agree with Dr. Benham when he reasons that because species of one genus—*Acanthodrilus*—which is widely spread in other southern lands, are found in New Zealand and Queensland there must have been at one time a land connection between New Zealand and north-eastern Australia. There is another explanation which appears to accord better with the distribution of other groups, if a land connection is necessary. Far back in Cretaceous or early Tertiary times (Cretaceo-Tertiary of N.Z. geologists) before the north-eastern part of Australia had received its mammal fauna, the New Zealand area may have been connected with New Guinea *via* Lord Howe Island, New Caledonia, the New Hebrides, and the Solomon Islands; or more probably these islands were then connected with New Guinea and the main land, and afterwards when the land connection was broken up, some of them became connected with New Zealand, so that a few of the plants and animals which spread into Australia or northwards into New Guinea were also able to reach New Zealand. This is not a new suggestion; it has been proposed by Captain Hutton and others. Mr. H. Deane, in his presidential address, delivered before the Linnean Society of New South Wales, March 31, 1897, said:—"The difficulties are too great in the way of such a supposition (a Pacific continent), but only connections similar to that which we are certain existed between New Zealand, New Caledonia, the Fijis and the main land which was perhaps at its period of greatest development in a state of oscillation need be conceded." Regarding the alpine flora of the Owen Stanley Range in New Guinea, the late Baron Sir F. von Mueller, after enumerating a number of extra-tropical genera found there, said: "Many of these approach in their affinity to forms familiar to us in Europe, a few even being identical with British species, and appear thus to reach in New Guinea their most southern geographic limits. But, on the other hand, many of these Papuan highland plants are of far southern type, such as Drimys, Drapetes, Donatia, Styphelia, Phyllocladus, Libertia, Carpha, Oreobolus, Gahnia, Dawsonia; indeed, some of the species are absolutely the same as congeners of the Australian and New Zealand Alps" (*Proc.* Roy. Geographical Soc., Australia, Queensland Branch, vol. v. p. 20, 1889). But without the necessity of a land connection, when in Tertiary times the New Zealand land area extended as far as Lord Howe Island, and perhaps New Caledonia, a few earthworms and other animals may have been carried across the intervening comparatively narrow sea by birds and on floating timber.

New Zealand insects have been much neglected, and some groups have hardly been touched. The Coccids, however, have been admirably worked up by the late Mr. W. M. Maskell, so that a comparison is possible. When we add to Maskell's "Synoptical List of Coccidæ" the forms described in his three subsequent papers (*Trans.* N.Z. Inst., vols. xxviii., xxix., xxx.), and summarise the results, we find that of the 105 species and varieties which have been found in New Zealand, 78 (74 per cent.) appear to be endemic. Of the remaining 27 forms, 13 occur also in Australia. These 13 are widely ranging forms which have been found in other countries—North America, Europe, &c., and occur in New Zealand in greenhouses, and on introduced plants.

Most of them have no doubt been recently introduced to both Australia and New Zealand. Two or three, such as *Icerya purchasi*, may have originally come from Australia. Coccids often multiply and spread very rapidly when introduced to a country where the conditions are favourable to them. The number of forms peculiar to Australia is 202. As regards the distribution of the genera, twenty-three have been found in New Zealand, of which only two are peculiar to that country; two of them have been found in other countries but not in Australia; and two occur in New Zealand and Australia, but not elsewhere. These latter are *Ctenochiton* with eleven species in New Zealand and two in Australia, and *Coelostoma* with five species in New Zealand and three in Australia. This would seem to indicate that New Zealand was the original home of both. The remaining seventeen genera occur in Australia and other countries, most of them being cosmopolitan or almost so. Of the ten genera which have been found, so far, only in Australia, four belong to the sub-family *Brachyscelinae*, which is essentially Australian, four of its five genera, and forty-five species, being found only in Australia, and not one representative of this sub-family occurs in New Zealand. It has often been pointed out that the animals and plants characteristic of Australia are absent from New Zealand, and those of New Zealand from Australia.

A large number of beetles have been described by Capt. Brown ("Manual of New Zealand Coleoptera"); Mr. A. T. Urquhart and others have described many spiders in the *Transactions* of the New Zealand Institute; and Mr. R. W. Fereday has enumerated 617 species of lepidotera in the same publication (vol. xxx. p. 326). When these and the other groups come to be revised, and disentangled, and their affinities worked out, it may be reasonably supposed that the results will accord with what has already been done.

In view of the above facts it is clear that not only is it *not* "probable that the whole of the fauna of New Zealand has been originally derived from that source" (Australia), but that only a small and insignificant portion came thence; that the New Zealand terrestrial fauna, as a whole, is essentially distinct from all others; and that its alliance with the fauna of Australia is extremely slight. As far back as 1880 Captain Hutton pointed out that, "The better the fauna of New Zealand becomes known, the more prominently does it stand out distinct from that of any other country" ("Manual of N.Z. Mollusca," p. 2).

In discussing the affinities of the New Zealand fauna it is fair only to consider those groups which have been revised, for many animals have been recently introduced from Australia, and rapid changes have been going on since settlement began in New Zealand and the Australian Colonies. Also in former times collections often got mixed; naturalists and collectors were not very particular about localities, for they did not then know the immense importance and interest attaching to the distribution of species.

The paucity of New Zealand insects is not by any means so great as has been represented. The reason that so few species have been described in many groups is largely due to the fact that they have been neglected by New Zealand naturalists, rather than that there are few to be found. A diligent worker here will be amply rewarded by the discovery of many new forms, whatever group he may choose to take in hand. Mr. P. Marshall recently described sixty-six species in a first instalment of New Zealand diptera, fifty-four of which were new (*Trans.* N.Z. Inst., vol. xxviii.).

As the general laws regarding the distribution of species can only be discovered from the knowledge of a very great number of facts, I fully agree with the Rev. T. Blackburn that "the special task to be accomplished by this generation, and in the present state of knowledge, is that of collecting and recording *facts and data*" (Presidential Address, *Trans.* Roy. Soc. South Australia, 1891, vol. xiv. p. 371); and that when we attempt to generalise we find how very little is known in comparison to what is yet to be discovered, and feel "the need of that exhaustive collection of the data and records of the facts that we are at present engaged in procuring." Nevertheless, I cannot concur in the suggestion that we should altogether relegate "the investigation of the *reasons* of the facts of nature" to the naturalists of the next generation. Not only is it even now exceedingly interesting and important to summarise what we do know and to understand the direction in which our observations are tending, but it also makes all future work immensely more interesting, and enables the work to be carried out more intelligently and thoroughly. It is, however, very necessary when recording facts to have the mind free from all theories and preconceived ideas which might in any way influence one's observations and conclusions. H. FARQUHAR.

Wellington, N.Z.

The Resistance of the Air.

REFERRING to Mr. Bryan's summary, on page 107 of the current volume of NATURE, of the observations on the resistance of the air, made by Le Dantec and by Canovetti, it is but fair to say that the conclusion "No. 3," viz. that the resistance to a plane surface depends upon its contour, *i.e.* whether circular, square or triangular, is by no means new. Precisely this result was deduced by Prof. Hagen, of Berlin, in his most delicate experiments published by the Berlin Academy in 1874. His memoir is the first in Abbe's collection of translations, entitled "The Mechanics of the Earth's Atmosphere," and a detailed discussion of his results is given at pp. 234–238 of his "Treatise on Meteorological Apparatus and Methods." Hagen's results, when expressed in grams, decimetres and seconds, give the resistance per square decimetre as $(0{\cdot}00707 + 0{\cdot}0001125\,p)\,v^2$ where p is the contour of the plate and v the velocity. As his experiments were made with plates of only from 1 to 12 decimetres on a side, and as he showed that the size affects the coefficient quite as much as the shape, it would scarcely be proper to exterpolate from his small plates up to the large ones used by the French investigators. We should not expect any close agreement for a surface of one metre square between Hagen's figures and these newer ones, but the general law that the pressure per square unit depends upon both the size and the shape of the plate is due to Hagen. The explanation of this result is also largely due to him; it is not merely a question of gaseous viscosity or internal friction, but especially of that dissipation of energy that occurs in the ideal perfect fluid, and which has been called convective friction in the above-mentioned treatise and elsewhere. Le Dantec and Canovetti, by experimenting on a large scale, have necessarily encountered such irregularities and difficulties as must have limited the accuracy of their results quite as much as in the case of many other experiments since those of Sir Isaac Newton. In general, inasmuch as resistance per square unit varies with the size and shape of plane plates or other bodies, it can hardly be called an important physical constant of great scientific interest. It certainly has a practical interest to the aeronaut, the navigator, and the millwright, but the scientific interest of such experiments consist essentially in determining the lines of flow and the transformations of energy involved in the discontinuous motions. C. A.

Washington, December 13, 1899.

THE object of my notice was to give a general account of Le Dantec's and Canovetti's experiments, and certainly not to deliver judgment on those delicate questions of priority which are mainly of personal interest. The "law of perimeters" being so noticeably put forward as a new result, I could do no less than cite the views of Le Dantec and his referee, between whom and Hagen or his advocate "C. A." the matter must rest. There is surely a contradiction of terms in your correspondent's expression, "that dissipation of energy that occurs in the ideal perfect fluid, and which has been called convective friction in the above-mentioned treatise and elsewhere." A fluid which dissipates energy, especially by means of anything called friction, is not an "ideal perfect fluid" according to universally accepted definitions. As to the "scientific interest" of determinations, not only of the aërial resistance of a square metre, but also of the weight of a cubic centimetre of water, the so-called mechanical equivalent of heat, the electrical resistance of a copper wire, the E.M.F. of a Clark cell, or any other physical quantity whose value is affected by various conditions, this surely is a matter of opinion; but the great amount of attention which is now devoted to accumulating statistical data of this class is sufficient indication of a general consensus of opinion in favour of such researches being regarded as valuable from a scientific standpoint. G. H. BRYAN.

Grey's Rock Paintings.

IN Prof. Haddon's review of Mr. Mathews' "Eaglehawk and Crow" there are several references to Grey's rock paintings, amongst which your reviewer remarks, "These rock paintings are certainly very puzzling, and deserve renewed investigation on the spot." They were investigated by Mr. A. C. Gregory, the Australian explorer, who, about seventeen years ago, gave me the following particulars relating to them:—

"The importance of the native coloured drawings, published by Grey in his "Travels," is much exaggerated. The colours are by no means so bright as printed, and the drawings are generally of a very primitive kind, more or less crude outlines of hands or weapons placed on the face of rocks, and lines marked round the edge of the object" (see *Jour. Anth. Inst.*, xvi., p. 133). I have also a clear remembrance of Mr. Gregory blaming the printers for attempting to make comparatively finished drawings of the faces out of crude outlines much in the same way as was so commonly done in the elaborate plates that accompany the volumes of Cook's "Voyages." Mr. Mathews' "identification" may therefore be dismissed. H. LING ROTH.

Halifax, Yorks., January 1.

Evidence of Upheaval in Vanua Levu, Fiji.

DURING an examination of the geology of this large island evidence of very extensive upheaval frequently came under my observation. Speaking generally, the main elevated mass of the island is the product of submarine fissure-eruptions. Its surface is in great part traversed by mountainous ridges, which form an intricate system, and consist in each case of an axis of basic and often coarsely crystalline volcanic rocks concealed beneath calcareous tuffs and volcanic muds, which in their turn are covered over by agglomerates. During the movement of upheaval, and in the ages that have since elapsed, the denuding agencies have been so actively at work that it is not easy to restore the original form of the surface; but it may be observed that in the eighteen months of my stay no evidence of a crateral cavity came under my notice in the main mass of the island. By studying the contours it can be shown that Vanua Levu has been formed by the union during the process of upheaval of a number of smaller islands with a central larger island.

Foraminiferous and pteropod-bearing muds together with calcareous volcanic tuffs are not infrequent up to elevations of 1100 or 1200 feet. They are of scanty occurrence at greater heights; but they are to be found in different parts of the island at elevations of from 1500 to 2000 feet; and in one locality I found sea-shells in a coarse tuff at 2200 feet. Elevated coral-reefs have taken a very little part in the building-up of the island. They exist in a few localities at the coast, and do not attain a higher level than some 200 feet. In this connection it should be noted that flints and silicified corals occur on the surface of the lower regions all over the island. Corals in various stages of silicification are found in quantities in some places, especially where a low-lying district now marks the situation of what was once an inland sea. H. B. GUPPY.

R. C. Mission, Rewa, Fiji, November 21, 1899.

THE ECLIPSE EXPEDITION AT VIZIADURG.[1]

II.

WITH regard to securing the best possible observations along all lines, the perfect organisation of time signals was of the first importance; indeed, a fundamental condition for success. The headquarter staff, under Captain Batten, was stationed at the eclipse clock, about which a word must be said. In an eclipse, especially when there are as many observers as we had on this occasion, it is well that every one shall know that he will get a good square look at it some time or other. In early eclipse work this was not recognised, and I never felt more annoyed in my life than, when I was in India, in 1871, I found that in consequence of my ignorance of eclipse organisation, Captain Bailey, of the Royal Engineers, who travelled 400 miles to our camp to help us, did not see the eclipse at all. He volunteered to give us the time, and took to rehearsing the work daily. I said to him, "What you have to do is to put your chronometer on the table and then sit down facing the sun, so that at any time you like during the eclipse you can look off the face of the chronometer and see the eclipse; because now you have come so far it won't do for you to go away without seeing anything." He said, "Well, I have been practising for the last two days, and I find it very difficult." I said, "What are you going to do about it?" He replied, "Well, I shall go on practising it till I do it." But to my horror, just before the eclipse began, I saw him take his chair to the other side of the table, deliberately place his back to the sun and look at the chronometer, and he never saw the eclipse at all. I was determined that that should never happen again in any eclipse that I had anything to do with, and since then I have always doubled the timekeepers, and given one-half of the eclipse to one timekeeper, and the other half to another. The "eclipse clock" is of rather peculiar construction. It only possesses a seconds-hand controlled by a seconds-pendulum. The face of the clock shows seconds, and a spiral on which the times are marked, so that there can be absolutely no mistake made as to the time. Not only can the even seconds be given in that way, but if a signal at any particular time is requisite for any particular operation in any of the observatories, the time signalman can give that time as well, so that all the operations are kept perfectly steady. The pendulum (and therefore the clock) is started by cutting a thread at the word "go," which means the beginning of the eclipse. Then one of the timekeepers turns his back to the sun, stands in front of the clock, and reads out the time-signals "120 seconds left," and so on, which are marked along the spiral, as the hand reaches them, while the other is looking at the eclipse. The half-time signal ("60 seconds" on this occasion) is sung out by both, and then they right-about face, one man going off duty and the other taking it up. In that way both see the eclipse. In order to give an idea of the importance of keeping the time during an eclipse, I will give our eclipse time table.

At 11 o'clock the "Thermometer" party commenced work.
11.12 a.m.—The "first contact" took place.
12.16 p.m.—"Naturalists and Landscape" party commenced operations and were followed at
12.30 p.m. by the "Slit Spectroscope and Prism" parties.
Ten minutes before "totality" Lieut. de Wet, with an Admiralty chronometer "gave the word," on which the "alert" was sounded on the bugle.
At this signal—
The "stops" were taken off telescopes.
Caps off siderostat and cœlostat.
Clocks wound.
Timekeepers reported eclipse clock correct.
Observers at discs blindfolded.
Remainder of observers turned backs to sun.
Seven minutes before "totality". 3 "G's" were sounded on bugle as a signal to Prof. Pedlar with 6-inch.
25 seconds before "totality"—90° from Lieut. de Wet. 2 "G's" on bugle.
5 seconds before "totality"—45° from Lieut. de Wet. 1 "G" on bugle.
On the order "go" the first timekeeper, with his back to the sun, called out "127 seconds," and every 10 seconds till 17 seconds, followed by 10 seconds and 7 seconds, and then every consecutive second till "over" was given.

Why it was necessary to use the bugle will be seen at once. That was the order given to the various parties, several of whom, especially the disc observers, were a long distance from us. At the "alert" the stops were taken off the telescopes; a very wise precaution, for in some eclipses even caps have not been taken off at all—there were other things to think of! All the clocks were wound, and the observers at the discs were blindfolded. Then all the observers turned their backs to the sun in order that they might not weary their eyes by trying to see a series of phenomena of no interest to anybody. At 25 seconds before totality we had two "G's" sounded on the bugle. It had been determined that at that moment the uncovered arc of the sun measured exactly 90°. It was most important for the spectroscopic work that we should get a signal 5 seconds before totality—that is to say, 5 real seconds before totality quite independent of any errors in the *Nautical Almanac*. For the work of the prismatic cameras it was important to get a signal as nearly as possible five seconds before the beginning of totality, and, in order to eliminate the possible error of the chronometer, it was arranged to determine this by direct observations. Captain Batten did a thing which has certainly never been done in any eclipse expedition before. We expected, of course, a very definite shadow, and he was good enough to find a native dhow and charter it, and anchor it in the roadstead at such a distance that the shadow would strike it exactly 5 seconds before it struck the camp. For another signal we calculated that 5 seconds before totality the portion of the sun still visible would subtend an angle of 45°. The moment of totality was to be determined by means of the $3\frac{3}{4}$-inch.

THE WORK ATTEMPTED.

The Prismatic Cameras.

In the two prismatic cameras about sixty photographs were required, the exposures varying from one to fifty seconds. These included two series of ten snap-shots at the beginning of totality, and another ten at the end of totality, and shots of different periods, up to thirty-six seconds in one case, taken during the totality itself. That was done, of course, in the hope that one exposure would be better than any of the others, so that we should be sure of getting something at its best. Another reason was that we hoped to get records of fainter phenomena in the middle of totality than we were likely to do at the beginning and end of it. It was necessary to throw the sunlight into the camera by means of a mirror of a siderostat.

To carry out this programme of work, to secure the results required, a minute subdivision of labour was imperative. In the case of each of these two instruments six volunteers were employed, and they were distributed in the following manner:—

One observer with the finder, his duty being to keep the image in the centre of the field of view which corre-

[1] Continued from p. 233.

sponded (by previous adjustment) to the centre of the plate in the prismatic camera. He had a timekeeper to record the times of contact.

A third acted as timekeeper to record the exact moments at which the exposures were begun and ended.

A fourth volunteer, by means of a piece of cardboard, covered and uncovered the front of the prism, from directions given by Mr. Fowler and Dr. Lockyer respectively.

In one case two, and in another three, men were required to hand and receive the large dark slides before and after exposure, taking them out of, or placing them back in, bags made for this purpose.

Six-inch Prismatic Camera.

This instrument, the dispersion of which had been increased by the addition of a second prism, was worked by Mr. Fowler, with the assistance of Lieut. de Wet and five men. Mr. Fowler's programme was to begin taking a series of ten snap-shot pictures five seconds before the commencement of totality, to obtain a record every second or thereabouts of the spectrum of the chromosphere. After this he exposed eight other plates to secure photographs of the coronal rings, the exposures being of various lengths. It was also arranged that at five seconds before the end of totality he should commence another series of ten snap-shots, exposing the last of these some few seconds after totality.

FIG. 4.—Six-inch prismatic camera.

Nine-inch Prismatic Camera.

This instrument was in charge of Dr. W. J. S. Lockyer, who was assisted by Lieut. Percival Jones, R.N.R., and six men. This instrument was also fed by a siderostat, but the tube was not placed horizontally. It was intended with one of the prismatic cameras to so mount the tube that the arcs formed on the photographic plate should be symmetrical about the direction of dispersion, and it was decided that the 9-inch camera should adopt this plan of mounting.

The exact position of the tube to obtain this result was carefully determined by calculation. To facilitate the erection of the instrument at the station two wooden frames to carry the tube were previously made and taken out.

It is satisfactory to state that the photographs showed that the experiment was very successful, the arcs coming out exactly as forecasted.

FIG. 5.—Nine-inch prismatic camera.

Although this instrument was capable of only giving about half the dispersion of the 6-inch, the optical parts were better adapted for recording the ultra-violet region of the spectrum.

The programme adopted was similar to that of the 6-inch, there being two large plates ($16 \times 6\frac{1}{2}$) for recording a series of ten snap-shots at and near the times of second and third contacts, and nine smaller plates for exposure during totality.

Integrating Spectroscope.

This instrument consisted of a large collimator, two prisms of 60°, and a receiving camera. It was entrusted to the care of Lieut. G. C. Quayle, R.N., with two assistants. The light which fed this instrument was obtained from a cœlostat, and there was still sufficient room for another instrument to be utilised, so the coronagraph was set up in the same hut.

employed, of $4\frac{3}{8}$-inch aperture, was entrusted to Staff-Engineer A. Kerr, R.N., who was assisted by three volunteers from the engine-room staff.

There being still a small amount of available surface of the cœlostat for other purposes, this was utilised for the 10×8 landscape camera, which was operated by Mr. Turner.

Discs.

The discs, six in number, were put into position by Lieut. G. C. Quayle, R.N., and Lieut. C. E. B. Colbeck, R.N., being ranged along the southern wall of the fort, close to the Eclipse Camp. The great altitude (53°) of the sun rendered the operation of setting them up somewhat difficult. Their sizes varied from six to two inches, and they were so placed that they cut off 3, 5, and 7 minutes of arc round the dark moon.

FIG. 6.—The coronagraphs and the integrating spectroscope.

Six-inch Equatorial with Grating Spectroscope.

This instrument consisted of a 6-inch lens mounted equatorially. The small grating employed contained 17,296 lines to the inch, and in the focus of the eyepiece was placed a small photographic spectrum of iron for comparison.

Prof. R Pedler, who came to take charge of this instrument, was assisted by Mr. Steele, R.N., gunner, and three other volunteers.

The Coronagraph.

We made no attempt to obtain any very fine photographs of the eclipse, because we knew that the Indian observers would do that. But it was necessary to get some photographs which would give us the relationship between the different parts of the corona which we saw and those photographed by means of other instruments. The chromosphere and coronal rings we especially hoped to get in the prismatic cameras. The instrument

Each disc occupied the time of three men, so that in all eighteen volunteers were employed. Of each party of three, one volunteer kept the eye end in adjustment up to the time of totality, another who was blindfolded ten minutes before totality acted as observer, and the third wrote down the remarks of the observer.

The $3\frac{3}{4}$-inch Equatorial Telescope.

This telescope was used by me to observe the exact time of second and third contacts to give the signals "go" and "over" to the timekeepers. For the first fifty seconds of totality I employed this instrument myself to minutely observe the structure of the rifts and streamers. In my absence it was used by Assistant Engineer H. H. Willmore, R.N., for the examination of the structure of the corona.

Star Observations.

I will pass from the larger instruments and come to the star observations. These observations were entirely in charge of Lieut. Blackett, R.N., and what he did every night before the eclipse was to get his staff of seven or eight to observe certain groups of stars from the deck of the ship or from the shore, and determine their magnitudes as well as they could, and make maps of them. It was perfectly wonderful how, after three or four nights, they could make a map of the constellation of Orion, not going very far wrong. That stood us in very good stead during the eclipse.

Each observer was supplied with a photograph of a small star chart of the region near the sun, prepared by Dr. Lockyer. This was afterwards supplemented by another on a larger scale photographed at the office of the Trigonometrical Branch of the Survey of India at Dehra.

Observations of Shadow Bands.

Staff-Surgeon Nolan, R.N., observed these phenomena with the help of two assistants. Previous to the eclipse a large white table-cloth was spread on a flat piece of ground in front of two walls intersecting at an angle of 115°, which were whitewashed.

FIG. 7.—The kinematograph hut.

Small Prism and Grating Observations.

The spectroscopic work was in charge of Lieut. Colbeck, R.N., and Senior Engineer Mountifield, R.N. I took out several spare prisms and spectroscopes with me in the hope they would be of service, and they were used to the very great advantage of science.

Meteorological Observations.

Mr. Eliot, the Meteorological Reporter to the Government of India, brought with him several important instruments with a view of making observations similar to those he had arranged along the whole line of totality. He was assisted by twelve volunteers.

Landscape Cameras and Kinematographs.

All the available landscape and hand cameras were put in charge of Mr. Turner, of the Survey Department, Calcutta, who was assisted by five volunteers.

As a well-defined shadow had been anticipated, the kinematograph was used for the first time in an attempt to photograph its passage through the air.

The Marquis of Graham brought out with him two kinematographs, one for the recording of the whole phenomenon of the eclipse, and the other for photographing the moon's shadow as it swept across the earth's surface. The latter was put in charge of Mr. H. P. Barnett, R.N., Paymaster, with one assistant. The kinematograph for the eclipse was worked by the Marquis of Graham himself, and five volunteers. The instrument was fed by a small cœlostat.

The above statements will give an idea of the completeness of the organisation rendered possible by such a wealth of observers, and it is to be hoped that the example set in 1898 may be followed in the eclipses of this and the following years. NORMAN LOCKYER.

THE YANGTZE VALLEY.[1]

MRS. BISHOP'S volume gives an account of a journey undertaken, the author tells us, solely for recreation and interest after some months of severe travelling in Korea. The book is a valuable contribution to the literature of travel, both from the remarkable personality of the writer and from the public interest recently directed to our projected "sphere of influence" in the Yangtze Valley. The greater part of the route followed has become a "beaten track" for travellers who from time to time have recorded their experiences and supplied valuable statistical accounts of the potentialities of this part of China. The author, however, in her daring attempt to reach the heart of the Mantze country, entered upon new and untrodden ground, and has given a graphic account of her adventures in one of the most picturesque mountain lands of China, the home of this obscure aboriginal tribe.

The story is all the more fascinating because it is written by a woman who has been careful to note the details of her environment day by day in a manner quite her own, and always interesting. Some light has been thrown upon this race of mountaineers, who, physically and in their manners and customs, are a people apart from the Chinese, who have maintained their characteristics, their language, and their independence through the centuries, and at last have been driven by their foes to the mountain solitudes of Szechuan and other parts of the empire.

It is to be regretted that Mrs. Bishop was unable to add to her excellent series of photographs some types of the race, or to afford some clue to the language, which appears to be an unknown tongue written in Tibetan characters. They are, one would suppose, allied to the Sifan and Lolo visited by Baber.

The first chapter deals with the Yangtze Valley—our sphere of influence. Approximate figures are here set

[1] "The Yangtze Valley and Beyond." By Mrs. J. F. Bishop. Pp. xv + 557. (London: John Murray, 1899.)

down relating to geographical area and population, and the constant soil-creating and fertilising functions of the great river. The Yangtze and its many tributaries are described, supplemented by an account of the inestimable value of these affluents as highways of commerce. The annual rise of the Yangtze is dealt with, and its influence over the districts flooded during part of the year.

The burning questions of "spheres of influence" and the open door are noted as modes of expression designed to conceal (especially spheres of influence) "much greed for ourselves not always dexterously cloaked, and much jealousy and suspicion of our neighbours, and much interest in the undisguised scramble for concessions, in which we have been taking our share at Peking." All this while we ignore the men who have been for two thousand years making China worth scrambling for. The author dreads "breaking up the most ancient of earth's civilisations without giving any equivalent." After having read the book throughout, the impression left on one's mind is that China's most antiquated type of civilisation is not without its grave defects, and that it might be replaced with advantage by a fresh importation from any European state.

Theoretically, there is much virtue and goodness in the paternal government of China, while its practical results, as one sees them in the condition of the people, are far from satisfactory. The rulers have fallen away from the ancient paths of righteousness, and lapsed into iniquity. The *malfaisance* of Mandarins may not prove so oppressive in the interior of Szechuan as in other parts of China, where nature is less bountiful, and the consequent struggle for existence harder. The author says: "The human product of Chinese civilisation and government is to us the greatest of all enigmas," and so he remains to those who know him best. His best points are then catalogued correctly, and the qualities which are the making of him when an immigrant under a liberal and enlightened government in a colony such as the Straits Settlements, and which, at the same time, render him a most objectionable addition to a community where his thrift, sobriety and industry enable him to compete successfully in the lower fields of white labour. One peculiar phase of Chinese character may be noted, that is, the dignified gravity of the race, which one is disposed to think is the product of mingled vacuity and conceit, rather than the expression of deeply sensitive Confucian minds.

"The Yangtze basin is a magnificent sphere of influence for all the industrial nations for fair, if not friendly rivalry, and to preserve the open door there."

This squares with the consensus of opinions of travellers in that favoured region. It offers no field for emigration; it is now over-populated, hardly producing food enough for the requirements of its people, who during failure, or partial failure of crops, perish in thousands of famine and pestilence. It is alone to the commercial possibilities that will follow opening up the country, and exploiting its vast coal-fields and stores of mineral wealth, that foreign enterprise must look for its reward.

Shanghai is described and illustrated. The value of the exports and imports of this great trading centre is set down at 37,000,000*l.* sterling per annum. Here British, American and French settlements adjoin, and one notes that nothing is said in praise either of the French settlement or French colonial aspirations. Civilisation of an antique and obsolete sort may have its charms; but the contrast drawn between the model European settlement of Shanghai and the Chinese city of like name leaves no shade of doubt as to the respective merits of the two civilisations—the old and the new. Here one is confronted with another enigma. For the past half century the Chinese city, in insanitary and withal dignified apathy, has been looking on this splendid European settlement, a fitting outpost of all that is best in modern advancement.

FIG. 1.—God of Thunder, Lin-Yang.

Mrs. Bishop says: "On returning to the broad, clean, well-paved and sanitary streets of foreign Shanghai, I was less impressed than before that many of its residents are unacquainted with the dark, crowded, dirty, narrow, foul and reeking streets of the neighbouring city. So native Shanghai, with its 5,600,000 souls, goes its sweltering way as of yore, breathing the mingled precepts of Confucius, and malodours of the waste products of centuries."

We breathe again freely as the author conveys us to Hangchow, giving a popular description of its picturesque surroundings, the present condition of the grand canal, pointing out the cause of its falling into utter disrepair.

The city has a chequered history like that other favoured city Soochow. It is a centre of sereculture and resort of opulent and leisure-loving literates and merchants. The illustrations of this part of the work, in common with others scattered through the book, are remarkable for their artistic excellence and fine technical quality, reflecting great credit on the author, who is a lady successful in many pursuits.

There is an interesting account of Medical Missions in China, throwing light on the valuable work done by this important branch of Christian Missions. "I believe in Medical Missions, because they are the nearest approach now possible of the method pursued by the founder of the Christian faith." The Medical Mission has proved one of the most successful branches of mission work in China.

The division of missionaries into sects is unfortunate, and militates against success. Chinese are apt to inquire why such differences exist in the one faith, and within one's own experience to say that "when you have all made up your minds what to believe, come and teach us." But there remains the potent influence at work,

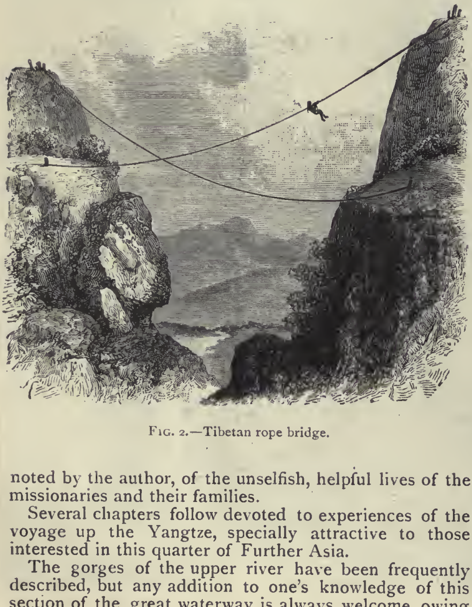


FIG. 2.—Tibetan rope bridge.

noted by the author, of the unselfish, helpful lives of the missionaries and their families.

Several chapters follow devoted to experiences of the voyage up the Yangtze, specially attractive to those interested in this quarter of Further Asia.

The gorges of the upper river have been frequently described, but any addition to one's knowledge of this section of the great waterway is always welcome, owing to the difficulty of navigation and danger caused by old and new rapids to native craft in the carrying trade. Mr. Little succeeded in taking a small steamer up the rapids to Chungkeng, but navigation of the gorges by steam must yet be more fully tested before it can be proved that the loss entailed by wreckage will not outweigh the advantages derived from the enterprise.

There are several mistakes in place names. One rather confusing error occurs in describing the Mi-tsang Gorge. It is set down in the index as Mitan Gorge, and the photograph showing the entrance to this gorge is labelled Ping-shan Gorge. It is at the entrance to this gorge that the great Ch'-ing-tan rapid bars the way to steam traffic on these upper turbulent waters. Blackuton, Thomson, Baber, Gill and others have passed this way, but Mrs. Bishop has been the first woman to give us the benefit of her keen observation, sense of humour, and literary talent in throwing some new light on native characteristics, and on weighty matters concerning this part of China.

The book must be read, and the reader will not be without his reward when he has finished the volume.

The most important part of the journey was the daring attempt to penetrate the mountain lands of the aboriginal Mantze, which nearly cost the author her life, and in which she succeeded so far as to be able to give a most interesting and graphic account of this obscure race. One would like to know something of their language, which is wholly different from Chinese, and written in Tibetan. It is also to be regretted that the camera of the intrepid explorer so scared the natives as to render portraiture impossible. The reader is purposely left to his own resources, and must read for himself the author's account of her adventures among the Mantze.

The work concludes with one or two brief essays:—"On the Poppy and its Use," "Christian Churches in China," "Secret Societies," "Questions of the Future," &c., subjects which have occupied the attention of other writers, disclosing a singular lack of unanimity of opinions on the part of the writers.

THE RELATION BETWEEN SCIENCE AND MEDICINE.

AN address upon the relation of science to experience in medicine, delivered to the Middlesex Hospital Medical Society by Sir J. Burdon-Sanderson, Bart., at the first meeting of the present session, is printed in full in the *Middlesex Hospital Journal* for December. The concluding part of the address is here reprinted, and the principles stated in it deserve careful consideration both from the point of view of science and of education. What Sir J. Burdon-Sanderson insisted upon throughout his address was that though the physician regards disease as a thing to be cured or prevented, while the investigator aims at discovering the causal relations between certain morbid changes and the conditions which give rise to them, both depend for their success upon the extent to which their faculties of observation have been developed. He held that medicine has hitherto advanced chiefly by the perfecting of its clinical method, using the expression in its modern and most comprehensive sense, but that future progress will be obtained by the scientific study of disease as a natural process. Some suggestions as to the best means to promote this advance are contained in the following extract from the address:—

We may, I think, rightly regard the Metropolitan schools collectively as constituting in themselves a great medical university. We do so in the hope that at no distant period they may be united for university purposes. Now, the two great functions of a university are education and the extension of knowledge by research. As regards the first I shall have nothing to say this evening. We may confidently anticipate that the clinical instruction given and the opportunity for clinical study afforded to students will improve year after year, and that practitioners will twenty years hence be even better informed, and their practice more sound than it is at present. But it is the other function of a university to which I would call your attention. Admitting, as I think must be admitted, that the Metropolitan schools have been hitherto, and will continue to be, admirable institutions for the training of men competent to exercise the healing art to the public advantage, it may still be asked whether our hospitals are, as they ought to be, observatories in which the scientific method is employed, not with a view to immediate utility, but for the eventual benefit of mankind by the advancement of knowledge. If we are right—as I am sure no one present doubts—in regarding a hospital school as an academical institution of which it is as much the function to make additions to knowledge as to educate, the organisation of every hospital school should comprise a special department for research in medicine—that is, that just as we have recognised for long the importance of pathological anatomy by the establishment in each school of a museum for the collection and display of morbid specimens, so we should provide what is of much more importance to the progress of medicine—a working place for the investigation of morbid processes. And, inasmuch as in most instances such investigation could be carried out much more effectually by the co-operation of several hospitals, I should further desire to see established a Hospital Association or an Association of Hospitals for the advancement of medicine by research. The organisation of such an Association would be simple. Each hospital would, as I have said, provide a research laboratory, under the direction of a working pathologist, the equipment of which would be the best that the resources obtainable for the purpose would admit of. The function of the Association would be the selection of subjects suitable for combined investigation.

Of the nature of these problems I need, I think, speak only very shortly. They would probably be of two kinds, namely, etiological and therapeutical, for it seems evident that for the investigation of the action of remedies—including under this term all the agencies which can be employed for the purpose of modifying pathological states—the same combination of clinical with physiological research is required as for the investigation of the processes of disease. But the greater part of the work of the Association would come under the other head. It would be advisable to restrict the scope of the investigation undertaken by well-defined limitations, and particularly to guard against the attractiveness of topics deriving their interest from their novelty, or from the rarity of the diseases to which they relate, rather than from their intrinsic importance. Preference would rather be given to the standing questions of clinical pathology, as, for example, to the investigation of the nature and causes of functional disorders or organic changes which, however frequently they may occur, are very imperfectly understood; and among these it might be well to select those in respect of which current medical opinion appears to be less in agreement than could be wished with the data of science. Let us take, for example, the case of gout. Here the difficulty which we find in harmonizing what is ordinarily believed as to the etiological relation of gout with uric acid, with the relatively complete knowledge we now possess of the physiological significance of that substance, at once suggests that it is desirable that the two kinds of knowledge now apparently at variance should be, so to speak, confronted. Another field in which it is difficult to reconcile the clinical and physiological aspects of the same phenomena is that of the relation between chronic renal disease and the functional disorders of the vascular and lymphatic system to which it gives rise. Here, again, the light which has been thrown on these subjects by such experimental investigations as those of Dr. Starling (which, I may mention in passing, have since their publication been confirmed by subsequent work in Germany) make us feel a certain degree of disappointment in finding ourselves still compelled to speak with the utmost reserve about such questions as the etiology of renal dropsy. Here, as in many other instances of a like nature, unsolved problems present themselves in connection with even the best-known diseases from the moment that we turn our attention to the underlying processes, of which the familiar clinical characteristics are but the outward and visible signs.

I trust that the suggestion I have made to you may not seem wholly unworthy of your attention, however imperfectly I may have been able to set it forth. I do not, myself, feel it to be premature. I should not, however, have the boldness to propose it even now, were it not that, as I have already told you, the reason which would have forbidden its being entertained no longer exists. We have now what we had not before—a sufficient number of men who, with youthful enthusiasm and with the best of their lives before them, have at the same time the scientific training necessary for pathological research.

If, as I trust may be the case, the new Metropolitan university is successfully constituted, it may be hoped that the economy of resources consequent on a better organisation of scientific teaching may set free the hospital medical schools from obligations which at present seriously impair their efficiency as academical institutions. At present, as we all know, elementary chemistry, elementary natural philosophy, and natural history are taught in schools of medicine; and large sums have, no doubt unavoidably, been spent in providing accommodation for subjects which lie outside the legitimate scope of medical study. It is surely not too much to hope that when these preparatory disciplines are duly provided for elsewhere, the resources hitherto required for their maintenance may be devoted to purposes in which we, as the representatives of medical science, can take a deeper interest, and particularly to the establishment in all hospital schools of well-equipped working places for clinico-pathological researches.[1]

In all that I have said this evening my aim has been to advocate the claims of scientific research in medicine; I have made no reference to the teaching of science. It is, however, easy to see that if the organisation of pathological research were to become more distinctly recognised as a function of a hospital medical school, the tendency of the change would be to infuse into the teaching of the science of medicine a reality and life which it has not as yet possessed.

Under present conditions there is much too wide a gap between the scientific and the practical part of the course of study for medicine. Let me take, for example, the case with which I am most familiar—that of the Oxford or Cambridge student, who, after receiving his preliminary instruction in the exact sciences in biology, and then acquiring a more thorough knowledge of anatomy and physiology, repairs to a Metropolitan medical school for the most essential part of his medical education. A considerable portion of these comparatively well-trained students are able to grasp the connection between science and practice, so as to appreciate the bearing of the science they have learned with the practical work in which for the rest of their lives they are to be engaged. But as regards the rest, we know what happens as soon as they have got rid of their last examination in science. It would be of little consequence that the details of the knowledge which has been so painfully acquired should fade from the memory, if one could believe that some notion of the scientific way of looking at questions was retained.

Whatever plan of study is followed, it is inevitable that the competent should succeed and the incompetent fail; but in our medical course there are causes of failure which it seems possible to obviate. One of these is no doubt the over-loading of our preparatory scientific curriculum with subjects which have no bearing on future work, an evil against which the General Medical Council has failed to protect us. The other is the unfortunate interruption of continuity which exists between the practical and the scientific stage in medical study.

It may, I think, be stated generally that every student when he enters on his hospital career feels that he is turning over a new leaf. It is quite natural that he should do so, and quite right, provided that he does not lose his interest in what he has previously learned. How is this to be prevented?

I have submitted to you this evening the proposition that research ought to be a recognised function of every medical school that lays claim to an academical position, on the ground that research is necessary for the advancement of medical science. The more this principle is acted upon the more effectually will the science of medicine be taught, for there is no qualification so essential to a teacher of science, and especially of pathology, as that he should himself be engaged in trying to master its difficulties.

Every advance in the direction I have indicated will have a direct effect upon teaching. The breach will cease to exist. The physiologically-minded student will no longer feel that in approaching the bedside he must leave his scientific preconceptions behind. In turning over the new leaf he will not forget what was inscribed on the old, but will rather find that the old has acquired a new value from its intimate connection with the work of his life.

But, gentlemen, all depends on whether you accept the proposition I have submitted to you—namely, that the science of medicine, even more than the art, holds the promise of the future.

[1] At the Middlesex Hospital a systematic investigation of the pathology of cancer is now in contemplation. I learn that it is intended to appoint a highly-qualified young pathologist to conduct the proposed research, and that in the necessary clinical work he will have the co-operation of the Registrar of the Cancer Department of the Hospital. The whole will be under the direction of a Committee of the Hospital staff. I refer to this as an example of the kind of work that can be done, and of the way of doing it.

SIR JAMES PAGET, BART, F.R.S.

THE death of Sir James Paget removes from our midst one of the ornaments of the medical profession. The loss is not an acute one since, though living up till some ten days ago, Sir James has for the last decade taken little active part in professional matters, but still, although the sphere of his activities has been during this period restricted by infirmity, one had evidence from time to time that he was there, using to the best of his strength that cultured mind, which never lost its vigour, for the benefit of those branches of knowledge which he loved so well.

This week's medical papers are so full of the professional attainments of the subject of this notice, and so rich in minute biographical detail, that there remains on these subjects little to be said. Sir James Paget was chiefly known to the world as a great surgeon, who, in addition to his actual professional abilities, exercised a profound charm over his patients. He was for the years he worked actively at St. Bartholomew's the student's model; not only what he did in the wards, but how he did it, served as a type to be imitated. His lectures and demonstrations were eagerly attended, and no note of discordance was there. The medical student, now of academic habits, was apt, in the early teaching days of Paget, to be rowdy, but there was never any disorder at his lectures, his fascinating diction rendering even the details of the most unæsthetic subjects sufficiently attractive to ensure the attention of his class.

Although Sir James Paget's practice as a surgeon, when he was at the height of his vigour, has perhaps never been surpassed, it was to the science of surgery rather than to its art, to its theory rather than to its practice, that he mainly contributed. He was no operating surgeon in the sense of Billroth. His surgery always contained in it an element of philosophy, a projection, so to speak, of his own philosophical spirit. He was a teacher, and enunciator of principles rather than mere facts.

In these days of what may be termed mathematical biography, one is apt to sum up a man's works, his contributions to knowledge, and regard the sum of them as an accurate measure, if not an actual expression, of his intellectual influence. This is not a fair test of the actual work of Paget. His original work on the catalogue of the Hunterian Collection at the College of Surgeons, and on that of the museum at St. Bartholomew's, his discovery of the trichina spiralis, his description of Paget's disease of the nipple and osteitis deformans, are perhaps the chief examples of his labours sufficiently sharp to wedge themselves through the crude and erratic surface of popular professional recognition. This, however, is no real measure of the man; he learnt from everything and taught from everything. He had the power of impressing the most varied subject-matter with his own philosophical individuality; the subject-matter in 1846 being the flora of Yarmouth; in 1896, or thereabouts, the medical student; his routine duties as warden at St. Bartholomew's affording to him material for a most valuable essay as to the ultimate fate and chances of success of the medical student.

In Paget's intellectual prime principles of exact science were beginning to be applied to medicine and surgery, such men *inter alia* as Pasteur, Liebig, Helmoltz, Brücke, &c., were busy examining with instruments of precision the fundamental phenomena and manifestations of life; not the least merit of Paget was that he kept well abreast of these stirring times, and gleaned from the purely scientific work of the great masters, facts and principles which he applied to surgery and surgical pathology. In these days of triennial medical congresses one can form but a very poor idea of what it meant in Paget's early days to be well up in contemporary science. His frequent advice to students to learn German seems now difficult to understand; it would be interesting to inquire how many men there are now who wish they had taken it.

Paget must be regarded, then, as an original teacher more than an original worker or writer; his ideas, perhaps somewhat metamorphosed in accordance with more exact technique, by his pupils, are springing up today on all sides, and will continue to do so. Like all truly great, he was truly benevolent, and many suggestions and ideas emanating from his mind have seen daylight under the names of his pupils.

F. W. TUNNICLIFFE.

NOTES.

THE Chemical Society's Victor Meyer Memorial Lecture will be delivered by Prof. T. E. Thorpe, President of the Society, on the evening of Thursday, February 8, at 8.30.

WE learn from *Science* that Prof. William Harkness, astronomical director of the U.S. Naval Observatory, retired as Rear-Admiral on December 17, on reaching the age of sixty years. Prof. S. J. Brown has been appointed to succeed him at the Observatory.

A SEVERE earthquake occurred on New Year's day in the province of Tiflis. The greatest amount of damage was done in the district of Achalkalak, in which six villages were completely destroyed and seven others had many houses ruined. Up to the present time, eight hundred dead bodies have been recovered.

WE regret to have to record the death, on January 1, after a very short illness, at his residence in Norwood, of Mr. W. T. Suffolk, the Treasurer of the Royal Microscopical Society, in his sixty-ninth year. Though but little known to the general public, and carried out in a very unobtrusive way, his services to microscopical science were great.

THE general manager of the South-Eastern and Chatham Railway, Mr. Alfred Willis, has made arrangements with the Wireless Telegraph and Signal Company for the Marconi system to be used in the course of a few weeks on the company's Royal Mail steamers between Dover and Calais, and also on their Royal Mail steamers between Folkestone and Boulogne. By this arrangement the vessels when in mid-Channel, or half-an-hour from either the French or English shores, will have telegraphic communication with either side.

THE Paris correspondent of the *Chemist and Druggist* remarks:—Prof. Riche, who was recently succeeded at the Paris School of Pharmacy by Prof. Moissan, was born at Gray (Hautes Saône) in 1829, and studied at the Faculty of Sciences and the Polytechnic School. He was appointed assistant professor at the School of Pharmacy in 1859, and professor of inorganic chemistry in 1873. His principal researches are on tungsten and its compounds. He has done some valuable work at the French Mint in compounding alloys, and is an active and usefu member of the Paris Council of Hygiene. His successor, M. Moissan, declares that it was in listening to his chemical lecture that he felt his first enthusiasm for the subject and resolved to become a chemist.

SINCE last week's issue we have received the *Connaissance des Temps* for 1901, the opening year of the new century. We then quoted a statement in the *Times* that the Paris Observatory "will henceforth in all its publications reckon the day from midnight to midnight." In spite of a suggestion to the contrary made some time ago, both the *Nautical Almanac* and the *Connaissance des Temps* have made no change, and the day is reckoned from noon to noon.

THE *Board of Trade Journal* states that nettle fibre has of late come greatly into favour in the manufacture of fine yarns and tissues. In Germany there are factories which use these fibres both in spinning and also for ulterior purposes. Nettle fibre produces one of the finest tissues obtainable from any known kind of vegetable fibre. In view of the importance which this seems likely to attain in connection with the weaving industries, it is intended to introduce the cultivation of nettles, if possible, into the Cameroons. The idea is to prepare the products of this experimental culture at the place where they are obtained, and test them in German factories. Should favourable results follow from these experiments, it is intended to organise nettle-growing enterprises on an extensive scale.

A NEW commercial intelligence branch of the Board of Trade has been established with a view to meet the constantly increasing demand for prompt and accurate information on commercial matters, so far as it can be met by Government action. In deciding to establish this new branch, the Board of Trade have been largely influenced by the recommendations contained in the report of a departmental committee appointed to consider and advise as to the best means of collecting and of disseminating among those interested prompt and accurate information upon commercial subjects, and as to the collection of samples, especially of goods of foreign manufacture competing with British productions, and the exhibition of such samples to manufacturers and traders in this country. The principal officer is Mr. T. Worthington, who recently acted as Special Commissioner to the Board in an inquiry into the condition and prospects of British trade in certain South American countries. The *Board of Trade Journal* will be the chief medium through which intelligence collected by the Branch and intended for general information will be conveyed to the public. The journal, which has up to the present been published monthly, is now issued weekly.

THE science of aerostatics has just lost one of its pioneers by the death of Mr. H. T. Coxwell, at the age of eighty-one. Mr. Coxwell's balloon ascents with Mr. James Glaisher, F.R.S., for the investigation of the meteorological conditions of the atmosphere at high altitudes, have long been prominent in scientific history. The circumstances which led him to take part in the work are described in an obituary notice in the *Times*. It appears that in 1862, hearing that a committee of the British Asociation at Wolverhampton had been making some unsatisfactory experiments with a Cremorne balloon, in order to take meteorological observations in the upper regions, he set about the construction of a special balloon for this purpose, finally producing one that stood 80 feet from the ground, had a diameter of 55 feet, and was capable of containing, when fully inflated, 93,000 cubic feet of gas. Mr. James Glaisher, F.R.S., who had not previously made an ascent, was to go up with Mr. Coxwell and take charge of the observations, while Mr. Coxwell himself was to attend to the balloon. The first of the long series of ascents thus carried out by them under the auspices of the British Association took place at Wolverhampton on July 17, 1862, and on that occasion they travelled sixty miles in two hours, and attained a height of four miles. It was on September 5, in the same year, that the pair made the record journey of rising to a height of no less than seven miles above the surface of the earth; and the story of this exciting exploit shows that the intrepid investigators had a very narrow escape indeed of their lives. The result of the many ascents by Mr. Coxwell and Mr. Glaisher was some important contributions to the science of meteorology. Moreover, they proved more clearly than had ever been done before, that ballooning was not merely a pleasant pastime, but might be rendered of great practical utility. From the same point of view Mr. Coxwell was most persistent in urging the advantages of employing balloons in times of war.

THE advantages of cremation as a means of disposing of the dead are too well known to need to be stated here. Neglecting sentimental considerations, the problem is, as Sir Henry Thompson puts it:—"Given a dead body: to resolve it into carbonic acid, water, and ammonia and the mineral elements rapidly, safely, and not unpleasantly." The present mode of burial is neither a satisfactory nor sanitary means of accomplishing this; and some of its dangers were pointed out by Dr. R. Farquharson in an address recently delivered at Aberdeen, and reported at length in the *Court Circular* of December 23, 1899. The lecture will be of service in enlightening people upon the subject of cremation, and directing their attention to the terrible condition of many old burial grounds.

IN the course of an interesting paper on lightning and its effect on trees, Mr. F. J. Brodie remarks in the *Journal* of the Royal Agricultural Society that in America much damage to live stock by lightning is believed to have arisen from the increasing adoption of wire fences. The director of the Iowa Weather and Crop Service, in his report on the thunderstorms of 1898, says: "Unquestionably wire fences, as now constructed, serve as death-traps to live stock, causing a vast amount of loss every year. And it is also quite evident that a considerable percentage of danger may be avoided by the use of ground wires at frequent intervals in the construction of wire fences." The point appears to be a practical one, deserving the notice not only of American but of English farmers, the means of protection from a real source of danger being after all very simple.

THE Meteorological Reporter to the Government of India has published a statement of the meteorology and rainfall of India during the past six months, and a forecast of the cold weather rains in Northern and Central India for the three months ending February 1900. The forecast issued in June last, from the conditions antecedent to the south-west monsoon, anticipated a rainfall slightly above the normal. This prediction was unfortunately not verified, as an area comprising nearly two-thirds of India is suffering from the most severe drought of the century. It is to be regretted that the meteorological conditions of October and November of last year strongly indicate the probability that the general character of the winter rains in the Persian area and North-Western India will be similar to that of the past four cold winters, and that the amount of the precipitation will probably be in general defect. The chief chance of the occurrence of more favourable rain than is anticipated lies in the early termination of the unknown causes which have produced abnormal conditions in the Persian and Upper India areas.

THE twenty-first yearly report of the Deutsche Seewarte, for 1898, has just been issued. The department of maritime meteorology continues to show great activity; the number of complete logs received from the mercantile marine alone amounted to 470, exclusive of 258 abstract-registers containing less complete observations. The great majority of the voyages were in the North Atlantic, but other oceans were fairly represented. In order to obtain as many observers as possible, agencies are established in many ports outside Germany, including the Consulates at Glasgow, London, Liverpool and Cardiff. The results of the observations are published in various ways useful to sailors, and have been frequently referred to in our columns. The system of weather telegraphy, and the possible acceleration and improvement of telegraphic weather reports receive considerable attention; storm warnings were issued to the various ports on 74 days, but the amount of success is not stated. In March last a conference was held under the presidency of Dr. Neumayer, on the subject of the rating and improvement of chronometers; those of German manufacture were recommended for use, as far as practicable.

THE Rev. John M. Bacon, on the occasion of a night balloon ascent, underwent an enforced detention in the upper regions of the atmosphere exceeding in duration that of any other English balloon voyage on record, and he made use of the opportunity to study the varying currents blowing at different altitudes. In the January number of *The National Review* he gives the results of these observations in an article, entitled "The War of Winds," which, together with the facts he has collected, forms an interesting commentary on weather forecasts.

DR. FREDERICK A. COOK'S description of the Belgian Antarctic expedition, of which he was a member, contributed to the January number of the *Century Magazine*, is accompanied by several exceptionally fine half-tone colour plates representing some of the Antarctic views seen during the journey of the *Belgica*. How promising the Antarctic is as a field of exploration may be judged from the following summary of the geographical results of the expedition:—"The work of the first two weeks when assembled proved the discovery of a highway perfectly free for navigation during the summer months from Bransfield Strait, two hundred miles south-westerly, through an unknown land to the Pacific. This highway has received the name of our ship, Belgica Strait. To the east of Belgica Strait we discovered a high, continuous country, which connects with the land charted as Graham Land. This has been christened Danco Land, in honour of our companion, Lieutenant Danco, who died on the ship during the long drift in the pack-ice which followed. The land to the west of the strait is cut up into islands by several channels, and was named Palmer Archipelago, in honour of Captain Nathaniel Palmer, the American sealer, who first of all men saw the outer fringe of this land. Scattered about in the waters of Belgica Strait are about one hundred islands and some groups of islands. About fifty of these are of considerable size. The islands, the capes, the bays, the headlands, and the mountains will mostly receive the names of Belgian friends of the expedition; but prominent outside workers have not been forgotten, as is evidenced by Nansen and Andrée Islands, and Neumeyer Channel."

MR. JOSEPH JACOBS, in an article, entitled "The Paths of Glory," in the current number of the *Fortnightly Review*, subjects the latest issue of "Who's Who" to a rough analysis, with the view of giving some idea of the kind of career which confers distinction on Englishmen. It seems that one Englishman out of every fifteen hundred throughout the British Empire attains popularity enough to secure a place in the biographical dictionary referred to. Among the results at which Mr. Jacobs has arrived, it may be noticed that "the comparative importance of politics as a means of figuring prominently in the world's thought" has changed but little during the thirty years since the publication of Mr. Galton's "Hereditary Genius." A comparison of the conclusions in this book with the contents of "Who's Who" leads to the remark that "scientific men must have increased more than fourfold in the interval (the last thirty years), yet their proportional parallax has declined from 73 to 42. Specialisation, doubtless, advances science and secures a man's position, but it rarely brings him prominently before the public." The argument as to the decline of the "proportional parallax" of men of science is, of course, unsound; for if "Who's Who" had been edited by some one familiar with the work of scientific men instead of a literary man, many minor writers would have been omitted from it and the names of more investigators well-known in the scientific world would have been included. The data from which Mr. Jacobs determines his "proportional parallax" are thus not comparable.

FOR several years Prof. W. O. Atwater has been engaged in investigations to determine whether the energy given off from the body of a man in the form of heat, or of heat and external muscular work, is equal to the potential energy or heat of combustion of the material actually burned in the body; in other words, whether the law of the conservation of energy holds good for the living organism. The lastest number of the *Physical Review* (vol. ix., No. 4) contains a concluding account, by Prof. Atwater and Mr. E. B. Rosa, of experiments made with the view of testing this point. A slight difference was found between the estimated income and measured outgo of energy in the experiments, and the authors conclude: "In view of defects and sources of error in methods and apparatus, we would, perhaps, be unwarranted in assuming that the experiments thus far made completely demonstrate the applicability of the law of the conservation of energy in the human organism. They do, however, seem to us to be reasonably near to such demonstration." The mechanical efficiency of a man was determined by a comparison of the energy used when at rest and when performing muscular work. The work done, divided by the total energy yielded by the body, gave 7 per cent. as the mechanical efficiency. As, however, a large amount of the energy received was used up in the body, only the excess of energy absorbed in the work experiment over that required when the subject was at rest should be charged against the work done. When this was taken into account the mechanical efficiency of man came out at 21 per cent., which equals or exceeds that of the best compound condensing engines with the highest efficiency boilers.

TWO more parts of the zoology of the Norwegian North Atlantic Expedition have recently been issued; one (No. xxv.), by Hans Kiær, dealing with the Thalamophora (Foraminifera), and the other (No. xxvi.), from the pen of Kristine Bonnevie, treating of the Hydroid Zoophytes. As usual, an English translation is printed in parallel columns with the Norwegian text; and although this, in the main, is well done, it would have been all the better for revision by an English proof-reader. The Foraminifera indicate that the portion of the Atlantic basin surveyed by the expedition is capable of division into three areas. Firstly, the southern grey clay, including the fjords and banks along the Norwegian coast, about as far as long. 19° E., as well as the similar clay area near Iceland and Jan Mayen. Secondly, the northern grey clay, comprising the fjords and banks along the aforesaid coast to the eastward of long. 19° E., and likewise the vicinity of Bear Island and Spitzbergen. Thirdly, the brown clay, subdivided into the *Biloculina* and the transition clay. So greatly does the brown clay differ in its fauna from the grey, that of the species of Foraminifera found on the former, only about two-thirds are common to the latter. It is also noticed that, with the exception of the eastern portion, the grey clay on the Norwegian coast is remarkably rich in these organisms, half of those met with during the expedition being taken there. From the great depths towards the coast the *Globigerinae* gradually diminish in number, until they almost disappear near the coast and in the fjords.

Modern Medicine states that Dr. A. Campbell White has been experimenting with liquid air on the tissues of the body. The results obtained encourage the belief that it will come into use as a local anæsthetic, and possibly for other medical and surgical purposes. The difference in temperature between liquid air and the human body is so great that it affords a unique means of producing a sudden and extreme shock to a localised part of the body, without localised destruction of tissue, or without affecting the general system.

MR. G. A. HEMSALECH, who, in conjunction with Prof. Schuster, recently published an account of their joint researches on the constitution of the electric spark (*Proc.* Roy. Soc., vol. lxiv. p. 331), has continued the research in the laboratory of M. Lippmann, in Paris. In the *Journal de Physique* (Series 3, vol. viii. pp. 652-660) he gives a detailed account of the action of the jar spark, with and without self-induction in the secondary circuit, on the metals bismuth, copper, cadmium, zinc, lead, iron, cobalt, silver, mercury and also on the gases hydrogen and oxygen. In every case the effect of self-induction in the secondary is to lower the temperature of the spark, the resulting spectrum being intermediate between that of the arc and the ordinary condensed spark, the air lines entirely disappearing and the long lines of the metals only persisting. With a very long exposure (fifteen times normal), the band spectrum of nitrogen was faintly perceptible in the spectrum of the self-induction spark. In the case of metals containing impurities, the spectrum of the impurity is well shown in the modified spark spectrum. Photographs of the metallic spectra mentioned accompany the paper, showing clearly the contrast between the two types of spark. The apparatus consisted of a 10-inch spark coil, three Leyden jars, each of 1200 sq. cm. surface, with self-induction varying from 0·00012 to 0·0038 henry in secondary circuit. The photographed spectra extended from λ 5900 to λ 3400.

THE Annual Progress Report of the Geological Survey of Western Australia for 1898, reached us at the close of 1899. Field-work has been carried on mainly by Mr. A. Gibb Maitland and Mr. Torrington Blatchford in areas which were considered to be of economic importance. Among these the crystalline rocks of the southern and western portions of the colony received attention. The schists and gneisses have a general strike to N.E. and S.W., but it was not found possible to draw any lines separating granite from gneiss or other schistose rocks. A belt of iron-bearing schist, about six miles in width, has been traced to the north of Northam. The country consists chiefly of granite, in which are belts of vertical mica- and hornblende-schists, and banded iron-bearing quartzites. In places these quartzites have proved to be auriferous.

THE anthropological aspect of primitive mathematics has recently been approached in two such very different ways by Herr L. Frobenius ("Die Mathematik der Oceanier"; *Naturwissenschaftliche Wochenschrift*, Bd. xiv. 1899, p. 573), and W. J. McGee ("The Beginning of Mathematics"; *American Anthropologist*, N.S. vol. i. 1899, p. 646) as in itself to constitute an interesting psychological study. The German investigator gives lists of numerals from numerous localities, and classifies them into structural groups, which fall naturally into geographical districts; for example, the group which has practically only two numerals lies to the south of Indonesia (*i.e.* part of New Guinea and Australia); that with five is found in the middle district (portions of New Guinea), while that with ten numerals is characteristic of the northern district, whence it has spread into Micronesia, Melanesia, and Polynesia. The various exceptions and variations are noted, as well as the way in which the numerals illustrate primitive addition, multiplication and subtraction. The American student starts with the axioms that (1) Primitive men are mystics; (2) Primitive men are egoists. The Australian binary concept of things is expressed not only by their numeration, but even more clearly by their social and fiducial systems. The most widespread of the mystical numbers is four, the devotee of the Cult of the Quarters is unable to think or speak without habitual reference to the cardinal points. To most of the devotees of the quatern concept—forming probably the majority of the middle, primitive tribes of the earth—the mystical number four is sacred, perfect, all-potent, of a perfection and potency far exceeding that of six to the Pythagoreans and the hexagram to Paracelsus. A somewhat higher stage is marked by the use of six as a mystical or sacred number; in this stage the cardinal points are augmented by the addition of zenith and nadir. In the case of the last two cults the exoterically perfect numbers of four and six are esoterically perfected through the unity of subjective personality; hence the mystical numbers of five and seven. The author denies that the quinary system was primeval. The method of treatment by Prof. McGee is sufficiently illustrated by these quotations.

AN account, with illustrations, of the most interesting of the medals awarded to students in London Hospitals, is contributed to the current number of the *British Medical Journal* by Mr. T. E. James.

THE twenty-seventh annual dinner of the old students of the Royal School of Mines will be held on Friday, January 26, at the Hotel Cecil. The chair will be taken by Mr. H. G. Graves, who, for the past eight years, has acted as hon. sec. of the dinner committee.

THE current number of the *Electrician* contains, as a supplement, a large sheet-table giving details concerning the Electricity Supply Works in the United Kingdom. An immense amount of information concerning the plant in stations in operation or in progress is given in the table.

THE fish hatching experiments recently started by the Crystal Palace School of Fish Culture have now been resumed, and the operations may be witnessed daily at the Palace. The first lot of ova salmonidæ was laid on Friday last.

MESSRS. WHITTAKER AND CO. have published the fourth edition of Mr. T. H. Blakesley's "Papers on Alternating Currents of Electricity for the use of Students and Engineers.' A prominent characteristic of the book is that various electrical problems are dealt with by geometrical methods.

A COPY of the seventh volume of *Natur und Haus*—an illustrated magazine for naturalists, using the word in its widest sense—has been received. Numerous excellent illustrations are distributed through the pages, and the articles will interest all students of natural history having even an elementary knowledge of the German language. The publisher is Gustav Schmidt, Berlin.

THE second of the Selborne winter lectures will be delivered at the Linnean Society's Room at Burlington House, W., on Tuesday, January 16, at 8.30 p.m. The subject will be "Man's First Contact with Nature," by Prof. G. S. Boulger. The February lecture will, it is hoped, be the one promised some months ago by the Hon. J. Scott Montagu, M.P., on "South African Fauna and Flora"; and the March lecture by Dr. Lubbock.

THE thirteenth edition of "Discoveries and Inventions of the Nineteenth Century," by Mr. Robert Routledge, has been published by Messrs. G. Routledge and Sons. In matters which have been brought prominently before the public, such, for instance, as Röntgen photography and wireless telegraphy, the book is up-to-date, but in some of the less familiar sections it is many years behind the times. The section on the spectroscope particularly needs to be revised. Used with discrimination, the book contains much instructive information concerning achievements of modern science and industry.

HORTICULTURAL science and practice are fortunate in having such a trustworthy exponent as *The Garden*, of which the first number of a new series has just been published. The journal was founded in 1871 by Mr. William Robinson, and during its existence has done much to promote improved methods in horticulture and extend the knowledge of beautiful flowers, shrubs and trees, and of the best ways of dealing with them. Botanists, horticulturists, and all lovers of plants should see the number which commences the new series. Among the articles we notice one on the Royal Gardens, Kew, illustrated, as are the other contributions, with several instructive half-tone pictures.

ASTRONOMY figures prominently in the January number of *Knowledge*. Mr. A. Fowler contributes an article on the constituents of the sun, in which he summarises the researches and conclusions of modern solar physics. Mr. E. W. Maunder commences a series of articles on astronomy without a telescope, and the Rev. J. M. Bacon describes the balloon ascent made by him with the object of observing the Leonid meteors. Among other subjects of articles are plants and their food, by Mr. H. H. W. Pearson, and the natives of Australia and their origin, by Mr. R. Lydekker, F.R.S.

OUR contemporary, *Science Gossip*, is doing good work in publishing a series of papers, by competent naturalists, dealing with different groups of the British invertebrate fauna, in the form of popular monographs. Portions of three memoirs of this series appear in the January number—namely, one, by Mr. Sopp, on dor-beetles; a second, by Mr. Soar, on freshwater mites; and a third, on spiders, by Mr. F. P. Smith. By the quotation from *Antony and Cleopatra*, the author first named seems to have proved beyond cavil that the Shakespearian term *shards* refers to the elytræ of the dor-beetle. While thus keeping in the main to the British fauna, the editor has admitted one descriptive paper dealing with a wider area—to wit, a contribution, by Dr. H. C. Lang, describing the Palæarctic butterflies, of which the present section is devoted to the numerous species of the beautiful genus *Parnassius*.

THE *Jubelband* of the *Zeitschrift für physikalische Chemie* contains an interesting memoir by Dr. T. Estreicher upon the solubility of argon and helium in water. The value given by Prof. Ramsay in his preliminary note in 1895 for the solubility coefficient of helium (·0073 at 18°·2) would make helium the least soluble of gases, a conclusion borne out by its exceedingly low critical point: but from the experiments of Dr. Estreicher it would now appear that the true value of the coefficient is about double this preliminary value. The apparatus used was identical in principle with that of Ostwald, but was improved in two important points: the use of a glass spiral connecting the measuring and absorption vessels, enabling the apparatus to be made wholly of glass, and the immersion of the whole apparatus in water. This water jacket rendered accurate determinations of the solubility coefficients possible at temperatures between 0° and 50° C. The results are plotted in the form of curves, nitrogen being also shown on the same scale for the sake of comparison. The solubility curve of argon is of the usual type, decreasing with rise of temperature from ·0578 at 0° to ·02567 at 50°. The solubility of helium varies very slightly with temperature, the curve exhibiting a minimum at about 25° C., the values being ·015 at 0°, ·01371 at 25°, ·01404 at 50°. The nitrogen and helium curves intersect at 30°, where their solubilities are the same; above this temperature nitrogen has a smaller solubility than helium. The author points out that although the occurrence of a minimum of solubility is peculiar, it is not unique, since Bohr and Bock found a minimum of solubility for hydrogen at about 60°.

THE additions to the Zoological Society's Gardens during the past week include a Diana Monkey (*Cercopithecus diana*) from West Africa, presented by Mr. S. W. Thompston; a Common Tern (*Sterna fluviatilis*), European, presented by Mr. J. Newton; a Tawny Owl (*Syrnium aluco*), British, presented by Madam de Bunsen; Moor Macaque (*Macacus maurus*) from the East Indies, a Crested Porcupine (*Hystrix cristata*) from West Africa, two Crossbills (*Loxia curvirostra*), European; three Serrated Terrapins (*Chrysemys scripta*), a Prickly Trionyx (*Trionyx spinifer*), a Bull Frog (*Rana catesbiana*) from North America, deposited; two White-eyebrowed Wood-Swallows (*Artamus superciliosus*), two Masked Wood-Swallows (*Artamus personata*) from Australia, purchased.

OUR ASTRONOMICAL COLUMN.

CENTRAL STAR OF RING NEBULA IN LYRA.—M. W. Stratonoff, of the Tashkent Observatory, has been engaged in measuring the brightness of the central star of the annular nebula in Lyra, and has communicated his results to the *Astronomische Nachrichten*, Bd. 151, No. 3607. A considerable number of photographs of the nebula have been obtained with the large telescope of 0·83m. aperture, extending over the period September 8, 1895, to September 15, 1899, the exposures varying from 30 to 90 minutes. From his measures of the brightness of the central star as compared with the magnitudes of 30 neighbouring comparison stars, M. Stratonoff shows that the magnitude varies from 13·1 to 9·5. A special series of photographs taken with extra long exposures, however, renders the question of variability, as measured from photographic impressions, somewhat doubtful. On a plate exposed for anything between 22m. and 1h. 23m. the mean magnitude of the star was 11·6. On a plate exposed for 10 hours, the magnitude was 10·1; while on exposing for 20 hours, the measured magnitude was 3·6. The author suggests, as explanation of this, that the star may really be simply a condensation of part of the whole nebulous matter, and the effect of long exposure will be to lessen the contrast between the condensed centre and the outlying fainter matter.

THE INDIAN UNIVERSITY OF RESEARCH.

A Conference was held at Simla at the end of October last to consider the Tata scheme for a Research University for India. A full report of the Conference is in the Madras *Educational Review*, from which the following particulars have been derived:—

The gentlemen invited by the Government of India to meet in conference with Mr. J. N. Tata regarding the proposed University were as follows:—The Hon. Mr. T. Raleigh, presiding, Mr. Jamsetji N. Tata (with his Secretary, Mr. Padshah), the Hon. Mr. Justice Ranade, Surgeon-General Harvey, the Hon. Dr. Duncan, Director of Public Instruction, Madras, Prof. Pedler, F.R.S., Director of Public Instruction. Bengal, Mr. Sime, Director of Public Instruction, Punjab, Principal MacMillan, Bombay, Mr. A. H. L. Fraser, Officiating Home Secretary.

The Conference first discussed fully the manner in which the scheme should be launched, so as to keep in view the ultimate ideal and at the same time make progress as funds permit. The Conference were of opinion that it is an essential feature of the scheme to have a central institution for research, as well as a central authority to control the operations conducted under the scheme. And they were of opinion that there is ample room, and indeed a clear necessity, for such a central institution.

At the same time they realised the necessity for taking advantage of existing facilities for research, whether in the shape of special local facilities (as of trade, products, &c.), or in the shape of good laboratories or museums, and men qualified for scientific research. They acknowledged that even in the unfavourable circumstances hitherto existing, students had shown in certain instances distinguished aptitude and capacity for research; and they believed that much good would be done by the grant of studentships, and also, where necessary, by assistance to the teaching and supervising staff. While, therefore, recognising that a central institution is necessary, and that there are certain departments of research (such as Technical Chemistry), which must even from the very first be provided for at that central institution, they recommended that at the outset every effort should be made to utilise existing facilities and so economise funds and resources. It is undoubtedly clear that certain branches of research must be conducted away from the central institution. But the Conference are of opinion that that institution should be gradually strengthened as circumstances permit.

The Conference also concurred fully in the view accepted by the Provisional Committee that certain parts of the scheme should be first carried out, and that the rest should follow as funds permit. They concurred in giving preference to Parts I. (Scientific and Technical) and II. (Medical) and leaving Part III. (Philosophical and Educational) to follow, though they were of opinion that the promoters of the scheme and its governing body ought to keep in view the scheme in its entirety. They were also of opinion that the scheme of studies and of subjects should be stated in the most general terms, and that provisions should be made for its revision from time to time so as to leave the authorities in charge of the work as free a hand as possible in taking up subjects that seemed specially at any time to demand attention, and in conforming to the progress of science. In regard to bacteriology, they were quite prepared to postpone action, both because there are many subjects to which the funds may at the first be at least as usefully applied, and also because they understood that the Government of India are taking such action as seems at present necessary in regard to this subject. They think that probably the best application of their funds to this subject, for the present at least, will be the provision of studentships in the Government institutions.

The Conference considered the question of the site of the central institution. It seemed to them that of all the sites named the choice lay between Bombay and Bangalore. In regard to the former the main considerations were (1) the fact that it is the home of the founder (who, however, rather favours Bangalore); (2) that it is a great centre of commercial and industrial activity; (3) that it is easy of access from all parts of India and from England; and (4) that a strong governing body could be easily obtained there. On the other hand, the climate, though not altogether unfavourable, is not bracing, and is injurious to machinery and apparatus. It would not be so favourably regarded by Europeans as Bangalore, and in Bombay land is not available in sufficient quantity. If (as is believed) special concessions in respect to site, and aid in regard to the scheme generally, be made in Bangalore on condition of the institution being there, the Conference would recommend that site.

The Conference considered the name or title of the institution. There was a strong opinion in favour of the title "Institute" as more suitable than "University" to the objects in view. But in deference to the views of Mr. Tata, and in consideration of the sentiment of the educated community of India, the Conference decided that it was expedient to adopt the well-known title of "University." They, therefore, decided to recommend that the institution be styled "The Indian University of Research." They were, however, of opinion that it should maintain its post-graduate character, and that it should, therefore, grant not degrees but fellowships.

The Conference are unanimously of opinion that there is great need for such an institution as has been indicated; that there is no reasonable ground for doubt that its work would be successful; that it would exercise a most beneficial influence on higher education and on the development of the resources of the country; and they strongly recommend it to the sympathy and support of the Government of India. They trust the Government of India will express their favourable opinion on the scheme, and give the promise of necessary legislation to be carried out as soon as it is matured, so that an appeal may be made to the public for funds, and that the details of the scheme may be definitely settled.

The Conference then proceeded to revise the Draft Bill and determined to recommend the Draft Bill as revised to the Government of India for publication. And at the request of Mr. Tata they resolved to ask the Government of India to nominate some officer to consult with him about the transfer of the property with which he proposed to endow the University.

The *Gazette of India* gives the following outline of the Tata University scheme:—It is proposed to found an institution which shall be or correspond to a teaching University for India, its primary aim being to teach, not to examine. Diplomas, therefore, will be conferred on those who have completed a certain course of higher education. This work of higher instruction will be conducted on principles followed now in Europe—*e.g.* in German Seminaria, French Conferences, and English and American Research Classes. These courses will be the beginning of a purely specialist training. In order not to interfere with the existing agencies, the new institution will take up teaching where Colleges and existing Universities leave off. The new courses will be post-graduate. The new specialist courses, which are post-graduate, will naturally be professional and technical, rather than simply literal school sanitary and science practice. For qualified medical men a school of pedagogics for those intending to be higher secondary teachers (inspectors, head-masters, &c.), and a school for higher studies, are some of the obvious directions of the development. It is not proposed to take all these up at once. The order in which they may be proceeded with will be best arranged by the committee. It is not intended to cut off the post-graduate students from education in Europe. It is contemplated to select the best for further training in Europe or America, with a view to their future return to this country. It will be necessary to make ample provision for scholarships and fellowships, both for the students in the institution and for those who proceed from it to Europe or America. The development of a scheme so complete must entail a vast capital annual expenditure, the construction of libraries, laboratories and museums, and the invitation to specialists to teach and prosecute research. All this must require large sums of money. A committee has been formed to secure the necessary financial support by making a general appeal for funds to take the preliminary steps in connection with the scheme, and to obtain a short legislative enactment enabling the institute to hold property.

His Excellency the Governor, the Chancellor of the University of Bombay, has kindly consented to let it be known that the proposed scheme has his personal approval and sympathy.

The Government of India accept the recommendations of the Conference, and they desire to place on record their appreciation of the generosity and public spirit displayed by Mr. J. N. Tata in making his munificent offer of an endowment for the proposed University of Research. They are confident that the proposed University will meet a great need, and will contribute to the advancement of higher education and the development of the resources of the country. They will be ready to proceed to legislation as soon as the scheme has been matured in all its details. They wish the undertaking every success. In accordance with the request made by the Conference, the Government of India have requested the Government of Bombay to nominate an officer to arrange with Mr. J. N. Tata for the transfer of the property with which he proposes to endow the University.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DR. F. KOHLRAUSCH, president of the physikalisch-technischen Reichsanstalt, has been appointed honorary professor of physics at Berlin.

MR. G. F. HARDCASTLE, senior assistant in the chemical department of the Technical College, Huddersfield, has been appointed instructor in dyeing, and assistant in chemistry, at the Municipal Technical School, Leicester.

THE Annual General Meeting of the Association of Technical Institutions will be held on Wednesday, January 24, at the Mercers' Hall, London. The president (Earl Spencer, K.G.) will preside, and an address will be given by the president-elect, Sir Swire Smith.

A COURSE of fifteen lectures on organic chemistry will be given at the Goldsmiths' Institute, New Cross, S.E., on Friday evenings, at 8.30, by Mr. W. J. Pope, commencing on January 19. Particular attention will be paid to the discussion of recent work and current views relating to organic chemistry.

THE University of Pennsylvania's free museum of science and art at Philadelphia, one of the late Dr William Pepper's cherished hopes, was, says *Science*, formally opened in the presence of several thousand people on December 20. Immediately following the presentation to the board of trustees of the museum, a bronze statue of the late Dr. Pepper, the gift of friends, was unveiled. Mrs. Pepper, the widow of Dr. Pepper, has presented to the university trustees, as her memorial to the memory of her husband, a gift of 50,0.0 dollars, as a fund to carry on the work started by Dr. Pepper.

THE dissertation for which Mr. H. N. Dickson has received the B.Sc. research degree of Oxford University was "On the circulation of the surface waters of the Atlantic north of 40° N. lat." The work consisted primarily of a chemical and physical examination of the surface waters of the North Atlantic during the twenty-four successive months of the years 1896 and 1897. For the purpose of the investigations special arrangements were made for the continuous supply of samples by officers of ships trading in the North Atlantic. The results were exhibited in monthly charts showing the distribution of temperature and salinity, and the changes during the period are fully discussed. The existence of definite seasonal changes in the circulation has been established by the investigation.

WITH a view to encourage the adoption of scientific methods in the teaching of physical geography, the authorities of the Cambridge Local Examinations have issued a syllabus of a course of work which has several commendable characteristics. In the first place, it is distinctly stated at the head of the syllabus that "The object of the examination will be to ascertain as far as possible to what extent the candidates' powers of observation and reasoning have been cultivated." Even more noteworthy than this remark is the schedule which accompanies the syllabus and contains an outline of a course of practical instruction designed "(1) to develop the power and habit of observation; (2) to give the pupils clear and accurate conceptions of natural phenomena and their relations; and (3) to enable them to seek for the causes and rational explanations of the phenomena which they observe." Among the subjects in which practical instruction is to be given are: the drawing of sections from contour maps, the study of local land-forms, the use of meteorological instruments, the study of ocean current maps, simple astronomical observations, the determination of time and latitude, and the use of the terrestrial globe. It is to be hoped that the efforts of the Cambridge authorities to encourage the scientific study of the earth will meet with success. No subject stands in greater need of rational methods of instruction than geography.

THE English Education Exhibition, which was opened by H.R.H. the Prince of Wales at the Imperial Institute on Friday last, contains the materials from which the English educational exhibits for the Paris Exhibition will be chosen. The whole field of educational activity in this country is more or less satisfactorily represented by these exhibits, though a walk through the galleries shows the initiated observer how impossible it is to materialise certain factors of educational effort, which though intangible are none the less real and powerful. Every step in a career from the kindergarten to the university can be followed by the inspection of the objects collected in the different sections. It is satisfactory to be able to record that the equipment necessary for proper instruction in science takes a prominent place in the collections sent by nearly all the elementary schools, most of the secondary schools, the technical institutes, and the colleges of university rank. Hand and eye training is evidently now almost universal, for one exhibit after the other contains admirable examples of wood-work, metal-work, clay-modelling, and miscellaneous occupations of a varied kind having the same end in view. We noticed with some satisfaction an etching of Charles Darwin in the Shrewsbury School exhibit: even if he received little encouragement in science at the school, it is quite clear the authorities are proud of him.

SCIENTIFIC SERIALS.

Wiedemann's Annalen der Physik und Chemie, No. 12.—Magnetic deflection of kathode rays, by E. Wiechert. The velocity of kathode rays is determined by deflecting them at two different points of their path by currents of a Lecher wire system slightly retarded with respect to each other. The velocity comes out as about one-seventh of that of light, and the mass transported with each electron is about 1/1300 part of an oxygen atom.—Relation between electric conductivity and pressure, by G. Tammann. Gaseous ionisation is reduced by increase of pressure, while the ionisation of a solution is increased. In incompletely dissociated solutions, an increase of conductivity with pressure is observed. Thus, a deci-normal solution of acetic acid is reduced in resistance to one-half its original value by a pressure of 2500 atmospheres.—An experimental and theoretical fallacy in electrical doctrine, by E. Lecher. The author maintains that a magnetic line of force can in no sense be defined as a line along which a positive pole would move, and that as a matter of fact a pole never moves along a line of force.—Distribution of free electricity at the surface of a Crookes' tube, by E. Riecke. The author uses a mixture of red lead and sulphur to discover the free charges on the outer surface. The fluorescent patch is marked by a wide ring of sulphur, the interior of which is marked by irregular patches of red lead, showing negative charges distributed irregularly, probably owing to want of symmetry in the kathode. The remainder of the tube is coated with sulphur, except the portion behind the kathode, which is negative again.—Strains in Rupert's drops, by K. Mack. Rupert's drops show black on the screen in polarised light, but they can be made to show their colours by immersing them in a trough containing a liquid of the same refractive index, such as cedar oil or a mixture of carbon bisulphide and ethyl ether. The colours resemble those of peacock's feathers.—Magnetic deflection of Becquerel rays, by F. Giesel. The deflection may be demonstrated by means of a polonium preparation attached to a sensitive plate laid face downwards across the poles of an electro-magnet. The deflected rays on the negative show a curious hairy structure.—The photography of current curves, by J. Zenneck. Instead of using a sliding plate or a revolving mirror with the Braun kathode tube, the author produces the current curve direct upon the screen in the kathode tube.—He uses two deflecting magnets, one for producing the oscillation due to the current under investigation, and the other for imparting to the kathode beam a lateral movement proportional to the time.

Memoirs of the Novorossian (Odessa) Society of Naturalists, vol. xxii. Part 2.—The whole of this volume is given to the results of the exploration of the *liman* (salt lake) of Kuyalnik, situated near Odessa, which exploration was undertaken several years ago by the Odessa University. Most of the volume is occupied by a most exhaustive report, by A. Wassilieff, about the astronomical, topographical and bathymetric work made in connection with this liman. A large scale map (1 : 16, 800) of the lake and several vertical profiles accompany the report, which will be a precious document for all subsequent exploration.—The rest of the volume is taken up by a paper, by L. Silberberger and M. Weinberg, on the bacteria found in the mud of the liman. They originate partly from the surrounding air and partly from the waters entering the lake, their composition varying with the seasons. The mud is not favourable for the life of the bacteria, which add to the mud by their decay.

IN the *Journal of Botany* for December 1899, the most important article is by Dr. A. B. Rendle, Notes on *Xyris*, in which several new species are described.—Messrs. J. A. Wheldon and Albert Wilson conclude their paper on the mosses of West Lancashire. In the number for January 1900 we find papers on *Sphagnum medium* in Britain, by Mr. H. W. Monington (with a plate).—Some Welsh hawkweeds, by the Rev. Augustin Ley, in which one more is added to the long list of British "species" of *Hieracium*.—On some species of *Cracca*, by Messrs. Jas. Britten and E. G. Baker.

THE *Journal of the Royal Microscopical Society* for December 1899 contains a continuation of Mr. F. W. Millett's paper on recent Foraminifera of the Malay Archipelago, and the usual summary of current researches in zoology, botany and microscopy. In the latter section several valuable recent novelties in microscopic construction are described. This number also contains the list for 1899 of new terms introduced during the year in zoological and botanical literature.

SOCIETIES AND ACADEMIES.

LONDON.

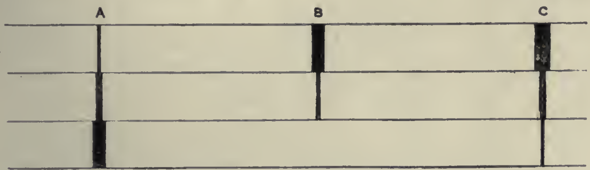
Royal Society, November 23, 1899.—"Note on the Spectrum of Silicium." By Sir Norman Lockyer, K.C.B., F.R.S.

The recent observations show that the lines of silicium may be divided into three sets, no two of which behave alike under varying electrical conditions. The wave-lengths of the lines composing the different sets are:—

$$\left.\begin{array}{l}3856\cdot1\\3862\cdot7\\4128\cdot1\\4131\cdot1\end{array}\right\}\text{A.}\qquad\left.\begin{array}{l}4089\cdot1\\4116\cdot4\end{array}\right\}\text{B.}\qquad\left.\begin{array}{l}4552\cdot8\\4568\cdot0\\4575\cdot3\end{array}\right\}\text{C.}$$

There is a line at λ 3905·8 which is associated in the spark spectrum of silicium with the lines in set A, but while these are entirely absent from the arc spectrum of silicium, 3905·8 is a strong line in the arc spectrum. This line differs from the others, therefore, in not being enhanced in intensity in passing from the conditions of the arc to those of the spark. So far as is known, the lines in sets B and C have not been recorded by any other observers of the silicium spectrum.

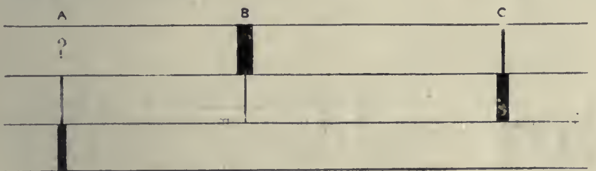
The behaviour of the three sets of lines in terrestrial spectra is shown in the following figure:—



1. SiF_4 vacuum tube (capillary). 2. SiO_2 spark with Spottiswoode coil. 3. Vacuum tube (bulb) SiO_2 spark with small coil.

It is found, on investigating the occurrence of these silicium lines in stellar spectra, that the three sets of lines respectively attain a maximum intensity at the three different levels of stellar temperature represented by β, γ, and ζ Orionis.

The accompanying figure shows the behaviour of the different sets A, B, and C in the spectra β, γ, ζ Orionis.



1. ζ Orionis. 2. γ Orionis. 3. β Orionis.

We find that set A is most prominent in the spectrum of β Orionis, that set C predominates in the spectrum of γ Orionis, and that set B is by far the strongest in that of ζ Orionis.

That the stars named represent three different grades of temperature, ζ Orionis being the hottest, and β Orionis the coolest, has been previously deduced by the discussion of other lines in their spectra. This result was embodied in a paper "On the Order of Appearance of Chemical Substances at different Stellar Temperatures," read to the Society in February, 1899. In that paper α Crucis was given as a typical star representing a stage of temperature between those of β Orionis and ζ Orionis. That star can be very well replaced for the purpose of the present discussion by γ Orionis, the two spectra being nearly identical.

It was recently shown that silicium made its appearance first at the temperature represented by α Ursæ Minoris, and strengthened at the higher temperature of α Cygni and β Orionis, afterwards weakening as we pass through the still higher temperatures of ζ Tauri and γ Orionis, until at the ζ Orionis stage it is bordering on extinction.

In the same paper the behaviour of a line at λ 4089·2 was plotted, and at the same time it was quoted as an "unknown" line.

It is interesting to note that this line is now traced to silicium, and is the strongest line in set B. It is apparently a short-lived line in stellar spectra, as it only occurs between the stages of temperature represented by γ Orionis and ζ Orionis, being one of the weakest lines in the spectrum of the former star, and one of the strongest in that of the latter.

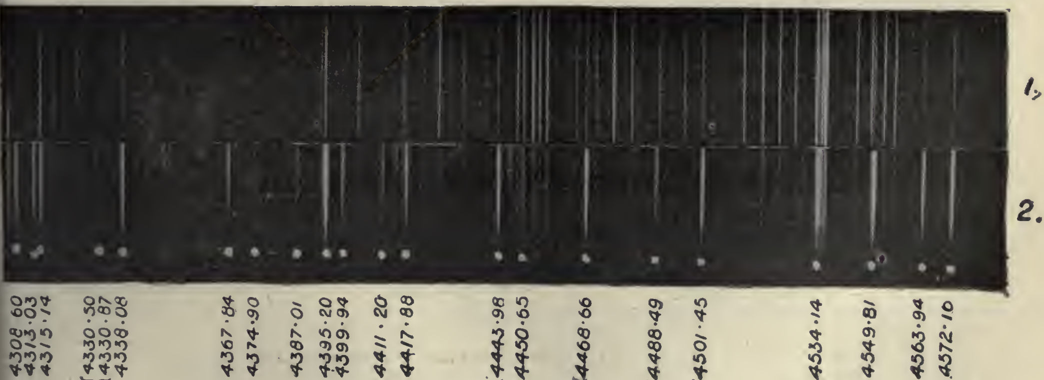
November 23, 1899.—"Preliminary Table of Wave-lengths of Enhanced Lines." By Sir Norman Lockyer, K.C.B., F.R.S.

The important part which the enhanced lines of the element play in the study of stellar spectra cannot be over-estimated, but a great advance can only be made in this direction by a systematic examination of the spectra of all the elements. Such an undertaking as this involves considerable time and labour. The author has been fortunate enough to have the use of the large 42-inch Spottiswoode coil, made by Apps, for a short space of time, and employed it in this work, for which it is specially adapted, as the brilliancy of its spark shortens the time of exposure.

The elements which have been dealt with in this investigation are the following:—"Aluminium, bismuth, chromium, copper, iron, magnesium, manganese, titanium, and vanadium."

For each of these elements the spark and arc spectra were photographed and compared, and the wave-lengths of the enhanced lines, that is, those lines which are intensified in passing from the temperature of the electric arc to that of the spark, were determined, and tables are given of their wave-lengths.

An illustration shows the enhanced and arc lines in the spectrum of titanium.



Titanium.—Enhanced Lines.
1. Arc. 2. Spark.

Chemical Society, December 21, 1899.—Prof. Thorpe, President, in the chair.—The following papers were read:—On the refractive and magnetic rotatory powers of some aromatic hydrocarbons, and on the refractive powers of mixtures, by W. H. Perkin, senr. The replacement of hydrogen in an aromatic nucleus by methyl is accompanied by a greater increase in molecular refraction, and a smaller increase in magnetic rotation, than is the replacement of hydrogen in a side chain by a methyl group.—Formation of α- and β- acrose from glycollic aldehyde, by H. Jackson. Tetrosazone and α- and β- acrosazone are obtained from the condensation product formed by the action of soda on a dilute glycollic aldehyde solution at 0°; on prolonged condensation at 0°, the quantity of tetrosazone obtainable decreases.—The interaction of mercurous nitrite and ethyl iodide, by P. C. Rây. Mercurous nitrite and ethylic iodide react to form nitroethane and ethylic nitrite.—On mercurous nitrite, by P. C. Rây.—The action of alkyl iodides on the mercuric iodide sulphides of the fatty series, by S. Smiles. The alkylic sulphides combine with mercuric iodide to form compounds of the type R_2SHgI_2 containing tetrad sulphur; these substances when treated with methylic iodide yield compounds of the type R_3SIHgI_2 which possibly contain hexad sulphur.—On brasilin and hæmatoxylin, Part III., by A. W. Gilbody and W. H. Perkin, junr. The acid $C_{15}H_{16}O_6$ previously obtained from brasalin yields metahemipinic acid on oxidation; the latter acid is also formed during the oxidation of tetramethylhæmatoxylin. It is shown that brasilin is a derivative of resorcinol and catechol, whilst hæmatoxylin is a derivative of pyrogallol and catechol.—The action of alcoholic potash on monobromoglutaric ester, by N. E. Bowtell and W. H. Perkin, junr. Monobromoglutaric ester is converted by alcoholic potash into transtrimethylenedicarboxylic acid.—Luteolin, III., by A. G. Perkin.—The action of chloroform and potassium hydroxide on orthoamidobenzoic acid, by W. J. Elliott. Orthoamidobenzoic acid yields an aldehydoorthoamidobenzoic acid on treatment with chloroform and potash.—Azo- and hydrazone compounds differentiated by bromine, by H. E. Armstrong.

Linnean Society, Dec. 21, 1899.—Dr. A. Günther, F.R.S., President, in the chair.—Mr. W. G. Freeman exhibited a tree of *Hevea brasiliensis* (Parà Rubber), showing the method of tapping adopted in Ceylon.—Dr. R. Braithwaite exhibited specimens of *Hypnum Hochstetteri*, Schimp., collected by him on the Isle of Barra, Outer Hebrides, the only known locality for it in Europe, though found in the Azores and Canary Islands.—The Zoological Secretary communicated a paper, by Prof. T. W. Bridge, on the air-bladder and its connections with the auditory organs in the *Notopteridae*. The anatomy of the air-bladder, auditory organ, and associated parts was described in detail in *Notopterus borneensis*, it being shown that their condition was essentially the same for that species and *N. Pallasii*, and that Cuvier and Valenciennes had erred in regard to the latter by confusing the auditory cæca-containing and cranial cavities. Comparison was instituted with other Teleosteans in which the air-bladder enters into relationship with the occipital region of the skull, and the physiological significance of the facts was discussed.—Mr. F. Chapman read a paper on some new and interesting Foraminifera from the Funafuti Atoll, Ellice Islands. The specimens described, and illustrated by means of lantern-slides, comprised the larger forms found at Funafuti and on coral-reefs generally, together with a new genus (*Haplocatenia*) and eight new species.

DIARY OF SOCIETIES.

THURSDAY, JANUARY 11.

MATHEMATICAL SOCIETY, at 8.—A Problem in Pesonance, illustrative of the Mechanical Theory of Selective Absorption of Light: Prof. Lamb, F.R.S.—Elementary Distributions of Plane Stress: J. H. Michell.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Report of the Institution's Visit to Switzerland. The Report will be taken as read, and the discussion will be opened by Mr. Crompton by a Comparison between British and Continental Practice in Electrical Engineering.

FRIDAY, JANUARY 12.

ROYAL ASTRONOMICAL SOCIETY, at 8.—Note on the Variable Star η Argûs: Colonel E. E. Markwick.—Observations of Meteors, November, 1899: Royal Alfred Observatory, Mauritius.—Tables for Facilitating the Calculation of the Radius Vector and True Anomaly for Orbits of any Eccentricities: W. S. Aldis.—Note on the Physical Constitution of the Lunar Surface: George Forbes.—The Determination of Selenographic Positions and the Measurement of Lunar Photographs: S. A. Saunder.——*Probable Paper*: On the Unpublished Observations made with the Transit Instrument and Quadrants at the Radcliffe Observatory, Oxford, between the Years 1774 and 1838: Prof. A. A. Rambaut.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Theory of Structures and Strength of Materials: Prof. T. Claxton Fidler.

MALACOLOGICAL SOCIETY, at 8.—On some Recent Gastropods referred to the Family Turritellidæ and their Supposed Relationship to the Murchisoniidæ: Miss Jane Donald.—On the Anatomy of *Turritella communis*: W. Randles.—Note on *Strombus belutschiensis*, Melvill: E. A. Smith.—Descriptions of New Land Shells from Costa Rica, South and Central America: S. I. DaCosta.—On some Forms of *Cypraea*: Mrs. A. F. Kenyon.

MONDAY, JANUARY 15.

VICTORIA INSTITUTE, at 4.30.—Notes on Oriental Congress, Rome, 1899 Theophilus G. Pinches.

TUESDAY, JANUARY 16.

ROYAL INSTITUTION, at 3.—Structure and Classification of Fishes: Prof E. Ray Lankester, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Papers to be further discussed:* The Purification of Water after its Use in Manufactories: Reginald A. Tatton.—Experiments on the Purification of Waste Water from Factories: W. O. E. Meade-King.——*And, time permitting, Paper to be read:* Swing-Bridges over the River Weaver at Northwich: J. A. Saner.

ROYAL STATISTICAL SOCIETY, at 5.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—Screen Gears for Half Tone: W. Gamble.

WEDNESDAY, JANUARY 17.

SOCIETY OF ARTS, at 8.—Ventilation without Draughts: Arthur Rigg.

ROYAL METEOROLOGICAL SOCIETY, at 7.45.—Annual General Meeting.—Address on "A New Discussion of the Greenwich Meteorological Observations, 1848–1898": F. Campbell Bayard.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Annual Address by the President.

ENTOMOLOGICAL SOCIETY, at 8.—Annual Meeting.—Address by the President, Mr. George Henry Verrall.

THURSDAY, JANUARY 18.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* Upon the Development of the Enamel in certain Osseous Fish: C. S. Tomes, F.R.S.—Further Observations on "Nitragin" and on the Nature and Functions of the Nodules of Leguminous Plants: Miss Maria Dawson.—On the Innervation of Antagonistic Muscles, Sixth Note: Prof. Sherrington, F.R.S.—On the Behaviour of the Becquerel and Röntgen Rays in a Magnetic Field: Hon. R. J. Strutt.—On an Experimental Investigation of the Thermo-dynamical Properties of Superheated Steam by Prof. Osborne Reynolds' Method: J. H. Grindley.

ROYAL INSTITUTION, at 3.—The Senses of Primitive Man: Dr. W. H. R. Rivers.

SOCIETY OF ARTS (Indian Section), at 4.30.—Our Work in India in the Nineteenth Century: Sir William Lee-Warner, K.C.S.I.

LINNEAN SOCIETY, at 8.—On the Existence of Nasal Secretory Sacs and of a Nasopharyngeal Communication in the Teleostei: H. M. Kyle.—On the Origin of the Basidiomycetes: George Massee.

CHEMICAL SOCIETY, at 8.—Nitrogen Halogen Compounds: Julius Steiglitz and E. E. Slosson.—Chlorine Derivatives of Pyridine. Part V. Synthesis of αα'-Dichlorpyridine and Constitution of Citrazinic Acid: W. J. Sell and F. W. Dootson.—Action of Fuming Nitric Acid on α-Dibromocamphor: Dr. A. Lapworth and E. M. Chapman.—Electrolysis of Nitrogen Hydrides and of Hydroxylamine: Dr. E. C. Szarvasy.

FRIDAY, JANUARY 19.

ROYAL INSTITUTION, at 9.—Flight: Lord Rayleigh.

EPIDEMIOLOGICAL SOCIETY, at 8.30.

CONTENTS.

THURSDAY, JANUARY 18, 1900.

THE PRINCIPLES OF MECHANICS.

Newton's Laws of Motion. By Prof. P. G. Tait. Pp. viii+52. (London: A. and C. Black, 1899.)

HOW is the science of mechanics to be taught to medical students who have to "get up" natural philosophy in three months? If a teacher, confronted with such a problem, took refuge in sheer "cram," his action could cause no astonishment; an attempt, such as Prof. Tait has made, to provide a solution in which cram has no place commands admiration, even if it cannot be pronounced successful. The author's method is to furnish the student with a set of perfectly recorded lecture notes, and thus leave him free to follow the lectures instead of taking notes of them. Perhaps no better method can be devised, if the substance of the lectures is as good as the record in the notes is perfect, and if the student is made to apply the ideas explained in the lectures to simple examples. The latter of these conditions is doubtless fulfilled in Prof. Tait's classes; we are concerned here with what can be made out in regard to the former. After all the books that have been written on the subject, there was still room for a pointed statement of the principles of mechanics, with sufficient detail and sufficient illustration, but short; and such a summary, if only it were precise and lucid, could not fail to be useful to a class much wider than that immediately in view; but its value would be diminished in proportion as it was marked by vague statement, inexact definition and loose argument.

The work before us begins with three pages of introductory remarks, and these are followed by a chapter on kinematics and a chapter on dynamics. In the introductory pages we find a statement of the laws of the conservation of matter and of energy, and a reference to the laws of the inertia of matter and of the transformation of energy. As a specimen of the dogmatic tone adopted we may quote the following:—

"The objective realities of the physical world are of two kinds only—matter and energy. Our conviction of their objectivity is based on the experimental fact that we cannot alter the quantity of either."

No exception could be taken to this statement if the evidence for it were going to be adduced; and indeed the kind of summary that is likely to be most useful is just one that would trace the operation of the laws of conservation and transformation of energy, and of the law of the inertia of matter, in the processes of every-day experience and in easily observed phenomena. In picking out *mass* and *energy* as the two fundamental conceptions the author is certainly right, but much depends on the way in which they are discussed.

The same wisdom in the selection of the topics to be treated is apparent in the chapter on kinematics, and the arrangement also of these topics is excellent; it is to some of the details that exception must be taken. There is a general discussion of *vectors*, but the definition which is given of a vector is incomplete, and the necessary distinction between a vector associated with a particular line and one for which all parallel lines are equivalent is not explained. In the definition which is given of the *moment of a vector*, the fact that the rule of signs is a part of the definition is lost sight of, and the reason why the moment itself should be regarded as a vector is obscure. The proof, on p. 20, that angular velocity is a vector involves a *petitio principii*. In this, as in the proof of the parallelogram of velocities, what is most required is an explanation of the sense in which a point can be said to have two simultaneous velocities, or a body two simultaneous angular velocities. The definition of *velocity* is always one of the stumbling-blocks in the way of students; the author avoids giving a definition; he says, "Speed need scarcely be defined, as every one knows what it means." It may be that the writers of current text-books know what it means; they seem quite unable to explain it; nearly all of them proceed in a vicious circle, saying that the velocity of a point when variable is measured at any instant by the space that would be passed over in a unit of time if the velocity continued the same as it is at the instant—as well might one define the curvature of a curve at a point as the angle that would be contained between the tangents at the ends of an arc of unit length if the curvature continued the same all along the arc as it is at the point. If the student is not meek he will ask, "But what is it at the point?" It is only because he thinks he "knows what it means" that he does not ask the like question about speed. Prof. Tait gives countenance to the widely-spread vicious definition without reproducing it. Surely he might have spared some space to explain the mathematical notion of a limit, and to define velocity as a limit. Why do writers of elementary books treat the student as a baby when any limit is in view, and talk to him, for example, about "the next point" to a point on a curve? (p. 9). He knows as well as his teacher that there is no next point. The commonly received absurdities about what are really limiting processes secure acquiescence by frequent repetition, but they foster in the mind of the student a belief in the unreality of the whole business.

The chapter on dynamics suffers from defects which are not merely faults of detail, but arise from the position taken up, viz., that Newton's laws of motion still form the simplest foundation of the subject. Some remarks in Prof. Tait's address to Section A of the British Association in 1871, dealing with the use of Euclid's "Elements" by British mathematicians in the teaching of elementary geometry, apply, with at least equal force, to the use of Newton's laws of motion in the teaching of elementary dynamics. He said of the teachers:

"They seem voluntarily to weight alike themselves and their pupils for the race; and a cynic might, perhaps without much injustice, say they do so that they may have mere self-imposed and avoidable difficulties to face instead of the new, real, and dreaded ones."

The defect of the laws of motion as a statement of the principles of dynamics is not that the principles are not implicitly contained in the laws, but that the principles have to be extracted from the laws, and that the laws themselves are stated in terms of insufficiently defined abstractions. How much of the contents of the laws of motion is of the nature of definition, and how much is a statement of facts ascertained experimentally, is not disclosed. To assert that these laws still form the simplest foundation for the subject is to ignore the progress that has been made since the publication of Thomson and Tait's "Natural Philosophy." The difficulties into which writers who follow Newton uncritically must needs fall can be illustrated by sentences on pp. 27 and 28. On p. 27 we read, "Force is defined as any cause which alters the momentum of a body"; and on p. 28 we are told that force is "merely another name" for "the vector-acceleration of momentum." This makes the same word do duty for the cause of the change and the rate of the change. Others of the definitions given are wanting in precision. The definition of the *mass* of a body as the quantity of matter in it is a definition of one previously undefined thing in terms of another. The description of the first law of motion as a "statement of the inertia of matter" is not helpful; inertia is a property of matter under ordinary conditions, and the first law is a statement about matter under conditions in which it has never been observed. It ought to be realised that the three laws form a connected system, and that all of them are as much needed as any one of them for the precise definition of *force*, or the exact statement of the inertia of matter. The definition given of *work done* is obscure; the work of a force is defined as a product, and no indication is given of the sense in which this product can be said to be "done." What is wanted here is much the same as in the case of force: we all have an anthropomorphic idea that some cause must operate to start or stop the motion of a body; we have a similar idea that a man has done something when he has lifted a weight or thrown a cricket ball, and these ideas should be taken hold of and made precise by the introduction of measurable quantities which are adequate to represent them.

The difficult ground of definition and statement of principles once covered, the rest of the book is for the most part excellent, the geometrical methods employed being especially elegant. Room is found for an elementary discussion of strain, of compounded simple harmonic motions, of attractions, including the distribution of electricity on a sphere under influence, and of the velocity of waves along a stretched cord, in addition to interesting and unhackneyed accounts of the matters which are the stock-in-trade of books on the elements of mechanics. The book on the whole is thoughtful, in many parts it is much better than the current text-books, and the parts that call for criticism are no worse than the corresponding parts of most other books on the subject; but they are the most important parts, and they might have been so much better. There was a great opportunity, and it has been missed. A. E. H. L.

THE SCIENCE OF LAND FORM.

Physical Geography. By Prof. W. M. Davis, assisted by W. H. Snyder. Pp. xvii + 428 + 9 plates. (Boston and London: Ginn and Co., 1899.)

AN examination of this volume gives rise to feelings of both congratulation and regret—congratulation that so admirable a manual for the elementary student of physical geography has been produced, and regret that so little attention is given to the subject in our schools and colleges. Rational methods of instruction are now advocated for all the concrete sciences, and are being extensively applied to physics and chemistry; but geography has only been very slightly benefited by the pedagogic reforms of the last decade, and in the majority of our secondary schools it is still represented by definitions, outline maps, uninteresting statistics, and lists of names which make no real impression upon the minds of the pupils. Physical geography, the elements of which should be presented at the very beginning of the study of the earth, is usually neglected altogether, or taught in a fashion that fails entirely to place pupils in the receptive intellectual attitude reached after sound instruction in any science.

The present position results chiefly from the want of teachers with a broad conception of the field of geographical science. Every teacher is supposed to be qualified to give instruction in geography; and if the word merely signified the description of the political divisions of the earth, any one could put pupils in the way of acquiring that information. But, rightly defined, geography should be the consideration of the earth as the abode of man, and it should comprise the elements of astronomy, physics, meteorology, botany, zoology, and ethnology, as well as knowledge of commerce and government. To present the subject in these broad aspects, the teacher must be inspired by the scientific spirit and have given personal attention to the facts and phenomena of nature; and where such teachers are not available instruction in geography cannot proceed on scientific lines.

The volume under notice provides an admirable means of improving geographical teaching. Prof. Davis is not only an expert in most of the branches of physical geography; he is also a practical teacher who has devoted much attention to the educational side of the subject. The result is that, with the assistance of Mr. Snyder, he has produced what is certainly one of the best manuals of physical geography ever published. The book is well planned, trustworthy, clearly written, and liberally illustrated; it presents the facts of physical geography in such a way that the reader sees them as part of an organic whole—as organised knowledge which constitutes science. The facts are traced backward to their causes and forward to their consequences; indeed the phrase "causes and consequences" has served as a touchstone by which the treatment of each subject has been tested.

The order of treatment is the earth as a globe, the atmosphere, the oceans, and the lands. These facts are not, however, treated in equal detail; indeed, the last part occupies more than four times the number of pages devoted to the three preceding parts taken together. From this it will be seen that the book is not concerned with physiography as it is usually understood in this country, but with the science of land form In physiography the student receives practical instruction in physics, chemistry, astronomy and cognate sciences before he considers atmospheric phenomena the circulation of water on the land, the earth's solid crust, and the changes which take place in it: in physical geography, however, the facts of physical science are made subservient to the descriptions of land forms and other matters directly connected with the study of the earth. In the present volume, for instance, "the non-geographical elements of astronomy, the principles of physics, and the divisions of geological time, are carefully excluded." The authors are, of course, entirely justified in limiting the sections dealing with these subjects to any dimensions they please; and many teachers of physical geography will agree that the method of treatment adopted distinctly defines the scope of physical geography. At the same time, the opinion of the writer is that it is impossible for a student to clearly perceive many of the facts of physical geography unless he has a practical acquaintance with physical science. A student with a knowledge of Boyle's law can fully understand why half the earth's atmosphere is left behind in ascending to a height of three and a half miles above sea-level; but a student of physical geography may be told that this is the case, and have no real conception of the cause. Almost every fact concerning the constitution and movements of the atmosphere can be far more easily comprehended by students who have received experimental instruction in the principles of physics than by those who read them for the first time in connection with natural phenomena. Similar introductory knowledge is also required to intelligently follow the action of internal forces such as give rise to volcanic eruptions, the system of oceanic movements, the solvent and disintegrating actions of water, causes which affect climate, and many other natural operations and conditions. A practical knowledge of the principles of the science of matter and energy is indeed essential to the scientific study of the earth; and without such knowledge students of physical geography can have only a limited comprehension of the causes of natural processes.

As bearing upon this point, mention may appropriately be made of a new syllabus of physical geography which has just been prepared for the Cambridge Local Examinations. The syllabus includes a course of practical instruction drawn up with the distinct object of cultivating the pupils' faculties of observation and reasoning; it therefore represents a praiseworthy attempt to make lessons in physical geography of real educational value. So far as the descriptive part is concerned, the volume under notice is exactly the kind of book to use in classes which follow the Cambridge course, and the appendices will be found of service in showing the observations which may be usefully made out of doors. But the sections on the atmosphere and on astronomical geography are too brief to be clearly comprehended by students unfamiliar with the rudiments of physics and astronomy. In the Cambridge syllabus experimental work in each of these divisions of physical geography is rightly given prominence; and we consider that a larger amount of space might have been devoted to them with advantage in the present volume. As these sections now stand they will convey information, but will not do much to encourage individual observation. Moreover, most teachers will find it necessary to postpone the descriptions of atmospheric circulation to a later stage than is suggested by the place in which it is here dealt with; for though the volume contains a most admirable account of wind systems, every teacher knows that charts of winds and isotherms are not easily visualised by the student who has not learned to read such diagrams.

Apart from the question of the relative importance which should be attached to the different divisions of physical geography, it would be difficult to suggest how the volume could be improved. No better description of the lithosphere, and the changes which take place in it, could be desired by the student of physical geography than is given by the authors. The examples of characteristic land forms are naturally more often American than European or British; but as emphasis is always laid upon the association of land forms with settlements and industries, a useful lesson is conveyed even if the selected district is strange to the reader. Several words, such as *monadnock*, *cuesta*, *drumlin*, *peneplain*, *esker*, and *mesa*, not usually found in books of physical geography used in this country, are employed to describe particular formations, though no explanation appears to be given of more common terms in physical geography, such as *hydrosphere*, *lithosphere*, *erratic*, *volcanic dyke*, *geoid*, *Roches moutonnées*, *scoriae*, *tundra*, *selvas*, *pampas*, and *regelation*—or if they are mentioned they are not indexed. Little importance need be attached to this, for physical geography should be more than a collection of definitions; but as the student will in all probability meet with the words later, he should know their significance. This is, however, but a minor point, for a good dictionary will furnish the meanings of these words, but it is only occasionally that a volume of such an inspiring character as the one here noticed is produced, and where so many good qualities are exhibited, a judicious critic hesitates to suggest any alterations. R. A. G.

THE REMINISCENCES OF A. D. BARTLETT.

Bartlett's Life among Wild Beasts in the "Zoo." By the late A. D. Bartlett. Edited by E. Bartlett. Pp. xviii + 375. (London: Chapman and Hall, Ltd., 1900.)

THE issue of the present volume may be taken as an indication that its predecessor, "Wild Animals in Captivity," was a success and has met with the appreciation of the public. Obviously, therefore, it is not the part of a critic to decry what has practically been already approved, the work before us being a continuation of the first series of Reminiscences. Undoubtedly there is a very large amount of extremely entertaining matter in this second venture. Especially is this the case with regard to the author's experiences of Gorillas and Chimpanzees, his important practical experiments and observations with regard to hybrids, his account of the verification of the hunters' stories as to the annual shedding of its horns by the American Prongbuck, and his description of the habits of the Indian Panda, or Cat-bear. The latter observations afford, indeed, an excellent example of the acuteness of Bartlett's judgment as to the affinity of an animal by the study of its habits alone. The systematic position of the Panda was at the time in question much disputed. Mr. Bartlett insisted on its near relationship to the Racoons, especially the Kinkajou: and his opinions were more than borne out by the contemporary investigations of Sir W. H. Flower into its internal anatomy. The public, too, will be much interested to learn that Bartlett was a firm believer in the existence of a "sea-serpent," although whether they will be inclined to share his opinion that there are reptiles that can live for months at a time at the bottom of the ocean without coming up to breathe may be questioned.

But much as these and many other portions of the book may interest and attract the general reader (not to mention the scientific naturalist), there are other parts for which such commendation can scarcely be claimed. We have, for instance, several descriptions of species, such as that of the white-whiskered Lemur (*L. leucomystax*) on p. 22, and Monteiro's Galago (*G. monteiri*) on p. 24, which can be of no possible interest to any one but a specialist, especially in the absence of figures. But this is not all, as the aforesaid Lemur is now regarded by qualified naturalists merely as the female of (*L. macaco*), and its retention as a species is consequently a mere misleading of the public.

If this were the sole instance of a want of efficient editorship it might, indeed, well have been passed over in silence, but unfortunately it is only one among many. For instance, on the very first page of the volume we have a repetition of the old story that the Apes seen by Hanno, the Carthaginian, were Gorillas (in the modern sense of that term), whereas it has been shown over and over again that such could not have been the case; Mr. Winwood Reade believing the creatures to have been Baboons, while Sir Harry Johnstone thinks they were more probably Chimpanzees. Neither is it a true statement that the skull of the Gorilla obtained by Dr. Savage at the Gaboon was ever sent to Owen, who only received sketches of the same; the specimen itself having apparently gone to America. It is quite true that these statements were made by the author of the papers which constitute this volume, but it was for the editor to have made the necessary amendments.

Then, again, we have to deplore a lack of efficient editorship in the manner in which the different sections of the book are introduced, or rather not introduced. For example, who would guess that the dissertation on hybrid bovine animals, commencing on p. 71, is reproduced, with the exception of the opening sentence, word for word from the *Proceedings* of the Zoological Society for 1884? And if the quotation is not acknowledged as such by the usual marks in this place, why are such marks introduced in another equally long quotation from the same serial on p. 6? Neither is there any indication to show that the portrait of the Chimpanzee "Sally" on p. 7, as well as the picture of hybrid Cattle on p. 70, are copied from plates in the Zoological Society's *Proceedings*. And very indifferent copies at that, the reader will probably add! Indeed, the illustrations generally are far from being a strong point of the book, while, like the regiments in the British army, there are too few of them.

Neither can we avoid saying that the nomenclature is hopelessly out of date; this being sufficiently apparent when we mention that *Troglodytes* is given as the generic name of the Chimpanzee and Gorilla, *Ceriornis* for the Tragopan, and *Felis* for the Hunting Leopard or Chita! If popular writers will not keep somewhat in touch with the systematic work of the day, it is their fault if they are treated with contempt by professional naturalists.

In spite of the errors and imperfections to which we have called attention, we, as already said, fully recognise the large amount of interesting matter in the volume before us; and if our readers desire a really amusing story, we may refer them to the adventure of Mr. and Mrs. Jamrach with the Lions. At the same time, we think that the editor would have been much better advised had he reduced the present volume and its companion to the limits now occupied by one of them.

R. L.

ELECTRICAL OSCILLATIONS.

Recherches Expérimentales sur les Oscillations Électriques. Par A. Turpain. Pp. 154. (Paris: Librairie Scientifique, A. Hermann, 1899.)

THE classical researches of Hertz on electromagnetic waves have opened up a new field of experimental research, which has already yielded a rich harvest of results. As regards the literature of the subject, we have, besides Hertz's original papers, two or three other works dealing with the theory and phenomena of electromagnetic waves. Dr. Lodge's little book contains a general and easily intelligible sketch of the whole subject. In Prof. J. J. Thomson's "Recent Researches" we have an elaborate exposition of theory, along with an account of the experimental development of the subject down to the date of publication. Poincaré's "Oscillations Électriques" is probably the best-known Continental work on electromagnetic waves.

The work before us is one which does not trench on the ground already covered by the above-named treatises. It is a record of original researches, some of which have already appeared in various scientific periodicals. The scope of these researches is limited to the propagation of waves along conductors.

After a brief introduction, the author gives us in Chapter i. a full and clearly illustrated description of the experimental arrangements used by him, including the various forms of oscillators, resonators and their micrometers, and methods of concentrating the electromagnetic field between wires or plates.

Chapter ii. deals with the methods of measurement. Besides the classical method of determining the sparking distance by means of a micrometer observed either with the naked eye or by the aid of a lens, the author used a resonator with an additional air-gap which was bridged by a battery and telephone receiver. Every time sparks passed across the micrometer-gap, the circuit of the battery and telephone was completed. This method of investigation—which, however, requires very careful adjustment—the author found less fatiguing than that in which the eye is unduly strained in trying to detect the presence of minute sparks.

Chapter iii. describes the methods adopted for adjusting the length of the wires so as to get a sharp division into nodal and ventral segments. This is followed by an account of the various positions in which the resonator was placed; of the results obtained with an ordinary Hertzian field between two wires, and round a single wire. The author next considers the *interference* field, which is obtained between two wires whose ends are connected to plates placed on opposite sides of the *same* plate of an oscillator. The effects on an ordinary 2-wire field of bending one of the wires so as to lengthen it by $\frac{1}{4}$, $\frac{1}{2}$ and a whole wave-length are next investigated. The author shows that all the effects obtained may be deduced from the results obtained with a single-wire field. An account of some experiments with 3, 4 and 6 wires concludes this chapter.

Chapter iv. deals with the action of the resonator. The effects of varying the position and direction of the micrometer-gap, the disturbance due to the presence of the resonator in the field, and the effect of varying the length of the resonator are studied in detail. The form of resonator with a gap bridged over by a cell and telephone receives careful attention, the effect of altering the position of the gap relatively to the micrometer spark-gap being fully investigated.

Chapter v. is concerned with the important problem of the propagation of waves in dielectrics other than air. Oil and water were the two dielectrics studied by the author, and the effects obtained clear up some rather obscure and apparently contradictory results obtained by other experimenters in this field.

Chapter vi. contains a useful *résumé* of the more important results obtained by the author.

In Chapter vii. the author describes a system of multiplex Hertzian wave telegraphy (*not* wireless), regarding whose practical value we may well be pardoned for feeling somewhat sceptical.

The book forms a valuable storehouse of facts, and the author is to be congratulated on the extremely lucid and well-arranged account of his important researches. They were all carried out on a large scale (in the experiments on oil and water, 230 to 260 litres of the liquid were used), and must have required an unusual amount of skill, care and patience.

A striking feature of the work is the entire absence of mathematical reasoning, not a single symbol of differentiation or integration occurring throughout the whole of the book. The author has carefully avoided all theoretical discussions, and confined himself to an accurate description of experimental facts. The clearness and elegance of the language in which this description is given render it a pleasure to read the book, which will prove a source of delight to every true experimentalist.

OUR BOOK SHELF.

Indicators and Test Papers. By Alfred I. Cohn, Ph.G. Pp. ix + 249. (New York: John Wiley and Sons. London: Chapman and Hall, Ltd., 1899.)

THIS book contains an account of the source, preparation, application and tests for some scores of indicators and test papers which have been proposed for use chiefly in determining the end-point in volumetric chemical analyses. The book opens with a general discussion of the action, use, and theory of indicators, and ends with four useful tables and a good index. The first table is Trommsdorff's showing the sensitiveness of indicators to acids and alkalis, the second is R. T. Thomson's (hitherto the chief English guide), the third is Dieterich's table showing the sensitiveness of various test-papers, and the fourth is a tabular summary of the principal indicators by the author.

The compilation of this book must have demanded much patient labour, and acknowledgments are due to the author for the care and pains he has bestowed upon the work. It will prove a useful addition to analytical literature. Whilst saying this, some points of criticism cannot be withheld. In the first place it must be said that the author has not dealt in a very clear way with the theory of indicators. The subject is not an easy one, and the average operator has not hitherto troubled himself much about it. Litmus has been to him a substance provided by Nature for the discrimination between acids and alkalis rather than the means of furnishing blue alkaline salts from which a weakly acidic substance of red tint is "displaced" by the action of nearly all other acids. Again, the reasons why methyl orange is good for the titration of bases and not of acids is not usually inquired into. Such considerations make it the more desirable that the principles underlying the use of indicators should be stated very clearly. Mr. Cohn has given explanations, including the application of the ionic theory, and of the speculative mechanical theory (somewhat antiquated and unfruitful) of F. Mohr, but he has not set forth the matter with the desirable clearness and coherence.

Next with regard to the substance of the book, it is worth considering whether, in any future edition, type of two sizes might not be employed. Many of the indicators described are of extremely doubtful value, and the worker really wants to know definitely which indicators have been found meritorious by other people than those who have suggested their use. In this connection also a protest must be raised against naming indicators after their inventors. It is useful to know the composition and nine synonyms of Tropæolin OO, but there is surely no call to add to these the term "Von Müller's Indicator."

The book would have been improved by references to original papers. For example, the reflecting galvanometer is scheduled as an indicator, but there is neither a full description of its use nor a reference to Küster's paper on the subject. References would have been valuable throughout the book. A. S.

Optical Activity and Chemical Composition. By Dr. H. Landolt; translated by Dr. J. McCrae. Pp. xi + 158. (London: Whittaker and Co., 1899.)

THIS small book is a remarkably clear exposition of what is a somewhat recondite and difficult branch of chemical physics. It is well known to students of optical science that there are liquids and solid substances in solution which have the strange power of rotating the plane of vibration of a polarised ray of light that is passing through them. Familiar examples are turpentine and other essential oils, sugars, tartaric acid, quinine and albumen. But Dr. Landolt says that more than seven hundred substances, all carbon compounds, are known to exhibit this molecular rotation.

Of course the fruitful discoveries of Pasteur—the right and left-handed tartaric acids, racemic acid, molecular asymmetry, &c., are briefly described; and the more recent simultaneous discoveries of van 't Hoff and Le Bel receive fuller attention. It is shown how this property is met with only where one at least of the carbon atoms of an organic compound is united with four different atoms or radicles; and the results flowing from this kind of structure are explained and illustrated—results which form what is now called stereochemistry.

But the principal object of Prof. Landolt's book, as expressed in its title, is the connection that may be found o exist between the chemical constitution of a substance and the degree of its rotation. The fact that such relations do exist in the case of other optical properties, such as molecular refraction, dispersion, and magnetic rotation, no doubt gave rise to the expectation that some similar connection would be found in regard to this rotatory power. In the above cases the optical differences depend mainly on the nature and number of the elements composing the substance, though modified to a certain extent by the manner of combination. But here it seems to depend almost entirely on the mode of grouping. Such able experimenters as Guye, Chavanne, Walden, Tchúgaeff, Nasini, van 't Hoff, and in our own country Frankland and Crum Brown, have investigated the question. The problem has not yet been solved; but a number of suggestive results have been obtained which will no doubt lead to further research, and the clearing up of the relationships between composition and amount of rotation which unquestionably do exist.

J. H. G.

Science and Faith; or Man as an Animal and Man as a Member of Society: with a Discussion of Animal Societies. By Dr. Paul Topinard. Translated from the Author's Manuscript by Thomas J. McCormack. (London: Kegan Paul, Trench, Trübner and Co., Ltd., 1899.)

THE editors of the *Monist*, some four years ago, invited discussion on the main problems of the philosophy of science and the reconciliation of science and faith. This book is Dr. Topinard's answer—the longest and fullest received—to their question. Man is regarded from the standpoint of anthropology; at the outset a creature merely selfish, but ultimately actuated by the sense of duty to the community. Thus he is a battlefield of opposing influences, egoism and altruism. Can we then explain the development of the latter on scientific principles, or must we have recourse to some external influence or impulse; in other words, assign a part to faith. In a series of chapters the author sketches man's development, as a member not only of the animal kingdom, but also of societies, seeking to trace in the lower forms of life the rudiments both of structures and of ideas. Finally, he arrives at the conclusion that Science and Faith mutually exclude each other. This perhaps would be generally admitted, even by those who would maintain that neither science nor faith alone could give a complete explanation; for each investigates different aspects of the problem and by a different method. Thus far the two are exclusive; nevertheless both may be necessary in order to obtain complete knowledge. For on many minds a problem presses to which Dr. Topinard offers no reply, namely, "Why" is all this? What is the cause of all these phenomena? Of what kind of power are they an expression? To answer this, he might reply, is not the province of science. That may be true, but the question remains, and not a few hold that to ignore it is an arbitrary narrowing of the field of investigation. In other words, whether Dr. Topinard's book will or will not satisfy inquirers is very much a question of temperament. Grant certain postulates—for such they are, and not axioms—in regard to the field of investigation, and it will; repudiate them, and it will not. He maintains "that the two domains of science and faith are two contrary poles"; others will say that each is necessary if a globe is to be complete, and that a very large zone exists between the circumpolar regions in which each of these apparent opposites plays a part, now the one, now the other dominating. But the book is worth reading, whether we are or are not satisfied with its conclusions, whether we regard it as a real or only a forensic success.

Who's Who. 1900. An Annual Biographical Dictionary. Pp. xviii + 1002.

The Englishwoman's Year-Book and Directory. 1900. Edited by Emily James. Pp. xxi + 340. (London: Adam and Charles Black, 1900.)

"WHO'S WHO" is now in its fifty-second year of issue and as a handy work of reference containing biographical particulars and addresses of persons of greater or less prominence in science, art, and literature it stands alone. Tested by several years of use, the publication has been proved to be a dictionary of biography which can be referred to with confidence. Science is fairly well represented, every Fellow of the Royal Society from whom particulars could be obtained being included, and also other workers in the scientific world. A complete list of Fellows of the Royal Society is given among the useful miscellaneous information which precedes the biographical sketches. Curiosity induced us to see how many of these names also occur in the list of members of the Privy Council, and we found that although 25 of the 265 members of the Council have been admitted into the Royal Society, only two or three can with the most liberal interpretation be considered as engaged in scientific work.

"The Englishwoman's Year-Book" shows the numerous opportunities which now exist for women to exercise their activities, and testifies to the abundant use made of them during last year. There are fourteen sections, each concerned with opportunities and progress in a particular branch of work, among them being education, medicine, and science. Under the latter head is given lists of scientific articles and papers contributed by women to magazines and learned societies during last year, and also of women science lecturers and demonstrators. The volume should be of service in promoting the best interests of women by exhibiting their intellectual accomplishments.

Le Phenomène de Zeeman. Par A. Cotton. Pp. 100. (Paris: Georges Carré and C. Naud, 1899.)

THIS is the fifth number of the physical series of "Scientia," under which title is appearing a collection of handy volumes dealing with recent advances in science, and intended primarily to enable specialists in one department to keep themselves abreast of the times in regard to the work being done in other departments. A concise account of the Zeeman phenomenon will be valuable to many.

M. Cotton has limited his treatment to the experimental aspect of the phenomenon. He commences with a summary of recent progress in spectroscopy, and of the different causes which tend to modify the spectral rays. The history of Zeeman's discovery is then introduced, and in the next chapters M. Cotton discusses the changes in the rays emitted parallel and perpendicular to the lines of force, and the absorption effects dependent on the Zeeman phenomenon. In the last chapters M. Cotton describes the experiments of Righi, of Macaluso and Corbino, and of Voigt. The author is to be congratulated on the amount of information he has been able to convey in so small a compass.

Dictionnaire des Termes de Médecine, Français-Anglais. By H. de Méric. Pp. vi + 243. (London: Baillière, Tindall and Cox, 1899.)

THE English-French part of this dictionary has already been noticed (vol. lix. p. 484). We hardly see the necessity of giving, in a technical dictionary, the English equivalents of such common words as civilisation, classe, concave, doctrine, division, idée, intelligence, reptile, visage, nuit, and many others. This, however, will not make the volume any the less serviceable to physicians and students of medicine.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Contemporary Meteor-Showers of the Leonid and Bielid Meteor-Periods.

Part II.—Co-Bielid Showers.

AMONG nearly 120 meteor-tracks of the period November 20th–30th, partly seen here in recent years, and partly drawn from the Reports of the Luminous Meteor Committee of the British Association, of the years 1861–80, and among a list of 100 *Bielid*-period meteor-paths observed in Italy, as will be further illustrated and more especially described below, on November 19th–30th, 1897, there were found to have occurred, in this long-past years' collection, 30 *Bielid* meteors and 188 unconformable or ordinary *non-Bielid* meteor-tracks. Several of the former meteors were recorded before the startling discovery in 1872, of the swarm of meteors connected with Biela's comet, had made known the existence of a focus of cometary *Bielid* meteors in this period near γ *Andromedae*; so that several evidently *Bielid* meteors of the list had never before had their true radiant-point, near γ, τ *Andromedae* assigned to them. The great body of *Bielid*-tracks having been subtracted, and the remaining 188 ordinary meteor-paths projected on a planisphere containing all the fifty radiant-points for the *Leonid-Bielid* period, of Mr. Denning's Select List, the paths of all these meteors, without any outstanding very refractory or certainly irreducible exceptions, were found to be satisfactorily referable by trueness of direction joined to suitable descriptions, to one or other of the many radiant-points contained in Mr. Denning's List.

Relative numerical strengths could thus be assigned to many of the fifty contemporary showers, expressing the numbers of meteors traced truly and suitably back to all the best distinguished active sources, among about 30 more or less exactly corroborated radiant-centres. For simplicity the numbers of such meteors per hundred of all the 188 projected ordinary meteor-tracks are noted, to show their relative numerical intensities, against the seven most active of the thus detected ordinary showers which are presented, in descending order of meteor-density or shower-vigour, in the accompanying Table. The percentage strength of the *Bielid* shower itself, which is introduced for comparison with the less productive meteor-systems, is reckoned on the same scale of proportion, to the total number of *non-Bielid* meteors, with that of the slenderer displays, and it only insignificantly outshone the brightest of those contemporary meteor-streams, from no observations having happened to be made, in this collection, in any of the years when the *Bielid* meteor-showers was at a maximum.

The ε *Taurid* shower, at 63°, +21°, stood nearly as high as the *Bielid* stream itself, in marked abundance of its meteors. Together with an apparently distinct, but perhaps associated stream of η *Taurids* at about 56°, +18°,[1] this central shower of *Taurids* shows an almost cometary strength and stability of display, approaching in yearly constancy, although not at all in profusion of its meteors, to the showers of August *Perseids*. It produces, moreover, about the middle of November, a notable number of large meteors, and even, as has been proved in one case at least, also detonating fireballs. Its marked superiority over all the showers contemporary with it, only excepting that of the *Bielids*, is easily seen by the slow gradation and comparative smallness of the meteor-frequencies noted in the Table for the next most steady and productive showers. But all these latter streams also considerably outshone the great bulk of weaker streams marked by much fewer numbers of satisfactorily assorted tracks; and their six or seven especially productive *foci* would no doubt, among many showers of very variously interesting and eminent importance in the contemporary List, abundantly repay, in coming years, some further study. To assist discussions by projections of any such new observations, a few less productive radiant-points of Mr. Denning's *Leonid-Bielid* Period List, may even, perhaps, be here mentioned with advantage, although they each furnished no more than four independent meteor-tracks, or 2 per cent. of all the ordinary meteors' paths collected and compared together in the mapped collection.

Taking their numbers and positions as before from Mr. Denning's list of fifty contemporary showers of the *Leonid-Bielid* period, and adding in numbers and mean positions, D('99), of a few shower-series from his extensive General Catalogue of 1899, the following were the recognised centres of divergence of eleven weaker showers (or sometimes of small groups of showers) each contributing about one in every fifty of the whole projected number of ordinary meteor-paths.

TABLE IV.—*Relative abundances of meteors from different ordinary Meteor-showers in the* Bielid *Period, November 20th–30th, among* 188 *ordinary and* 30 Bielid *shooting-stars mapped in some* non-maximum Bielid *nights of the years* 1861–97; *and relative frequency of the* Bielid *meteors.*

Radiant-point's Number and positon in Denning's *Co-Leonid* List.	[25°+42°, γτ *Andromedae*.] *Bielids.*	13; 63°+21° εω *Tauri.*	11; 60°+28 ζ *Persei.*	18; 77°+32° ιχ *Aurigae.*	17; 74°+15° *y Orionis.*	7; 46°+21° εζ *Arietis.*	26; 110°+25° δικ *Geminorum.*	28; 124°+55° *k Lyncis.*
Numbers of the Shower's Meteors per 100 of all *Non-Bielid* Meteors.	16	12	5 Seen only in 1897.	4½	4½ Seen only in 1897.	3½	3½	2½ Not seen in 1897.
General Appearances of the Showers' Meteors.	Bright, orange yellow, slow; very bushy and spark-tailed; no streaks.	Bright, yellowish meteors; sometimes spark-tailed.	Small, yellowish meteors, with spark-tails.	Yellowish, white; slightly tailed or streaked.	Moderately swift and bright; no streaks.	White or yellow, tailed; rather bright and slow.	Bright, white, swift; with pretty persistent streaks.	Swift, tapered, brushy meteors, leaving streaks.

1	9° + 34°, π *Andromedae*	seen, almost entirely in 1897.
D('99)39	44 + 57, η *Persei*	
8	48 + 43, βκ *Persei*	
14	70 + 66, *c*, or α *Camelopardi*; scarcely seen in 1897.	
	And nearer the equator,	
D('99)273	253 + 4, ι *Piscium.*	
D('99)3 and 11	9 + 9 { γ *Pegasi* and ε *Piscium.*	
5	30 + 16, α *Arietis*	chiefly seen in 1897.
6	43 + 6, α *Ceti*	
D('99)49	53 + 8, *e* or ξο *Tauri* (three tracks only),	
32	136 + 8, ζ *Hydrae*; not seen in 1897.	

[1] A good display of meteors of this shower was seen this year by Mr. W. E. Besley, at Clapham Park, S.W., on November 8th. Seven bright meteors (and another of 1st magnitude on November 10th), were noted in the short space of 1h. 48m., ending at 12h. 46m. on that night, with a very well-defined radiant-point at 52°, +22°. Their apparent magnitudes in the fixed-star scale were, 4, 2, 1, 1, 3, 2, 1½, 1, and they were long-pathed, slow, trained meteors. Two of the brightest, at 11h. 26m. and 11h. 33m., on November 8th, showed pale green colour in the heads. The meteors of the showers near η *Tauri*, at 56°, +18°, it should be noticed, are chiefly observable in the first half of November, and reach a well-marked maximum of abundance on November 6th–10th; while the ε *Taurids*, at 63°, +21°, have an equally distinct date of maximum on about November 20th, and are usually seen in greatest numbers in the last half of November.

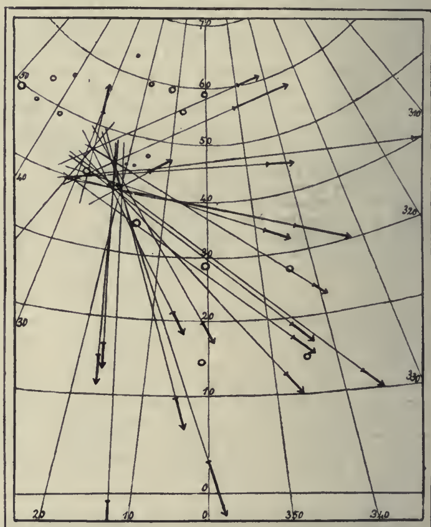
The *Bielid* meteors numbered only about $\frac{1}{6}$th, and the *Taurids* about $\frac{1}{8}$th, of the number of ordinary, or *non-Bielid* shooting-stars; and of the latter divers-centred meteors, the above seven greater and ten lesser ordinary showers supplied together about $\frac{5}{8}$ths of the whole meteor number. At the rate of frequency of shooting-stars on ordinary November nights, of about six or seven per hour, it is evident that on such nights, watches would ordinarily have to be continued for six or eight hours to obtain a sufficiently copious path-register of six or seven *Bielid* or *Taurid* shooting-stars, for determining their radiant-points' positions with exactness; and for the less productive showers of which the six stronger and nine weaker ones of the above lists furnished on an average only four and two per cent. of the sundry-centred meteors, watches to record the same numbers of their flights would in general have to be maintained for 25 or 50 hours on successive clear November nights. But as the *Bielid* shower betrays, no weight sufficient to deter observers from attentive watches for them should be attached to most of these showers' low average productivenesses, because they usually appear in sudden rushes of more or less abundant profusion, on no very fixed dates of apparition. Such a marked example of sudden change of strength, seen actually in a single night, appears to have presented itself this year in the *Taurid* meteor-stream, during the preliminary watches kept in the beginning of November for possible forerunners of a coming shower of *Leonids.* No later vestiges at all of the brief shower of seven bright η *Taurids* seen in his watch by Mr. Besley between 11 h. and 13h. on November 8th,[1] were noticeable here in my 2 hrs. watch after 13 h. 40 m. on that night. Only one meteor's path seen here, an exactly true ξ *Taurid*, but 4° distant in its direction from the point near η Tauri, among the eighteen meteors mapped in clear sky during those two hours, proceeded backwards from any focal region nearer than 10°–15° to η *Tauri*; and no signs of even diffuse radiation from a considerable space round the shower's radiant-point near η Tauri, were shown among the 46 meteor-paths recorded here in my earlier and later watches of 2½–3 hrs. each, on the nights of November 6th and 10th; so that this shower of remarkably bright meteors must certainly, it appears, have been a pretty conspicuous one of very brief duration.

Nor must it be expected that the same showers will be visible every year, in the same strengths, or in the same relative strengths to one another. Such changeful phases of appearance and non-appearance of showers in different years, were well exemplified in the present shooting-star survey, by a fact of great value and help to the collection, that nearly half of its meteor-tracks (100 paths) were observed in a single fortnight of November, 1897, under the clear sky of the Riviera Coast of Italy, by my nephew, Mr. J. A. Hardcastle, who also reduced his own observations and sorted them under their several radiant-points. It thus happens that the radiants marked in the above two lists, of main showers, and of less prominent *addenda*, as only, or chiefly seen in 1897, were not distinguished by more than one meteor, at most, among the earlier set of English observations (the y *Orionids*, ζ, η and κ *Perseids*, α *Arietids*, α *Cetids*, and π *Andromedes*); and that on the other hand the c *Camelopardids*, k *Lyncids* and ζ *Hydrids* were scarcely seen at all in November, 1897; while the remaining radiant-points, γ *Andromedae*, ϵ *Tauri*, δ *Geminorum*, ι *Aurigae*, ϵ *Arietis* and o *Tauri*; γ *Pegasi* and *Pisc.s*, presented themselves about equally in both the lists.

To correspond with the ϵ *Taurids*, so plentifully visible on these *Bielid* nights, only a branch shower, apparently, of this main *Taurid* stream, at 68°, + 17°, was noted here, this year, in the beginning of November; and only one (doubly observed) meteor then was recognised as belonging to the active *co-Bielid* meteor-centre near ι *Aurigae.* Similarly a well-focused flight of ten o *Taurids* among 64 ordinary meteors of the earlier watch, produced among about thrice as many ordinary *co-Bielid* meteors, only three meteors from the same radiant-point; and these few distinctions rather than likenesses between the two periods' showers, were the only examples which occurred of either identity or general resemblance in the two periods' stream-directions. But since they all, or nearly all, formed part of a well established contemporary shower list for the middle of November, frequently renewed, well sorted observations would no doubt disclose many distinct continuities of the same ordinary showers from one meteor-period in November to the other, just as the radiant-points extracted for the *Bielid* period from a long series of years were found to agree distinctly in a considerable number of cases, with those recorded in a single year.

Twenty-one *Bielid* shooting-stars were among the 100 meteors mapped at Alassio in November, 1897; and in a projection of his observations which was then made by Mr. Hardcastle on one of Prof. Lorenzoni's gnomonic polar nets, these are shown in the adjoining map, diverging from near τ, υ and γ *Andromedae.* Of the two maxima of frequency or of hourly rate of appearance, shown at the foot of the map, which they seem to have presented on November 23rd and 26th, the first agrees closely with the date of the shower's last bright return on November 24th, 1892; while the second seems to be a still-lingering remnant of the older date of the stream's returns, on November 27th, in 1872 and 1885, before the meteor-cluster's node was shifted backwards 4°, as Dr. Bredichin has proved, by

Paths of 21 *Bielid Meteors observed at Alassio, Italy, November* 19*th*–27*th*, 1897, *by J. A. Hardcastle.*



Dates, 1897, November	19	20	22	23	24	25	26	27
Duration of Watch, in clear sky	2h.	2h.	3h.	2½h.	3h.	¾h.	1½h.	2h.
Numbers of Bielids mapped ...	1	3	4	5	3	1	3	1
Numbers of Bielids per hour ...	0·5	1·5	1·3	2·0	1·0	1·3	2·0	0·5

strong attractions of the planet Jupiter on the meteor-swarm in the year 1890. No large action of Jupiter on the swarm, it has been shown by the late Dr. Abelmann,[1] would afterwards occur again until the year 1901, when another near approach of the cluster to the giant planet will shift the node backwards 6°, and make the date of the shower's next expected great return November 17th, 1894 or 1895. On the two occasions of the earth's passage through the node on November 23rd or 24th, in 1898 or 1899, Mr. Denning has conjectured that the earth would first pass in front of and then behind the cluster, thus escaping a very central passage, which might, in that case, however, be expected to occur, with the comet's periodic time of revolution of 6½ years, with near enough exactness for a great display, on November 17th, 1905. But as watches for the *Bielid* star-shower, at the present nodal passage will now no doubt have been kept attentively at many stations well favoured, if not very generally in the British Isles, by clear sky and fair weather for observing both the *Bielid* shooting-stars and other meteors, these recent meteor-notes may perhaps usefully suggest

[1] Referred to in the *Note* on p. 271, as apparently a very important observation of a meteor-shower, from the brightness and very perfect radiation of the meteors, and from the clearness and accuracy of their paths' descriptions.

[1] *Astronomische Nachrichten*, No. 3516, September; and *The Observatory*, October 1898.

some trial radiant-points for any remarkable shooting-stars or large meteors of the two past years' expected maximum *Bielid* periods which may have been recorded.

Observatory House, Slough, A. S. HERSCHEL.
December 16th, 1899.

Is New Zealand a Zoological Region?

WILL you allow me to make one remark on the letter of Mr. H. Farquhar (p. 246), advocating an affirmative answer to the above question. It is this: Throughout the whole argument there is an assumption which vitiates it, namely, that the amount of resemblance of the New Zealand fauna to that of *Australia* is what alone determines its resemblance to that of the *Australian Region*.

Apparently, Mr. Farquhar does not believe that New Caledonia and the New Hebrides belong to the Australian Region, otherwise he would not adduce the fact of the land-shells of New Zealand being related to those of the above-named islands as an argument in his favour; and if these are omitted, then must New Guinea be also omitted. And if Australia by itself is to become a "Zoological Region," New Guinea and its surrounding islands must be also a "Region," the Central Pacific Islands another, and the Sandwich Islands yet another! This indicates the difficulties that arise if the Australian Region, as originally defined by Dr. Sclater and myself—and which I still hold to be far more natural than any subdivision can make it—be rejected.

ALFRED R. WALLACE.

Molecular Structure of Organised Bodies.

PROF. VINES, in his "Physiology of Plants," says that the molecular structure of cells can only be inferred from their properties, and that a correct conception of this structure is essential for a proper comprehension of cell growth. In the same work the author also states that Naegeli argues: "Since the optical properties of these organised structures are apparently not dependent, like those of a crystal or a piece of glass, upon the relative position of their constituent particles, they must be inherent in the particles themselves. Each micellæ, then, possess the optical poperties of anisotropic crystals. Naegeli concluded, therefore, that the micellæ are crystals."

Naegeli's micellæ theory rests almost entirely on the failure of any effort to temporarily destroy the anisotropism of organised structure. Obviously, if it were possible to so act on or swell a vegetable fibre that its anisotropism were destroyed, and that this anisotropism returned after the treatment were discontinued, Naegeli's theory, as far as it relates to the optical properties of micellæ, would fall to the ground.

It is well known that organised structures cease to be doubly refractive at the moment when their organised structure is destroyed. This is usually explained by saying the micellæ are at the same time disintegrated.

As far as I am aware, it has never been shown that this property of double refraction, common to organised structures, can be destroyed by suitable swelling, and restored again when the body returns to its original condition. I have been able to do this, in the case of cotton fibre, and it seems to me to give the *coup de grace* to Naegeli's theory.

I take it that if in one instance the anisotropism of organised structure can be temporarily destroyed, it is a correct inference, that to do so in every case only requires a suitable medium; which will reduce the strains to a necessary degree without the destruction of the physical form of the organised structure.

In the course of some investigations on the destruction of nitro-cellulose fibres, by means of solvents, I observed that in one particular case the double refraction disappeared long before the physical structure, and that on getting rid of, or diluting the solvent, the anisotropism returned. It is because I think this observation will be of interest to biologists I am troubling you at length.

It is well known that on converting fibrous cellulose into nitro-cellulose, the fibres retain their optical properties as regards polarised light. Nitro-cellulose, however, has a very wide range of solvents, and the examination of organised fibres when treated with solvent, becomes very extended.

Most nitro-cellulose solvents, such as acetone, nitro-benzene, the ethers, &c., do not lessen the anisotropic properties. The fibres may be swollen to twice their diameter, but still polarise light, until their physical structure is quite gone. This is not so, however, if nitro-cellulose fibres are acted upon with a mixture of acetone, benzene and ethyl alcohol. With this solvent the nitro-cellulose becomes gelatinised, and the anisotropism disappears, yet on examination the fibres are seen to be present in great abundance. These isotropic fibres can be given their double refractive properties again, by diluting the solvent with excess of alcohol or benzene.

The accompanying photographs show this action very well.

Nitro-cellulose was prepared from cotton-wool, with large excess of acids, so that there should be no unnitrated fibres present. The resulting nitro-cellulose was practically all of the

FIG. I.

insoluble variety, and contained 13·3 per cent. nitrogen. It wa completely soluble in excess of acetone, and contained no cotton fibres.

Some of this nitro-cellulose was treated with ten times its weight of a solvent consisting of:

6 parts benzene
3 ,, alcohol
2 ,, acetone

and allowed to stand in a stoppered bottle twenty-four hours, a jelly resulted.

FIG. II.

Figs. I., II. and III. are from a little of this jelly, mounted with two crossed cotton fibres to fix the point of view, and give an object to focus and develop. The three photographs are taken from the same slide and the same point of view.

Fig. I. is a view under crossed nicols of the jelly, and taken immediately after mounting. It will be noticed that the object shifted slightly during exposure.

Fig. II. is the same view, taken immediately after I., but with the polariser opened a little.

Fig. III. was taken after the slide had been treated with Canada balsam and benzene, and allowed to stand five days fixed in the microscope. The benzene and Canada balsam gradually diluted the solvent and brought back the anisotropism of the nitro-cellulose fibres.

The magnification in all photos was × 50 diameter, and the exposure in I. and III. was in each case twice that of II.

In Fig. I. it will be observed that a little light is active besides the crossed cotton fibres. This is more noticeable in the negative. As a matter of fact, with this strength of acetone the anisotropism is just evanescent in a percentage of the fibres.

A comparison of Figs. II. and III. shows that nearly all the fibres seen in II. are anisotropic in III. The fibres obvious in II. and not evident in III. lie in the plane of polarisation. The fibres obvious in II. and III. are isotropic in I.

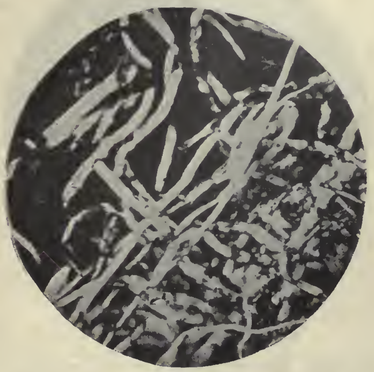


FIG. III.

I leave the correct interpretation of these experiments to competent biologists. To me it seems probable that the anisotropism of fibrous cellulose is due to a strain put on the fibre by the tension of the most outward layer of the cell-wall, and that a medium such as here described lessens this tension, whereas ordinary inhibition does not. Some such a theory as the above seems necessary to account for the different action of solvents which swell organised structures. This view is a modification of Strasburger's theory, as I understand it, and would be independent of whether cell growth takes place by lamellæ or particles.

F. W. JONES.

Barwick, Herts.

School Science and Knowledge-Making Power.

THE lecture of Prof. J. G. Macgregor, as reported in NATURE, of December 14, is of very great interest to science teachers, more especially to those in secondary schools. It will afford great comfort to the still very large number of controllers of the curricula in such schools who do not really sympathise with, nor believe in, the good results obtained from scientific teaching. As one who has to deal with all ages of pupils in a large school, may I be allowed to make a few comments on Prof. Macgregor's lecture as it strikes a science teacher?

In class work it seems that the lower forms, when watching an experiment performed before them, are quicker to put one thing with another, and to be led to explain or suggest explanations of the results obtained. This is apparently in accordance with Prof. Macgregor's opinion, that younger pupils have a greater knowledge-making power.

Thus a class of boys, whose ages range from seven to nine years, is much more ready to ask and answer questions concerning the subject of the lesson than classes towards the middle of the school.

The reluctance shown, or the difficulty felt, by higher classes in answering or suggesting questions is considered by Prof. Macgregor to show a lessened power of knowledge-making possessed by them. But even if the science teaching is, throughout the forms, of a constant character in its aim of bringing out the inquiring spirit, in my own experience the same thing is noticed. Can there be another explanation? As boys grow older they are more careful not to make such mistakes in their verbal answers as would lead to the slightest ridicule on the part of their class fellows. Thus, by remaining silent, they give one the impression that they are not following the work with the ability shown by their juniors. Again, with increased experience, questions do not appear so simple in their nature; alternative explanations are suggested to the boy's mind, and the choice is difficult to make. It is possible that the few suggestive solutions offered by a higher form show more power than the many more obvious ones given by the lower form.

Prof. Macgregor says that at present Latin is the only subject which really brings out this knowledge-making power. Surely this is comparing the results obtained from the best classical teaching in small selected forms where each boy is really known to have done his work to the very best of his ability, with the results from science teaching of a very old-fashioned kind, in which the lesson, given to a large class, is of the nature of a lecture. Such a comparison may be made to the disadvantage of any educational subject. It is still the custom in some classes to learn Euclid's propositions by heart! Yet no one would think of displacing the subject on this account.

Referring to the difficulties of increasing the knowledge-making powers of boys, certain enemies are mentioned. There is the use of synoptic or cram-books, which has been found to be necessary to push pupils through examinations in which "knowledge is power" is held as the maxim. Such books, after all, only take the place of written notes of lectures given to the highest forms, and have the advantage of saving the pupil's time. Further, text-books do not all consist of this kind of publication; in fact, some of them are as interesting to an intelligent boy as one of the ordinary run of story-books. Properly used, text-books are of great value surely in this way: the whole attention of the scholar is directed to the demonstration, and after the lesson the book is used to refresh the memory, which it does, not simply by repeating the results, but also the deductions from the results and the necessary steps of reasoning involved.

Prof. Macgregor objects to text-books which contain details of practical work to such an extent that the pupil is told what to do, what to expect, and the reasons why. If the teaching is carried out under such a system as that referred to as the Heuristic, then in the practical text-book it is not necessary to include all these details, but some appear to me to be absolutely necessary. Teachers know well enough the difficulty of getting printed instructions accurately carried out; and certainly letting even a small class of moderately steady boys loose into a laboratory would give the controller of the laboratory an anxious time. If, then, instructions are needed, why not print them? They must otherwise be written on the blackboard, or be of a verbal nature—the latter involving many repetitions.

The best chance that practical science (of course, commenced as early as possible) has of producing knowledge-making power, appears to be in the opportunity it affords of solving questions in a manner closely following an experiment previously carried out. In this connection modern science teaching combines the advantages of the study of propositions in geometry and riders thereon, with employment, simultaneously, of brains and hands. Now an experiment previously carried out implies instructions given.

The other enemy referred to by Prof. Macgregor is the examination syllabus. It is certainly difficult under the best of circumstances for a teacher to go completely through, say, the Cambridge local examination syllabus in science on the Heuristic system, in the time usually allowed by school time-tables. With such a task in front of him the teacher is bound at times to descend, so to speak, to dogmatic teaching. The modern syllabus, both in this examination and in that for the London matriculation, covers so wide a ground that there is danger of the work becoming of the same character as it is said to have been under the older syllabuses. It would appear, even now, to be absolutely necessary to use "synoptic books" when such lengthy syllabuses are prescribed and written examinations held.

But it is hard to see how even a practical examination can test the knowledge-making power of boys when a lapse of memory may prevent the performance of a measuring experiment, *e.g.* in the recent Cambridge local examination one simple question, to find the area of an ellipse by two methods, is a very admirable question, but presumably one-half the marks allotted are lost should a candidate forget the formula πab.

And, again, it was required to find the specific heat of a liquid by a non-mixing method. Why should this restriction have been made? The practical exercise is sufficiently difficult without any restrictions as to the process employed.

It is only fair to the science teachers in schools to call attention to this side of the question of knowledge-making power in boys, and, instead of merely saying that few teachers have the necessary inspiring spirit, to point out the hindrances with which they have to contend, as Prof. Macgregor has done.

G. H. WYATT.

Emmanuel School, Wandsworth Common, S.W.

Echelon Film Gratings.

MANY of your readers will doubtless be interested to learn that Mr. T. Thorp, of Manchester, who has so successfully reproduced copies of Rowland's gratings, has been able to make an "Echelon" grating on the principle suggested by Prof. A. A. Michelson last year, but stated to be well-nigh impossible on account of mechanical difficulties. The success of the operations depends on the shape, depth, and spacing of the grooves, and after many calculations and preliminary trials Mr. Thorp finds he can produce echelon films throwing the *whole* of the light into the first, second, or other requisite order, the direct image being practically suppressed. The first successful films made in this way were obtained in November last, and it is hoped that in a short time several will be available for examination. If permanent, they should be capable of giving star spectra with the same facility as prisms.

Royal College of Science, S.W. CHARLES P. BUTLER.

The Stockholm Fisheries Conference and British Fishery Investigations.

IN my letter published in NATURE of January 4, I attributed to the Government a larger grant in aid of the fishery investigations of the Royal Dublin Society than was actually given. My friend Mr. Holt informs me that, of a total sum of 2800*l.* originally provided for the work of the Marine Laboratory for five years, the Government only supplied one-half, viz. 1400*l.*, the remaining 1400*l.* being voted by the Society out of its private funds. It being found impossible to carry out the work satisfactorily with such small funds, the Society has recently voted a further sum of 500*l.* for the purchase and equipment of a fishing boat. My contention that existing institutions should be adequately supported before Government money is employed for starting a new organisation is therefore considerably strengthened.

E. J. ALLEN.

The Laboratory, Plymouth, January 12.

THE REPRESENTATION OF THE UNIVERSITY OF LONDON.

IT would seem that the University of London is in some danger of missing a great opportunity in connection with the vacancy created in its representation by the elevation of Sir John Lubbock to the Upper House.

Our readers need not be reminded that the theory on which the representation of academic bodies in Parliament is based is often assailed by politicians and thinkers, and is only tenable on the assumption that those bodies may be trusted to select persons of special eminence in science or learning, and qualified to obtain the confidence of the nation as representatives of its higher educational interests. This principle has been kept in view by Dublin in its choice of Mr. Lecky, by Cambridge and Oxford in the choice of Prof. Jebb and Sir W. Anson, and by the University of London so long as it was represented by Mr. Lowe and Sir John Lubbock. Unless men of higher intellectual rank than mere politicians are sent to the House of Commons by the Universities, there would no longer be any *raison d'être* for University representation at all, and in a democratic community the privilege would not be likely to survive long.

It appears now that there are two small Committees—the one Liberal and the other Unionist—which seek to control the Parliamentary elections of the University; and that on this occasion, instead of heeding the larger public interests involved in a University election, each caucus has been content to nominate one of its own active members, though wholly unknown to the learned and scientific world, or indeed to the general public.

Dr. Collins, the nominee of the Liberal party, took a very distinguished degree in medicine and surgery; has been prominent in the domestic controversies of Convocation, and has been for a time a member of the Senate. Outside of the University he is known as a man of great ability and promise, who achieved marked success as Chairman of the London County Council. But he is considered very unlikely to secure the adhesion of the medical or the scientific graduates.

Mr. Edward Busk, the Unionist candidate, is less known to the outer world. He has a creditable reputation in his own profession as a solicitor, and also as Sir John Lubbock's election agent. As chairman he has paid assiduous attention to the meetings of Convocation and of the annual committee: and has come to be regarded by a certain section of the members—especially by those who opposed the recommendations of the Royal Commission and the University Act—as in some way a guardian of the interests of the country graduates. But his supporters do not claim for him that either in the departments of scholarship and science, or in general academic or educational politics, he has yet evinced any interest or is known to possess any authority or influence.

The fact that both of the Committees, with their special command of electioneering apparatus, have been able to gain a start in point of time, and in some cases to secure provisional pledges, ought not to conceal from the general body of graduates the gravity of the present crisis, or prevent them from acting with due care and circumspection and a strong sense of responsibility in the choice of their member. The truth is that neither of the candidates selected by the named party organisations is of the *calibre* required to fill the seat of Sir J. Lubbock. The election of either would lower the reputation of the University as a learned body, and bring serious discredit on the principle of University representation itself. This has been pointed out with strong emphasis in letters and a leading article in the *Times*, which it is reasonable to expect that the graduates will not fail to consider with attention.

It is to be hoped that before the seat is actually vacated the name of a distinguished graduate may be submitted to the electors—a name not associated with any party politics, but commanding high and general confidence in the scientific and learned world.

ZOOLOGY AND THE AUSTRALIAN MUSEUMS.[1]

ALL who are interested in Mammalian Palæontology and exploration in the Interior of Australia will readily recall the graphic account contributed to our pages in 1894 (NATURE, vol. l., pp. 184 and 206), by Prof. Stirling, of the work of an exploring party sent out to Lake Callabonna, under the auspices of the South Australian Museum, of which he is the Hon. Director, for the purpose of collecting the remains of the gigantic vertebrates of Pliocene age known to be there entombed.

[1] "Memoirs of Royal Society of South Australia," vol. i., Part 1. By E. C. Stirling, C.M.G., M.A., M.D., F.R.S., and A. H. C. Zietz, C.M.Z.S.
"Fossil Remains of Lake Callabonna." Part 1. Description of the Manus and Pes of *Diprotodon australis*. Pp. 40 + 18 photographic plates.

The lake, known as Lake Mulligan until, at Prof. Stirling's instigation, its name was changed (as he himself informed us at the Zoological Society, on the occasion of his last home-coming), presents conditions wholly unfavourable for successful preservation of organic remains, owing to the action of a saline infiltration. The skeletons of the monsters which there lie are found some four feet beneath the surface mud, spread out in positions indicative of "death *in situ* after being bogged," the creatures having crowded down, as the area available for food and water gradually diminished under the influence of climatic change—the whole looking, as Prof. Stirling has aptly remarked, "a veritable necropolis of gigantic extinct marsupials and birds which have apparently died where they lie."

The name *Diprotodon* was applied by Owen in 1838 to a piece of a jaw, discovered in the Wellington Caves, and a considerable accumulation of material from various localities enabled him nearly forty years later (1877), in his "Fossil Mammals of Australia," to diagnose the genus and more fully describe the greater part of its skeleton and dentition, with the exception of the manus and pes. He admitted one good species (*D. australis*), and in the meantime (1862) Huxley had founded another (*D. minor*). Beyond this, our knowledge has been until recently confined to sundry scattered descriptions of odd teeth and bones, some of the latter having been apparently confounded with the limb bones of Chelonians and other reptiles and mammals. Our greatest desideratum therefore concerning these animals has been a knowledge of their pedal skeleton, and it is precisely that which the present memoir makes good. Moreover, the fact that while the living Diprotodont Marsupialia, with the exception of the South American *Coenolestes*, are all Australian, recent exploration in the fossiliferous beds of Patagonia has, according to Moreno (*cf.* NATURE, vol. lx. p. 396), revealed the presence of remains, if not of the genus Diprotodon itself, of near allies, invests both this genus and the present memoir with a very special interest, as involving the question of former inter-relationship between the great continents, now a burning topic of the times.

The material, as already stated, was discovered in a state unfit for preservation and removal; and Mr. Zietz, who has been chiefly concerned in its transport and subsequent treatment, by judicious use of glue and isinglass, has succeeded in so successfully preventing its disintegration, that Dr. Stirling was enabled to bring with him in 1897 for exhibition before the Zoological Society some bones of the large extinct bird *Genyornis* which they had then just described; and those who were so fortunate as to see them will recall their condition as a triumph for the preparateur's art. Some idea of the additional difficulties which had to be overcome, and of the tax on the patience and endurance of the authors in the field, may be formed from the description they give of a "Diprotodont skull-mass," which, dried and prepared, with its matrix, weighed close upon 2 cwt., and from the fact that when their booty was packed ready for transport their camels would start operations by getting "bogged to their bellies in crossing the strip of lake-surface which intervened between the working camp and the nearest solid land, unloading being a necessity, before extrication" and resumption of the 200 mile tramp which lay beyond.

These difficulties overcome, five years' continuous work has enabled the authors to make known their results, and so important are these esteemed by the Royal Society of South Australia that they have founded a special series of memoirs (of which that under review is the first) for their publication as the materials are worked out.

Dealing, first, with synonymy, the authors, in a preliminary statement concerning dental characters, admit Owen's *D. australis*, and incline to the belief that Huxley's *D. minor* may be identical with their smaller species; while, concerning a probable third species, somewhat larger than this, they reserve fuller consideration for a future memoir. Owen's *D. Bennettii* is dismissed with a passing comment.

The main portion of the memoir is devoted to a description of the pedal skeleton, fourteen examples having in all been obtained. The figures and descriptions are based upon dissociated remains, no single member having been found wholly complete in itself. The bones of the right side are for both fore- and hind-limbs, each delineated as a whole in one plate, as here reproduced except for a slight modification in the lettering, the remaining sixteen plates being devoted to the representation of individual bones in aspects necessary for their full study, as described in detail in the text.

Concerning the fore-foot (Fig. 1), the authors state that the radius completely crosses the ulna, and that there is a special radio-ulnar articulation formed, to admit of supination. Typically marsupial are the relationships of the

FIG. 1.—*Diprotodon australis*, skeleton of right fore-foot, dorsal aspect, ¼ natural size.

pisciform (*p.*) and cuneiform (*cn.*), which are massive, and together furnish a deep concavity for the ulnar condyle. Trapezium (*tm.*), trapezoid (*td.*), magnum (*mg.*), and unciform (*un.*) are all present. Interest chiefly centres for the fore-limb in the identification of the preaxial proximal carpal element (*sc.*) (regarded by Owen as a scapho-lunar) as the scaphoid, the term "scaphoid sesamoid" being applied to a small bone which (*s.s.*) flanks its lower free border with which it is apparently in articulation. Concerning this our authors are very brief, but we venture to think that, in view of the recent researches of Pfitzner and Forsyth-Major, the validity of their interpretation may be open to doubt; and we would recommend to their consideration Emery's memoir on the development of the marsupial limb-skeleton (in Semon's "Forschungsreise")—the best piece of work on the subject during recent years.

Both fore- and hind-limbs are pentadactyle, the digits of all five in front and of all but the hallux behind terminating in ungual phalanges. Passing to the hind foot (Fig. 2), the most superficial glance at once proclaims it a marsupial limb, begotten, as Huxley has so strongly argued for that of the order (in which he has been recently supported by Dollo), of an arboreal type. The fixation of the sole remaining element of the hallux (1) in extreme abduction, the slenderness of the digits 2-3, suggestive at first sight of syndactyly, are among its most conspicuous features; indeed, our authors believe the latter process to have involved even the fourth digit as well, but of this we do not see the proof. The immense proportions of the calcaneum (*ca.*), and the surmounting of this by the astragalus (*as.*) which alone furnishes the ankle joint, are conspicuous features of this very remarkable limb; but that which is most striking is the enormous expansion of the fifth metatarsal (5) to an extent unparalleled by any other known marsupial form, that element being so modified as to furnish a base of support for the outer border of the limb. *Diprotodon* is further unique among all known marsupials for the like

FIG. 2.—*Diprotodon australis*, skeleton of right hind-foot, dorsal aspect, ½ natural size.

modification of its corresponding metacarpal (5, Fig. 1). As concerning the hind-limb, the inward and upward enlargement of the navicular (*nv.*), which the element termed by the authors entocuneiform (*ms. en.*) is seen to have also undergone, would seem to us to suggest a similar supporting function for the inner border of the limb, and to explain the presence of only the tarsal element of the hallux (1) in its greatly developed form—that bone and the inner lobe of the navicular being apparently together specialised for purposes of support. And we are led to surmise that in this there may lie the clue to the reduction of the middle digits, rather than in a supposed syndactyly.

Considerable interest attaches to the discovery of an *os trigonum*, wedged in between the tibia and fibula and the astragalus. It is unfortunate that our authors term this the "os pyramidale," apparently by comparison with the "pyramidale," discovered by Owen in the Wombat, to which they do not however allude. To it the comment we have made on the "scaphoid sesamoid" may equally be applied. But two cuneiforms are described as separate elements in the text and indicated in the plates, labelled ecto- and ento-cuneiform respectively, thus leading to the supposition that the meso-cuneiform may be absent. The authors, however, point to details which justify their regarding the latter bone as a compound (as indicated in our revised lettering) of the ento- and meso-cuneiform, in itself a unique feature of the genus; and it is a great pity that this is not rendered evident on the plates, in which the lettering indicative of the ento- is placed on the meso-cuneiform, to an utter confusion of ideas.

Beyond this we have no remarks which are critical, and we reserve comment on the authors' views concerning the position of the genus in the marsupial series until their later memoirs appear. Certain it is that the possession of these magnificent remains will render the South Australian Museum famous, in the manner that the Munich Museum is for its Pterodactyles, the Brussels for its Iguanodons and Mosasaurs, the Yale for its Ungulates and Toothed Birds; and we consider it incumbent on the authors, having so successfully overcome the difficulties of transport and preservation, that they will close their series of memoirs on Diprotodon with a careful reconstructional drawing of the entire skeleton, and render it possible, in the interests of science, for others to obtain a corresponding papier-maché restoration, as has been so successfully done with Marsh's Dinocerata, or a cast, as with Dollo's Iguanodons.

Upon the acquisition of these treasures our Australian *confrères* are to be congratulated; and it is opportune to point out that the event marks but one of a series of recent great advances in our knowledge of the unexplored interior of that continent, in which Prof. Stirling has played a not unimportant part. Chief among those, however, whose names will live in the annals of later Central Australian investigation is his co-explorer, Prof. Baldwin Spencer, of Melbourne. Of his scientific attainments and enterprise, as exhibited in his conduct of and contributions to the Horn Expedition, and his recently published book in conjunction with Mr. Gillen on the Arunta Tribes, no praise can be too high. Not content with this, he has recently accepted office, in succession to the late Sir W. M'Coy, as Director of the Melbourne Museum; and in so doing, to his brilliant reputation as a teacher, scientific investigator and explorer, he has added fame as a Museum Curator, for, fired by a whole-souled enthusiasm which has characterised his previous acts, he has foregone remuneration and taken office as Hon. Director, in order that the money available may be applied to bettering the position of the assistant he found in charge, and the providing of additional aid in the momentous task of reorganisation upon which he has resolved. He thus becomes at once a Trustee and Hon. Director, and using his influence with the Government, he has already obtained a grant of 13,000*l.* for building purposes, and has in course of construction a spacious hall of some 150 + 110 feet in area. The collections, rich both in materials and literature, have been found to include three of du Chaillu's original adult gorillas, an entire *Nestor productus*, a very fine Aepyornis egg, a good series of Antelopes, and a ninety-foot Whale's Skeleton. Already a considerable rearrangement has been effected; a group of giraffes, a case of lyre birds with nest and dancing ground, another of megapodes, of albatross with the parent on a genuine nest, all mounted after the fashion of the exhibits in our own Natural History Museum (amidst natural surroundings, as was first done for birds in the famous Booth collection at Brighton), are examples foreshadowing a complete transformation, under which a geographical arrangement will give place to a zoological and more scientific. The cases are, however, lacking in Australian materials. These Prof. Spencer intends to secure with all possible speed, and to that end he is already laying plans for renewed exploration of the Bush and the Interior. It is his intention to make the museum at once a thoroughly representative Australian Collection and a great Educational Institute. In this he has a labour of years; and that he will succeed we have not the slightest doubt, for pluck, endurance, far-sightedness and enthusiasm are in him unusually combined.

The work of the Sydney Museum has rapidly developed in interest and importance during recent years; the introduction of "new blood" there, as more recently at Adelaide and now at Melbourne, has brought to bear upon the investigation of the indigenous fauna and the natural resources of the country, now so largely dying out, a body of earnest students intent on work while yet it is not too late. The present memoir, which is an outcome of this movement, may thus be regarded as a sign of the times; and we sincerely hope that those which are to follow will be pushed forward with all possible speed, it being now five years since the discovery of the remains of which it treats was announced.

FLOATING STONES.

DURING my recent visit to South-West Patagonia, in 1899, for excavations in the remarkable Glossotherium or Neomylodon Cave near the farm Puerto Consuelo or Eberhardt, I made, with my fellow traveller, Dr. O. Borge, the following curious observation. Whilst rowing in the long and narrow channel of Ultima Esperansa, to study the plankton, we observed, when the sea was calm or only agitated by a slight swell, small fragments of slate which floated upon the surface packed together in larger or smaller clusters. They drove hither and thither in the neighbourhood of the shore, until they were driven away by the strong current which at intervals swept forward in the channel. The quantity was considerable; for instance, 700 of them were obtained at one cast of the net in a few minutes. The stones had evidently drifted out from the beach, which consisted mainly of similar stone fragments washed off from the cliffs composed of a bituminous mesozoic slate. The surface of the stones was dry, and they sank immediately when it became wet by touching or by the movement of the swell.

Fragments of slate found floating upon the sea-surface at S.W. Patagonia.

The slate fragments collected on the sea-surface had a specific gravity of 2·71. The specific gravity of the water in the channel was only 1·0049 at a temperature of 15° C (59° F). The largest stone which I obtained from the surface (pictured in natural size on the accompanying zincotype) weighed 0·8 gram. Twenty of the smaller fragments had a mean weight of 0·3 gram. The fragments contain no air cavities perceptible to the unaided eye. They must, therefore, not be confounded with the volcanic ejections (and perhaps slags from meteors) with its numerous air cavities which are often found drifting on the surface of the ocean.

The following consideration will help to explain the apparently paradoxical fact that stone fragments of a specific gravity of 2·71 and a weight up to 0·8 gram have been observed floating on a fluid of a specific gravity of 1·005. On examining the floating stones one could discern small gaseous bubbles attached to the under surface of them, and at the shore stones can be seen on the very fringe of the beach which are just beginning to float lightened by gaseous bubbles. Unfortunately, I had not occasion to investigate the conditions more closely, as I was busy with other researches; neither had I any apparatus at my disposal for the collection of the gas that had accumulated under the stones. It is probable that the stones were not only provided with gas bubbles, which can be perceived by the eye, but that they were surrounded by an envelope of gas supported by an insignificant coating of algæ, of which the stones are surrounded. At least, traces of diatoms and algæ are discernible on the stones after drying. The greasy surface of the mineral of which the floating stones consisted also prevented the water from adhering to them, and caused the stones to be surrounded with a concave meniscus, which naturally may have contributed to, and perhaps was the main cause of, their floating, which sometimes was further facilitated by a patelliform shape of some of the bigger stones.

The observed phenomenon is not without some geological interest. In the described manner a considerable transport of solid matter takes place, not only in the narrow Patagonial channel, but no doubt also at several other shores of the ocean; and new strata will be built up possibly enclosing mixture of remains from far distant geological periods.

ERLAND NORDENSKIOLD.

DR. ELLIOTT COUES.

BY the death, on Christmas Day, of Dr. Elliott Coues, America loses one of its leading ornithologists; indeed, we may say, without disparagement of others, the most prominent since Spencer Baird was taken from us. Born in 1842, at Portsmouth, in New Hampshire, and graduating in the Columbian University, Coues entered the medical service of the United States Army in 1862, receiving the brevet rank of Captain for his conduct during the war, after which he held several appointments of various kinds, and especially one in Arizona, which gave him the opportunity of indulging his inborn taste for natural history. Subsequently he held in succession the posts of Professor of Zoology in the University of Norwich, in the State of Vermont, of Anatomy in the National Medical College at Washington, and of Biology in the Virginia Agricultural College, besides being, in the interim, surgeon and naturalist to the United States Northern Boundary Commission, and from 1876 to 1880 secretary and naturalist to the United States Geological and Geographical Survey of the Territories. The duties of these different offices seem only to have stimulated his efforts, and the number of his zoological papers contributed to various scientific journals would alone accord him a high place; but, apart from them, his "Birds of the North-West," his "Fur-bearing Animals," and "Birds of the Colorado Valley," to say nothing of his "Key to North American Birds"—of which a third edition was announced for the ensuing spring—and his "Ornithological Bibliography," each a model of accurate work, proclaim him to have been far in advance of any other contemporary of his own country, or indeed of many others. In the summer of 1884 Dr. Coues visited England, to the great satisfaction of British ornithologists, to most of whom he had been only known by name, for thus his attractive personality attached to him many warm friends. After taking a considerable share in the publication of the "Century Dictionary," of which he was the Natural History editor, he latterly turned his attention to some of the earlier geographical explorations of his own country, and we owe to him admirable editions of the "Travels" of Lewis and Clark, and of General Pike.

Last summer Dr. Coues revisited Arizona, intent on ethnological researches, but found a camp life at the elevation of 7000 feet too much for his powers. Returning to Washington in the autumn, distressing symptoms of a serious ailment soon began to show themselves, and in a touching letter to an English friend, written at the end of November, he announced that the only hope for the prolongation of his life lay in the success of a very formidable surgical operation which he was about to undergo in the Johns Hopkins Hospital at Baltimore. The last mail brought the sad news of its failure, and the ornithologists of Britain will assuredly condole with those of North America in the loss of the most accomplished of their brethren. A. N.

NOTES.

IN calling attention to the article in another column concerning the future representation of the London University in Parliament, we may state that there is a very widely expressed feeling that such representation, being a matter of national concern, should be considered from an absolutely non-political standpoint. A strong feeling has been expressed in many quarters that if the representative of the University be not a man of European distinction, a great opportunity will have been lost. Among those thought of from this point of view is a distinguished office bearer of the Royal Society. We trust that if he has been asked to serve in such a cause, he will not refuse to come to the assistance of those who are working to promote it.

PROFS. DARBOUX AND MOISSAN have been nominated to represent the Paris Academy of Sciences at the forthcoming celebration of the second centenary of the Berlin Academy of Sciences.

THE Council of the Royal Astronomical Society have awarded the Society's gold medal for this year to M. Poincaré, for his researches in celestial mechanics.

THE Municipal Council of Paris have adopted a proposal by M. Daix, to light the place de la Concorde with acetylene gas during the forthcoming Exhibition.

THE Geological Society has this year awarded its medals and funds as follows:—The Wollaston medal to Prof. G. K. Gilbert, of Washington; the Murchison medal to Baron A. E. Nordenskiöld, of Stockholm; the Lyell medal to Mr. J. E. Marr, of Cambridge; the Wollaston fund to Mr. G. T. Prior; the Murchison fund to Mr. A. Vaughan Jennings; the Lyell fund to Miss G. L. Elles; and the Barlow-Jameson fund to Mr. G. C. Crick and Prof. T. T. Groom.

THE annual congress and exhibition of the Sanitary Institute will be held at Nottingham about the end of August.

THE annual general meeting of the Institution of Mechanical Engineers will be held on Friday, January 26.

THE Royal Bavarian Academy of Sciences has conferred upon Herr Eugen Wolf, the explorer, its large gold medal for services rendered to science.

THE St. Petersburg correspondent of the *Times* announces that a special separate department has been created in the Russian Council of State, to be called the "Section of Industry, Science and Trade." Under the head of Science, it is intended that this new department shall help to direct the advance of national education, a subject which, in connection with the economical development of Russia, is now beginning to obtain the powerful support so much needed.

WE learn with regret from Prof. H. H. Giglioli that Mr. John Bernard Stallo, of Cincinnati, U.S.A., died at Florence on January 6, in his seventy-sixth year. Judge Stallo, as he was usually called, was well known as a philosopher, mathematician and physicist; he was, during President Cleveland's first term of office, Ambassador of the United States at Rome. Since then he had lived in Florence amidst his books, taking to the very last a keen interest in the progress of science. Prof. Mack's last book is dedicated to him.

WE learn from *Science* that Prof. E. B. Wilson, of Columbia University, has been elected president of the American Society of Naturalists, in succession to Prof. W. G. Farlow, of Harvard University; and Dr. William McMurtrie, of New York City, has been elected president of the American Chemical Society, in succession to Prof. Edward Morley.

SIR WILLIAM MACCORMAC is contributing to the *Lancet* some valuable notes on the treatment of the wounded at the seat of war, and the wounds produced by modern bullets. He is particularly well qualified to express an opinion on the severity of bullet-wounds, for he had excellent opportunities of observing the lesions resulting from bullets during the Franco-Prussian war, and he states that in most cases the damage done by the modern bullet, especially by the Mauser, cannot be compared in severity with that inflicted by the needle-gun or the Chassepôt. His articles put medical men in the possession of much information not hitherto available, and constitute a real contribution to scientific knowledge.

SEVERAL correspondents have sent descriptions of solar halos and parhelia observed from various parts of Sussex and Surrey on Thursday last, January 11, between 9.30 and 11.30 a.m. Judging from the particulars communicated to us, what was seen was a typical exhibition of this meteorological phenomenon, which is not unfrequent in these latitudes, though it is rarely so well defined as it was on Thursday. The halos consisted of (1) a first bow concentric with the sun, red within, blue or green without, and having an angular radius of 21° or 22°; (2) a second circle or halo, similar to the first, but at twice the angular distance from the sun; (3) two inverted arches touching the two concentric halos, blue or green on the concave side, and red on the convex; (4) bright patches or mock suns on the same level as the sun, and apparently lying on the halos. The sky, except near the horizon, was cloudless but misty, the sun being faintly visible. This is the usual condition for the formation of halos, which are produced by the reflection and refraction of the sun's rays by the minute ice-crystals which constitute cirro-stratus clouds. A writer from New Shoreham, Sussex, remarks that the mock suns are there called "sun hounds," and in Kent "sun dogs."

FROM a recent issue of the *Times* we learn of a brilliant daylight meteor which was seen by several observers on the after noon of January 9. Mr. H. H. P. Bouverie, writing from Glynde Place, Lewes, remarks: "Whilst shooting here to-day I saw a brilliant meteor, which started from near the moon, that was quite bright at the time; it travelled for a short distance towards he north-east, and left a marvellously luminous path of white ight. The time of its appearance was as near 2.55 p.m. as possible. I never heard of such a thing being seen in broad daylight." Another observer writes: "At 2.55, in brilliant sunlight, a remarkable meteor was seen by a party of five from Reigate Heath Golf Ground. The course of the meteor was south to north, and it traversed a considerable portion of the heavens. In appearance it resembled a kite with a tail of a luminous white colour. It was visible for about a second." From the Drive, Brighton, the Rev. R. Hudson writes with respect to the same meteor: "The colour was brilliant white, like an incandescent gas-light. There was a nucleus and tail of considerable length. The altitude was about half that of the moon, which was visible at the same time. The sky was cloudless and blue, and the sun was shining brightly. The general effect was that of the falling stick of a rocket, and, indeed, my first impression was that it was a peculiar daylight rocket, but a moment's consideration of the direction of flight convinced me that it was a very remarkable meteor."

THE *Scientific American* states that the American Museum of Natural History has acquired, through the generosity of President Jesup, the second half of the Cope collection of fishes, amphibians and reptiles brought from Kansas, Colorado, Wyoming, Montana and other sections of the West between the years 1867 and 1896. In 1895 the first part of this collection was presented to the Museum by the trustees, so that now the entire life work of the late Prof. Cope will be permanently represented there. The proceeds of the sale of the collection will form an endowment fund for a professorship of natural science in Philadelphia.

ALL the vertebrate collections of the late Prof. O. C. Marsh, belonging to the U.S. Government have been transferred from New Haven, Conn., to the U.S. National Museum at Washington. Such material as may be necessary will be used for study and illustration in the completion of the monographs that were in course of preparation by Prof. Marsh at the time of his death. The actual number of specimens represented in this collection cannot yet be stated. They range in size from minute teeth of fossil mammals to individual specimens weighing from 500 to 2000 pounds each. The collections are rich in large Dinosauria, especially in examples of *Triceratops* and *Stegosaurus*, while the series of Titanotherium skulls is one of the best, if not the best, in existence. It contains fifty or more complete examples cleaned, and a number in the rough, besides many hundreds of bones. Among the specimens transferred are the types of forty or more species, including Dinosaurs, and Jurassic, Cretaceous and Tertiary mammals. The value of the entire collection is estimated at over 150,000 dollars. Referring to the transference, Prof. S. P. Langley remarks that the addition of this immense collection of most important American fossil remains to the treasures already assembled in the National Museum will afford the greatest satisfaction to all workers in the field of palæontology both at home and abroad.

AN account of certain preliminary experiments conducted with the view of establishing communication by wireless telegraphy between Chamounix and the summit of Mont Blanc has been detailed before the French Physical Society by MM. Léon and Louis Lecarme, and is summarised in No. 140 of the *Bulletin* of the Society. The experiments were conducted last August. The chief difficulties from the point of view of the propagation of Hertzian waves were: (1) the difference of altitude of 3450 metres between the two stations, with a consequent considerable difference of potential between the two masts; (2) the influence of cloud layers more than 200 metres thick in bad weather, these clouds often consisting of snow in a dense state of condensation; (3) the intense electric phenomena which frequently occur at high altitudes; (4) the two earthed wires whose extremities in this case could not be regarded as at a common zero potential owing to the thick coating of ice and hard snow covering the upper part of the mountain, whose high resistance might cause a considerable difference of potential between the "earth" of the summit and of Chamounix. The transmitting apparatus at Chamounix consisted of a coil giving an 18 cm. spark and a Hertzian oscillator, the balls were 2 cm. apart for giving the best results. The manipulator sent the current from a dynamo of 50 volts through the primary of the coil, and an "antenna" 25 metres long concentrated the waves. The receiver, situated at the Vallot observatory 4350 metres in altitude, was 12 kilometres distant as the crow flies, and consisted of a Branly radioconductor. The experiments were carried on for six days, and gave satisfactory results, but the three-phase currents employed in the electric lighting installation at Chamounix entirely stopped all communication. MM. Lecarme, however, propose to make use of these currents in future experiments.

ATTENTION has already been called in these columns to the system of electrical and magnetic units advocated by Dr. Franz Kerntler in his paper "Die Unität des absoluten Maass Systems. . . ." (Budapest, 1899). An account of the Kerntler system is now given by Prof. Rinaldo Ferrini, who, writing in the *Rendiconti del R. Istituto Lombardo*, expresses himself as distinctly in its favour.

THE established system of electrical units has been subjected to analysis and criticism by Prof. J. A. Fleming, F.R.S., in recent issues of the *Electrician*, and the concluding article of the series appears in the current number. Prof. Fleming does not definitely advocate any particular system, but he gives the outlines of a scheme of units which merits consideration both from theoretical and practical points of view. In conclusion, he remarks: "Those who have experience in teaching will agree that a clear view of the fundamental facts and statements is essential if the student is to make any satisfactory progress in handling advanced problems and ideas. In the class-room, no less than in the workshop, every one concerned with electromagnetic phenomena needs exact conceptions and not confused ideas of first principles. Experience shows that our present system of unitation and our existing terminology in describing electric and magnetic effects are not well adapted to facilitate this clearness. We may then ask: Should not the entrance into the twentieth century be inaugurated by some attempt to organise, simplify, and render more symmetrical the language and symbols in which are described the phenomena of electricity and magnetism, with the object of making calculation more easy and thought more precise?"

THE Pilot chart of the North Atlantic Ocean, issued by the Hydrographic Office of Washington, for January contains, in addition to the usual useful information, a sub-chart showing the average tracks of 121 January storms over the North Atlantic during the ten-year period of 1889–98. The chart shows that the region of maximum storm frequency for that month lies to the north of the steamship routes, in a belt extending north-eastward from Nova Scotia and Newfoundland across the Atlantic. Some of these storms are the most severe, the largest in area and the longest in duration, and may be traced entirely across the ocean, while others disappear to the northward. The storms are divided into nine classes, according to the regions in which they first appeared.

THE Central Meteorological Observatory of Moncalieri has published Vol. II. of the *Annuario storico* for the year 1900 (398 pages). The work contains a large amount of useful information, including articles and memoirs on various interesting subjects by Italian men of science, and notices of several prominent Italian meteorologists. The work also includes valuable bibliographical notices (1) of recent publications and of articles which have appeared in scientific periodicals both in Italy and other countries; and (2) references to the works of several deceased Italian meteorologists.

BRITISH agriculturists are slowly waking up to the advantages of scientific methods of dealing with diseases of crops. Dr. J. A. Voelcker, consulting chemist to the Royal Agricultural Society, reports in the *Journal* of the Society that the use of "blue vitriol" (sulphate of copper) for agricultural purposes has been considerably extended of late. It has long been employed, either alone or in different preparations of which it formed a constituent part, as a dressing for seed wheat. But of later years the spraying of the potato crop with "Bouillie Bordelaise" mixture, to guard against potato disease, has become more general; and quite lately a further employment of sulphate of copper has been brought to the front in the spraying of corn and other crops infested with charlock, a solution of this salt being used, apparently with good result, for the purpose. Dr. Voelcker has found that the sulphate of copper supplied to farmers is frequently adulterated with sulphate of iron. He points out that the two things do not serve the same purposes agriculturally; for, while sulphate of copper has undoubtedly great value for grain-dressing preparatory to sowing, potato spraying, and charlock destruction, sulphate of iron is practically useless.

TWO papers on the purification of waste in water from manufactories were read before the Institution of Civil Engineers on January 9. One of the authors, Mr. R. A. Tatton, gave a detailed description of the works at three manufactories where the trade waste is efficiently treated. In one of these, where the process of ordinary bleaching, dyeing and finishing is carried on, the works for purifying the trade waste consists of precipitation-tanks and filters, sludge-tanks, presses, &c. The volume of water at times amounts to 500,000 gallons per day; it is treated with lime and "iron alum" and settled in tanks in which most of the suspended solids are intercepted; from these tanks the water is pumped to a second series of tanks for further precipitation, and the clear liquor is finally passed through cinder filters to the stream. In the works of a large firm of woollen manufacturers, dyers and finishers, the trade waste is pumped into a series of three tanks, in which the solids are precipitated by lime and ferric chloride, the clear liquor passing forward through a second series of tanks and filters into the stream; the sludge is discharged on to filters composed of cocoanut matting, and after it has dried sufficiently, it is pressed and the oil extracted. The dye-water from the mill, to which is added the clear liquor from the grease tanks when they are being drawn off for cleaning, is settled in a series of tanks and filtered. The volume of water dealt with is 180,000 gallons per day. In another firm, carrying on the processes of calico printing, dyeing and bleaching, the pollution is caused by alizarine, logwood and other dyes, soap, starch, &c. The total volume of the trade waste amounts to about 70,000 gallons per day; the water from the various departments is collected to a well, whence it is pumped to the purification works, which consist of a central settling-tank and two precipitation-tanks used alternately; iron alum is used as precipitant. The sludge is drawn from the settling and precipitation-tanks into a well and is thence pumped to a sludge-drying area. The water from the precipitation-tanks is finally filtered through fine ashes.

THE mineral resources of Vancouver and adjacent islands, British Columbia, are dealt with by Mr. W. M. Brewer (*Trans.* Inst. Mining Eng., 1899). Gold, iron-ore (magnetite) and coal are chiefly referred to. The author considers that th possibilities of Vancouver Island as a mineral-producing region are very promising. The climate is temperate, and there are numerous deep-water harbours. There is, however, at present a lack of waggon-roads and good trails from the coast to the interior.

THE mineral wealth of Zoutpansberg forms the subject of an article by Mr. Douglas S.-S. Steuart (*Trans.* Inst. Mining Eng., 1899). The district of Zoutpansberg (Salt-pan Mountain) lies in the northern part of the Transvaal, and comprises about 25,000 square miles, of which proclaimed gold-fields cover 3500 square miles. The author now gives special attention to the gold-bearing reefs in the strata of the Murchison range; these extend seventy miles, and have an average width of four miles. The oldest rocks, known as the Letaba and Murchison range schists, are considered to be of pre-Cambrian age. The series has been tilted into an almost vertical position, and it includes various schists and quartzites, granites and gneisses, which are penetrated by dykes of basic igneous rock. Numerous richly auriferous veins occur among the schists. Auriferous banket, yielding 5 to 15 dwts. per ton, occurs at the base of the Drakensberg series—a group of sandstones, quartzites and conglomerates, which rest unconformably on the older rocks. The paper is illustrated by map, sections and pictorial views.

THE *Zeitschrift der Gesellschaft für Erkunde zu Berlin* contains a paper on the desert of Atacama, by L. Darapsky, with a new map of the region. The main features of the topography are described and illustrated by photographs, and some analyses of the waters of thermal springs and salt marshes are given.

IN the new number of *Spelunca*, M. E. A. Martel gives a summary of the results of recent observations on the movements of water under glacier ice. The paper consists for the most part of a correspondence between the author and Prof. Forel, especially concerning experiments in tracing the movements of underground waters by coloration with fluorescein.

BEGINNING with the number for the last week of November, *Die Natur* publishes a series of articles on the Antarctic regions and Antarctic voyages, translated from a paper by Axel Ohlen in *Ymer*, by A. Lorenzen. The detailed account given of the history of Antarctic discovery is of special interest at the present time.

PROF. W. M. DAVIS, of Harvard University, contributes a valuable note on "A Fault Cliff in the Lepini Mountains" to the December *Bollettino della Societa Geografica Italiana*, illustrated by a number of excellent photographs. The note is translated by Fr. M. Pasanisi, who adds some bibliographical paragraphs, and expresses the hope that the study of geomorphology may receive more attention from Italian geographers.

BESIDES the usual meteorological notes, the new number of the *Mittheilungen von Forschungsreisenden und Gelehrten aus den deutschen Schutzgebieten* contains an interesting paper on the native methods of extracting and manufacturing iron in Togoland. Diagrams of different forms of furnace are given, and a vocabulary of technical terms in various dialects.

THE publication of the scientific results of the Norwegian North Polar expedition (1893–1896), edited by Dr. Nansen, will be commenced almost immediately by Messrs. Longmans, Green and Co. The whole work is estimated to form five six quarto volumes, which it is hoped will be completed in the course of about two years; it will be issued in the English language only.

AN Earthquake Investigation Committee was instituted by the Japanese Government in 1893, for the collection of facts relating to earthquakes in Japan. The work was at first superintended by the late Prof. S. Sekiya, and, since his death, in January 1895, has been carried on by Mr. M. Tayama. It is now approaching completion, and, in the meantime, Prof. Omori has issued a catalogue which will serve as an index to the future report of the Committee (*Journal* of the College of Science, Imperial University, Tokio, vol. xi. Part 4). This has been compiled from 427 different kinds of Japanese histories and chronicles, and gives the dates, districts and intensities of 1898 earthquakes between the years 416 and 1867. The catalogue is followed by a most valuable discussion of its contents by Prof. Omori, in which he considers the distribution of the earthquakes in time and space. The total number of destructive earthquakes is 220, but, as the early annals are incomplete, it seems likely that one part or other of Japan will be visited by a destructive earthquake once in about two-and-a-half years. While they sometimes happen singly, they tend to recur in groups during epochs of maximum frequency, which happen on an average once in every thirteen or fourteen years. If the shocks are counted during consecutive half-centuries, the destructive and the small shocks have their maxima and minima at nearly the same epochs. But when examined in detail this is not the case. For instance, destructive shocks are most numerous during the months of July and August, while the ordinary shocks are least frequent at about the same time. The explanation which Prof. Omori suggests for this reversal is that the constant recurrence of small earthquakes maintains the region concerned in a normal or safe condition, thereby preventing any abnormal accumulation of stress in the earth's crust. Again, dividing the destructive earthquakes into local and non-local, according as the damage caused by them was confined to one province or distributed over several, it appears that the provinces on the concave or Japan Sea side of the group of islands were disturbed almost wholly by local shocks, while those on the convex or Pacific side were often disturbed by great non-local ones, the origins of which were situated beneath the ocean, and sometimes caused fearful sea-waves.

MINUTE, neatly worked flint implements have recently been found in great numbers in East Lancashire and South Yorkshire. Mr. R. A. Gatty describes in *The Reliquary and Illustrated Archaeologist* (vol. vi., 1900, p. 15) how he has found many hundreds of these "Pigmy flint implements," as he terms them. Others have been found in various parts of England, but not so abundantly as in Yorkshire; but that may be owing to their having been overlooked. They appear to be always associated with rough Neolithic implements, but there was a total absence of polished implements. Mr. Gatty figures some of these interesting objects, and places side by side figures of "pigmy flints" from Indian caves and from the surface of the ground at Hoxton Roberts (Yorks.); the forms are apparently identical. Similar tools have been met with in France and Belgium.

Two Neolithic graves in the neighbourhood of Worms are figured in *Die Umschau* (Tom. iii., p. 1023). In the man's grave were found stone implements and pottery, the latter is also figured; and in the woman's grave was a food-pounder.

HERR E. LEMMERMANN reprints, from the *Proceedings* of the Natural History Society of Bremen, an account of the Plankton algæ (including Peridinieæ) collected in Prof. Schauinsland's expedition to the Pacific in 1896–1897. The general features of the Plankton flora of the Pacific Ocean are discussed, and four new genera of Schizophyceæ are described—*Coelosphaeriopsis*, *Chondrocystis*, *Haliarachne*, and *Katagnymene*—as well as a number of new species and forms.

MR. M. A. CARLETON publishes, in the form of a report to the U.S. Department of Agriculture (Division of Vegetable Physiology and Pathology, *Bulletin* No. 16), an exhaustive paper on the Cereal Rusts of the United States. He finds six, or probably seven, distinct rusts affecting the cereal crops, of which by far the most destructive are the "black stem rusts" of wheat and oats, *Puccinia graminis Tritici* and *P. graminis Avenae*. The injury to the crops by these fungi is on an enormous scale. The report goes into details respecting the varieties of the cereals best able to resist the parasites, and the best means of warding off their attacks. It is illustrated by several very well executed coloured plates.

WITH the exception of two papers by Dr. O. Finsch on birds, the latest issue of the *Notes from the Leyden Museum* is devoted to invertebrates. Perhaps the most generally interesting contribution is one by Dr. J. G. de Man on the crabs collected by the Dutch Scientific Expedition to Central Borneo; the materials obtained showing, as in the case of the crayfish previously described, how extremely imperfect was our knowledge of the carcinological fauna of the country. Out of a total of fifteen species collected, of which all but one were land or fresh-water forms, no less than eleven or twelve proved to be new to science. And whereas only three fresh-water crabs were previously known to inhabit the island of Borneo, the number is now raised to fifteen. Very noticeable is the discovery of a crab belonging to the genus *Menippe*, closely allied to the rare *M. panope* from Tranquebar; since, with the possible exception of the last-named, all the species of that genus hitherto known, as well as those belonging to the allied *Myomenippe*, are marine forms.

MANY interesting and instructive articles on diverse scientific subjects are contained in the volume of *Knowledge* for 1899, a copy of which has been received. The fine collotype illustrations distributed through the volume form an attractive characteristic of this monthly magazine of science.

THE fourteenth volume of the new series of *The Geographical Journal*, containing the numbers from July to December 1899, has just been published. The papers, articles, monthly bibliography, and numerous maps, combine to make the volume, like preceding ones, a valuable record of the progress of the knowledge of the earth.

THE genus Cardium, of which the edible cockle is by far the commonest member, forms the second number of the memoirs of the Liverpool Marine Biology Committee, the author being Mr. J. Johnstone. A detailed account is given of the anatomy of the cockle as a typical Lamellibranchiate Mollusc, and the economic importance of the cockle, with special reference to the Lancashire Sea-Fisheries district, is described in an appendix. Seven plates illustrate the points dealt with in the memoir.

THE "Annuaire" of the Bureau des Longitudes, for 1900, has been received from Messrs. Gauthier-Villars, Paris. It is noteworthy that all the dates are expressed in Paris Mean Civil Time, commencing at midnight and reckoning from 0 to 24 hours, instead of dividing the day into two parts of twelve hours each as heretofore. As usual, the volume is filled with information of interest and value to all observers of the heavens, and also to other students of science, for the tables of constants contained in it cover a wide range of scientific work. The subjects of the special articles are machines for generating electric currents, by Prof. Cornu; the new gases in the atmosphere, by Prof. Lippmann; and work done at the Mont Blanc Observatory, by Dr. Janssen, who also writes on the application of aeronautics to the observation of certain astronomical phenomena.

THOUGH articles of scientific interest only occasionally appear in British monthly periodicals read by the general public, they are more frequent in the American magazines published here. The *Monthly Guide to Periodical Literature*, the first number of which has just been issued by the Advertising Agency of London, is therefore not without value from the scientific side; for it shows the titles and writers of articles in the chief magazines and reviews which reach us from the United States, and also in similar periodicals having their origin on this side of the Atlantic. Assuming that the editors of the various popular magazines know the pabulum best appreciated by their readers, an examination of the list of articles shows that science is given but scant attention by the reading public. A few editors with scientific knowledge as well as literary capacity might do much to increase interest in natural knowledge, and raise their readers' minds above the dead level of indifferent fiction and sensational science.

THE *Zeitschrift für physikalische Chemie* contains a very ingenious application by J. J. van Laar of thermodynamics to the results of Ramsay and Shields upon the association of liquids. Assuming that θ simple molecules of water are associated to form a compound molecule, Dr. van Laar applies the thermodynamical conditions of equilibrium to the rate of change of the constant of association with temperature, and applies the resulting formula to the experimental figures of Ramsay and Shields. The value of q, the heat of dissociation of the molecule $[H_2O]^\theta$ thus determined, should be constant if the right value of θ is assumed, and this is the case for water at temperatures between 0° C. and 60° C. if $\theta = 2$. The results are not so good if θ be taken as 3 or 4, and hence the author concludes that the association is correctly expressed by

$$(H_2O)_2 \rightleftarrows 2H_2O$$

with an absorption of 1930 calories per 18 grams of water. Ethyl alcohol also appears to be bimolecular, but for methyl alcohol and acetic acid $\theta = 3$ at least. The contraction ensuing when alcohol and water are mixed and the phenomenon of the maximum density of water are also considered from this point of view, with the striking result that the assumption of the partial association of liquid molecules explains, not only the contraction on mixing with alcohol, but also the irregular expansion of water.

THE additions to the Zoological Society's Gardens during the past week include a White-throated Capuchin (*Cebus hypoleucus*) from Central America, presented by Mrs. Vernon; a Blue and Yellow Macaw (*Ara ararauna*) from South America, presented by Mr. H. W. Stride; two Java Sparrows (*Padda oryzivora*) from Java, presented by Mr. Walter Buchanan; an Indian Dial-Bird (*Copsychus saularis*) from India, presented by Mr. W. H. St. Quintin; a Delalande's Gecko (*Tarentola delalandii*) from West Africa, presented by Mr. May; two Spotted Salamanders (*Salamandra maculosa*), European, presented by Mrs. Brett; a Hocheur Monkey (*Cercopithecus nictitans*) from West Africa, a Vulpine Phalanger (*Trichosaurus vulpecula*) from Australia, ten Nose-crested Iguanas (*Iguana tuberculata rhinolophus*) from Nicaragua, two Whooper Swans (*Cignus musicus*), European; a Starred Tortoise (*Testudo elegans*) from India, deposited.

OUR ASTRONOMICAL COLUMN.

NEW MINOR PLANET (1899 E.Y.).—Herr Otto Knopf, of the Jena Observatory, gives the elements and ephemeris of this planet in *Astronomische Nachrichten*, Bd. 151, No. 3612, from which the following abridgment is obtained:—

Elements for Epoch 1900 *January* 0·0 *Berlin Mean Time.*

$$\begin{aligned} M &= 345^\circ\ 32'\ 15''\cdot 3 \\ \omega &= \ \ 3\ \ 32\ \ 19\cdot 9 \\ \Omega &= 89\ \ 46\ \ 43\cdot 3 \\ i &= 15\ \ 22\ \ 20\cdot 0 \\ \phi &= \ \ 5\ \ 13\ \ 16\cdot 4 \\ \mu &= 651''\cdot 293 \\ \log a &= 0\cdot 490821 \end{aligned} \quad \left.\begin{matrix}\\ \\ \\ \end{matrix}\right\} 1900.$$

Ephemeris for 12*h. Berlin Mean Time.*

1899.		R.A. h. m. s.		Decl. ° ′
Jan. 18	...	4 9 34	...	+17 32·5
22	...	9 22	...	17 54·2
26	...	9 36	...	18 16·4
30	...	10 15	...	18 38·9
Feb. 3	...	11 19	...	19 1·9
7	...	4 12 46	...	+19 25·0

SCIENCE TEACHERS IN CONFERENCE.

THE Committee responsible for the arrangements in connection with the English Education Exhibition, which is now being held at the Imperial Institute, very wisely decided that a series of conferences, lectures and demonstration lessons arranged by the chief educational bodies throughout the country would form a valuable adjunct to their exhibition. The invitations which the Committee sent out met with a very cordial reception, and the programme of meetings for the discussion of educational questions includes nearly every grade and phase of English school life.

One of the most interesting of these events was a conference of science teachers from all parts of the country, arranged by the Technical Education Board of the London County Council. The success which attended similar gatherings during January 1899 convinced the promoters that nothing but good resulted from the discussion of methods of teaching different branches of science, and the meetings on January 10 and 11 were arranged in much the same way as those of the first conference last year. But whereas the subjects considered in 1899 were various branches of physics and chemistry, the greatest prominence was this year given to plans of instruction in natural history and manual training.

THE TEACHING OF BOTANY.

At the first meeting held on the morning of January 10 at the Imperial Institute, when the methods of teaching botany was the subject dealt with, the chair was taken by Sir John Lubbock. Papers were read by Prof. Miall, F.R.S., of the Yorkshire College, Leeds, and Miss von Wyss, of the North London Collegiate School for Girls.

Prof. Miall gave it as his opinion that the teaching of botany in schools is not spreading, though there is hardly any scientific inquiry which is at once so practicable and inviting. A special reason for encouraging the study of botany is that a knowledge of the great facts of plant-life is essential to scientific agriculture. Those who live by agriculture, which is still our greatest industry, are already beginning to demand that, in our rural schools at least, the scientific basis of agriculture shall somehow enter into the course of instruction. A school course may conveniently be divided into three stages according as the pupils are children (age 8–12), boys and girls (13–16), or young men and women (17–19). The science lessons given in the first stage should take the form of object lessons. In the second stage systematic science may be begun, and here chemistry and physics will be the common choice, but natural history should be kept alive by school natural history clubs and rambles. In the third stage, students who will follow some pursuit in which natural history plays a part, should take up natural history again and study it methodically in the light of their chemistry and physics.

In the first stage the following maxims were recommended by Prof. Miall. (1) No technical terms in Latin and Greek. (2) No lectures or information lessons. (3) No books in class. (4) Let all lessons be interrogations of actual objects, and largely of live plants. (5) Try to make the class active and responsible throughout. Later, it was urged that everything that is taught at all in a school should come round pretty nearly every day for at least one year. In the third stage of teaching, when botany is studied for some special purpose, the great problems of the nutrition and reproduction of higher green plants should be specially studied. Such a course of plant physiology should occupy several hours a week for two or three years.

Miss von Wyss described how object lessons in botany might with advantage be given. She deprecated the idea that botany could be satisfactorily taught to young children apart from the study of zoology, and urged that such object lessons should be co-ordinated with the teaching of drawing and literature. The current idea that there is a difficulty in obtaining specimens in a large town was shown by the experiences Miss von Wyss related to be quite erroneous, and the success which object lessons have met with at the North London Collegiate School for Girls was dwelt upon.

Juvenile Research.

The afternoon meeting at the Imperial Institute was presided over by Sir Henry Roscoe. Prof. H. E. Armstrong, F.R.S., described in an interesting address the methods he had employed with his own children at home to educate them in the way of discovering for themselves the answer to questions which were presented in their ordinary life. The address was illustrated by practical demonstrations by Prof. Armstrong's little daughter and two young sons, and a series of lantern slides made it quite clear how the system described had been developed. In reading a book by the late Henry Drummond, called "The Monkey that would not Kill," the children came across the statement that a stone was lighter in sea-water than in air, and to satisfy themselves of the truth of the statement was the object of the piece of research which the children entered upon under the general supervision of their father. The steps in the inquiry were worked through again before a large audience, and the children themselves explained with remarkable intelligence what the object and result of each experiment were. Throughout the course of training, which was exemplified by the demonstration, each child kept a careful account of everything which was done, illustrating each step by means of sketches and recording every numerical result obtained. Prof. Armstrong maintained that the teaching of science to children was not commenced early enough, and that too little faith is shown by teachers in the reasoning faculties of young children.

Object Lessons.

The second day's meetings were held at the Shoreditch Technical Institute. Prof. Woods Hutchinson was to have given an address in the morning on "The Early Teaching of Natural History in Schools," but he was too ill to attend. Mr. J. W. Tutt read a paper on "Object Lessons in Natural History," in which he detailed the educational advantages of this method of instruction, the mode of giving a good object lesson, and a suitable scheme of lessons for young children. A discussion, in which a large number of teachers took part, followed. But, from one cause and another, the subject in hand received very little attention, and few actual working methods were explained.

Manual Work in Metal.

The concluding meeting was presided over by Sir J. F. D. Donnelly, and was concerned with the discussion of "Metal Work as a Form of Manual Instruction in Schools." Papers were read by Prof. W. Ripper, of University College, Sheffield, and Mr. Bevis, Director of Manual Instruction for the Birmingham School Board. Prof. Ripper's paper was concerned with the general considerations which make a development of the subject of manual instruction in metal desirable. It was pointed out that there has been a decided advance in this direction in recent years, and it was stated by Prof. Ripper that the exhibition of metal work in the Education Exhibition at the Imperial Institute is better than that of the recent Chicago Exhibition. Mr. Bevis gave an account of the course of instruction in metal work which was given to boys of Standards V. and VI., who were between the ages of ten and thirteen years, in the schools of the Birmingham School Board.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Cambridge.—Mr. A. H. Evans, M.A., of Clare College, who is favourably known as one of the authors of the "Cambridge Natural History," was, on January 10, elected an Esquire Bedell in succession to the late Mr. Gill.

The Special Board for Biology propose that legal powers shall be obtained to vary the conditions of the Gedge Bequest for the furtherance of physiological research, so as to equalise the conditions on which "advanced students" compete with ordinary students for the prize under this foundation.

In his dedication of the fourth volume of "The Linacre Reports" to the Vice-Chancellor of Oxford University, Prof. R. Lankester avails himself of the opportunity to make some remarks upon the want of encouragement given by Oxford Colleges to work of the kind contained in the volume. The position of science at Oxford has already been dealt with in detail in these columns (vol. liv. 1896). The present method of apportioning the College endowments is most unsatisfactory, and Prof. Lankester's suggestion that two-thirds of such endowments should be given for the encouragement of the study of the natural sciences, and one-third for the subjects comprised under the general terms Literæ Humaniores and Modern History, is a more reasonable distribution. In any case, Oxford is not likely to become a University for students of science while a past professor is justified in making a statement such as the following concerning the distribution of endowments:—"It is, I know, useless to urge this, which is the judgment and practice of almost every University excepting our own, upon the consideration of those who now have the control of that splendid potential source of energy, the College endowments. They have, unfortunately, with rare exceptions, been brought up in complete ignorance of the scope and significance of the studies which they refuse to recognise; they deliberately and conscientiously use the advantage of their position so as to maintain the present one-sided system, and to discourage the study of the natural sciences by those who come as students to Oxford."

It is not only at Oxford that study and research in the domain of the natural sciences receive little encouragement. In the preface to the volume of "Studies in Biology from the Biological Departments of the Owens College," Profs. S. J. Hickson and F. E. Weiss refer to the fact that no more Bishop Berkeley Research fellowships will be available for original work. The remark "Biology is now left in our College without any fellowship or scholarship to enable a promising student to devote a year of his life to original investigation before commencing his career as a teacher or medical student, and our well-equipped research laboratory has consequently to remain unoccupied during the greater part of the year. We cannot help feeling that if these facts were more generally known some help might be forthcoming from those who realise what biology has done and is doing for the development of rational methods of modern medical research." Why the Bishop Berkeley fellowships, which once promised to rank among the best characteristics of Owens College institutions, are not now available is not explained.

At a general meeting of Convocation of London University held on Monday, the report of the standing committee was presented. The report dealt with the election by Convocation of members of the Senate under the new statutes. It stated that the representatives allotted to Convocation will have to be chosen in May. The representatives of Convocation will consist of the Chancellor (elected for life), the chairman of Convocation, and sixteen members, of whom eight will retire every two years. These eighteen will form a majority of the members of the Council for external students, who will have to advise the Senate regarding the whole of the present work of the University. The Academic Council, elected mostly by teachers of the University, will perform a like function for internal students. There is no restriction on the choice of candidates. The new constitution will probably be in the hands of the University before the next meeting of Convocation in May, and by that time the University will probably have taken up its abode in its new home at the Imperial Institute. After a short discussion, the report was adopted.

SCIENTIFIC SERIAL.

THE latest issue of the Memoirs (*Trudy*) of the Society of Naturalists at the St. Petersburg University, Section of Geology and Mineralogy (vol. xxvii., fasc. 5, 1899), will be found most interesting for mineralogists and petrologists—the more so as each paper, in Russian, is followed by a full, detailed summing up in German. The volume is edited by K. von Vogdt, and contains three important papers. The first, by M. Boris Popoff, is upon the elipsoidal inclusions contained in that most interesting granite, the Rappa-kivi ("rotten stone") of East Finland. It is an excellent, very well-written analysis of the different porphyr-like inclusions which are found in the granite—some of them surrounded by an oligoclase-envelopment and with defined outlines, while the others are devoid of that envelope, and in this case have an undefined or a wave-like surface. To explain the appearance of the different sorts of inclusions being mixed together in this granite, the author resorts to the hypothesis of a slow motion of the crystallised ovoids, formed in different parts of the mass, but consequently moving about within it during the cooling of the mass. The second paper is a note on a variolite found on the left bank of the Lower Yenisei. The third paper is a detailed work (353 pp. in Russian, and 37 pp. of German *résumé*), by B. Polenov, on the massive rocks of the northern parts of the Vitim plateau of East Siberia. The author has most carefully worked out the beautiful collection of samples of rocks which was brought in, in 1865, by the mining engineer, I. A. Lopatin. A most elaborate descriptive catalogue of this collection has already been published a couple of years ago by B. Polenov. Now he gives a summary of the geological conclusions which may be drawn out of this collection. He begins his work by a most valuable sketch of the geological structure of the plateau, based on Lopatin's, Kropotkin's and Tchersky's explorations; this sketch (28 pp.), unfortunately, is not summed up at all in German. The remainder of B. Polenov's work (325 pp.) is given to a careful discussion of the various rocks entering into the composition of the plateau—namely, the oldest granites with their subordinate syenites and gabbro-norites; the younger group of plagioclase rocks—syenites, diorites, and diabase rocks; and the youngest group of basalts which cover the plateau on immense stretches; and, finally, the metamorphism phenomena which have been going on in all these rocks. A number of plates accompany the papers.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 7, 1899.—"Vapour-density of Bromine at High Temperatures." By E. P. Perman, D.Sc., and G. A. S. Atkinson, B.Sc. Communicated by Prof. Ramsay, F.R.S.

The authors have determined the vapour-density of bromine at temperatures ranging from 600° to 1050° by a modification of the Dumas method, from which it differs in the following particulars:—

(1) The globe was filled with bromine by repeated exhaustion and admission of bromine vapour.

(2) The bromine was drawn off by repeated exhaustion and admission of air, collected in a solution of potassium iodide, and estimated by titration with sodium thiosulphate solution.

(3) The globe remained in position (in a muffle furnace) the whole time.

Temperature was determined by means of a Le Chatelier pyrometer. The chief results are as follow:—

Temperature.	Pressure.	Mean Vapour-density.
About 650°	Atmospheric.	80·0
830°	,,	79·7
900°	,,	78·6
950°	,,	77·5
1015°	,,	76·7
1050°	,,	74·3
1040°	755 mm.	76·0
,,	319	73·9
,,	189	73·3
,,	47	71·8

By plotting the results at atmospheric pressure on a curve, it is seen that dissociation begins at about 750° C.

These results are in accordance (as far as they can be compared) with those of V. Meyer and Crafts, but in opposition to those of J. J. Thomson, who found dissociation to take place at about 100° C. on continued heating.

December 14, 1899.—"Observations on the Morphology of the Blastomycetes found in Carcinomata." By Keith W. Monsarrat, M.B., F.R.C.S.E.

The research was undertaken to confirm, if possible, the observations of Sanfelice, Roncali and others on the presence of organisms of the order Blastomycetes in Carcinomata, and to study the morphology of the same.

The observations may be arranged under four headings:—

(1) Isolation by Culture. (2) Staining Reactions. (3) Histology. (4) Tissue Reactions following Inoculation.

I. Isolation. Out of a large number of Carcinomata examined a positive result has up to the present been obtained only in the case of one Carcinoma of the breast. In this case a growth was obtained on glucose agar of an organism, the morphological characters of which are described below. The method of making inoculations on to media was by making numerous incisions into the growth with a sterile knife and inseminating the scrapings from the edges of these. The organisms grow readily both ærobically and anærobically at 37° C.

II. Staining Reactions. In the lesions produced by inoculation of the organism, the staining reactions were studied by a variety of methods, of which a modification of the method of Cladius for bacteria gave the most distinctive results, after fixation in Flemming's solution. By using this method for human Carcinomata both extra- and intracellular forms of cancer-bodies are distinctively stained.

III. The morphological characters of the organism are as follows: Fresh specimens from cultures are spherical, from four to ten micros in diameter, and in most cases take an aniline-chromatin stain diffusely. From this type there are all variations up to that in which no chromatin at all is to be observed. There is a capsule varying in density; multiplication takes place by budding. In certain cases, however, spore formation takes place. This was observed only in secondary nodules in certain organs, which followed growths in the peritoneum produced by inoculation. It consists in a thickening of the capsule, the breaking up of the chromatin of the cell into discrete particles, and the escape of the latter through a dehiscence in the capsule. There is no regularity in this process, no simultaneous division of the cell contents into a definite number of spores, and no simultaneous shedding of the same, as in the case of members of the Blastomyces Group.

IV. Tissue Reactions. Intraperitoneal injection in guinea-pigs has alone been used so far. One c.c. of a 48-hours old culture was injected in each case. Stated briefly, the results consisted in a production of "tumours" of endothelial elements in the peritoneum, and secondary nodules in lungs, liver, spleen and kidneys of a similar type. When brought in contact with endothelium, the organism is capable of stimulating proliferation and causing the production of new growths locally and in organs distant from the seat of inoculation.

Geological Society, December 20, 1899.—W. Whitaker, F.R.S., President, in the chair.—Dr. P. L. Sclater exhibited a large diagram of a new bore lately made for the Zoological Society of London, in the bottom of the old well in the Society's Gardens, Regent's Park. The section was a valuable addition to the literature of the water-supply from wells in the surrounding district.—On some effects of earth-movement on the Carboniferous volcanic rocks of the Isle of Man, by G. W. Lamplugh (communicated by permission of the Director-General of the Geological Survey). The author, since the completion of his survey of the Isle of Man, has studied the coast-section in the Carboniferous volcanic series between Castleton Bay and Poolvash, with the result that he has discovered evidence that the strata have undergone much deformation in pre-Triassic times. In the western part of the outcrop the volcanic material consists almost wholly of tuff, in places bedded and fossiliferous; in the eastern part exists a chaotic mass of coarse and fine fragmental volcanic material, traversed by ridges of basaltic rock, and containing entangled patches of dark limestone. The author now considers that the larger lenticles and most of the smaller blocks of limestone have been torn up from the underlying limestone-floor during a sliding forward or overthrusting of the volcanic series upon it. The phenomena described may be explained as the effects of earth-movement on a group of rocks consisting of limestone passing up into tuff, interbedded with lava-flows, and possibly traversed by sills or dykes of basaltic rock. The results of the disturbance appear to be limited vertically and horizontally, and to have been determined by the differential resistance of the component rocks. Analogous features occur in the Borrowdale volcanic series and in the Silurian volcanic rocks of Portraine. The President, after congratulating the author on his paper, read the following extract from a letter that he had received from Sir Archibald Geikie, who was unable to be present:—"Having been twice with Mr. Lamplugh over the ground which he describes, the second time quite recently, since his present views as to earth-movement were formed and matured, I am glad to bear my testimony to the exhaustive care which he has expended on the research. I agree with him on the main point—that there is conclusive evidence of considerable earth-movement since the deposition of the Carboniferous volcanic rocks at the southern end of the Isle of Man. He seems to me to have established this point beyond dispute."—The zonal classification of the Wenlock shales of the Welsh borderland, by Miss Gertrude L. Elles. This paper deals with the Wenlock rocks of Builth, the Long Mountain, and the Dee Valley. The results obtained by the author completely confirm the work of Tullberg on the Wenlock shales of Southern Sweden. In the discussion which followed, Prof. C. Lapworth pointed out the extreme interest of this paper, both from the stratigraphical and from the palæontological point of view. The zonal mapping of the Welsh Silurians commenced by Prof. Watts, carried through the Rhayader Valentian by Mr. Herbert Lapworth, had here been brought out in detail stage by stage through the Wenlocks of the Welsh border by the author.—On an intrusion of diabase into Permo-Carboniferous rocks at Frederick Henry Bay (Tasmania), by T. Stephens. The relationship of the abundant diabase to the Permo-Carboniferous strata of the island has been long a matter of dispute. Among others, Jukes describes sections which appeared to confirm the view that Permo-Carboniferous sediments were deposited round vast masses of igneous rock previously cooled and denuded. The author has identified and visited the sections, and finds in one that, although there is a step-like junction between the sediments and the igneous rock, it is the result of the intrusion of diabase, and not of the deposition of sediment. The sediment, which is fossiliferous, is converted into an intensely hard whitish marble, and the associated shale-bands into chert. The diabase, which is ordinarily an ophitic rock, acquires at the junction a finely crystalline-granular texture. Jukes's second section also gives undoubted evidence of intrusion.

Mathematical Society, January 11.—Lieut.-Colonel Cunningham, R.E., Vice-President, in the chair.—Prof. Love, F.R.S., communicated a paper, by Mr. J. H. Michell, on elementary distributions of plane stress.—Lieut.-Colonel Cunningham (Mr. Kempe, F.R.S., *pro tem.* in the chair) gave a preliminary sketch of a general method of factorisation of biquadratics, with special application to quartans, $N=x^4+y^4$.—The following abstract of a paper by Prof. H. Lamb, F.R.S., entitled "A Problem in Resonance, illustrative of the Mechanical Theory of Selective Absorption of Light," was read by Mr. Tucker.—The impact of sound-waves on a fixed spherical obstacle was discussed by Lord Rayleigh in a well-known paper (*Proc.* Lond. Math. Soc., vol. iv. p. 253, 1872), which also treats briefly the case where the sphere is movable, but is urged towards a fixed position by a force varying as the displacement (*l.c.* p. 272). In the present paper this latter problem is studied under a more general form, it being supposed that the sphere is capable of various independent modes of free vibration; and special attention is directed to the case where there is coincidence, or approximate coincidence, between the period of the incident waves and that of one of the free modes. The immediate acoustical importance of the question is perhaps not very great, since massive bodies are not usually set into vigorous sympathetic vibration by the direct impact of air-waves (the extreme precision of tuning that would be required militates against this), but rather through the intermediary of resonance-boxes and sounding boards. The problem has, however, an interest in another direction, as furnishing an analogy by which we can illustrate, without any great expenditure of analysis, the mechanical theory of selective absorption of light in a gas.—A paper by Dr. L. E. Dickson, an abstract simple group of order 25920, was also communicated.

MANCHESTER.

Literary and Philosophical Society, January 9.—Prof. Osborne Reynolds, F.R.S., Vice-President, in the chair. Mr. Thomas Thorp exhibited two film-gratings of a ruling designed to weaken the image and to condense the illumination in the spectra of the first and second order, and thus to compete with the prism spectrum in brilliancy.—Geometrical representation of the relation between wave-velocity and group-velocity, by Prof. Horace Lamb, F.R.S. In any medium where the wave-velocity varies with the wave-length, a simple geometrical representation of the *group-velocity* is obtained by constructing a curve with the former magnitude as ordinate and the latter as abscissa. The group-velocity is then given by the length intercepted by the tangent to the curve on the axis of y. Thus, for gravity waves on deep water the curve is a parabola, and it appears at once that the group-velocity is one-half the wave-velocity, as is well known. Various other cases are illustrated in like manner; in particular, the case when the waves are of such moderate length that both gravity and surface-tension have to be taken into account. The existence of a minimum group-velocity, equal to 1.211 times the minimum wave-velocity, is pointed out.

EDINBURGH.

Royal Society, January 8.—Sir William Turner in the chair.—Dr. W. Craig Maclagan read a paper on two historical fallacies: Heather Beer and Uisge Beithe. After discussing the various literary references and oral traditions concerning heather beer, the author proceeded to describe his own attempts to brew the so-called ale according to several detailed recipes. In this he had the valuable assistance of Mr. Melvin, of the Boroughloch Brewery, Edinburgh. All attempts to obtain from heather a decoction capable of alcoholic fermentation failed absolutely. The tradition seems to have had its source in the idea that there must be sugar in the heather flower since bees visit it; but analysis proves that there is no real sugar present, but that there is beeswax. A similar investigation proved that the uisge beithe or birch ale had as fabulous an origin as heather beer.—Sir John Murray communicated a paper by Mr. R. E. Peake and himself on the Azores bank, and some recent deep-sea soundings in the North Atlantic. From Mr. Peake's soundings around the Azores, the configuration of the bottom could now be shown in great detail. In depths less than 2000 fathoms the bottom was found to be very irregular, the bank falling in some places from a depth of 1400 to 2400 fathoms within a distance of five miles. Four new "deeps" or depths exceeding 3000 fathoms had been discovered—the Peake Deep between the Azores and the English Channel, and the Libbey, Sigsbee and Thoulet Deeps to the south of the "tail" of the banks of Newfoundland. Some remarkable differences in bottom temperature had been observed; for example, the temperatures taken on the southerly of two lines between the Azores and North America were about half a degree lower than those taken on the northerly line; and the temperatures along the northerly of two lines between the Azores and the British Isles were about three-quarters of a degree lower than the others.—Dr. W. Peddie and Mr. A. B. Shand, in a paper on the thermoelectric properties of solid and liquid mercury, described how by the use of solid carbonic acid they had traced the thermoelectric line of mercury well below its freezing-point. The line seemed to be a fairly continuous straight line down to the lowest temperature reached; it lay nearly parallel to the iron line, converging slightly so as to pass through a neutral point about $-550°$ C. It cut the line of 0° C. a little below the copper line.—A paper was also read on an optical method of determining the density of sea-water, by Mr. John J. Manley. The apparatus used was the hollow quartz prism and spectrometer belonging to the Royal Society of London. Into this the various samples of sea-water were put in succession, and the deviations of the D line compared with the deviation due to distilled water. All precautions were taken, and the method was found to have several advantages as regards rapidity and convenience over the usual methods of comparing densities of sea-water.

Mathematical Society, December 12, 1899.—Mr. R. F. Muirhead, President, in the chair.—Dr. Peddie gave an address on the dissipation of energy in vibrating matter, with lime-light illustrations.—It was agreed that Professor Gibson's paper on Proportion be printed in the Society's *Proceedings*.

PARIS.

Academy of Sciences, January 2.—M. Maurice Lévy in the chair.—M. Ph. van Tieghem, the retiring President, announced to the Academy the changes that have occurred amongst the members and correspondents during 1899.—M. Maurice Lévy delivered a short address on taking the presidential chair.—On the anomaly in the movement of the fifth satellite of Jupiter, by M. O. Callandreau. This deviation, to interpret which M. Asaph Hall has suggested a modification of the Newtonian law of attraction, may perhaps be explained in a less drastic manner by admitting that for such bodies as the sun and Jupiter, at the surface of which observation has shown fluids in relative movement in the neighbourhood of the equator, the resultant of the forces, instead of being rigorously normal to the surface at each point, tends, near the equator, to bring the molecules of this plane nearer together.—On the plastic activity of animal cells, by M. L. Ranvier. Some serous secretion from the peritoneum of the rat, containing some air bubbles, was heated in a moist chamber at 30° to 36°. It was observed that the lymphatic cells moved towards the bubbles, and, on arriving at their surface, were flattened there as against a resisting body. If the whole is cooled down to 21°, the cells become again spherical. The name of plastic activity is given to this phenomenon, which is a vital one. The flattening of the lymphatic cells against resisting bodies had been noted previously by the author; but it had not appeared to be possible that this effect could be produced by an air bubble.—On the culture of white lupins, by MM. P. P. Dehérain and C. Demoussy. As the result of three years' cultures, it was found that the white lupin does not attain its full development when there are no nodules on the roots. These nodules, when present, may differ greatly in size and appearance, the maximum assimilation of nitrogen corresponding with the smallest nodules.—The Perpetual Secretary announced the deaths of Sir James Paget, Correspondant for the Section of Médicine and Surgery, and of M. Matheron, Correspondant for the Section of Mineralogy.—The lunar eclipse of December 16, 1899, at the Observatory of Lyons, by M. Ch. André. The occultations of several stars were observed under excellent conditions.—Observations of the sun made at the Observatory of Lyons with the Brunner 16 cm. equatorial during the third quarter of 1899, by M. J. Guillaume. The results are expressed in three tables, showing the number of spots, their distribution in latitude, and the distribution of the faculæ in latitude.—On orthogonal systems, by M. Servant.—On the elementary law of electromagnetism, by M. Raveau. In the determination of the action of an indefinite current upon a magnetised needle, MM. Biot and Savart made the assumption that the effect of the wires from the battery could, owing to their distance, be safely neglected. According to the author this is not the case.—On the manganic oxidation of citric and malic acids, by M. G. Denigès. By the direct oxidation of citric acid with potassium permanganate, a good yield of acetone-dicarboxylic acid is produced, easily separable by mercuric sulphate in the form of an insoluble mercury compound. Malic acid, similarly oxidised, but treated with mercuric acetate instead of the sulphate, gives oxalacetic acid. The author suggests that these reactions may be advantageously utilised in analysis.—On acidimetry, by MM. Henri Imbert and A. Astruc. A study of the acidimetry of weak acids, including phenols, fatty and aromatic acids, halogen and nitro-derivatives of the acids, polyphenolic and amine acids, with the three indicators helianthine A, phenolphthalein, and Porrier's blue.—On some amines containing the camphor ring, by M. G. Blanc. The reduction of isolauronolic nitrile was attempted in the hope of producing β-aminocampholene, the amide of β-campholenic acid. The reduction proved to go further than this, a saturated base $C_9H_{15}.CH_2.NH_2$ being produced, of which the chlorhydrate, nitrate, chloroaurate, sulphate, oxalate, picrate, benzoyl derivative, and corresponding urea are described. The reaction of the base with ethyl iodide was also studied.—On the allotropy of benzophenone, by M. Œchsner de Coninck. It is shown that among the conditions governing the transformation of the stable modification of benzophenone into the unstable form, the phenomenon of slow oxidation is one of the most important.—The green pigment of *Amanita muscaria*, by M. A. B. Griffiths.—On the soluble ferments produced during germination of seeds with horny albumen, by MM. Em. Bourquelot and H. Hérissy. The seeds of *Trigonella Frenum graecum* and of *Medicago sativa* behave in a similar manner to the Carob bean during germination, secreting soluble ferments capable of hydrolising and rendering assimilable the reserve carbohydrates. The action of these ferments is comparable with that of warm dilute sulphuric acid.—The variations of plankton at Lake Chauvet, by M. Bruyant.—On the constitution of the ovarian follicle of reptiles, by Mlle. Marie Loyez. The follicle of reptiles is composed of two kinds of cells; small ordinary follicular cells, and large cells like young ovules, which may be considered as true abortive ovules, and the function of which is probably to assist in the formation of the vitellus.—Experiments on the freezing of ciders, by M. Descours-Desacres. A study of the fractional freezing of cider and perry.—Researches on beer, by M. Van Laer. It frequently happens that specimens of beer, which are clear and brilliant by transmitted light, appear to be turbid when examined by reflection. This disease, which is technically known as *double face* or *tweeskinde*, is due to contamination with a bacillus, named by the author *Bacillus viscosus bruxellensis*. A detailed account of the methods of isolation and cultivation of this bacillus is given.—On the plagioliparites of Cape Marsa (Algeria), by MM. L. Duparc and F. Pearce.

January 8.—M. Maurice Lévy in the chair.—Remarks on an earthquake in the province of Rhenish Hesse on December 20, 1899, by the French Consul at Frankfort-on-Maine.—Observations of the diameter and flattening of Jupiter, by M. G. Bigourdan. Since the calculated and found values for the motion of the fifth satellite of Jupiter are not in agreement, it appeared to be advisable to redetermine the magnitudes of the planet's diameter and flattening, since both these enter into the calculations. The mean equatorial diameter was found to be 38″·55, the mean polar diameter 36″·09, giving a flattening of 1/15·7.—Observation of the partial eclipse of the moon of December 16, 1899, made at the Observatory of Besançon, by M. P. Chafardet. The observations were interrupted by clouds at the commencement of the eclipse, but the occultations of six stars were measured.—On the absolute value of the magnetic elements on January 1, 1900, by M. Th. Moureaux.—On the theory of errors, by M. Estienne.—On the value of the internal pressure in the equations of Van der Waals and Clausius, by M. Daniel Berthelot. The author plots the curve $\omega\nu = f(\omega)$ (where ω is the reduced critical pressure and ν the reduced critical volume), and compares the experimental critical isotherm for carbon dioxide (Amagat) with the theoretical critical isotherms deduced from the formulæ of Van der Waals and Clausius, and shows that while neither coincides with the experimental curve along its whole length, the Van der Waals formula gives a good approximation for pressures above the critical pressure, deviating considerably at lower pressures; while the Clausius expression is just the opposite. By empirically modifying the internal pressure term, an expression can be obtained which fits the experimental curve closely, and still contains only three constants.—Action of the magnetic field upon the Becquerel rays, by M. P. Curie. The author confirms the results previously obtained by M. Becquerel, that the rays emitted by polonium are not deviated by the magnetic field, and hence concludes that the preparation of polonium used by M. Giesel must differ essentially from that of the discoverer. Of the rays given off by radium, those deviated by the magnet form only a small part of the total radiation. The rays which suffer the most deviation in the magnetic field are those possessing the greatest penetrating power.—On the penetration of those Becquerel rays which are not deviable in the magnetic field, by Mme. Sklodowska-Curie. There appears to be a fundamental difference between those radiations from radium which are deviated in the magnetic field and those which are not. For the former, the coefficient of absorption decreases, or perhaps remains constant, when the thickness of the material which they are traversing remains constant, while the non-deviable rays, on the contrary, are more easily absorbed the greater the thickness of the material they have passed through. This singular law of absorption is different from that of any other known radiation.—On the nature of white light, by M. E. Carvallo. The author criticises the current hypothesis that white light consists of an undulation of the form $e^{-kt} \sin ht$., and shows that it leads to a maximum of intensity at a wave length not corresponding with the maxima found by Mouton and Langley. If white light is due to a damped vibration $e^{-kt} \sin ht$, the spectrum given by a grating should not be coloured, but consist of white light only.—Apparatus for instantaneous photography producing the maximum effect, by M. Guido Sigriste. The modifications embodied in the apparatus described consist of a means of regulating the width of the slit of the shutter, keeping the edges absolutely parallel, and of moving the plane of the shutter a small determinate distance (0·1 mm.) from the focal planes. The times of exposure can be varied from 1/40 to 1/5000 of a second; the photographs with this instrument are very free from fog, and give the true light-values to the objects.—Application of the phase rule to alloys and to rocks, by M. H. Le Chatelier.—On the rhodio-cyanides, by M. E. Leidié. A detailed account is given of the best method of preparing the double cyanide of rhodium and potassium, which has the constitution $K_6Rh_2(CN)_{12}$. The crystals are isomorphous with the ferricyanide, cobalticyanide, manganicyanide, and chromicyanide of potassium.—New microchemical reactions of copper, by M. Pozzi-Escot. Ammonium iodide is added to the ammoniacal solution of copper salt; characteristic brownish-black rhomboidal tables are deposited.—On the presence of vanadium, molybdenum and chromium in plants, by M. Eug. Demarcay.—Mechanism of insufficient development in the offspring of diseased mothers, by MM. Charrin, Guillemonat and Levaditi.—On the andesites and basaltites of Cape Marsa, by MM. L. Duparc and F. Pearce.

DIARY OF SOCIETIES.

THURSDAY, JANUARY 18.

ROYAL SOCIETY, at 4.30.—Upon the Development of the Enamel in certain Osseous Fish: C. S. Tomes, F.R.S.—Further Observations on "Nitragin" and on the Nature and Functions of the Nodules of Leguminous Plants: Miss M. Dawson.—On the Innervation of Antagonistic Muscles, Sixth Note: Prof. Sherrington, F.R.S.—On the Viscosity of Argon as affected by Temperature: Lord Rayleigh, F.R.S.—On the Behaviour of the Becquerel and Röntgen Rays in a Magnetic Field: Hon. R. J. Strutt.—On an Experimental Investigation of the Thermo-dynamical Properties of Superheated Steam by Prof. Osborne Reynolds' Method: J. H. Grindley.

ROYAL INSTITUTION, at 3.—The Senses of Primitive Man: Dr. W. H. R. Rivers.

SOCIETY OF ARTS (Indian Section), at 4.30.—Our Work in India in the Nineteenth Century: Sir William Lee-Warner, K C.S.I.

LINNEAN SOCIETY, at 8.—On the Existence of Nasal Secretory Sacs and of a Nasopharyngeal Communication in the Teleostei: H. M. Kyle.—On the Origin of the Basidiomycetes: George Massee.

CHEMICAL SOCIETY, at 8.—Nitrogen Halogen Compounds: Julius Steiglitz and E. E. Slosson.—Chlorine Derivatives of Pyridine. Part V. Synthesis of $\alpha\alpha'$-Dichlorpyridine and Constitution of Citrazinic Acid: W. J. Sell and F. W. Dootson.—Action of Fuming Nitric Acid on α-Dibromocamphor: Dr. A. Lapworth and E. M. Chapman.—Electrolysis of Nitrogen Hydrides and of Hydroxylamine: Dr. E. C. Szarvasy.

FRIDAY, JANUARY 19.

ROYAL INSTITUTION, at 9.—Flight: Lord Rayleigh.

EPIDEMIOLOGICAL SOCIETY, at 8.30.—The Utility of the Bacteriological Examination of the Throats of School Children during an Epidemic of Diphtheria: K. W. Goadby.—Advantages of Bacteriological Diagnosis as instanced by the History of an Outbreak of Diphtheria in a Large School: F. H. Berry.

MONDAY, JANUARY 22.

SOCIETY OF ARTS, at 8.—The Nature and Yield of Metalliferous Deposits: Bennett H. Brough.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—An Expedition to the Summit of Mount Kenya, British East Africa: H. J. Mackinder.

TUESDAY, JANUARY 23.

ROYAL INSTITUTION, at 3.—Structure and Classification of Fishes: Prof. E. Ray Lankester.

ZOOLOGICAL SOCIETY, at 8.30.—Note on some Remains of *Grypotherium* (*Neomylodon*) *listai* and Associated Mammals, from a Cavern near Consuelo Cove, Last Hope Inlet, Patagonia: A. Smith-Woodward.—On a Collection of Insects and Arachnids made in 1895 and 1897 in Somaliland, with Descriptions of New Species: C. V. A. Peel and others.—On the Mammals obtained in Southern Abyssinia by Lord Lovat during an Expedition from Berbera to the Blue Nile: W. E. de Winton.

MINERALOGICAL SOCIETY, at 8.—Mineralogical Notes: Prof. Miers.—On the Constitution of the Mineral Arsenates and Phosphates. Part IV. Beudantite: Mr Hartley.—Petrographical Notes on some Rock-Specimens from the Little Island of Trinidad, South Atlantic: Mr Prior.—A New Method of Deriving the Thirty-two Classes of Crystal Symmetry: Mr. Barlow.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Swing-Bridges over the River Weaver at Northwich: J. A. Saner.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—Note on Dr. Vogel's Method of Preparing Subhaloid Salts of Silver: Major-General J. Waterhouse.

WEDNESDAY, JANUARY 24.

SOCIETY OF ARTS, at 8.—Local Government and its relation to Parish Water Supply and Sewerage: W. O. E. Meade-King.

GEOLOGICAL SOCIETY, at 8.—Contributions to the Geology of British East Africa. Part II. The Geology of Mount Kenya; Part III. The Elæolite-Syenite and Fourchites intrusive in the Coast Series: Dr J. W. Gregory.—Fossils in the University Museum, Oxford. II. On Two New Species and Genera of Crinoidea; III. A New Species of *Oldhamia*, a Worm-track from the Slates of Bray Head, Ireland: Prof. W. J. Sollas, F.R.S.

THURSDAY, JANUARY 25.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: Mathematical Contributions to the Theory of Evolution—On the Law of Reversion: Prof. K. Pearson, F.R.S.—On the Mechanism of Gelation in Reversible Colloidal Systems: W. B. Hardy.—A Preliminary Investigation of the Conditions which determine the Stability of Irreversible Hydrosols: W. B. Hardy.—On the Effects of Strain on the Thermo-electric Qualities of Metals, Part II.: Dr. M. Maclean.—On the Periodicity in the Electric *Touch* of Chemical Elements: Prof. J. C. Bose.

ROYAL INSTITUTION, at 3.—The Senses of Primitive Man: Dr. W. H. R. Rivers.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Adjourned Discussion on the Report of the Institution's Visit to Switzerland.—*And if time permit*: An Electrolytic Centrifugal Process for the Production of Copper Tubes: Sherard Cowper-Coles.

FRIDAY, JANUARY 26.

ROYAL INSTITUTION, at 9.—Motive Power, High Speed Navigation, Steam Turbines: Hon. C. A. Parsons, F.R.S.

PHYSICAL SOCIETY, at 5.—Some Developments in the Use of Price's Guard Wire in Insulation Tests: Prof. Ayrton and Mr. Mather.—Reflection and Transmission of Electric Waves along Wires: Dr. E. Barton and Mr. L. Lownds.—The Frequency of the Transverse Vibrations of a Stretched India-rubber Cord: T. J. Barker.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Water Meters of the Present Day, with special reference to Small Flows and Waste in Dribbles: William Schönheyder.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Simplon Tunnel: C. B. Fox.

SATURDAY, JANUARY 27.

MATHEMATICAL ASSOCIATION (University College, Gower Street, W.C.), at 2.—Dynamical Applications of the Theory of Correspondence: Sir Robert S. Ball.—Triangles Triply in Perspective: J. A. Third.—The Teaching of Indices and Surds: Prof. R. W. Genese.—Illustrations of Porismatic Equations: T. J. Bromwich.—A Note on the Focoids: R. F. Davis.

CONTENTS.

THURSDAY, JANUARY 25, 1900.

THE OLD AND THE NEW KINETIC THEORY.

The Kinetic Theory of Gases. By Dr. Oskar Emil Meyer. Translated from the Second Revised Edition by Robert E. Baynes, M.A. Pp. xvi + 472. (London: Longmans, Green and Co., 1899.)

A Treatise on the Kinetic Theory of Gases. By S. H. Burbury, M.A., F.R.S. Pp. vi + 158. (Cambridge: At the University Press, 1899.)

IT is difficult for a reader at the present time to imagine himself back in the seventies before the first edition of Meyer's "Kinetische Gastheorie" appeared. After the outlines of the kinetic theory of gases had been sketched out by Clausius and Maxwell, much was needed to bring the theory into closer accord with the requirements alike of the mathematician and of the experimentalist. The back numbers of the *Wiener Sitzungsberichte* testify to the keen interest taken in the subject at the period to which we are alluding, and in connection with diffusion and other allied phenomena mainly depending on the free paths of the molecules of gases, a prominent place must be given to the writings of Oskar Emil Meyer. It was Meyer, for example, who taught us that in the diffusion of two gases whose molecules have unequal powers of penetrating into one another, a counter-current must set in to compensate for the differences of pressure which would otherwise be produced by the transference of molecules in the direction of the more penetrable gas—a theory which has met with wide acceptance.

Mr. Baynes, in preparing the English version of a new edition of Meyer's treatise, has given English readers a book calculated to meet the wants of a large and varied class of persons interested in the kinetic theory. Mathematicians will naturally turn their attention to the 112 pages of "Mathematical Appendices," and will there obtain an introduction to theories for the further development of which they will probably pass on to the writings of Boltzmann, Tait, Watson, Natanson and others; while the removal of this mathematical matter to a separate section renders the book specially suited to students of physics and chemistry who are interested with experimental conclusions rather than with abstract reasoning. It was for such readers that Meyer's first edition was written in 1877, and there can be no doubt that the book, presenting, as it does, the subject in the aspect of a physical reality and not as a mere collection of formulæ which may or may not accord with results of experiments, has done much to popularise the kinetic theory of gases, and thus indirectly to help to make its name at least familiar even to elementary pass-degree candidates. Now that we have an English edition students can have no excuse for not carrying their knowledge of the subject rather further; for a better introductory treatise could hardly be written, and there is little in Meyer's treatment that could present difficulties even to the veriest beginner. After an introductory chapter on the foundations of the theory, the relations between pressure and energy are dealt with very fully. "Maxwell's Law" is illustrated by a curve showing the distribution of speed, a diagram showing shots on a target distributed according to the error-law, and a statistical table showing the relative proportions of molecules whose speeds lie between different limits, reminding one of the statistical reports required by the Civil Service examiners. The two last illustrations well exhibit the fact that the probability of a molecule having its *speed* zero is infinitely small, and that there is a certain speed whose frequency is a maximum, notwithstanding that the most probable value of the *velocity component* in any direction is zero. In the chapter on "Ideal and actual gases," we have an account of Van der Waals' and allied hypotheses; while under the heading "Molecular and atomic energy" the specific heat ratios of gases and their dependence on the number of degrees of freedom of a molecule for heat-motions are discussed.

The second part deals with molecular free paths and the phenomena depending on them. It contains an exhaustive account of all that has been done in explaining viscosity, diffusion, and heat-conduction by the kinetic theory, the part on viscosity alone extending over seventy-six pages. The third part, which is much shorter than the two preceding ones, deals with "direct properties of molecules," including determinations of the size, number, and speed of molecules and the magnitudes of intermolecular forces. This concludes the physical portion of the book. In the mathematical appendices, the calculations are in many cases based both on Clausius' hypothesis of equal speeds, and also on Maxwell's distribution, and while the former method is at the present day of purely academic interest, its inclusion may be serviceable to beginners. Mr. Baynes has supplied an index besides adding to the already copious references to original memoirs, which are an important feature of the treatise. While a number of new theories have been inserted, and on the other hand many recent developments have been excluded, the author has perhaps wisely made the general scope and plan of the book the same as in the first edition. As he remarks in his preface,

> "with the present limitation to the old range it has cost very much trouble and very much time to work up the literature of the subject, which has grown mightily in these more than twenty years."

While Prof. Meyer and Mr. Baynes are contented to accept "Maxwell's Law" as a working hypothesis, Mr. Burbury has taken up the far more difficult task of working out the distribution of a system of molecules under conditions to which the ordinary proofs of the Boltzmann-Maxwell distribution are inapplicable, viz. when finite intermolecular forces exist, or when the volume of the molecules is not infinitely small compared with the total volume of the gas. The appearance during recent years of several papers from Mr. Burbury's pen has acquainted us with the general character of his labours, which involve practically the foundation of a new kinetic theory, and we are glad to read the general conclusions in the form of a handy treatise. In investigating the distribution of molecular co-ordinates and momenta, Burbury points out that we may take two different fundamental assumptions for our starting-point, namely, "Condition A," that the chance of any molecule having velocity components within given limits *is* independent of the distribution of co-ordinates and velocities of the other molecules; or "Condition B," that the chance of a given molecule having at any instant assigned velocities *is not* independent of the positions and velocities of all the other molecules at the instant. Condition A readily leads to the Boltzmann-Maxwell distribution, but Burbury finds that the assumption of Condition B (which is, of course, of wider application than Condition A) leads to a new law of distribution, according to which the chance of a system of molecules having their velocity components within the limits of the multiple differential of these components is

$$Ce^{-hQ}du_1dv_1dw_1 \ . \ . \ . \ du_ndv_ndw_n,$$

where

$$Q=\Sigma m(u_r^2+v_r^2+w_r^2)+\Sigma\Sigma b_{rs}(u_ru_s+v_rv_s+w_rw_s).$$

The b coefficients are functions of the distance between the molecules, which become inappreciable except when this distance is very small. When the b coefficients are negative, their meaning is that two near molecules are more likely to be moving in the same than in opposite directions, and the motions of the molecules are then said to be *correlated;* while in the opposite case of b_{rs} positive the motions are said to be *contrarelated.* It should be observed that $u_ru_s+v_rv_s+w_rw_s$ is equal to $q_rq_s \cos e$ where q_rq_s are the speeds, e the angle between their directions.

The view that the ultimate distribution differs from the Boltzmann-Maxwell distribution being at variance with the results of "Boltzmann's Minimum Theorem," Burbury carefully examines the proof given by Boltzmann, and concludes that "what the H theorem proves then is this, that the distribution of velocities expressed by the equation $F'f'=Ff$ is the only distribution which can be permanent consistent with the existence, and the continued existence of Condition A or its equivalent." In the motion obtained by reversing the velocities Condition A is not satisfied. Burbury considers that in this proof Boltzmann's assumption that the motion is "molecular ungeordnet" is equivalent to "Condition A." He remarks:—

"Let us endeavour to construct synthetically a system which shall without doubt be molecular ungeordnet. The molecules being distinguished by numbers, I ask (say) Dr. Watson to assign velocities to them according to any law he pleases. Then I, in complete ignorance of those assigned velocities, scatter the molecules at haphazard through space, and they shall start from the positions which I so give them with the velocities so assigned them by Dr. Watson. That is *prima facie* a molecular ungeordnet system; in fact, it is as near an approach to chaos as is possible in an imperfect world."

Burbury next proves that if the intermolecular forces, are finite, Condition A cannot exist, and $uu'+vv'+ww$ has an average finite value, a function of r which is positive if the forces are repulsive. This proof involves the assumption that uu' is zero in the absence of intermolecular forces, and we are told:

"Strictly, n the number of molecules in the system being finite and the centre of inertia at rest, it must be negative, but it may be neglected when n is great."

This is rather a difficult assumption to accept without further explanation. The proof that "correlation" must exist when the molecules are equal elastic spheres is much more laborious. In the chapter on "General theory of the stationary motion," it is shown that "Maxwell's law of partition of energy" does not necessarily hold except when Condition A is satisfied. This is as it should be; otherwise the heat given to a polyatomic gas would be divided equally between all the atoms of all the molecules, instead of being divided, as Boltzmann teaches us, mainly between the translatory and rotatory motions of the molecules, which are the only motions to which Condition A is applicable.

Under the title "On molecules as carriers," we have a short account of Boltzmann's simple method of treating diffusion and allied phenomena, based on the latter's "Vorlesungen über Gastheorie." We hope that the general mathematical reasoning on which Burbury's theory of correlation rests is not to be gauged by his method of investigating the mean free path on p. 115, in which he says: "Let $1-\pi c^2N\lambda/\omega=\phi(\lambda)=\phi$," and a few lines later infers that $\phi=e^{-k\lambda}$ where $k=\pi c^2N/\omega$, and $k\lambda$ is finite.

The chapter on "Thermodynamical relations" well brings out the fact that while Burbury's new distribution, like the conventional one, fulfills the condition that dQ has an integrating divisor, the usual symbol for which (in this country) is the first letter of the word "Temperature," but little progress has so far been made in explaining the fundamental properties of temperature by molecular motions. The properties of irreversible thermodynamics are nowhere more manifest than in the friction, heat conduction, and imperfect elasticity of solid bodies whose molecules are not only correlated, but appear inseparably interlocked. Yet hardly any headway has been made in getting the equation of energy-equilibrium between two bodies into a form analogous to that expressing equality of temperature, except under highly specialised assumptions as to the law of distribution of energy, which prevent the conclusions from being applied to any but attenuated gases. Every attempt to advance in the desired direction has hitherto led to hopeless mathematical difficulties.

A discussion on the merits of Burbury's new method of analysis would be out of place in the present review. His theory represents the outcome of much thinking, and is not to be disposed of hastily. It boldly faces the question of correlation, and thus brings us one step nearer towards explaining the properties of dense assemblages of molecules. It has the remarkable property that the character of the motion changes completely when the expression Q ceases to be essentially positive, by the vanishing of the determinant of the coefficients of Q or of one of its leading minors; and we know that the state of a gas also suddenly changes by liquefaction. Seeing, however, that it is necessary to regard actual molecules, not as spheres or material points, but rather as non-spherical rigid bodies, it still remains for Burbury to tackle the far more difficult question of the distribution of translatory and rotatory motions of unsymmetrical or axially symmetrical molecules when correlation exists. And we have a kind of vague feeling that probability considerations and finite molecular forces which are functions of the distances and positions of the molecules are bringing us not much nearer the desired goal of explaining temperature. Indeed, the question of deducing the laws of irreversible heat-phenomena from probability considerations becomes more and more difficult the more it is studied. But physicists have given us another source of irreversibility, of which the kinetic theorist has hitherto made little use. The equation

$$\frac{d^2(r\phi)}{dt^2}=a^2\frac{d^2(r\phi)}{dr^2}$$

representing propagation of spherical waves is satisfied mathematically by $r\phi = F(at+r)+f(at-r)$; but the physicist has to make the axiom that waves always radiate *from*, and never converge *to* a source of disturbance, and hence, that the second term alone exists in nature. Seeing that the molecules on our earth derive so much of their heat-energy from the sun, which energy is (if we may use the expression) transported across some ninety million miles of ether by equations of this type, it is surely desirable that some working hypothesis should be formulated for the conversion of radiant energy into energy of heat motion, and a kinetic theory involving such a hypothesis would explain irreversibility as a natural consequence of the simple axiom involved in the suppression of $F(at+r)$.

We trust that neither Mr. Burbury nor Prof. Boltzmann will construe any of these remarks into expressions of criticism on the points of difference between their conclusions, and we hope that ere long both these writers will enlighten us further on the questions at issue. The writer of the present review has (doubtless in common with many others) spent a considerable amount of time in trying to attack that tantalising question of temperature from a kinetic standpoint coupled with probability considerations, or even deducing the law of molecular distribution from the temperature-property; but every attempt leads to an impenetrable wall built of dense assemblages of molecules which cannot be assumed to follow the Boltzmann-Maxwell distribution, and which seem to say to the mathematician, "Thus far shalt thou go, but no further." G. H. Bryan.

THE ZOOLOGY OF THE INDIAN SEAS.

A Descriptive Catalogue of the Indian Deep-Sea Fishes in the Indian Museum. Pp. iii+212 and viii.

An Account of the Deep-Sea Brachyura. Being Systematic Reports upon the Materials collected by the Royal Indian Marine Survey Ship "Investigator," 1874–1899. By A. Alcock, M.B. Pp. ii+85. (Calcutta: Printed by the Trustees of the Indian Museum, 1899.)

The Catalogue of Deep-Sea Fishes is a monumental work, since it completes the description in full of a large number of species already listed in the author's papers, now well known, and illustrated in the "Illustrations of the Zoology of the *Investigator*" which he inaugurated in 1892, and which, thanks to the skill of his native artists, is likely to become classic.

The fishes dealt with number 169 species, the Anacanthini and Physostomi being, as might be expected, in the majority, and but two of them Plectognathi. 126 of these stand to the record of the *Investigator* alone, and 43 only appear identical with species found elsewhere; 23 are said to be common to the Indian seas and the Atlantic, and a special feature is the occurrence of a Trachinoid fish (*a Bembrops*) originally found in Japan. Dr. Gunther, as is pointed out, has already familiarised us with the idea of a former open connection between the Mediterranean and Japanese seas; and, discussing this fish and certain related forms, the author dismissing the "comfortable formula" "similarity of conditions," is led to the conclusion that "a considerable part of the fish-fauna of the Oriental region originated from, and to a certain extent is a remnant of, the fauna of the Tertiary Mediterranean of Suess—of a Mediterranean that extended from the present Gulf of Mexico, through the present Mediterranean basin, far into the eastern hemisphere."

The chief novelty of the present work is a chart compiled from Koken's "Vorwelt und ihre Entwickelungsgeschichte" with the object of rendering clear the bearings of the above conclusion. The present coast-lines and those supposed to have existed during the Tertiary period are indicated in dissimilar contours, and the presumed area of the Inland Sea is rendered appropriately clear. In the construction of this chart the author has sought the advice by Mr. T. H. Holland, formerly of the Royal College of Science, London, and that gentleman's splendid work on the Geological Survey of India amply justifies the choice.

The fresh-water fishes (mainly Ostariophyseæ and Cichlidæ) come in for consideration. The occurrence of a Symbranchid species common in Tropical America and Australia, of Cyprinodonts known from Tropical Africa and America, are duly emphasised, while the author's records concerning the Cichlidæ (Chromides) have an especial value now that our knowledge of this remarkable group is being revolutionised by our distinguished English Ichthyologist, Boulenger.

It is praise sufficient to remark that this grand monograph in no way falls short of its predecessors we have so recently reviewed (see Nature, vol. lx. p. 459), and that it will remain for generations a standard work of reference.

The report on the Brachyura is serial with those on the Madreporaria and Ophiuroidea, and, like the former, is prefaced by an account of the history of the expedition and of its association with the Indian Museum. It completes the work of the expedition on the crabs, and as regarding descriptions of new species it is supplemental to a series of earlier papers by the author, his former associate and predecessor in office, the late Prof. Wood-Mason, and his present colleague, Dr. A. R. L. Anderson, extending over a period of more than twenty years. The present volume deals with 53 species and 38 genera, with two exceptions from depths of over 100 fathoms; and of these 21 genera and 5 species are known from other seas. Interest centres in the discovery of affinities between the fauna of the Indian and Atlantic deep-sea areas, which the author is disposed to interpret as indicative of a former open connection between the two, for which he has already argued in reporting upon the Madreporaria. Bathymetrically one species only (an *Ethusa*) was obtained at a depth exceeding 1000 fathoms, 3 (*Ethusa*, 2 sp. and a *Hypsophrys*) between 800 and 1000 fathoms, 3 between 500 and 800, and 18 between 400 and 500, while of the majority obtained at depths of from 100 to 400 fathoms many also occur in shallower water. A supposed *Doclea* stands alone as a true shallow-water species captured at the hundred fathom line.

The list reveals a predominance of Oxystomid and Oxyrhynchid forms, and the careful diagnoses which comprise the bulk of the report are illustrated by four exquisite plates, drawn by the native artists who so fully distinguished themselves in the delineation of the corals. For accuracy and beauty of execution they would be difficult to surpass, and it affords us great pleasure to add that in the collotyping process employed by Messrs. Taylor and Francis, who have reproduced these drawings, nothing has apparently been depreciated or lost. The result is an entirely new departure in English art work, full of promise for the future. In dealing with the higher Crustacea Dr. Alcock is on his strongest ground, for his "Materials for a Carcinological Fauna" is already an established work of cyclopædic importance. The result of the present undertaking is a triumph for those concerned, the *tout ensemble* a memorable one, and as a final comment upon it we can only add that Dr. Alcock has incurred yet another contribution to the debt of gratitude due to him by zoologists at large.

ANTIQUITIES OF CENTRAL AMERICA.

A Glimpse at Guatemala and Some Notes on the Ancient Monuments of Central America. By Anne Carey Maudslay and Alfred Percival Maudslay. With Maps, Plans, Photographs, and other Illustrations. Pp. xvii + 289. (London: Murray, 1899.)

FOR the last two decades the name of Mr. A. P. Maudslay has been the most conspicuous of those associated with archæological work in Central America. No other explorer, not even excepting Mr. Stephens himself, has covered so much ground and obtained such valuable results in this wide field of research. Since 1881 he has spent many years amid the ruined cities of Guatemala, Yucatan, and Honduras, has studied the monuments in minute detail, taken innumerable drawings and castings of carvings and inscriptions, drawn elaborate ground plans of palaces and temples from which the rank vegetable growths had first to be cleared. On the main and special features of these crumbling remains he has published several copious monographs in the *Geographical Journal* and elsewhere, and is now giving to the world the results of his seven expeditions in the *Biologia Centrali-Americana*, of which eight parts, with no less than 200 plates, have already been issued.

When, therefore, this sumptuous volume was announced, specialists and other close students of American antiquities looked forward to a great banquet spread out with a view to their particular tastes and expectations. In this respect they will certainly be somewhat disappointed, while the general public will be all the more charmed with a book of travels which is written in a fascinating style, and in which the note of living human interest is stronger than that of a vanished past. The book is exactly what it professes to be—a brightly written account of a final visit paid in 1894 to the scene of his long and fruitful labours, the main object being to take a general look round, and give in a small compass a rough idea of the vast amount of work which has been accomplished, and will be permanently recorded in the more costly and less accessible volumes of the *Biologia*.

During this last survey Mr. Maudslay was accompanied by his wife; and the arrangement by which the lighter and more descriptive sections were entrusted to her skilful pen has been attended with the happiest results. Besides some very searching "glimpses" at the country, its scenery, vegetable and animal life, and present inhabitants, special visits were paid to Coban, Rabinal, Copan, Quiregua, Ixkun, Chichen Itza, Palenque, and Tikál, and some further archæological work carried out at several of these places. Special chapters written by Mr. Maudslay are devoted to such work, while Mrs. Maudslay takes charge of the incidents of travel, household matters, the surroundings, attitude of the natives, and so forth. Some of her pictures are extremely graphic, as when she enters sympathetically into the bird life, and tells us how

"we shared our dining-room with the birds, who came in flocks to feed on the ficus and other fruit-bearing trees, and we were never weary of watching them at play amongst the branches overhead. At first the parrots and parroquets vastly outnumbered all the others, and appeared to have formed a settlement in the tree above our tent. These parrots were a boisterous family, who woke at dawn, and began screaming and chattering whilst they performed round the branches all those gymnastic feats which I have thought were only devised in captivity to vary the monotony of cage-life. But the parroquets, who lived in the same tree, appeared to be quiet little creatures, who nestled near to one another, whispering and cooing gently, until some sudden impulse would seize both parties, and they would dash off in the air, flashing circles of gold and red and green as the sun caught the glint of their plumage, and then return as suddenly to the shelter of the trees to chatter loudly over their exploits."

While all this is going on, Mr. Maudslay is busy amid the neighbouring ruins on the banks of the Copan, which he had first surveyed in 1881, and studied more carefully in 1885. Here was revealed the fine ornamental doorway of a temple, and here the important discovery was made that nearly all the truncated pyramidal mounds had been crowned by temples, thus bringing these monuments, like those of Chichen Itza, Uxmal, and so many others in Yucatan, in line with Cholula, Teotihuacan, Papantla, and the one or two other extant Mexican *teocalli*. The genesis of all is the same—mounds raised above the remains of departed chiefs, and terminating, not with a point as in Egypt, but with a platform on which to perform sacrificial rites and build the teocalli ("God's House"), when in due course the great chief joined the Clympians. But were these structures built by the same race, and, if so, by whom? In a chapter on "Conclusions" Mr. Maudslay discusses this vexed question in connection with the obscure relations of Toltecs, Nahuas, and Mayas, and infers that the Toltecs were not of Aztec (Nahua) but of Maya stock. He, however, speaks with uncertain voice, and still doubts whether the stream of migration set from Mexico southwards or from Central America northwards. But the problem may now be regarded as solved in favour of the first assumption; and if Mr. Maudslay hesitates, it is only because he overlooks one of the factors essential to its solution. The cradle of the Maya race is not Yucatan, which they appear to have been the first to occupy as an already civilised people (Mercer). They brought their civilisation with them from the Anahuac tableland, which they had reached from the Atlantic slopes (Tamaulipas, Vera Cruz), where the original stock still survives. Here the widely-diffused Huaxtec nation speaks, not a dialect or a later form, but an archaic type of Maya speech. Here also they had attained a high degree of culture in remote times, as attested by the wonderful truncated pyramid of Papantla, which, although described by Humboldt, appears to be again forgotten. Though of small size, Papantla must rank as the most wonderful structure of the kind in the New World, being built, not of adobe, like Teotihuacan, Cholula, and those farther south, but of huge porphyry blocks covered with glyphs and carvings of snakes and alligators, and exquisitely polished, like the monoliths of Tiahuanaco on the shores of Lake Titicaca. The pyramid is disposed in receding terraces, and the platform on which the sacrifices were offered is approached by a broad flight of steps. Papantla is consequently a type of these structures, which, like the dolmens and menhirs of the Afro-European men of the New Stone Age, may now be followed along the Maya line of migrations through Cholula to Tula (Tollan), and thence by the western (Pacific) route to their new homes in Central America. What drove them south? Natural expansion or invasion? Clearly the latter, else they must have held their ground in the great centres of their culture on the plateau—Teotihuacan and Tula—where the ruins are not of Nahua, but of Maya type. The Nahuas, probably distant kinsmen of the North American Shoshones, came later, and swept in successive waves of barbarism over the tableland, clearing out the cultured Huaxtecs (northern Mayas), and destroying their great city of Tollan, whence came their name, "Toltecs." The last wave was that of the Aztecs, who, after settling in the Valley of Mexico (Tenochtitlan) and developing a certain culture under Huaxtec influences, also spread southwards, following the same Pacific route, and ranging as far as Guatemala, Salvador and Nicaragua (Pipils and Niquirans). Now everything may be explained. Safely entrenched on the Chiapas-Guatemalan plateau, the early Mayas continued to develop their "Toltec" culture, partly assimilating the Quichés and other rude aborigines, all of whom now speak languages of Maya stock, and at last passing at the apogee of their civilisation into the hitherto unoccupied limestone peninsula of Mayapan (Yucatan). Here they were still later (not long before the discovery) followed by the conquering Aztecs, whence the traces of distinctive Nahua art, such as

"those curious mural paintings recently found by Dr. Gann in British Honduras, on the eastern limit of the Maya area, paintings essentially Nahua in style, yet accompanied by a legend in Maya hieroglyphs" (p. 252).

Mr. Maudslay also devotes a chapter to this Maya script, which he rightly distinguishes from the Aztec, while "doubtful if more than a mere trace of phoneticism has as yet been established" (p. 254). A very full and lucid account is given of the ingenious method by which Mr. J. T. Goodman has with some measure of success attempted to solve the riddle of the Maya Calendric system. But, strange to say, no reference is made to Mr. Cyrus Thomas's more extended and perhaps more fruitful labours in this difficult field of palæographic research. In his "Day Symbols of the Maya Year" (*16th Ann. Report Bureau Eth.*, p. 205), Mr. Thomas seems at all events to prove that the Maya Script had passed from the pictographic through the ideographic to an initial stage of a true phonetic system. As in the Egyptian hieroglyphs, all the processes are no doubt intermingled, while several of the symbols must be read phonetically as syllables if not as letters. The system would thus appear to have reached the rebus stage, in which some of the characters are to be taken as pictograms, some as ideograms, and some as syllables irrespective of their pictorial value.

On the broader question of the independent evolution of American culture, Mr. Maudslay takes what may now perhaps be called the orthodox view.

"It is, indeed, possible that accidental drifts from Asia may occasionally have influenced American culture, but such drifts across a great ocean must have been few and far between. If the population of America came originally from the Asiatic Continent, such an original migration must have taken place so early in the history of the human race that it antedated the use of bronze, iron, or domestic animals in the land from which the migrants came" (p. 272).

In other words, whatever the American aborigines owe to the Old World dates from the Stone Ages, as the expression is commonly understood, all else has been locally developed independently of any extraneous influences.

The volume, it is almost needless to say, is superbly illustrated with over a hundred photogravures, chromo-lithographs, ground-plans and etchings, besides a large scale-map of all the Central American lands (Guatemala, Yucatan, Chiapas, Honduras and neighbouring districts) in which ruined cities have been discovered. There is also a sufficiently copious index, and the volume is altogether handsomely equipped. A. H. KEANE.

OUR BOOK SHELF.

Das Geschlecht der Pflanzen. Von R. J. Camerarius. Pp. xiii + 78. (Leipzig: Engelmann, 1899).

IT seems difficult to believe that scarcely two centuries have elapsed since botanists first began to recognise the most elementary fact in the sexual propagation of plants, namely, the function of the pollen as the male fertilising agent. Yet such is the fact. The letter of Camerarius to Valentin, "De sexu plantarum," published in 1694, marks an epoch in the history of botany. Up to that time a knowledge of the processes which must precede the production of a fertile seed had remained *in statu quo ante* since the time of Theophrastus, the pupil of Aristotle; nor was any further substantial advance made before the writings of Kölreuter and Sprengel, seventy and one hundred years later.

The services of Camerarius to botanical science have been amply acknowledged by the historians of botany, especially by Sachs in his "Geschichte der Botanik" (see Garnsey's translation, pp. 385-90), who speaks of his letter to Valentin as being "often mentioned, but apparently little read"; but now for the first time we have a translation of it in any modern language, and the little book is a valuable addition to the botanist's library.

Camerarius' method was thoroughly Darwinian. His conclusions were based entirely on most careful personal observations; and all objections to his explanations were impartially noted and carefully considered. It was largely from the phenomena exhibited by unisexual, and especially by diœcious, plants that Camerarius drew the conclusion admirably summed up in his own words (Garnsey's translation): "In the vegetable kingdom no production of seeds . . . takes place unless the anthers have prepared beforehand the young plant contained in the seed. It appears, therefore, justifiable to give these 'apices' a nobler name, and to ascribe to them the significance of male sexual organs, since they are the receptacles in which the seed itself, that is, the powder which is the most subtle part of the plant, is secreted and collected, to be afterwards supplied from them. It is equally evident that the ovary with its style represents the female sexual organ of the plant."

The thanks of all botanists are due to the publishers and to Prof. Möbius, who has prepared the translation, for this somewhat tardy tribute to the work of a great investigator. But few of his contemporaries recognised its merits; our own fellow-countryman, Ray, perhaps, more than any other. A. W. B.

Journals and Papers of Chauncy Maples, D.D., F.R.G.S., late Bishop of Likoma, Lake Nyasa. Edited by Ellen Maples. Pp. 278. (London: Longmans and Co., 1899.)

THE presence of an attractive and educated personality for some twenty years in equatorial savage Africa is explained by the fact that Chauncy Maples was an Oxford member of the Universities' Mission to Central Africa. The first sixty pages contain the journal of his journey through the Meto country, an abstract of which was given before the Royal Geographical Society in 1882. The last paper is the unfinished one of a series in the *Nyasa News*, the first paper printed on the lake, and started by him in 1893. It ends with pathetic abruptness by an unanswered question: he was drowned in the lake as he was writing it. The papers form a sequel to the "Life," which has already been noticed in NATURE; they manifest a sincere, human and kindly perception of the aims of scientific investigation. There is much chatty natural history throughout these papers. One of them compares Anyanja with Melanesian as depicted in Dr. Codrington's "Studies." But perhaps the most valuable contribution is the paper read in 1891 before the Oxford Graduates' Missionary Association on the power of the conscience, the sense of the moral law, and the idea of God amongst certain tribes in East Africa. Anthropologists will, in fact, find the first-hand impressions of a cultured English gentleman after years of residence. J. F. H.

Leçons de Chimie Physique. Par J. H. van 't Hoff. Ouvrage traduit de l'allemand par M. Corvisy. Deuxième partie: La Statique Chimique. Pp. 162. (Paris: Hermann, 1899.)

WE have now before us a French translation of the second part of van 't Hoff's admirable lectures on physical and theoretical chemistry. Attention was drawn in the notice of the first part (NATURE, vol. lix. p. 458, 1899) to the somewhat unusual division of the subject. There, under the title of chemical dynamics, equilibrium and velocity of reaction were dealt with on the basis of thermodynamics and the law of mass action; here, under the title of chemical statics, we have a methodical and systematic treatment of molecular chemistry. In Part I. mathematical methods were of necessity adopted; n Part II. the methods are more purely chemical, and will appeal in especial to the organic chemist.

After a short review of the nature of the atomic and molecular theories, the author proceeds to discuss molecular weight and polymerism in a section which occupies half the present volume. Avogadro's law and the molecular weights of gases naturally receive first attention, and are briefly disposed of. Then, at much greater length, come the methods for the determination of molecular weights in solution, the classification being in accordance with the thermodynamic cycles involved in their deduction from the gas-laws for dilute solutions. Molecular complexity and the anomalies encountered with isomorphous mixtures and electrolytic solutions are next discussed, the section concluding with an account of the work done on solid solutions. The author clearly discriminates between crystalline and amorphous solutions, and it is interesting in this connection to find that he is of opinion that palladium-hydrogen probably contains the hydrogen in the state of single atoms, and that the retention of dyes by fibres is not, strictly speaking, a case of solid solution, but of surface action, like the absorption of various substances by charcoal.

The second section of the book is on molecular structure, and includes subjects of such general chemical interest as the determination of constitution and configuration, isomerism, tautomerism and racemism. As one might expect from the chief founder of stereochemistry, the treatment of this section is masterly, both in its brevity and in its clearness.

The third and concluding section deals with molecular grouping and polymorphism. In it are discussed the laws regulating the transformation of polymorphous substances, the theories of crystallographic structure, and the orientation of molecules in the crystal.

To those who teach and to those who study advanced chemistry the book is indispensable. J. W.

Gli Agrumi. By Prof. Antonio Aloi. Pp. xi + 238. (Milano: Ulrico Hoepli, 1900.)

THIS book, which is one of a series of manuals, deals with the cultivation of oranges, lemons, and other species of the genus *Citrus*.

Among the subjects treated of are the soil and climate suitable to the growth of these plants, manuring, grafting, spacing of the trees, pruning, irrigation, parasites, and maladies. One may mention as deserving special notice the tables given to elucidate the scientific treatment of manuring, which are calculated from chemical analyses of fruit, leaves, &c., combined with the computed production of the latter per plant. With regard to maladies, different remedies, which have been suggested and tried, are described. The concluding chapter contains calculations as to the expenses and profits connected with the cultivation of the plants in question. The book is small, nicely got-up, and contains five coloured plates illustrating different diseases, and twenty-two wood-cuts. It should be very useful to those concerned in the cultivation of oranges and other plants; many points in it, moreover, are of interest to the general botanist.

Star-Land. By Sir Robert S. Ball, F.R.S. New and revised edition. Pp. viii + 388. (London: Cassell and Co., Ltd., 1899.)

THE new edition of this popular work on astronomy, based on lectures addressed to a juvenile audience, calls for little remark. A few additional illustrations have been introduced, but we are astonished to find that some of the original diagrams have not been amended. Fig. 17, for example, shows a large sun-spot far outside the sun-spot zone; and Fig. 23 shows the altitude of the sun at noon on the shortest day much too great in comparison with the position indicated for the longest day. If the author's name were unknown, diagrams like these would certainly suggest a want of personal acquaintance with astronomical phenomena.

Brain in Relation to Mind. By J. Sanderson Christison, M.D. Pp. 142. (Chicago: Dr. Christison, 1899.)

"COMPARATIVELY few physicians and fewer laymen," says Dr. Christison, "have a satisfactory view of the relationship of brain to mind," and we are afraid that Dr. Christison is not among the minority. When the writer of a book that purports to be a serious work on psychology commits himself to such statements as that "the use of means to a given end implies the pre-existence of a specific potentiality having a plan in the abstract, for only the pre-existing can be the cause of a necessity"; and that "the evolution idea . . . is absolutely incompatible with law and order," it would be out of place to deal with him in a serious review.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Is New Zealand a Zoological Region?

As some weeks must elapse before Mr. Farquhar is able to reply to the questions asked (p. 273) by my good friend Mr. Wallace, I would urge your readers to bear in mind that no particular sanctity should be attached to the word "Region." Such a sanctity was once ascribed to the word "Species," and to no one living more than Mr. Wallace are we indebted for the removal of the misconception therein involved. Properly used both are very good words, and it would not be easy to get on without them; but to each may be ascribed a virtue which it does not rightly possess. In the case of New Zealand I would meanwhile refer to the expression of Prof. Huxley's views in the *Proceedings* of the Zoological Society for 1868, which so far as I know have never been refuted. ALFRED NEWTON.

Cambridge, January 20.

Compensation in Weather.

As our climate does not, in a long series of years, undergo permanent change, we are accustomed, in a time of extreme cold, wetness, or other quality of weather, to expect, in a vague way, that we shall have, ere long, a variation in the opposite direction, equalising matters. Is it possible to attain greater definiteness in such expectation, and, utilising the principle of compensation, to forecast, in a measure, the character of an approaching season?

I propose to inquire what sort of relation subsists between the cold of a given winter and that of the thirty winters preceding.

We may conveniently measure the cold of winter seasons by the total number of frost days from September to May. (For brevity, we shall here designate each winter season by the year in which it *ends*; 1842, *e.g.* meaning 1841–42.)

Let us, then, begin by adding the numbers of frost days in the thirty winters 1842 to 1871, 1843 to 1872, and so on. We thus get a series of twenty-nine numbers, varying from 1593 to 1717, with an average of 1653.

The following table may now be considered:—

Groups of 30 winters containing, of frost days,			Average number of frost days in winter following.
(1) Under 1610	...	3 cases	... 68·0
(2) 1610–1629	...	6 ,,	... 66·2
(3) 1630–1649	...	5 ,,	... 60·4
(4) 1650–1669	...	6 ,,	... 44·0
(5) 1670–1689	...	2 ,,	... 51·0 *e*
(6) 1690 or more	...	6 ,,	... 42·0

Thus, in general, the larger the number of frost days in the 30-winter groups, the smaller, on an average, is the number in the winter following. A reversal occurs at No. 5. (But there are only two cases.)

This is, perhaps, very much what we should expect on the principle of compensation.

Analysing further, we must bear in mind that the data considered are not very numerous, and beware of building too much on a slender foundation. The remarks here offered are rather by way of suggesting a method which might perhaps be found practically helpful, if fuller data were found to point in the same direction. We may, then, note these three facts:—

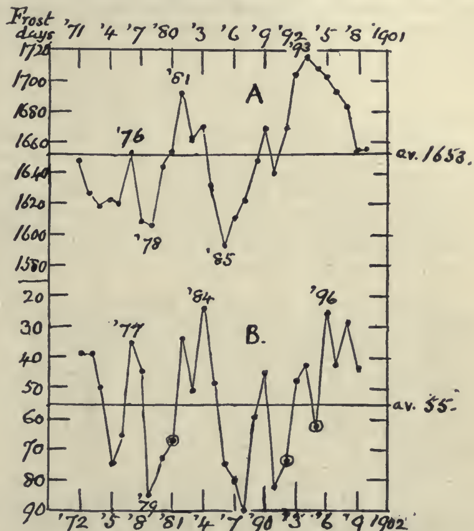
(1) The six mildest winters (since 1871) were each preceded by a 30-year group having *more* than the average of frost days.

(2) The six *coldest* winters were each preceded by a 30-year group having *less* than the average of frost days.

(3) Of fifteen 30-year groups with excessive cold (*i.e.* over the average), as many as *twelve* were followed by mild winters, and only *three* (*i.e.* one-fifth) by severe winters.

Applying the same method to frost days in the first half of each year, it might be shown that out of *twelve* 30-year groups with excessive cold, *ten* were followed by mild first halves, and only *two* by severe first halves.

Reverting to the former case (total winter seasons), the diagram represents, in curve A, the total frost days in 30-winter groups ending 1871, 1872, &c. Below is an inverted curve, the first point of which indicates the number of frost days in winter 1872, the second in winter 1873, and so on. (The time scale below, it will be seen, is shifted one year to the left.)



A. Curve of frost-days in 30 winters ending 1871, 1872, &c.
B. Curve of frost-days in winters 1872, 1873, &c. (inverted).

A certain correspondence may be traced between these curves. And taking the dots above the average line in A, it will be seen, how, except in three cases, marked by a small circle (in B), each corresponds with a mild winter in B, a fact already noted.

There is a curious lag in part of the second curve. We find two conspicuous wave-crests in A, viz. in 1881 and 1893, and the highest points (*i.e.* lowest values) in B are in 1884 and 1896. Further, the lowest point in A is in 1885; the lowest in B in 1888. An interval of three years in each case. It might be worth while to observe whether this is repeated to any extent in the future course of these curves.

Now the last thirty winter seasons (ending 1899) have a total of 1657 frost days, and if we allowed ourselves to speculate as to the quantity of frost in the current winter season (1900) we might at least perhaps fairly anticipate, or might have anticipated, that this would not turn out an extremely severe winter, and that the chances are rather against its being extremely mild either. But the point I would emphasise is that, with copious material, useful hints might possibly be obtained as to the limits within which the character of a coming season (or other portion of time), as to heat or other quality would probably occur. To this end, I may remark, some might find a diagram of dots helpful, in which, taking the case of winters, the abscissæ and ordinates are used for the 30-winter groups, and the following winters respectively, a dot being placed at each crossing point of the lines from the two scales. ALEX. B. MACDOWALL.

THE METHODS OF INORGANIC EVOLUTION.[1]

II.

I HAVE already said that I think most chemists would consider that the formation of larger masses by polymerisation is more probable than by the coming together of dissimilar atoms; but if we consider chemical compounds, certainly the analogy is all in favour of the latter view if the principle of continuity be taken into account, for we are ignorant of the point at which one evolutionary process resigns in favour of another. The present separation of compound from simple bodies is, indeed, simply a measure of our ignorance arising from the feebleness of our laboratory resources in relation to the temperature required to produce more and more simplifications.

I discussed this question in my "Chemistry of the Sun"[2] in 1887, and showed that the analogy of the completely studied hydrocarbon series beginning with CH_2 suggested a hypothetical elemental sequence.

$a \quad b$
$a+b$
$a+(b+b)$ written by chemists ab_2
$a+(b_2)\ (b_2)$,, ,, ab_4

and so on.

In the concrete hydrocarbon series we have continuous additions of CH_2 to CH_4 until we reach a molecule defined by $C_{16}H_{34}$, and as the building up of this molecule can be traced without difficulty, so we can imagine it simplified by successive *sheddings* of its constituent CH_2; we pass from a simplification which we can bring about by simple halving to one which provides us with relatively large and small masses.

The next question which arises then is whether there is any way open to us of getting still more light on this matter beyond that furnished by orthodox chemistry.

Let us consider the regions of thought from which we may expect it. To do this, I must go back to my original conclusion derived in 1873 from the spectroscopic facts then accumulated in the work on the sun and stars, and the laboratory observations made to attempt to understand them.

I then wrote:—

"I have asked myself whether all the above facts cannot be grouped together in a working hypothesis which assumes that in the reversing layers of the sun and stars various degrees of 'celestial dissociation' are at work, which dissociation prevents the coming together of the atoms which, at the temperature of the earth and at all artificial temperatures yet attained here, compose the metals, the metalloids and compounds."[3]

With the progress of science the idea of "atoms" has considerably changed, and this change of view enables us to study the question of dissociation in a more rigid way than was previously possible.

Formerly "atoms" were regarded as merely chemically different from element to element; the recent investigations have introduced a new conception. It is now no longer chemically different matter merely, but matter, whether chemically different or not, *carrying an electric charge.* In the first work along this new line physicists, in order to grapple with the phenomena of electrolysis and solutions, imagined sub-molecules or sub-atoms carrying an electric charge in an electrolyte from the anode to the kathode; this was called an ion (Gr. a goer). This conception has been more recently used to explain those movements of particles of matter which produce light, and therefore spectral lines. The sub-particle, this *ion*, with its electric charge e and its mass m, is supposed to move in an elliptic orbit under the attraction of a centre. At first the theory supposed the ions to be electrified particles, but a recent extension considers them to be complex dynamical systems the motions of which are registered by spectral phenomena.

It will be gathered from what I have already said relating to the various questions connected with the study of "series" of spectral lines how the idea of "complex dynamical systems" is also demanded to explain the phenomena presented by them.

Thus I have shown it to be probable that the hydrogen atom which the chemist weighs may be built up of hundreds of the things, call them what you will, a few of which in the hottest stars produce the vibrations which we take as demonstrating the existence of hydrogen in the celestial spaces.

Both these lines of modern evidence tend to justify the view that the different spectra are not produced by different material, but by different conditionings of the same material.

These different conditionings may refer either to the electric charge or to the mass of the ion, or of the molecule round which the ion circulates. The units of matter present in the ion or in the central molecule may vary in number, or their arrangement may vary.

Imagine a series of substances "chemically" different, the intrinsic difference of which really consists merely of their being built up of *different numbers of units*, from A the simplest to Z the most complex. When Z is simplified by heat, its complex system of centre of force and ion with their electric charges will undergo changes which we may expect to result in the formation of less complex systems doubtless built on a like pattern, and therefore capable of producing spectra; hence we are bound to see the spectra of some of the intermediate forms which, when they are stable and go about in company, it may well be that physicists have already recognised. These we may call B or C, or R or S, or X or Y, as representatives of various complexities.

The more complex the form experimented on and the higher the temperature employed in the laboratory, the more spectral lines indicating different chemical "elements" in intermediate stages may we see.

I say in the laboratory because in the stars the result will be different. There, in consequence of the long continued action of heat and the shielding of the reversing layer from the effects of lower temperature, we may only see at the highest temperature the spectra of the forms A and near A. We now know what these are.

To take another case, let us assume that the electric charges or arrangement as well as the number of the units of matter may vary. Under these conditions, when we dissociate Z, not all, but only some, of possible intermediate forms may be expected to afford spectral evidence. Say, to take an example, those in the vertical columns of Mendeléef's table, and I am led to make this suggestion because Kayser has shown that in "series" the duplicity or triplicity of lines is associated with the position of the elements producing them in these columns. A concrete case would be afforded by contrasting the behaviour of sodium and cæsium, representing relatively simple and complex substances. We might observe the lines of sodium when cæsium is dissociated; we should not expect to see the lines of cæsium when sodium is dissociated.

The two cases taken it is possible may illustrate the difference between related and not related groups of "elements."

The apparently constant appearance of representative lines of the spectrum of one substance of a group in that of the other member of the same group may be thus explained, although it has generally been attributed to the presence of impurities, as in the case of all common long lines seen in spectra; and this in spite of the pro-

[1] Continued from p. 131. [2] P. 263 *et seq.*
[3] Bakerian Lecture, 1873 (*Phil. Trans.*, clxiv. Part 2, p. 491).

test that if the purest specimens known (I have worked on beads of Stas' silver which had never been touched) were so impure, some of the decimals used to express their atomic weight might be well spared. But it is not a question of apparent impurities only.

It is possible that some of the gases of lower atomic weight which exist in the hottest stars may be represented by A in opposition to heavy metals represented by Z, the existence of which is known in the cooler stars only.

The giving off of gases from metals when high tension electricity is employed is well known. This has been explained by assuming them to be "furnace gases," that is, gases "occluded" by the metals during their reduction. But this does not seem to be a sufficient explanation, for the same gases are given off by meteorites. We now see why something like this may happen if there is any foundation for the modern conception of the structure of the "atom"; and do not these facts explain the chemistry of the hottest stars?

It is too early yet to attempt to discuss the effects of the electric charge in this connection, but it must be pointed out that so soon as the ions, however associated their units may be, which are supposed always to have an electric charge upon them, are subjected to the action of a voltaic or induced current, the spectral phenomena observed when they are heated are liable to great changes in some cases, and especially when high atomic weights are in question. Doubtless we have here a field of research which will ultimately supply us with the most precious knowledge. I have already shown that with the gases, such as hydrogen and oxygen, heat alone gives rise to no spectral phenomena, while in the case of such metals as sodium heat is so effective in its dissociating power that the subsequent application of electricity produces no further change.

We have, in fact, to consider that the effects produced on different substances under the same conditions may be different, and that the stars carry us further than our laboratories; that is there are stages of spectral change within and beyond our experimental powers revealing a *shedding* of ions at different temperatures.

Dr. Preston's Researches.

Quite recently the study of magnetic perturbations of spectral lines has brought a fresh array of evidence on this question.

It has now been proved that spectral phenomena are different when the light source under examination is subjected to the action of a strong magnetic field which, among other things, causes a precessional movement of the orbits of the ions to which I have already referred.

In order to consider the bearing of this, let us deal with the spectrum of zinc which contains triplets. It has been shown that denoting these in ascending order of refrangibility by A_1, B_1, C_1, A_2, B_2, C_2, &c., the lines A_1, A_2, &c., show the same magnetic effect in character, and have the same value of e/m. The lines B_1, B_2, B_3, &c., and C_1, C_2, C_3, &c., form other series, and possess a common value for the quantity e/m in each case.

Dr. Preston, one of the most successful workers in this new field, states:—

"The value of e/m for the A series differs from that possessed by the B series, or the C series, and this leads us to infer that the atom of zinc is built up of ions which differ from each other in the value of the quantity e/m, that each of these different ions is effective in producing a certain series of lines in the spectrum of the metal."

But this is by no means all that is to be learned from Dr. Preston's researches. He writes:—

"When we examine the spectrum of cadmium or of magnesium—that is, when we examine the spectra of other metals of the same chemical group—we find that not only are the spectra homologous, not only do the lines group themselves in similar groups, but we find in addition that the corresponding lines of the different spectra are similarly affected by the magnetic field. And further, not only is the character of the magnetic effect the same for the corresponding lines of the different metals of the same chemical group, but the actual magnitude of the resolution as measured by the quantity e/m is the same for the corresponding series of lines in the different spectra. This is illustrated in the following table, and leads us to believe, or at least to suspect, that the ion which produces the lines A_1, A_2, A_3, &c., in the spectrum of zinc is the same as that which produces the corresponding series A_1, A_2, A_3, &c., in cadmium, and the same for the corresponding sets in the other metals of this chemical group. In other words, we are led to suspect that, not only is the atom a complex composed of an association of different ions, but that the atoms of those substances which lie in the same chemical group are perhaps built up from the same kind of ions, or at least from ions which possess the same e/m, and that the differences which exist in the materials thus constituted arise more from the manner of association of the ions in the atom than from differences in the fundamental character of the ions which build up the atoms."

Magnetic effect.	Nonets or complex triplets.	Sextets.	Triplets.
Cadmium ... $\lambda=$	5086	4800	4678
Zinc ... ... $\lambda=$	4811	4722	4680
Magnesium ... $\lambda=$	5184	5173	5167
Precessional spin ...	$\frac{e}{m}=55$	$\frac{e}{m}=87$	$\frac{e}{m}=100$

[This table shows the effect for the three lines which forms the first natural triplet in the spectrum of cadmium compared with the corresponding lines in the spectrum of zinc and magnesium. It will be seen that the corresponding lines in the different spectra suffer the same magnetic effect both in character and magnitude. Thus the corresponding lines 4800, 4722, 5173 are each resolved into sextets, and the rate at which the ionic orbit is caused to precess is the same for each (denoted by $e/m=87$ in the table). Similarly for the other corresponding lines.]

This is a result of the first order of importance. I previously discussed what might be expected to happen if the complex system giving the spectrum of an element were *broken up*, and showed that if less complex systems of the same pattern—that is, consisting of centre of force and ion with its electric charge—were thus produced, these systems would be just as capable of giving spectra as the one the breaking up of which produced them. We should get new ions free to move and vibrate, and new spectra which may reveal the constituents, that is, the manner in which the complex system breaks up. But Dr. Preston goes further than this. He shows that the same ion associated with different centres of force gives us lines at different wave-lengths. That a certain ion which in the spectrum of magnesium gives rise to b is also present in zinc and cadmium, though there is no trace of b in their spectra.

Now, if the views held by those who have worked along any of these lines be confirmed, we shall be compelled not only to give up polymerisation as the only cause of greater complexity of the molecules of the elements, but to acknowledge a great strengthening of the view that all chemical atoms have a common basis, and build new mental images on this basis. I now pass from the spectroscopic evidence to work in a new field.

Prof. J. J. Thomson's Researches.

I have before referred to the fact that science now has to consider masses much smaller than the atom of hydrogen. This we owe not only to a discussion of the phenomena of series but also to some recent researches of Prof. J. J. Thomson, made in connection with his work on the kathode rays.

Since the kathode rays produce luminous effects their path can be traced, hence it is known that they are deflected in a magnetic field. This deflection depends upon the mass of each particle and the electric charge it carries, that is, upon their ratio, m/e. This ratio Prof. J. J. Thomson finds to be about one-seven-hundredth of the corresponding value for the hydrogen ion in ordinary electrolysis.

At the same time it has been found by Prof. J. J. Thomson and Mr. Townsend that the electric charge e is the same for kathode rays and a hydrogen ion. The m/e in fact may be regarded as independent of the nature of the gas. Since then the m/e of the hydrogen ion is 700 times greater than in the case of kathode particles, the m, the smallest mass whose existence Prof. J. J. Thomson has glimpsed, can only be about one-seven-hundredth of the hydrogen ion.

Prof. J. J. Thomson writes :—[1]

"The explanation which seems to me to account in the most simple and straightforward manner for the facts is founded on a view of the constitution of the chemical elements which has been favourably entertained by many chemists ; this view is that the atoms of the different chemical elements are different aggregations of atoms of the same kind. In the form in which this hypothesis was enunciated by Prout, the atoms of the different elements were hydrogen atoms ; in this precise form the hypothesis is not tenable, but if we substitute for hydrogen some unknown primordial substance X, there is nothing known which is inconsistent with this hypothesis, which is one that has been recently supported by Sir Norman Lockyer for reasons derived from the study of the stellar spectra."

* * * * *

"Thus on this view we have in the kathode rays matter in a new state, a state in which the subdivision of matter is carried very much further than in the ordinary gaseous state : a state in which all matter—that is, matter derived from different sources such as hydrogen, oxygen, &c.—is of one and the same kind, this matter being the substance from which all the chemical elements are built up.

* * * * *

"The smallness of the value m/e is, I think, due to the largeness of e as well as the smallness of m. There seems to me to be some evidence that the charges carried by the corpuscles in the atom are large compared with those carried by the ions of an electrolyte."

Thus the whole question of dissociation has been advanced because while on the chemical view we have to deal with intrinsically different kinds of matter from element to element, on the view of Prof. J. J. Thomson m is a constant for every element, reminding one of Rydberg's general formula for series in which N_0 is practically a constant for every element, although Rydberg acknowledges slight variations which may be due to errors of observation.

Prof. J. J. Thomson is thus led to the following view of the differences in construction of a simple "atom" and a compound "molecule" :

"In the molecule of HCl, for example, I picture the components of the hydrogen atoms as held together by a great number of tubes of electrostatic force ; the components of the chlorine atom are similarly held together, while only one stray tube binds the hydrogen atom to the chlorine atom."

Dr. Preston's results on the magnetic perturbation of lines, to which I have already referred, leads him to the same general conclusions as those arrived at by Prof. J. J. Thomson in favour of the view of dissociation. He says :—

"It may be, indeed, that all ions are fundamentally the same, and that differences in the value of e/m, or in the character of the vibrations emitted by them, or in the spectral lines produced by them, may really arise from the manner in which they are associated together in building up the atom."

And again :—

"We have, I think, reasonable hope that the time is fast approaching when intimate relations, if not identities, will be seen to exist between forms of matter which have heretofore been considered as quite distinct. Important spectroscopic information pointing in this same direction has been gleaned through a long series of observations by Sir Norman Lockyer on the spectra of the fixed stars, and on the different spectra yielded by the same substance at different temperatures. These observations lend some support to the idea, so long entertained merely as a speculation, that all the various kinds of matter, all the various so-called chemical elements, may be built up in some way of the same fundamental substance."

The Three Ways of Inorganic Evolution.

At the present time, then, we have before us three suggested ways of inorganic evolution.

Taking the chemical view, this may depend on

(1) Polymerisation, or the combination of similar chemical molecules, or

(2) The combination of dissimilar chemical molecules.

In the new physical view all this is changed into

(3) The gradual building up of physical complexes from similar particles associated with the presence of electricity.

In this last conception we have the material world, up to the highest complex, built up of the same matter under the same laws ; as in spectrum analysis there is no special abrupt change between the phenomena presented by the simple and compound bodies of the chemist, so also in the new view there is no break in the order of material evolution from end to end.

Certainly the new view seems competent to throw light on many facts which lacked explanation on the old one, by whatever method of evolution the higher complexes were assumed to be brought about. Because on the ionic theory we can imagine several first forms, so that the question of *descent* comes later with the introduction of more complex systems. These various first forms bring about the possibility of evolution along several parallel lines, as well as of the possibility of an infinite number of intercrossings. In this connection we must not forget that the constituents of the reversing layer of Bellatrix and of protoplasm are nearly identical, while the particular forms of matter of which they are composed make so little show in the sun.

The analogy before suggested between the earth and moon, and the central congeries of material units and the ion revolving round it, suggests that the ion may be the more constant in its structure, and that it is to a large extent to the varying mass charge representing the centre of force that spectral changes are due. It may be that the subordinate "series" indicate that very small variations of complexity are possible, as well as greater ones.

In the light of this analogy, the ions visible in the simple spectra of the hottest stars are those associated with the smallest centres of force. These are, so far as we know at present, hydrogen, helium, asterium, oxygen and nitrogen among the gases ; carbon and silicium, and calcium, magnesium and sodium among the metals, in the forms we study by their spectra at the highest temperatures we can employ in our laboratories.

As the stars cool larger aggregates of material units in the centres of force round which these ions revolve become possible, and hence the complexity of the spectrum of Uranium and of the sun, representing a cool star, are both explained by the same process, the various stages of which can be reproduced in the reverse direction by various degrees of dissociation.

NORMAN LOCKYER.

[1] *Phil. Mag.*, vol. xliv. p. 311, October 1897.

THE LONDON UNIVERSITY ELECTION.

SINCE the appearance of last week's NATURE, the course which we ventured to foreshadow in reference to the impending election has fortunately been found practicable. It was announced on the 17th inst. that a committee of graduates unconnected with either of the two party organisations had invited Sir Michael Foster, K.C.B., to contest the seat, and that he had consented to be put in nomination. This fact ought to reassure all those graduates who desired to see the University do itself honour by selecting a fitting successor to Sir John Lubbock. And a passage in Dr. Benson's letter to the *Times* led to a general belief that at least one of the candidates now before the constituency would be willing to retire before a man of really distinguished position and qualifications. Unfortunately, however, it appears that up to the present time neither of them has evinced any readiness to withdraw his personal pretensions.

The only reason assigned by their friends appears to us wholly untenable. They have both presented themselves to the constituency as the special friends of the country graduates. Both of them objected to the report of the Cowper Commission on the ground that in some way or other—not very clearly defined—the interests of the general body of graduates, particularly those who lived at a distance from the metropolis, would be sacrificed to the wishes and the influence of a body of professors connected with the London Colleges. Each of them has secured the adhesion of some of the members of Convocation by conveying the impression that the development of the University, on one of its two sides, as an institution capable of aiding and controlling the higher education of the metropolis, and of bringing the more eminent of the London teachers into vital connection with its governing body, would entail some possible injustice to the older graduates, and cause the value of their degrees to be lowered.

There is not, and never has been, any justification for a fear of this kind. The status of the existing graduates has not been affected, or indeed threatened, by any of the proposals of the Commission or by the subsequent legislation. Nothing has been done to lower the character of the degrees possessed by the present members of Convocation, or to put in peril any of their privileges.

Nor is the principle of external graduation in the future in any way at stake in this election. That principle has been emphatically endorsed in the recommendations of the Royal Commission, constantly restated and enforced in all the resolutions of the Senate as well as of Convocation, and finally safeguarded by the explicit terms of the Act of Parliament. It is difficult to see how a champion of that principle is needed in the House of Commons, or what a member of that House could now do to give to that principle increased strength and permanence.

The fact is that when the statutes of the reconstituted University shall have been framed and have received the Royal Assent, all the controversy which has been rife within the University itself will be at an end. And it is to be observed that in formulating those statutes Sir M. Foster and Mr. Busk have taken an equal share of responsibility, so that both are presumably well equipped with knowledge of the internal constitution of the University and its wants in the future. The domestic politics of the University, even were they far more important than they are, ought not to be uppermost in the consideration of any graduate who has in view the true reputation and influence of his University, and the purpose which ought to be served by the choice of a University member. Ordinary constituencies may be safely trusted to send to Parliament a sufficient number of members who will promise to obey the party Whip, and to look well after local affairs. But the claims of a University to representation rest on other grounds. Such a constituency is bound first to have regard to the national interests in respect to the promotion of learning and science, and to the exposition, when occasion requires, of the views of learned men. A University constituency fails wholly in its duty to the nation if it cannot enrich Parliament by sending to it men of recognised authority and large intellectual influence.

Much stress has been laid upon the voting at recent senatorial elections, as if it furnished a test of the views of the electorate. But any inference thus drawn is wholly unwarranted, and might be seriously misleading. The cases are not parallel. When the graduates are called on to select one of their own number to become one of the Senate, it is reasonable that what are called domestic politics should occupy a large share of attention. For the Senate is the executive body of the University, and is solely concerned with its internal affairs. But when the graduates are invited to choose a *burgess* in Parliament, their responsibility is of a wholly different character, and their choice should be determined by higher, larger, and more permanent considerations. What are the needs of the community in regard to national education, how far it is desirable or possible for the State to supply these needs, what should be the action of the Government in relation to matters in which the interests of science, literature, art, the higher professions, or the encouragement of research are concerned;—all these are grave questions requiring for their solution men of affairs, and of practical knowledge, and of acquaintance with other Universities than their own. And from this point of view it must be evident that the claims of Sir Michael Foster, who, in addition to his other distinctions, is known as a former student and professor in University College, and a graduate of London chosen by Cambridge to become one of its foremost professors, far outweigh the claims of any competitor whose name is before the constituency.

It is important that those members of the University who take this view of the public duty which is cast upon them at the present election will lose no time in making known their willingness to serve on Sir Michael Foster's committee. Pending the publication of a formal address, which is expected to appear immediately, graduates would do well to send in their names to Sir John F. Rotton, 3, The Boltons, S.W.

AMERICAN HIGHER TECHNICAL EDUCATION.

IN dealing with the question of American higher education, we must not lose sight of the fact (due to various causes) that any system of education in a young country like America would probably require certain modifications if adopted in an old world country. The latter would probably be steeped in traditions, many of which are doubtless of great value, yet unsuitable to the requirements of a new country. Americans have derived their fundamental principles of educational methods from us, and have formed them into a system adapted to their special needs. The question which naturally arises, however, after studying the American system, is whether in a modified form it might prove a success in our own country.

In order to more thoroughly understand this system, it will be necessary to explain their methods of working. It is intended to deal only with the course of training undertaken by an engineering student in America, as the same thoroughness characterises the work done by those qualifying for other professions.

The system is nearly the same in all the important American colleges. The student enters at an average age of about nineteen, after passing a severe entrance examination in English, mathematics, and one foreign language. There is at present a strong tendency to raise the standard required for entrance, in order to exclude all but well-trained students.

The length of the course is four years, and comprises mathematics, physics, chemistry, English, French, German, and engineering. The course in pure science is extensive and thorough; chemistry and physics both have fairly extensive laboratory work, while in mathematics the course includes differential and integral calculus, with a small amount of differential equations.

The bulk of the work in pure science is finished by the end of the first two years, the last two years being devoted mainly to professional subjects. The manual training classes or workshops are considered to be one of the most important parts of the engineering course. The reason for the great attention given to practical work is due to the entire absence in America of anything similar to our premium pupilage system. There is no desire to reach the level of hand skill of a good mechanic, the intention being to teach correct methods of using tools, and to show how work should be done.

There are usually four shops through which the student passes in rotation. In the wood shop the course consists of a series of exercises illustrating the use of tools and forms of simple joints; this is followed by a course in wood turning, which naturally leads on to pattern making; fairly complicated patterns are made, such as a spoked wheel, plug cock with the necessary core-box. In the foundry, moulding is taught both in sand and loam, and cores are made and baked by the students; castings are not made from every mould, but only sufficiently often to show the correct methods of working. In the smith's shop there are also a set of exercises on forging, and sometimes the student has to make and harden a complete set of lathe tools for his own use in the turning shop. In the fitting shop the student passes through a course in chipping, filing, scraping, and then goes on to the machine tools, such as the lathe, the milling machine, planer, and shaping machine. The exercises have all been carefully thought out, so that they form a progressive series, each illustrating some principle.

Summer workshop classes of about one month are common, when the students devote their whole time to practical work. During this period the students often undertake to make either the whole of a machine or to finish a previous year's work. At Sibley College they have built wholly in their shops a 60 horse-power triple expansion marine type engine, which is used for experimental purposes; the finish of this engine was quite equal to any ordinary engine, and it was said to run quite as well as any other steam plant.

The shops as a rule are large and well equipped; for instance, there are thirty engine lathes besides other machine tools at Sibley College. One of the most surprising features of their manual training is the amount of hand skill which the student acquires in his comparatively short course; this is, by the Americans, attributed to the fact that their shops are entirely devoted to teaching, and that therefore they can advance the men more rapidly than is possible in a commercial establishment. The question as to whether handicraft is a suitable subject to be taught in a university is too large to be discussed here; but as regards America there can be no doubt of its value, and it is found in every really important engineering course throughout the United States and Canada.

The experimental work in the engineering laboratories is very similar to our own, but everything is on a much larger scale; there are often quite a number of testing machines and experimental engines, each intended to emphasise some special point.

At Sibley College and at Boston there are special engines for teaching valve setting, both for slide valves and Corliss gear. They have at Sibley College a small ammonia refrigerating plant arranged for experiments on the action of inverse heat engines.

MacGill University has a very fine hydraulic plant for studying the laws of flow of water through orifices, pipes and over weirs. The electrical laboratories are large and well equipped; in the dynamo room there are machines of all types for illustrating continuous, alternating and polyphase currents. The supply of testing instruments, such as ammeters, voltmeters, wattmeters, appeared to be on a generous scale.

At several institutions there are full courses for mining engineers, with large laboratories for the reduction of ores to the metallic state, the same type of machinery being used as in a mine. Mining and metallurgy are often taken together; the metallurgy deals principally with copper, lead, silver and gold; the practical work, as regards iron and steel, appeared small when the industrial importance of these metals is considered.

The very large number of students to be found in one college is also significant. Canada is by no means a populous country, yet there are nearly three hundred engineering students at MacGill University, Montreal; and we find from two to five hundred students at all the leading technical institutions; yet in spite of these large numbers, the supply of graduates seems to be unequal to the demand. Almost every graduate can at once obtain a post carrying with it a salary small, but generally sufficient for an independence.

It is difficult for an outside observer to form an absolutely accurate idea of American methods of teaching, but they certainly rely to a greater extent than we do on text-books, and a considerable amount of home work seems to be the rule.

The recitation class, in which students are questioned on the matter of the text-book, is quite unlike anything in England; it is intended to give the teacher a means of discovering what the student knows, and as marks are assigned for success in recitation, it plays an important part in the course. The written examination does not appear to carry the weight that it does with us; no practical or drawing examinations are held, but every piece of work is marked and counts towards graduation.

A special feature is the way in which the purely professional subjects are subdivided. Thus, at Boston, we find no less than seven engineering professors besides assistant professors. There can be no doubt that this specialisation is beneficial to both staff and students. To the staff it must be a great advantage to be able to concentrate themselves on a special subject, which, of course, they can carry further than if they were obliged to cover a wide ground. The subjects of thermodynamics, mechanism, and applied mechanics are really quite separate, although often grouped together under the head of mechanical engineering.

Looking on the system of American technical education as a whole, one cannot but be filled with admiration for the manner in which they have carried out their ideals. Technical education may be looked upon as similar to a manufacturing process; it should turn out a product of the particular kind that is required for the industrial needs of its own country. The actual educational value of the methods of training employed should be subordinated to the commercial question, which is, whether the student obtains that knowledge which will enable him to be of use in industry. In a system of general education the training of the mind is generally taken to be of more importance than the actual knowledge, but professional education stands on a different basis. If this point of view be taken, then the persons who decide on the value of technical education should be the employers into whose service the graduate passes after completing his college course.

American manufacturers who require scientific assistants appear to be perfectly satisfied with the education which is given to the students. In some of the largest works the heads of departments and designers are all college graduates, and in not a few cases important and responsible posts are reached at what seems to us a very youthful age. Part of the success of American manufactures in outside markets is no doubt due to the systematic and thorough technical training of those who direct their manufacture.

The American student works harder than his English confrère, and his work is mapped out for him along strictly utilitarian lines; for the average man the American system is exceedingly good; for the very good man it is doubtful whether it is not too rigid, which may explain why there are so few scholars and brilliant exponents of research produced in proportion to the large number of students.

F. W. BURSTALL.

ARMOUR PLATES.

THE different classes of armour which may be used are as follows:—Wrought iron, steel, compound, Harvey, and Krupp types.

Wrought iron was largely used in the first armour-clad battleships, and the late Sir John Brown was practically the first manufacturer of them on a large scale in this country. Owing to its toughness and freedom from cracks under the impact from projectiles, this type held its own for a long time; it could be produced at a fairly cheap rate, and was readily worked into shape. Although attempts were made to employ steel long ago, owing to the higher cost of this material and the methods of fusion not being sufficiently perfected, until comparatively recently, to enable mild or soft steel to be produced—that is, steel low in carbon—this material did not make much way until, in France, methods were introduced of producing at one operation large masses of mild steel.

In this country, however, we branched off into compound plates—that is, plates composed of wrought iron with hard steel faces. There is no doubt, however, that the French policy was the better one, as mild steel plates, though perhaps more easily perforated, do not crack under impact to the same degree as compound plates.

Owing, however, to the enterprise of the American, Harvey, it was found possible to take soft steel plates and carburise them in a similar manner to that which has been used for centuries—that is, carburising by the cementation process (though, of course, Harvey's treatment was necessarily varied to suit the altered nature of the material being treated), so that steel plates were obtained with faces containing considerable percentages of carbon, up to ·70 or ·80 per cent., whilst the rear still retained its original soft and tough condition. Such a plate, after being treated and quenched in water, either wholly or on the hard side, then possessed a very hard surface, against which a shot broke into fragments.

Further improvements were introduced at Krupp's Essen Works, both as regards the composition of the steel used in the plates, a material being obtained of tough nature, yet having great tensile strength with high elastic limit, and also a further improvement was effected by carburising the surface by means of gas cementation instead of charcoal. More regular and uniform results have been thus obtained than by any other process, and though by means of specially shaped projectiles, or projectiles fitted with soft metal caps, such plates can be perforated, this is much more difficult than formerly. Ordinary ogival projectiles without caps go to pieces upon impact, their striking energy being wasted in breaking themselves instead of perforating the plate attacked. Briefly, it may be said that the latest type of hard-faced plates possess about twice the resistance of the older type of plates. This enables a great saving to be effected in the weight of armour to be used for the protection of the modern warship.

My firm has, however, recently produced capped projectiles which, with a slightly higher velocity than the average usually employed, readily perforate hard-faced plates, so that before long we may expect the latest type of plates to be found quite vulnerable. Thus the battle proceeds, first the plate wins, then the projectile, until perhaps some day all civilised nations may find it more profitable to revert to a simpler and more effective method of settling difficulties than by trying to kill each other.

R. A. HADFIELD.

NOTES.

EXPRESSIONS of opinion from political leaders as to the value of scientific advice, and the need for scientific methods in Government Departments, are so rare, that some remarks which Lord Rosebery made upon this subject at Chatham on Tuesday come almost as a surprise. We have over and over again referred to the lack of interest in the progress of science, and the disinclination to take advantage of available applications, shown by official authorities concerned with national affairs. Only recently some of the scientific lessons taught by the war have been pointed out in these columns (pp. 37, 83), and some of the services which a committee of men of science could render to the Government if their advice were asked have been indicated. From the subjoined extract from Lord Rosebery's speech it will be seen that he is in accord with the methods advocated in these columns. If the war leads to an acknowledgment of the value of scientific opinion, the result will be one upon which the nation may be sincerely congratulated. The *Times* reports Lord Rosebery to have said:—"We ought to get another great advantage out of this war, for, after all, we in this country have much to learn, and this war will have been a cheap one, whatever it may cost, if it has made us learn several important lessons. I humbly think that in this country we live a great deal too much from hand to mouth. We do not proceed by scientific methods. We go on the principle that things have carried on so well so far, that we are a noble nation, that we are very rich, that we are pretty numerous, and that we have so muddled out right in the end. But I say this, that we are a people of enormous waste. We waste simply by not pursuing scientific methods. I do not like to compare us with Germany. It is hardly safe to mention the name of foreign Powers lest some innuendo be suspected, or else some guilty thought in one's mind. But at any rate we may be certain of this—taking Germany as an example of the opposite method of treatment—Germany is infinitely more painstaking and scientific in its methods than we are. But, without taking as a model Germany or any other country, I believe, if we wish to take full advantage of the lessons of this war after it is concluded, we must become more scientific in our methods in commerce, in education, and in war. We are not methodical, we are not scientific, we are not abreast of the more advanced nations of the day; and if we want to keep our place we shall have to consider the lessons we have been taught in this respect. Depend upon it, however brilliant you may be, the tortoise of investigation, method, and preparation will always catch up and overtake the hare which leaves everything to the inspiration and effort of the moment. Great as the task before us in the field is at this moment, the task that remains for us after this war is completed is the greatest task that ever lay before a nation. You will have, when this war is over, to put your Empire on a business footing. We must have no more discussions as to the way in which one thing has happened to go wrong or has happened to go right. We must consider, deliberately, patiently, and scientifically, the methods by which we have been accustomed to proceed, and see in what way they have fallen short, and determine to reconsider and revise them."

PROF. H. G. ZEUTHEN, professor of mathematics in the University of Copenhagen, and M. Peron, of Auxerre, have been elected correspondants of the Paris Academy of Sciences.

WE notice with much regret the announcement that Prof. D. E. Hughes, F.R.S., died suddenly on Monday, January 22, at the age of sixty-eight.

SIR JOHN LUBBOCK, on his elevation to the peerage, has decided to take the name of Lord Avebury, after a property of his in Wiltshire. Letters Patent have been passed granting the adoption of this title.

DR. G. K. GILBERT, of the U.S. Geological Survey, has been elected president of the American Association for the Advancement of Science.

DR. GEORGE M. DAWSON, director of the Geological Survey of Canada, was elected president of the Geological Society of America at the annual meeting held on December 27, 1899.

THE death is announced, at the age of fifty-three, of M. Marion, Curator of the Natural History Museum at Versailles.

ON the 16th inst. two violent explosions occurred at the Avigliana dynamite factory near Turin, ten persons being killed and thirty injured. Both explosions were distinctly heard in Turin, although the distance is fully 25 km.

MR. C. A. SCHOTT, chief of the computing division of the U.S. Coast and Geodetic Survey, has retired from that post in order to devote his whole time to special scientific work. He has been succeeded by Mr. J. F. Hayford.

MR. J. B. CARRUTHERS has been appointed mycologist to the Government of Ceylon and assistant-director of the Botanical Gardens at Peradeniya. He will leave England early in March to take up his duties, which will chiefly be the investigation of the diseases of economic plants in the island.

DR KARL GOEBEL, professor of botany and director of the Botanical Institute at Munich, is now associated with Prof. E. Selenka and Prof. J. Rosenthal as editor of the *Biologisches Centralblatt*. All botanical communications intended for that periodical should be sent to Prof. Goebel.

M. DE FONVIELLE informs us that the solar halos and mock suns observed on January 11, and referred to in our notes last week (p. 279), were seen over a large part of Western France. A detailed description of the phenomenon, with illustrations, will appear in *Cosmos* of January 27.

THE distinguished diatomist, Dr. Grunow, has presented his very large collection of diatom-slides to the Imperial Natural History Museum at Vienna. A very carefully prepared selection of microscopic slides made by the late Mr. W. T. Suffolk has been presented by his representatives to the Royal Microscopical Society.

MR. WILLIAM HENRY POWER, F.R.S., the Assistant Medical Officer and Medical Inspector for General Sanitary Purposes of the Local Government Board, has been appointed to the office of Medical Officer of the Board, in succession to the late Sir Richard Thorne Thorne, K.C.B. Dr. H. Franklin Parsons has been appointed successor to Mr. Power, and Dr. R. Bruce Low has been appointed an assistant medical officer of the Board.

A REUTER telegram from Madrid, dated January 20, states that, in view of the declarations of the Minister of Public Works in the Chamber, the Spanish Government proposes to make the best possible arrangements at the Madrid Observatory for the reception of foreign astronomers, who will observe the eclipse of the sun on May 28. Nevertheless, other places are better adapted for the purpose, as, for example, Naval-Moral, 200 kilometres from Madrid on the Caceres line, because at that place the eclipse will be total for two minutes.

THE *Electrician* states that the Admiralty have determined to fit several vessels of the Channel Squadron, viz. the *Majestic*, *Magnificent*, *Hannibal* and *Jupiter*, with wireless telegraphic apparatus on the Marconi system; and the signal boatswains of the two flag-ships and two petty signal officers on each of the ships in question are now being instructed in wireless telegraphy on board the *Hector* at Portsmouth. It may be regarded as extremely probable that all the vessels of the navy will eventually be equipped with wireless telegraphic apparatus.

SCIENCE has suffered a considerable loss by the death of Mr. James R. Gregory, whose services to mineralogy are widely known. Mr. Gregory was born on December 29, 1832, and while a boy at school he showed great interest in minerals and fossils. He started his active career as an expert in gems, but afterwards took up mineralogy and geology, and got together some valuable collections. In 1867 he went to South Africa prospecting for minerals, and introduced from there the crocidolite. He exhibited a collection of minerals at the Paris Exhibition in 1867, and was awarded a medal. He also exhibited at the Fisheries and Health Exhibition, and wrote the report on minerals and gems for the Indian and Colonial Exhibition. In addition to many rare mineralogical and geological specimens, Mr. Gregory possessed a fine collection of meteorites, which he had been getting together for about forty years. He was a member of several scientific societies, and had sincere regard for the progress of natural knowledge.

INCORRECT maps and neglect of compass bearings are two of the causes to which the *Times* correspondent attributes General Gatacre's repulse at Stormberg. As science is concerned with both these matters, we reproduce the correspondent's remarks upon them:—(1) The map of the ground was utterly misleading and worse than useless. Not only was the contouring so incorrect as to give a totally false picture of the configuration of the hills, but the actual distances and the roads were inaccurately represented. (2) So far as I am aware, no one amongst the responsible authorities had taken any compass bearings, and consequently no one knew where he was being taken in the dark.—The special correspondent of the *Times* at Cape Town thinks that the latter point is exaggerated, and remarks:—"Owing to the abundance of magnetic ironstone all over South Africa (and the name 'Rooi-kop,' 'red-head,' probably indicates its presence near Stormberg) compass bearings are liable to be all over the place, especially at night, when it is impossible to know how near one may be to magnetic rocks. At Chieveley one day I was taking some bearings which made Colenso lie due east instead of north, north for the nonce happening to be a large stone a yard or two away."

AN earthquake, resulting in great loss of life, occurred on September 20, in the neighbourhood of Smyrna. More than 1600 persons, it is estimated, were killed, and more than 2000 wounded, while 11,000 houses were destroyed. The epicentre appears to have been situated in the Meander valley between Aidin and Sarakeui, and a large number of the damaged towns and villages are situated in this valley within an area more than sixty miles long. The railway line between Aidin and Omourlou was raised by fully one yard, while in other parts of the valley the ground has sunk. Some additional details are given in a letter that we have received through a correspondent. "Practically every building within an area of 1200 square miles," he says "was damaged to a greater or less extent—most being levelled to the ground. For instance, Denizli had 4500 houses, and of these 2400 are completely down; Sarakeui had 800, and of these 600 are down. . . . From a scientific point of view the earthquake was most interesting, and the cause or the consequences of it, was that the greater part of the Meander and Legens valleys have subsided from two to six feet."

ACCORDING to the *Listok* of Tiflis, the earthquake of December 31, 1899, which destroyed so many houses at Akhalkalaki (Transcaucasia) and in ten neighbouring villages, and during which more than 200 persons perished under the ruins of the houses, was well observed at the Tiflis Physical Observatory. The first shock was at 1h. 50m. 30s. p.m., and had the unusual duration of 1m. 4s. It was felt with special severity in the hilly part of the city, on the right bank of the Kura river. Lamps were set swinging in the houses, vessels fell from the cupboards, and heavy crosses went down from the bell towers of several churches. The direction of the shock was N.W. to S.E. The second, much feebler shock, was at 4h. 38m. 34s. p.m., and lasted four seconds only; its direction was N.N.W. to S.S.E. The third shock, at 8h 45m. p.m., was not shown by the seismoscope of the Observatory, which is situated on the left bank of the Kura, but was noticed on the right bank of the river. The earthquake was also noticed at the Tkvibuly, Tsipa, Varvarino and Kvirily stations of the Transcaucasian railway (from 1h. 47m. to 1h. 50m p.m.), where it damaged several station houses, as well as at the Kalagelan (1h. 48m.), Sviri and Zugdidi stations of the Kars railway (at 2h. 22m., at the two last ones), as well as at the high-level stations of Abas-tuman (4h. 50m.) and Kobi (2h. 1m.).

ONE of the wonders of the New York Zoological Park, recently opened to the public, is a great cage for birds. It represents an attempt to do for certain large and showy water birds precisely what has been done in the Park for the hoofed animals, the buffalo, the otter and other species—to give them all a section of Nature's own domains; and when the birds are finally put into the cage they will fly in real freedom, for it incloses three forest trees of considerable size. The structure is 152 feet long, 72 feet wide, 55 feet high, and consists of a series of steel pipe arches and purlins over which wire netting has been tightly stretched; chain netting is used so as to afford the least possible obstruction to the eye. It contains a pool of water 100 feet long and an abundance of shrubbery. Another important buiding is the reptile house, which is one of the finest structures ever erected in a zoological garden. It is 146 feet long, and its greatest width is over 100 feet; it cost about 45,000 dollars.

AT several stations on the Indian coast tidal curves are automatically recorded by means of self-registering gauges, and are used in the construction of tide-tables containing the predicted times and heights of high and low water at about forty ports. The report of the work of the Survey of India Department during 1898, which reached this country at the end of last year, contains tables showing the agreement of the actual with the predicted times and heights for each year of the period 1890–1897. Taking the averages of the eight years, it appears that at open coast stations, 71 per cent. of the predictions of the times of high water were within fifteen minutes of the actual times, and 70 per cent. of the low water estimates were within the same limits of accuracy. The estimated heights were more accurate, 95 per cent. of the predictions of the heights of high water being within eight inches of the observed height, and 93 per cent. of the low water heights were within the same margin of error. Of course, a difference of eight inches means more at some places than at others; nevertheless, the forecasts as a whole may be regarded as satisfactory.

FROM the annual report of the Royal Alfred Observatory, Mauritius, for the year 1898, we learn that the mean rainfall at seventy-one stations was 76·85 inches, against an average of 77·89 inches; the rainfall for the month of August was the greatest on record, and was highly beneficial to the sugar crop. There were apparently two tropical cyclones in the South Indian Ocean during the year, the tracks of which have been approximately laid down on a chart. The magnetographs were at work throughout the year; disturbances occurred on thirty-nine occasions; the principal were February 11–13, March 15–16, and September 9–11. Photographs of the sun were taken daily when the weather permitted, and the negatives were forwarded to the Solar Physics Committee. There were sun-spots on 302 days; the great feature during the year 1898 was the sudden outburst of activity in September, after a decided decrease as compared with the previous year. No brilliant auroræ were observed.

So little is known of the fauna of British lakes that a paper on the Entomostraca of Lake Bassenthwaite, by Miss E. M. Pratt, published in "Studies in Biology from the Biological Departments of Owens College," is of distinct value. In an introductory note, Prof. S. J. Hickson refers to the possible practical value of this investigation to fishery. It is well known to fishermen that the lakes in Cumberland vary very considerably in their "trout" reputation. Bassenthwaite is not regarded as a very good lake for trout, but, on the other hand, it contains an abundance of perch and pike. It would be extremely interesting if in time a systematic study of the relations between the fish-fauna and the Entomostracan fauna could be undertaken. This would not be a very costly investigation, and Prof. Hickson thinks it would require the whole time of a competent naturalist provided with a modest laboratory on the lake side for a period of two or three years. Biology stands in great need of investigations of this kind; but though there are many willing workers, few funds are available to equip them and provide them with the necessaries of life while their researches are in progress.

THE subject of parasitism in freshwater mussels has been investigated by Mr. H. M. Kelly (*Bulletin Illinois Laboratory*, vol. v., art. 8), with the object of determining to what extent the degree of infection would vary in allied species in the same or different localities. The results seem to indicate that the capacity for being infested by each particular host is to a great extent a characteristic of the species.

THE first number of the *Revue Scientifique* (*Revue Rose*) for 1900 contains an account of the addresses delivered by well-known naturalists on the occasion of the "jubilee" of the Société de Biologie. An interesting survey of the history, growth, and work of the Society was given by MM. Bouchard and Gley, from which it appears that the progress in the past has been satisfactory, and that there is every augury for a hopeful future.

THE managers of the Marine Biological Laboratory of Wood's Holl, Massachusetts, have issued an attractive syllabus of the course of study and instruction in the department of botany for the thirteenth season, from July 5 to August 15, 1900. It comprises courses of lectures, together with a laboratory course of instruction by experienced teachers, on cryptogamic botany, plant physiology, plant cytology, and microtechnique, together with special lectures and courses of lectures by experts on branches which they have made their special study.

IN vol. iii. (No. 6) of the *Records* of the Australian Museum, Mr. R. Etheridge, jun., describes, under the name of *Blechnoxylon*, some remains of a curious fern-like plant from the Coal-measures of New South Wales, indicating a totally new structural type. Fern-like in its general characters, this plant presents the peculiarity of developing secondary wood in its stem, so that we have the association of fern-foliage with a stem characteristic of higher plant-groups. It is suggested that it may prove to be allied to the so-called Cycado-filices of Dr. Potonie—organisms that appear to be on the border-line between the now well-differentiated groups of Cycads and Ferns.

IN the same journal, Mr. E. R. Waite records the occurrence, on the coast of New South Wales, of an example of the rare Ribbon-fish, or Oar-fish, of the genus *Regalecus*. Like all other known specimens, the present example was imperfect, and belonged to the female sex. As is well known, there is great variation in the relative length and breadth of the body, as well as in the number of the fin-rays, of the different specimens of *Regalecus* hitherto obtained; but Mr. Waite seems favourably inclined to the view that such differences are only of individual value.

IN the *Atti dei Lincei*, viii. (2), 11, Prof. Pietro Tacchini gives statistics of the earthquake which occurred at Rome on July 19 of last year, and Dr. G. Agamennone discusses the Emilian earthquake of the night of March 4–5, 1898, the epicentre of which was situated in the Apennines. Dr. Pericle Gamba contributes a brief account of the magnetic properties of bricks, &c., that have been struck by lightning, and his observations are in conformity with the theory that the singular points and zones ("punti distinti e zone distinte") observed in rocks and bricks are only produced in a powerful magnetic field, such as is due to violent discharges of atmospheric electricity, and that their magnetisation is independent of the earth's magnetic field. These conclusions accord with the views of Dr. Folgheraiter.

AMONG the various properties of multi-dimensional space, the analogues of the five regular polyhedra are of interest. In the *Verhandelingen* of the Amsterdam Academy, M. S. L. van Oss discusses the "regular 600-cell," *i.e.* the form bounded by 600 tetrahedra, which can exist in space of four dimensions. The paper, which deals also with the self-congruent displacements of the form in question, is illustrated by fourteen plates, showing the figures of the 600, the 120, and other regular forms in four-dimensional space, so far as these can be made visible by their projections on two mutually independent rectangular co-ordinate planes.

WE have received an elaborate memoir, by Dr. Wilhelm His, on protoplasmic studies of the ova of the salmon, published in the *Abhandl. Sächsischen Gesellschaft*, 1899, No. 3.

AS we learn from the Report of 1899, the Bristol Museum has been enriched by a fine series of Neolithic implements and weapons presented by Mr. J. E. Pritchard, by whom they were collected in Somerset and the adjacent counties. The same institution has likewise received an unusually fine skeleton of an Ichthyosaurus.

FROM Rome we have received a copy of *Vox urbis*, a periodical in Latin, mainly devoted to literature and fine arts, and published fortnightly. The present number is illustrated by views of Orvieto Cathedral, and the contents, which border most nearly on science, are short articles by R. Spina, on "Telepathy," and by A. Costaggini, on artificial gems.

THE first part for the current year of the *Proceedings* of the Washington Academy of Sciences consists of a synopsis of the Mexican and Central American Umbelliferæ, by Prof. J. M. Coulter and Mr. J. N. Rose, illustrated by several plates and numerous text-figures.

THE number of *La Nuova Notarisia* for January contains a biographical sketch, by Prof. G. B. De Toni, of the late Count Abbé F. Castracane, together with a complete list of his contributions to botanical literature. This occupies five pages of close print, and comprises upwards of one hundred and twenty separate papers, of which by far the larger number refer to the structure, reproduction, and mode of life of diatoms.

FROM Dr. A. Fock, of Berlin, we have received a pamphlet of 128 pages, entitled "Ueber die Grundlagen der exacten Naturforschung." It is a philosophical dissertation dealing with the fundamental conceptions of number, magnitude, length, time, mass, force and energy, the doctrine of causality, the atomic theory, the ether, and so forth, and it gives us the general impression of being well written and clearly expounded. Messrs. Mayer and Müller, of Berlin, are the publishers.

A FOURTH edition of the "Lehrbuch der Botanik für Hochschulen," by Profs. Strasburger, Noll, Schenck and Schimper, has just been published by the firm of Gustav Fischer, Jena.

A "LIVERPOOL MATHEMATICAL SOCIETY" has recently been established. At a meeting held on January 12, at the University College, Prof. Sircom read a paper on some hydrodynamical problems.

A NEW and enlarged edition of the Rev. James Gall's "Easy Guide to the Constellations" has just been published by Messrs. Gall and Inglis. The book provides a simple means to enable any one to become familiar with the constellations and the individual stars represented upon the thirty small maps.

MESSRS. HENRY HOLT AND CO., New York, announce for immediate publication Atkinson's "Lessons in Botany" and Barnes' "Outlines of Plant Life." Both books are simplified and abbreviated editions of earlier books by the same authors, and are adapted to the needs of pupils in secondary schools.

A CLASSIFIED list of separate papers from the various publications of the Smithsonian Institution, at present available at a nominal price, has just been distributed by the Institution. The papers will be supplied, by preference, to persons engaged in original research in the branch of science to which the work asked for pertains, to those engaged in educational work, and to collaborators of the Institution.

THE preface of the thirty-fifth volume of the "Zoological Record" contains the important announcement by the editor, Dr. David Sharp, F.R.S., that "This volume includes the literature of the Cœlenterata for two years, and brings the indexing of all the branches of zoological literature up to date." The volume was published towards the close of last year, and relates chiefly to the zoological literature of 1898.

MR. WILLIAM CROW, of Stratford, has issued a "century chart," designed to indicate that the nineteenth century does not end until the completion of this year. The chart shows 100 years marked upon a dial, the zero point being at the place where the figure XII. usually occurs on the face of a timepiece. The zero thus represents the dividing line between the end of one century and the beginning of the next, and a hand drawn upon the chart to indicate the position of the present year is shown to have to reach the zero again to complete the nineteen hundredth year.

AMONG the other scientific books in preparation at the Clarendon Press, the following are noteworthy:—"The Structure and Life-History of the Harlequin Fly," by Prof. L. C. Miall, F.R.S., and Mr. A. R. Hammond; "Physical Aspects of Soils," by Prof. R. Warington, F.R.S.; "A Catalogue of Eastern Lepidoptera Heterocera in the Oxford University Museum (Part II. Nocturna)," by Colonel C. Swinhoe; Gœbel's "Organography of Plants," translated by Prof. J. Bayley

Balfour, F.R.S.; and "A Textbook of Arithmetic," by Mr. Richard Hargreaves.

A NEW monthly magazine—*The International Monthly*—made its appearance at the beginning of this year, the publishers being the Macmillan Company. The periodical is a serious addition to contemporary literature, and contains instructive essays on progress in several departments of knowledge. Science is represented by an article, by Prof. N. S. Shaler, on the connection between solar energy and terrestrial formations and phenomena; and Prof. John Trowbridge gives an outline of recent advances in physical science. For each department of the magazine, there is an editor in France, another in Germany, and a third in England, as well as one in the United States.

A SERIES of monthly star maps, prepared by Mr. Walter B. Blaikie for the Scottish Provident Association, provides a concise source of reference to the ordinary observer not possessing any special astronomical knowledge. The maps give a planispheric projection of the heavens, as seen from London, for the first day of each month at 10 p.m., each map being divided into two portions, showing the northern and southern aspects respectively. A considerable amount of useful information is given in the letterpress accompanying the maps, including short descriptions of the more interesting celestial objects, and particulars respecting the planets visible during each month.

THE sixth volume in the biological collection of the "Scientia" series of scientific treatises, published by Messrs. G. Carré and C. Naud, Paris, is concerned with the "Evolution du Carbone et de l'Azote," by Dr. P. Mazé. The three chapters which make up the volume deal respectively with the origin of carbon in the organic world, the origin of organic nitrates, and the decomposition of organic compounds. Many subjects of interest to chemists and plant physiologists are passed in review: for instance, the mechanism of carbohydrates in leaves by means of diastasis, the assimilation of the organic carbon from the soil, and formation of fatty substances, the formation of the quaternary compounds in the higher plants, and the relation of various forms of life to the proportion of carbon dioxide in the atmosphere.

MESSRS. WILLIAMS AND NORGATE's current "Book Circular" contains the following announcements:—Dr. R. Hartig has thoroughly revised his "Lehrbuch der Baumkrankheiten," and will shortly issue the third edition under the title "Lehrbuch der Pflanzenkrankheiten."—A second revised and enlarged edition of Dr. Julius Wiesner's "Die Rohstoffe des Pflanzenreichs" is in preparation. The first part will be issued shortly.—Dr. Eugen von Halácsy will publish very shortly the first part of a flora of Greece, Epirus, and the Ionian Islands, under the title of "Conspectus Floræ Græcæ." The first instalment will consist of some 160 pages, and it is expected that the work will be complete in about eight parts. —The first part of the handbook of the Siphonogamæ, by Drs. Dalla Torre and Harms, will very shortly be published under the title "Genera Siphonogamarum."—A supplementary volume to Beilstein's "Handbuch" is being prepared by the German Chemical Society under the editorship of Prof. Paul Jacobson, and will be issued in parts during this year.

THE system of determining latitudes by observing at groups of stations close together instead of at a single station, was again given a trial by officers of the Survey of India department in 1898, and is referred to in the report which has recently been published. The system originated with Lieut. J. Herschel, several years ago, but was allowed to drop, because that officer was removed from the work before he had fully elaborated it. For the new experiments the longitudinal station at Agra was selected as the central point, but for reasons which had not been foreseen it was found impossible to connect the outlying stations by a sufficiently rigorous triangulation for a proper comparison of the observed and computed azimuths. The latitude observations led to interesting results, and opinion is expressed that in more favourable country the system will prove highly valuable.

THE dilution law given by Ostwald in 1888, $K = \frac{\alpha^2}{(1-\alpha)V}$ (where α is the percentage dissociation and V the volume of liquid containing one molecular weight of the binary electrolyte), was a most important step forward in the study of solutions. But as further investigations were made on this subject, it was found that this dilution law holds only for weak acids and bases, and not for salts, strong acids and strong bases. The Ostwald expression was derived directly from the law of mass action, but subsequent attempts to modify it in the direction of including strong electrolytes were empirical. Thus Rudolphi's $K = \frac{\alpha^2}{(1-\alpha)\sqrt{V}}$, and van 't Hoff's $K = \frac{\alpha^3}{(1-\alpha)^2 V}$ were advanced in 1895, and the latter, which can be more compactly written $K = C_i^3/C_s^2$ (where C_i denotes the volume concentration of the dissociated portion and C_s that of the undissociated salt), represents the facts fairly well for "strong" electrolytes. Since there is no sharp line of demarcation between strong and weak electrolytes, it follows that there must be electrolytes which are on the border line between these two classes, and for which neither formula holds with accuracy. In the current volume of the *Zeitschrift für physikalische Chemie*, Dr. W. D. Bancroft seeks to replace these by a third formula, which, though empirical and indeterminate, may describe all binary electrolytes. This formula is $K = C_i^n/C_s$, including both the Ostwald and van 't Hoff expressions as special cases. Dr. Bancroft points out that the simplest way of determining whether the general formula $K = C_i^n/C_s$ does or does not apply is to plot the value of log C_i against log C_s as ordinates. If the formula applies, the resulting curve will be a straight line, and the slope of the line gives the value of n. Values are given in the paper for solutions of potassium, sodium, lithium, ammonium and hydrogen chlorides, sodium potassium and silver nitrates, potassium iodide and caustic potash, and with the exception of the most concentrated solutions, the data lie absolutely on straight lines; the values of n found varying from 1·36 to 1·55. A theoretical explanation of these facts would be of the greatest interest.

THE additions to the Zoological Society's Gardens during the past week include a Vervet Monkey (*Cercopithecus lalandii*) from South Africa, presented by Mr. A. Althorp; a Woodcock (*Scolopax rusticula*), British, presented by Mr. W. A. Beauclerk; a Short-eared Owl (*Asio brachyotus*) captured in the Indian Ocean, presented by Dr. A. E. Prest Hughes; two White-headed Sea Eagles (*Haliaetus leucocephalus*) from North America, presented by Mr. Henry Anger; a Laughing Kingfisher (*Dacelo gigantea*) from Australia, presented by Mr. J. Kirkland; two Triangular-spotted Pigeons (*Columba guinea*) from South-West Africa, presented by Mr. J. Parminter; two Wagler's Terrapins (*Hydraspis wagleri*) from Brazil, six Blanding's Terrapins (*Emys blandingi*), a Grass Snake (*Contia vernalis*), a Mocassin Snake (*Tropidonotus fasciatus*) from North America, a Flat-backed Tortoise (*Testudo platynota*) from Burmah, an Indian River Snake (*Tropidonotus piscator*), an Indian Eryx (*Eryx johni*) from India, ten Reeve's Terrapins (*Damonia reevesi*) from China, two —— Chelodines (*Chelodina*, sp. inc.) from Australia, a Royal Python (*Python regius*) from South-West Africa, deposited; eight Burrowing Owls (*Speotyto cunicularia*) from South America, purchased.

OUR ASTRONOMICAL COLUMN.

DENSITY OF CLOSE DOUBLE STARS.—Many authorities hold the opinion that the mean density of close double stars is in general low as compared with that of the sun. In the *Astrophysical Journal* (vol. x. pp. 308–318) there are two papers, by Messrs. A. Roberts, of Lovedale, South Africa, and H. N. Russel, of Princeton, U.S.A., which examine mathematically the possible limiting values of the densities of those double stars constituting the Algol type of variables. The limiting value for the mean density of the star is calculated from the observed *period* and *duration of light variation.* The results obtained independently by the two authors are, considering the uncertainty with which many of the periods of variation are known, fairly well in agreement. The general conclusion is that these variables of the Algol type are probably more than five or six times less dense than the sun.

A NEW PHOTOGRAPHIC PHOTOMETER.—Dr. J. Hartmann describes in the *Astrophysical Journal* (vol. x. pp. 321–332) a new photographic photometer he has devised for use at the Potsdam Astrophysical Observatory, in the determination of stellar and other magnitudes. The difficulties involved in previous instruments—viz. distance between standard scale of intensities and portion of plate to be measured, apparent alteration of intensity owing to surrounding parts of plate—have been eliminated by employing a broken microscope, the two objectives of which feed a single eyepiece with the images of the standard scale and the portion of the plate under examination; and, by arranging small apertures over both scale and plate, practically all contrast effect is got rid of. The double microscope enables the two regions to be optically in juxtaposition, so that the point of equalisation of intensity can be found with great precision.

A BRILLIANT METEOR IN SUNSHINE.

ON Tuesday afternoon, January 9, at 2h. 55m. p.m., when the sun was shining brightly in a cloudless sky, a large meteor was observed as a conspicuous object by many persons in the south-eastern part of England. Moving in a direction from west to east, it dashed rapidly across the southern sky and finally terminated its career, as observed from several places in Surrey and Kent, when situated under the moon, then in E. by S., altitude about 33°. The rarity of a daylight fireball, and the astonishing brilliancy it must exhibit to enable it to present a striking aspect even in the presence of the sun, lends a special interest to the phenomenon, and makes it desirable to collect all the particulars concerning it.

I have seen about fifteen descriptions of the meteor, and they nearly all emanate from the counties of Surrey, Kent and Sussex. Three of these accounts have already been quoted in NATURE of January 18, and the remainder, in a summarised form, are as follow :—

Maida Vale, London, W. Time 2h. 59m.—Apparent course of meteor due W. to E. First appeared in S.S.W., and disappeared somewhat to the right of the moon. Track nearly horizontal, about 25° altitude. Nucleus elliptical; long tail; colour silvery; no sparks or explosion.—J. G. WOOD (*Times*).

Warlingham, Surrey. Time about 2h. 30m.—A very conspicuous meteor passed from about S.W. to N.E., and vanished almost under the then position of the moon. It was about 45° from the horizon, and its line of movement curved downwards. Colour very white, reminding one of burning magnesium wire. It was rounded in front and tapering to a tail, leaving a few sparks behind, but no cloud.—F. BENNETT (*English Mechanic*).

Guildford, Surrey. Time 2h. 53m.—The meteor was first seen to the S. [? W.] of the moon, and two-thirds of the distance from the earth between the moon and the earth, and moved downwards towards the N., and vanished exactly underneath the moon. The lowest star of the three stars in Orion's sword was as near as possible in the place where the meteor vanished, at 5h. 45m. p.m. The head was very bright, pure white, and appeared about 3 inches across. It left a faint tail. It went out and did not burst.—C. J. CARELESS.

Earlsfield, S.W. Time between 2h. 50m. and 3h.—A yellow meteor shot from the right-hand side of the moon downwards, disappearing under the moon. The duration was estimated as between 3 and 4 seconds.—Correspondent of *English Mechanic.*

Beckenham, Kent. Time 2h. 55m.—A brilliant meteor passed across the sky at about 60° above the horizon, and in a general direction from a little to the N. of W. to the S. of E. The meteor was very distinct, and apparently of large size. It comprised a head and a brightly glowing body, which, as it travelled, appeared to throw off flakes of flame. The meteor, leaving a trail of bright light behind it, vanished, as it seemed, quite low down.—EDWARD KINGSHALL (*Daily Graphic*).

Penshurst, Kent. Time 2h. 57m.—Brilliant meteor seen here like a ball of burning zinc, emitting yellow sparks. Seemed to move from S.W. to N.E. Vanished almost direct under moon. Path appeared perfectly horizontal. The meteor broke up as it travelled, fragments flying from it much yellower than the mass in front.—THOMAS PARKER (*English Mechanic* and letter to W. F. D.).

Dunstable.—The daylight-meteor was seen here by my grandson, aged 14, who says it fell almost vertically (?) from a N. or slightly N.W. direction. It resembled a very large, brightly luminous, white kite with a long tail. It seemed to fall straight on to the houses of this town.—WORTHINGTON G. SMITH (letter to NATURE).

Eastbourne, Sussex. Time between 3h. and 3h. 30m.—A very bright meteor rapidly traversed the sky from a little W. of S. to a little N. of E. The transit was very rapid, and the direction slightly curved downwards. I saw it from the front, between the Wish Tower and Beechy Head, and it disappeared over Hastings. It passed just below the moon. In spite of the sunshine the meteor showed with an intense white brilliance. The tail was long and feathered.—H. E. SQUIRE (letter to W. F. D.).

Worthing, Sussex. Time between 3h. and 4h.—As I stood facing E. I saw something fall like a rocket downwards, running from S. to N. The head was large with a very long tail; the light was similar to electric light.

Pyecombe, Sussex. Time 2h. 55m.—As my brother was on his machine from Poynings, he noticed a meteor which appeared to come from the moon, in the form of a ball of red and blue fire, taking a course due northwards, and leaving a trail of light behind it for some considerable time.—A. REED (*Sussex Daily News*).

The meteor was also seen at Weybridge, Surrey, darting towards the N. It resembled a huge diamond with a long pointed tail.

I have been in correspondence with Mr. Bouverie, who saw the meteor at Lewes, and with the Rev. R. Hudson, who noticed it from Brighton (NATURE, January 18). The former says the meteor took a course from the lower side of the moon at an oblique angle towards N.E. The observer at Brighton says the first appearance was 5° or 7° below the moon, and the path sloping downwards from S.E. to N.; estimated track from 50° alt. when first seen to 30° at disappearance behind houses in N.

It was a very fortunate circumstance that the moon enabled the place of the end point of the meteor to be correctly assigned. But the descriptions are, as usual in such cases, somewhat discordant; and the only alternative is to adopt a path which approximately satisfies the observations. There is no doubt that the meteor was descending, though not at a large angle, and that the earliest portion of the flight was over the S.S.W., as observed at Maida Vale and Eastbourne. Several observers evidently did not notice the first part of the path, and thought that the meteor commenced its visible flight from a place very near to the moon.

The radiant point was probably at a rather low altitude in the S.W. sky. It could hardly have been farther south, as the long path and rapid motion oppose such a view. Observations from the N. coast of France would be very useful in settling the question. I have derived the following figures for the real path, which may be regarded as provisional, and liable to revision if further descriptions come to hand.

Meteor began—59 miles in height, over a point 10 miles east of Valognes, near Cherbourg, France.
Meteor ended—23 miles in height, over Calais, France.
Length of path—175 miles.
Radiant point—280° – 12°.

The actual velocity is doubtful. An observer at Reigate Heath says the meteor "was visible for about a second," though "it traversed a considerable portion of the heavens." At Earlsfield, S.W., the duration was roughly estimated as 3 or 4 seconds. Several observers say it moved "rapidly."

SOME RECENTLY DISCOVERED SILURIAN FISH REMAINS. A LINK IN THE CHAIN OF ORGANIC EVOLUTION.[1]

EVER since the days of Agassiz and Murchison the subject of the Lower Palæozoic Fish Fauna has been the most sensational in the department of Palæichthyology, mainly on account of the existence at that early period of forms known as Cephalaspidian and Pteraspidian (Osteostraci and Heterostraci of recent classifications), so strangely constituted as to be well-nigh irreconcilable with any of our recent and more familiar fishes. Analogy to certain living species (ex. Coffer Fishes) seemed to suggest that, though archaic, these forms are among the most specialised of all known fishes, and while there has been a general consensus of opinion that this may be so, recent tendency has gone to regard them as the specialised their unique interest. Great though the memoirs of these and other investigators as concerning these strange organisms, none of them, from a point of view of general interest and accuracy of detail, excel those of the author of the two under review, our foremost authority in Palæozoic Ichthyology. His descriptions and restorations of these creatures are everywhere reproduced, and it is matter for sincere congratulation that he should recently have been compelled to return to their study.

Most particularly does the above remark apply to the Pteraspidiæ, with the determination of the systematic position of which the monographs before us are mainly concerned, and the conclusions arrived at are the more welcome, in view of a recent attempt to deduce, from the discovery of supposed resemblances in the minute structure of their plates and the exoskeleton of the King Crabs, a belief in a genetic relationship between the two—one of those notoriously flagrant flights

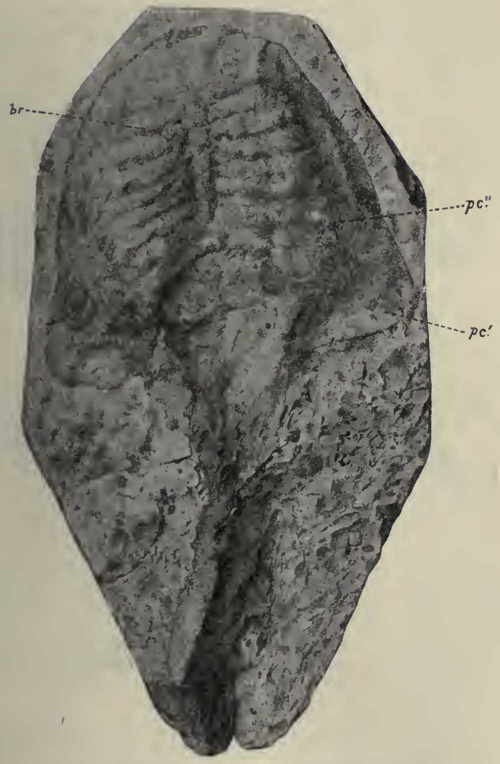


FIG. 1.—*Thelodus Pagei*, dorsal aspect, one-third natural size.

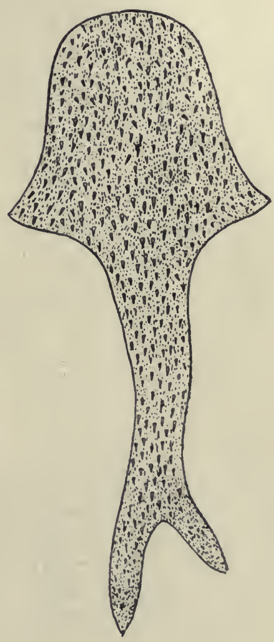


FIG 2.—*Lanarkia spinosa*, restored outline, with spines, half natural size.

representatives of an ancient and primitive stock, believed by some to have been aqnathous, and even akin to the Lampreys and Hags, which in our modern classificatory systems are not admitted to the Class Pisces at all.

Pander, McCoy and Huxley are among the names of past-masters memorably associated with the record of their early discovery; and, in later years, Powrie, Lankester, Jaekel, Reis and others; while Rohon has quite recently made them the subject of far-reaching generalisation in cephalogenesis, which, though extravagant, has sufficed to maintain of fancy which during recent years have done so much to bring pure morphology into unjust ridicule. Needless it is to say that the author of the memoirs dismisses this as unfounded.

Conspicuous among Dr. Traquair's later papers on these remarkable forms is that describing (*Proc.* Roy. Phil. Soc. Ed., vol. xii.) a giant Cephalaspis (*C. magnifica*) from the Old Red Sandstone of Caithness. At the time of its appearance (Dec. 1893) it seemed to those interested to give promise of further unique material from the Scottish Palæozoic; and, sure enough, in his penultimate discourse as Swiney Lecturer, the author, on October 12, 1898, announced at South Kensington the discovery of the remains here under consideration. At that lecture he dealt fully with the long known Cœlolepis scale, and dissipated the anomalies which had hitherto beset it, showing it to

[1] "On *Thelodus Pagei*, from the Old Red Sandstone of Forfarshire," and "Report on the Fossil Fishes collected by the Geolog. Survey of Scotland in the Silurian Rocks of the South of Scotland." By R. H Traquair, LL.D., F.R.S., being Nos. 21 and 32 of Part 3, vol. 29, *Trans.* R. Soc. Edinb.

be the shagreen granule of a remarkable fish—shark-like though not a shark; for while possessed of an expanded pectoral and an apparently heterocercal caudal fin, of an extensive branchial apparatus consisting (*br.*) of seven or eight sets of parts, it revealed no trace of teeth, jaws, fin-spines, or pelvic fins; while median fins other than the caudal could not be recognised. The impression created by this announcement was profound, and from the context of his remarks it became evident to the zoologists present that there had been discovered new and probably annectant forms of unique value, and that their best hopes of the Scottish Silurian deposits might yet be realised.

Shortly after his return to Edinburgh, the lecturer produced the first of the two memoirs under review, and therein announced that the fish in question is that described some thirty years ago by Powrie, its discoverer, from the Lower Old Red Sandstone at Turin Hill, near Forfar, by him named *Cephalopterus*, and which he himself, noting that that name was preoccupied, had in 1896 re-named *Turinia*. Further, he announced the very important discovery of its generic identity with Agassiz's *Thelodus*, and, retaining Powrie's specific name, put it finally forward with adequate description and illustration as *Thelodus Pagei*, a member of the family Cœlolepidæ, of the nature of whose representatives it enabled us to form the first comprehensive idea.

This discovery of the generic relationship between the so-called Cephalopterus and Thelodus furnished the keynote to the main series of observations which followed, and the author very properly made the *Thelodus Pagei* the subject of a first special memoir, introductory to the second. Towards the conclusion of this he lays special stress upon the peculiar characters of that which he regards as its pectoral fin-fold, which, according to his description, would appear (Fig. 1, *pc.′ pc.″*) to extend along the branchial free border, and to be "continuous anteriorly with the outline of the head"; while, of its posterior lobe, he remarks that the "lappet-like expansion" which it forms "suggests an analogy with the cornual flaps of *Cephalaspis*, which were originally considered by Lankester as the equivalents of pectoral fins." To this, to our reading the most noteworthy, passage in the whole monograph we shall return. Passing on, the author, pointing out that while the Cœlolepid in most respects resembles the Pteraspidian its dermal covering points to an Elasmobranch affinity, concludes that through the Thelodus allies the Heterostraci may have had a common origin with the primitive Elasmobranchs—an argument previously formulated by Reis, except that he regards the Pteraspidians as degenerate.

So much for the first memoir, which, if it alone contained all that has come to hand, would have marked an epoch in our knowledge of these most mysterious of fish forms.

Turning now to the second memoir, it may be said that the materials described in it were only obtained in 1897, and that the fact that it was not until the author received and compared these with the Powrie specimen that the identity of that became evident. Hence the delay in the final determination of this. The 1897 collection was obtained by Messrs. Macconochie and Tait while searching the Silurian Rocks of the Lesmahagow district of Lanarkshire, and it was by the latter gentleman supplemented in 1898 by material which included one of the new genera. The total yield has been five genera, of which four are new, and eight new species, and in the earlier part of the monograph the author, retaining the ordinal name Heterostraci for the Cœlolepid and Pteraspidian forms, extends the definition of the former, regarded as a family of the order, so as to include *Thelodus* and the first of his new genera, *Lanarkia* (Fig. 2). Of Thelodus two new species (*T. Scoticus* and *T. planus*) are recorded and described, and of *Lanarkia* three species. All are small, and *Lanarkia* is characterised by the presence of a dermal armature consisting of relatively large conical spines, without a basal plate (*cf.* Fig. 2).

For the reception of the remaining three genera, the author has found it necessary to create a new family, the *Birkeniidae*, and a new order, the *Anaspida*, setting aside for the moment yet another remarkable form, for which the formation of a new family of the Cephalaspidians or Osteostraci has been found necessary. To deal firstly with the Anaspida, the most remarkable character which the two genera (*Birkenia* and *Lasanius*) possess in common is the possession of a series of median ventral scutes extending along the greater length of the trunk, and bearing each, throughout the posterior series in *Birkenia* (Fig. 3) and their whole extent in *Lasanius* (Fig. 4), a broad compressed spine of formidable aspect. Beyond this very remarkable character they differ *in toto*. *Birkenia*, possessed of a heterocercal caudal fin and a single dorsal, which (*d.*), with its body, is encased in a dense armature of elongated scutes, at first sight suggests, as the author naïvely remarks, a Palæoniscid "with the rows of scales running the wrong way!" The characters of its head scutes, the absence of recognisable mouth, of teeth, jaws and operculum, the non-certainty of orbits, however, altogether outweigh these superficial appearances as criteria of affinity, and Dr. Traquair, dealing *en passant* with a series of apertures, which lie along the post-cephalic boundary and which he thinks may be respiratory, with justification makes out a case for an ostracodermatous kinship. *Lasanius* is still more remarkable; since, beyond the row of scutes and the heterocercal tail fin, upon which its presumed affinities with *Birkenia* are based, the specimens by which it is represented agree only in revealing a series of eight post-cephalic skeletal rods, which (*r.*) slope obliquely forwards, and by a forwardly directed series of processes approach their fellows of the opposite side near the dorsal middle line. They are serially disposed behind an oblique chain of ossicles (*r.′*), and

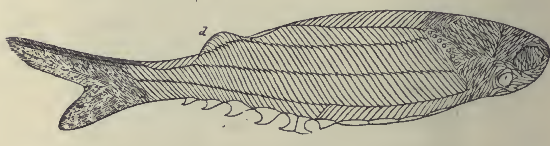


FIG. 3.—*Birkenia elegans*, restored outline, natural size.

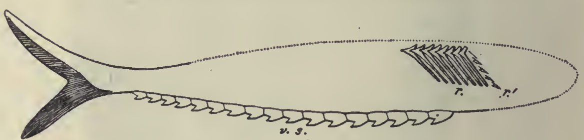


FIG. 4.—*Lasanius problematicus*, restored outline, about natural size.

remarkable in the extreme as are these structures, there is no suggestion forthcoming as to their probable significance. The author points out that *Lasanius* stands "much in the same relation to *Birkenia* as the nearly naked *Phanerosteon* does to the other genera of Palæoniscidæ," and we must be content to accept this on his authority, as justification for his provisional association of these strange genera with the Ostracodermi, pending further discovery, which can alone help us towards a fuller solution of the problem they present.

The remaining genus described as new is *Ateleaspis*, for which the author also creates a new family of the Cephalaspidian order Osteostraci. This genus is small, and beset by "shagreen bodies" which on the head have "coalesced into small polygonal plates" that in the tail region unite to form "flat rhombic scales." It is further remarkable for the joint possession of the configuration of a Thelodus or Lanarkia, and of a couple of crescentic markings on the top of its head which the author is inclined to regard as the "outer margins of a pair of orbits, placed as in Cephalaspis" (such as he has failed to detect in any of the other associated genera described in his monograph as new).

Passing on to general questions of classification and final consideration of the inter-relationships of these noteworthy creatures, Dr. Traquair hesitates, to our thinking rightly, to admit the Pterichthyidæ members of the Sub-Class Ostracodermi, apparently retaining this for the reception of the Pteraspidian and Cephalaspidian forms and their allies alone. The main outcome of his work is the association of the former with a supposed Plagiostome ancestry through the Cœlolepidæ, and he is led to find connecting links in the Drepanaspidæ, upon the Pteraspidian affinities of which he insisted in 1896. The sole representative of this family, *Drepanaspis*, from the Lower Devonian of Gmünden in West Germany, was only described by Schlüiter in 1887. We append a figure of it, from which it will be seen that while in respect to the possession of central (*c.*), lateral (*p.l*) and rostral (*r.*) plates it "points forwards" to the Pteraspidian type, in the possession of tesseræ it "points backwards" to the Cœlolepid; and by appeal to the condition of the Psammosteidæ, which the author holds to be near related forms, the "stellate tubercles" of which he has already come to regard as "shagreen-granules which have coalesced," he builds up an argument for the origin of the plates of the higher Pteraspidians by fusion of shagreen-granules in linear series.

Having thus with much justification strengthened his conviction that the Pteraspidian fishes have had a common origin with the primitive Elasmobranchs, and that the Cœlolepidæ, Psammosteidæ and Drepanaspidæ are in order representative of the ascending series which lead up to the Pteraspidians proper, the author returns to the consideration of the Cephal-

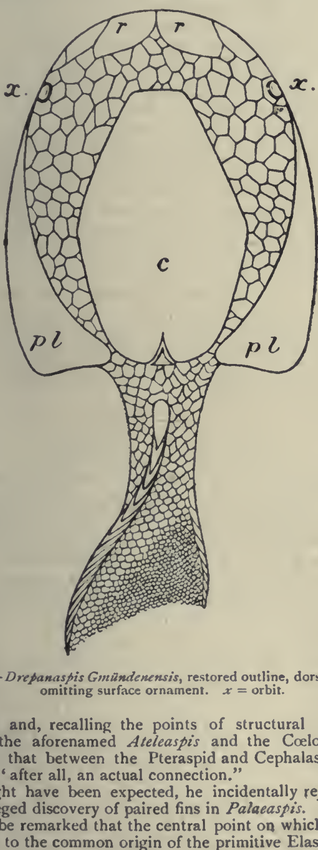


FIG. 5.—*Drepanaspis Gmündenensis*, restored outline, dorsal aspect, omitting surface ornament. x = orbit.

aspidians, and, recalling the points of structural community between the aforenamed *Ateleaspis* and the Cœlolepidæ, he concludes that between the Pteraspid and Cephalaspid groups there is, "after all, an actual connection."

As might have been expected, he incidentally rejects Claypole's alleged discovery of paired fins in *Palaeaspis*.

It will be remarked that the central point on which the conclusion as to the common origin of the primitive Elasmobranchs and the Ostracodermi (using this term in the author's sense) turns, is the homologising of the plates of the higher Pteraspidians with those of the less fully developed Drepanaspid and Psammosteid types. So far as the central and rostral elements are concerned well and good; but while admitting the assumed homology of the coronal plate of Pteraspis with the postero-lateral of Drepanaspis, we do not feel so sure about regarding these as the results of encasement of the lateral fin-flaps of Thelodus and Lanarkia, which are rendered thereby "utterly functionless as fins by being enclosed in unyielding bony plates." In dealing with these facts, Dr. Traquair has been led into a digression, savouring of leniency towards the lateral fold theory of the origin of the vertebrate limbs, to which indeed he has already expressed himself favourable in his recent memoir on the Selachian Cladodus Neilsoni. Following Powrie, he draws attention to the resemblance between the supposed fin-fold of Thelodus and that of the living Rays. If in this he is right, the characteristic feature of both is the forward extension into the head-region; and when it is remembered that ontogenetically the pectoral fin bud arises post-branchially, this extension can only be the result of forward rotation, and therefore an index of extreme specialisation. If this be so, the author's implication that "we have here a very interesting point in connection with the much discussed question of the morphology of the paired limbs in vertebrates—a new and important corroboration of the lateral fold theory," can hardly be taken in the sense which would seem intended. There is, however, an alternative reading, to which he has himself pointed the way, which we are most readily inclined to adopt, viz. that already alluded to (*cf. antea*) as involving a comparison between the posterior pectoral lobe of Thelodus (*pc.'* Fig. 1) and the cornual flap of Cephalaspis which, with the author, we believe Lankester to have been right in regarding as "the equivalent of a pectoral fin." To put the case otherwise, we do not see the proof that the presumed forward extension of the fin-fold (*pc.''*) is fin-like in structure, and we incline to the conclusion, especially in view of the perforation of its supposed investing plate by the so-called respiratory aperture in *Pteraspis* (1) that it is this alone which has been converted into the cornual plate of that genus and the postero-lateral plate of Drepanaspis; (2) that this is in all probability represented by the cornua of the Cephalaspidiæ, which may therefore well be accessory branchial organs probably enclosing a central passage —"atria," in fact, if not actual opercula! wherefore it would be interesting to ascertain whether they enclose a central canal or passage and are lined by shagreen-granules or tesseræ, as might well be if this interpretation is correct. And we further suggest as the natural sequence to this (3) that the posterior lobe of the supposed fin-fold of the Cœlolepidæ (*pc.'* Fig. 1) alone represents the pectoral member of the true fishes, and is in turn represented by the cornual flaps of the Cephalaspidians; and (4) that the pectoral member of the Pteraspidians has yet to be sought.

We put forward this view with all reserve, and we submit that while it is not opposed to the facts, it still further justifies the belief in a connection between the Cephalaspidian and Pteraspidian forms which Dr. Traquair has revived. All known facts of morphology justify the conclusion that the paired limbs of the vertebrate have been wholly evolved within that phylum, and there are not a few which suggest that the pectoral and pelvic members have been acquired independently in anterio-posterior succession. If so, may not the Cœlolepidæ and Cephalaspidiæ be now regarded (probably with the Pteraspidiæ as very distant allies) as the representatives of an apodal stage in evolution, at which the pelvic member had not yet come into existence. Their extreme structural simplicity and entire lack of jaws, teeth, and apparent endoskeleton capable of preservation in the fossil state, are certainly not at variance with this view, and under it the old belief in their extremely specialised nature and their presumed degeneration, towards which even Traquair himself inclines, with that in their affinity with the Marsipobranchs, largely disappears.

The question is one for the palæontologist; and while congratulating the officers of the Geological Survey and the Edinburgh Museum upon the addition to their already matchless collection of these wonderful remains, and the author upon the masterly manner in which, as a true morphologist, and with "soul," he has worked them out, we look to him and his friends in the field to furnish the next link in the chain. The present one is a triumph for all concerned, worthy the author of "The Palæoniscidæ" and interpreter of Palæospondylus, and as marking progress it is equal to anything achieved in the palæontology of the last two decades. G. B. H.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The following are among the lectures announced for the present term:—Prof. Clifton, acoustics; Mr. Walker, physical optics; Mr. Hilton, elementary mechanics and physics; Mr. Baynes, elementary heat and light; Mr. Jervis-Smith, dynamo and motor machinery and electrical testing; Prof.

Odling, silicon, boron and fluorine compounds; Mr. Fisher, inorganic chemistry; Mr. Watts, organic chemistry; Mr. Veley, physical chemistry; Mr. Marsh, the practice of organic chemistry; Mr. Vernon-Harcourt, the subjects of the preliminary examination; Mr. Elford, groups vi., vii., viii. in Mendeléef's periodic system; Mr. Elford, great chemists and their work; Mr. Walden, synthetical methods in organic chemistry, purin group, &c.; Mr. Wilderman, the velocity of reaction and equilibrium in homogeneous and heterogeneous systems; Prof. Sollas, history of the earth, Jurassic fossils; Mr. Dickson, the atmospheric circulation; Mr. Herbertson, river basins and shore lines; Prof. Miers, elementary crystallography; Mr. Bowman, some natural silicates; Prof. Weldon, general course of morphology, variation, inheritance, natural selection (continued); Mr. Goodrich, annelida; Mr. Jenkinson, elementary morphology; Mr. Günther, arthropoda (continued); Mr. Thompson, sauropsidan morphology, sauropsidan palæontology; Prof. Gotch, general course of physiology, physiology of the excitable tissues; Mr. Haldane and Mr. Ramsden, subjects of the Final Honour School; Mr. Burch, physiological physics; Prof. Vines, elementary course—botany; Prof. Tylor, anthropology in ancient literature; Mr. Stout, mental evolution; Prof. Case, psychology and the origin of knowledge.

CAMBRIDGE.—The Reader in Geography (Mr. Oldham) gives this term three courses of lectures, on the geography of Europe, on physical geography, and on the history of geographical discovery, respectively.

At Corpus Christi College, Mr. F. G. Channon, eighth wrangler, 1897, has been elected to a fellowship.

Mr. W. B. Hardy, Demonstrator of Physiology, has been awarded the Thurston Prize at Caius College, for his physiological researches.

The John Hopkinson memorial wing of the Cambridge University Engineering Laboratory will be opened on Friday, February 2, at 2.30. Lord Kelvin will deliver an opening address, after which the Master of Trinity will unveil a portrait of the late Dr. Hopkinson, presented to the Laboratory by subscribers.

WE learn from the *Athenaeum* that by the will of a wealthy Africander, Dr. W. Hiddingh, the Cape University profits to the extent of 25,000*l*., with a site for new university buildings, and 5000*l*. for the foundation of a scholarship. The South Africa College receives from the same source a legacy of 10,000*l*.

WE understand that the Berkeley fellowships at Owens College, referred to in a note last week (p. 284), were given only for a limited number of years by a generous friend of the College, and they have now ceased. There has never been an endowment upon which these fellowships were an annual charge.

A BILL "to authorise the regents of the Smithsonian Institution to confer certain degrees and for other purposes" has been introduced by the Chairman of the Senate Committee on the District of Columbia. *Science* publishes the following particulars of the provisions of the Bill:—That the regents of the Smithsonian Institution be authorised to appoint a board of five examiners, who shall, with the approval of the regents, prepare and publish a schedule of courses of studies preparatory to the degrees of master of arts, master of science, doctor of philosophy, and doctor of science. The examiners shall from time to time hold examinations in the City of Washington for the said degrees; and, on the satisfactory completion by any candidate of the prescribed course of studies for either of the above mentioned degrees, shall recommend such a candidate to the regents of the Smithsonian Institution for such degrees. The regents are hereby authorised to confer, under suitable regulations, the degrees above mentioned, and also the honorary degree of doctor of laws. Provided, That no person shall be accepted as a candidate for the degree of master of arts or of doctor of philosophy who has not completed a course of study at least equivalent to the course of study required of candidates for corresponding degrees in the most advanced universities in the United States; and provided further, That the degree of doctor of laws shall be conferred on no more than five persons in any one calendar year. The members of the board of examiners shall hold office during the pleasure of the regents of the Smithsonian Institution. Each examiner shall devote his entire time to the duties of instruction and examination assigned to him by the said regents, and shall receive a salary of 4000 dollars per annum, except that the chairman of the board shall receive a salary of 5000 dollars per annum.

THE inaugural lecture of the Department of Agriculture of the University of Cambridge, delivered by Prof. Somerville, has been published by the University Press. The subject is some aspects of the bearings of education and science on practical agriculture. Ten years ago very little was done for the education of the rural population in the principles of agricultural industries, but many agencies are now at work, and the assistance which science can give to agriculture is slowly being recognised by farmers. The establishment of a chair of agriculture at Cambridge, and its endowment for ten years, should serve to extend the movement for increased attention to agricultural interests in education. When the ten years provided for by the endowment have elapsed, it may confidently be expected that public opinion will see that the chair shall be placed upon a permanent footing. What has to be done between now and then is to show that farmers who use with intelligent discrimination the teachings of science have the best chance of success. Agricultural practice which neglects scientific results is doomed to failure, but if science is engrafted upon practice, it is possible for farmers to hold their own even in these years of depression. "It is the fortune of agriculture," remarks Prof. Somerville, "to be indebted to science at almost every turn. Zoology and physiology play their part in such directions as the breeding and feeding of live-stock, in the various ramifications of the veterinary art, and in the attractive section of economic entomology. Geology affects practical agriculture to a less extent, but no science adds more to the pleasures of a farmer's life. Mathematics and physics lend their assistance in such sections of a farmer's work as the calculation of volumes and areas, in draining, levelling, road-making, the use and maintenance of machinery, and the like." To this may be added that the agriculturist who has a knowledge of the principles of physical and natural science is better able to discern directions in which cultivation may be improved, and to take advantage of the results of agricultural research, than the farmer who does not possess such knowledge. Prof. Somerville's lecture should be widely distributed among agriculturists so as to correct the impression, still too common, that science is theory and that practice is independent of it.

SCIENTIFIC SERIALS.

American Journal of Science, January.—Products of the explosion of acetylene, by W. G. Mixter. The study of the explosion of acetylene was continued in order to obtain facts for or against the author's hypothesis that a sufficient frequency of molecular impacts is requisite to secure spread of explosive change throughout a gas. The experiments so far are not conclusive. Acetylene is always found after sparking and explosion. The author believes that it is not residual gas, but is formed by subsequent synthesis. This is supported by the fact that an endothermic compound of carbon and nitrogen is also formed in the eudiometer.—Glaciation of central Idaho, by G. H. Stone. The occurrence of wood in the esker gravels of Idaho suggests a comparison of that region with New England. The large valley ice sheets or Piedmont glaciers of north central Idaho formed a type intermediate in character between the more strictly local glaciers found further south and the great confluent ice sheet of British Columbia.—Graftonite, a new mineral, by S. L. Penfield. The mineral described is found on the south side of Melvin Mountain, about five miles west of the village of Grafton, New Hampshire. It is an iron-manganese phosphate closely analogous to triphylite, with which it is found intergrown.—Explorations of the *Albatross* in the Pacific Ocean, by Alexander Agassiz (see p. 211).—Constitution of the ammonium-magnesium arseniate of analysis, by Martha Austin. When ammoniacal magnesia mixture in slight excess is added to the faintly acid solution of arsenic acid (carrying no ammonium salts) in a volume not exceeding 200 c.c., the precipitate appears to fall in ideal condition.

Symons's Monthly Meteorological Magazine, January.—Low barometric pressure on December 29, 1899. The notes refer to the readings along the remarkable course of the storm, which took first an easterly track along the south of Ireland, and then suddenly changed it to a northerly one over the Isle of Man.

The minimum seems to have been about 28·1 inches; at Camden Square, London, where the lowest reading was 28·247 inches. The only lower readings there since 1858 have been: 28·332 inches on January 24, 1872; 28·364 inches on December 4, 1876; and 28·295 inches on December 9, 1886.—Severe frost in December 1899. A table shows the number of shade minima below 15°. Near Hereford a temperature of $-2°$ was recorded on the 15th in a screen of the Stevenson pattern. At Lyme Regis, Dorset, a correspondent writes that some soda-water bottles which were opened on the golf links all instantly froze; before being opened they were perfectly fluid and free from ice.

SOCIETIES AND ACADEMIES.

London.

Royal Society, December 7, 1899.—"*Polytremacis* and the Ancestry of the Helioporidæ." By J. W. Gregory, D.Sc. Communicated by Prof. Lankester, F.R.S.

The recent blue coral *Heliopora* presents striking resemblances in structure to the palæozoic *Heliolites*. All the earlier writers on corals accordingly regarded the two genera as intimately allied But some later authorities consider the resemblances as accidental, and that the corals have no special affinities. Thus, according to F. Bernard, *Heliopora* and *Heliolites* belong to distinct subphyla. Lindström admits only one species of *Heliopora*, and regards the genus as quite isolated, as essentially distinct in structure from *Heliolites*, and as further separated from the latter by "the total absence of all connecting links from the end of the middle Devonian to the recent times." The author, however, considers that the original view of the close affinity of *Heliopora* and *Heliolites* is correct, that the two genera are essentially similar in structure, and that they are linked by a series of eocene and cretaceous corals. Amongst these fossils is the genus *Polytremacis*, which is redescribed, and a new species of *Heliopora* from the cretaceous of Somaliland. It is suggested that *Heliopora* has descended from the palæozoic Heliolitidæ by degeneration in size and increase in number of the cœnenchymal cæca.

"On the Association of Attributes in Statistics, with Examples from the Material of the Childhood Society, &c." By G. Udny Yule. Communicated by Karl Pearson, F.R.S.

Geological Society, January 10.—W. Whitaker, F.R.S., President, in the chair.—On a particular form of surface, the result of glacial and subaërial erosion, seen on Loch Lochy and elsewhere, by Dr. W. T. Blanford, F.R.S. This form of surface, first noticed by the author on Lake Como, was afterwards observed in the Great Glen of Scotland and in British Columbia. It consists of an almost even plane sloping at a moderate or high angle, and cut at intervals by small ravines or channels. The sides of the Great Glen have been planed by glacier-action to a greater extent than usual, and between Loch Lochy and Loch Oich, near Laggan, the sides of the Glen have a regular and flat slope of over 35° up to about 1000 feet above sea-level. Numerous stream-cut channels draining down this slope are, on an average, not more than 10 to 15 feet deep, but some quite exceptional examples may be 50 feet deep; these channels occupy less than a fourth of the surface. In addition there are larger glens which, although they run out into shallow ravines where they cut the sloping side of the Great Glen, are frequently 500 feet in depth among the hills. If these were ordinary stream-valleys before the Glacial Period, the cutting away of the ridges separating them to the extent of at least 250 or 300 feet must be attributed to glacial erosion on the sides of the Great Glen. The erosion of the small ravines in the glacial slope must have been effected by streams in post-Glacial times, and the measurement of their rate of erosion might be expected to throw light on the amount of time which has elapsed since the Glacial Period in this district. "The general effect produced by the whole evidence is . . . the small amount of denudation that has taken place since the Great Ice Age, and the necessary deduction that no great period of time, measured in years, can have elapsed between the Glacial Epoch and the present day."—On the geology of Northern Anglesey (Part II.), by C. A. Matley.—The formation of dendrites, by A. Octavius Watkins. If two plane-surfaces be separated by a film of suitable plastic material, and one surface be rotated slowly on the other through a small arc, the plastic material collects into branching forms similar to the structure of dendrites. The dendritic form starts from the part farthest from the axis, and the flow of material is from the smaller to the larger branches, the smaller uniting to form the larger. The author explains dendritic structure by the formation of a fissure in rock which becomes filled with a thin film of dendritic material; if the fissure is slowly widened, the dendrite starts where the widening commences, coinciding dendrites being formed on each wall.

Royal Meteorological Society, January 17.—Annual Meeting.—Mr. F. C. Bayard, President, in the chair.—In his presidential address, Mr. Bayard discussed the meteorological observations made at the Royal Observatory, Greenwich, during the fifty-one years 1848–1898, and brought out in a novel way many interesting features in the variability of the various observations of the barometer, maximum and minimum temperatures, relative humidity, direction of the wind and rainfall. These were shown in a diagrammatic form on the screen by means of a number of lantern slides. The address was also illustrated by various views of the Royal Observatory and of the instruments employed.—Mr. G. J. Symons, F.R.S., was elected President for the ensuing year.

Paris.

Academy of Sciences, January 15.—M. Maurice Lévy in the chair.—On the distribution of the abnormal residues of a function, by M. H. Padé.—On the reduction of an algebraical problem, by M. J. Ptaszycki.—Determination of the invariants attached to the group G_{168} of M. Klein, by M. A. Boulanger.—Vector fields and fields of force. Reciprocal action of scalar and vectorial masses.—Localised energy, by M. André Broca.—On the distribution of potential in a heterogeneous medium, by M. A. A. Petrovsky.—On the co-volume in the characteristic equation of fluids, by M. Daniel Berthelot. A comparison of the experimental isotherms for carbon bisulphide, ethyl chloride, carbon dioxide and ethylene with various modifications of the Van der Waals formula. If the co-volume b be regarded as a function of the temperature, the Van der Waals equation can be made to represent well the liquid state. The formula proposed by the author is $b_T = b_c\left[1 + 0{\cdot}3\left(\frac{T}{T_c} - 1\right)\right]$, where b_T is the co-volume at T, b_c that at the critical temperature, T_c.—On the mechanism of hearing, by M. Firmin Larroque. For a simple sound, whether the wave phases are concordant or not, the centre of perception receives two transmitted impressions together, there being no interference in any case. For two simple or complex sounds, two corresponding impressions are received by the centre of perception, there being neither beats nor resultants, the two ears being acoustically distinct.—The permanent modifications of metallic wires and the variation of their electrical resistance, by M. H. Chevallier. If the resistance of a wire is R at a temperature T_0, then heated to T, and again measured at T_0, in general, the resistance R′ last measured will be different from R. The phenomenon appears to be due to a tempering effect, and is most clearly marked with metals and alloys that have not been hardened. The effect is very marked with ordinary platinum-silver wire.—On the Hall phenomenon and thermomagnetic currents, by M. G. Moureau. The thermomagnetic currents discovered by Nernst and Ettingshausen in 1886 to exist in a thin metallic plate placed in a magnetic field normally to the lines of force and traversed by a heat current. Several attempts have been made to explain these phenomena, by hypotheses resting upon numerous arbitrary assumptions. The author now shows that these results are an immediate consequence of the Hall effect, the values calculated from this point of view agreeing extremely well with the experimental numbers, except in the cases of nickel and cobalt, which require further investigation.—On the discharge of electrified bodies and the formation of ozone, by M. P. Villard. The author concludes from his experiments that in ordinary air incandescent bodies may emit kathode rays comparable to the Lénard rays, but of very low voltage. If this is the case, several distinct phenomena can be explained; the power of discharging electrified bodies possessed by flame, incandescent bodies and phosphorus; the discharge by ultra-violet light, the production of ozone by flames, incandescent bodies, oxidation of phosphorus, electric sparks, and by radium.—On a method of measuring the velocity of the Röntgen rays, by M. Bernard Brunhes. The ordinary methods of measuring the velocity of light cannot be used with the X-rays since they are not reflected, but by applying the discovery of M.

Swyngedauw of the effect of the X-rays upon the discharge of bodies just below their ordinary sparking potential, it has proved to be possible to obtain comparative measurements of the velocity, which would appear to be of the same order as ultra-violet light.—On the nature of white light and the X-rays, by M. E. Carvallo.—The numerical laws of chemical equilibrium, by M. O. Boudouard. The formula of Le Chatelier is applied to the reaction $CO_2 + C \rightleftarrows 2CO_2$, and the composition of the gas mixture calculated for temperatures between 450° C. and 1050° C.—On the electrolysis of potassium chloride, by M. A. Brochet. The yield of chlorate is considerably increased by the presence of a little potassium bichromate in the solution. Curves are given showing the amounts of chlorine present as hypochlorite, chloride, and chlorate after a varying number of ampère hours.—On a new crystallised molybdenum sulphide, by M. Marcel Guichard. By heating molybdenum bisulphide in the electric furnace a lower sulphide, Mo_2S_3, is produced, which can be obtained as long steel-grey needles from the melted mass by treatment with aqua regia. Heated to a red heat in sulphur vapour the bisulphide is reformed; at higher temperatures it is dissociated into sulphur and molybdenum.—The action of magnesium upon saline solutions, by M. Henri Mouraour.—Automatism of the nerve cells, by M. Pompilian. Curves are given for the automatic movements observed in *Dytiscus Marginalis*. The author concludes that nerve cells are constantly disengaging nervous energy, without any excitement being required, and hence that nervous activity is really automatic, although varying in intensity with time. The higher nervous centres under normal conditions exert a controlling influence over the lower centres, the activity of the latter being clearly shown when the former are removed. Hence it would appear in pathology that the tremors may be explained either by a diminution of the controlling power exercised by the higher cerebral centres upon the lower medullary centres, or by an increase of activity of the latter.—On a category of crystalline groups escaping optical investigations, by M. Fred. Wallerant. In general, in a crystalline grouping, the different crystals can be easily distinguished, their ellipsoids of optical activity having different orientations. If, however, the orientation of the crystals are symmetrical with respect to the elements of symmetry of this ellipsoid, it will be impossible to distinguish them by polarised light. Cumenglite and chiastolite are considered as examples.—On the denudation of the central plateau of Haye, or Forêt de Haye, by M. Bleicher.—On the presence of the Upper Eocene in Tunis, by M. Flick.

DIARY OF SOCIETIES.

THURSDAY, JANUARY 25.

ROYAL SOCIETY, at 4.30.—Mathematical Contributions to the Theory of Evolution—On the Law of Reversion: Prof. K. Pearson, F.R.S.—(1) On the Mechanism of Gelation in Reversible Colloidal Systems: (2) A Preliminary Investigation of the Conditions which determine the Stability of Irreversible Hydrosols: W. B. Hardy.—On the Effects of Strain on the Thermo-electric Qualities of Metals, Part II.: Dr. McMaclean.—On the Periodicity in the Electric *Touch* of Chemical Elements. Preliminary Notice: Prof. J. C. Bose.

ROYAL INSTITUTION, at 3.—The Senses of Primitive Man: Dr. W. H. R. Rivers.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Adjourned Discussion on the Report of the Institution's Visit to Switzerland.—*And if time permit:* An Electrolytic Centrifugal Process for the Production of Copper Tubes: Sherard Cowper-Coles.

FRIDAY, JANUARY 26.

ROYAL INSTITUTION, at 9.—Motive Power, High Speed Navigation, Steam Turbines: Hon. C. A. Parsons, F.R.S.

PHYSICAL SOCIETY, at 5.—Some Developments in the Use of Price's Guard Wire in Insulation Tests: Prof. Ayrton and Mr. Mather.—Reflection and Transmission of Electric Waves along Wires: Dr. E. Barton and Mr. L. Lownds.—The Frequency of the Transverse Vibrations of a Stretched India-rubber Cord: T. J. Barker.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Water Meters of the Present Day, with special reference to Small Flows and Waste in Dribbles: William Schönheyder.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Simplon Tunnel: C. B. Fox.

SATURDAY, JANUARY 27.

MATHEMATICAL ASSOCIATION (University College, Gower Street, W.C.), at 2.—Dynamical Applications of the Theory of Correspondence: Sir Robert S. Ball.—Triangles Triply in Perspective: J. A. Third.—The Teaching of Indices and Surds: Prof. R. W. Genese.—Illustrations of Porismatic Equations: T. J. Bromwich.—A Note on the Focoids: R. F. Davis.

ESSEX FIELD CLUB, at 3.—Visit to Museum of College of Surgeons. Conductor: Prof. C. Stewart, F.R.S.

MONDAY, JANUARY 29.

SOCIETY OF ARTS, at 8.—The Nature and Yield of Metalliferous Deposits: Bennett H. Brough.

INSTITUTE OF ACTUARIES, at 5.30.—Increasing Reversionary Charges: W. B. Paterson

TUESDAY, JANUARY 30.

ROYAL INSTITUTION, at 3.—Structure and Classification of Fishes: Prof. E. Ray Lankester, F.R.S.

ANTHROPOLOGICAL INSTITUTE, at 8.30.—Anniversary Meeting.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Steamers for Winter Navigation and Ice-breaking: Robert Runeberg.

WEDNESDAY, JANUARY 31.

SOCIETY OF ARTS, at 8.—The Undeveloped Resources of the Bolivian Andes: Sir W. Martin Conway.

THURSDAY, FEBRUARY 1.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* A Case of Monochromatic Vision: Sir W. de W. Abney, F.R.S.—Thermal Radiation in Absolute Measure: Dr. Bottomley, F.R.S., and Dr. Beattie.—Electrical Conductivity in Gases traversed by Kathode Rays: Dr. McLennan.

ROYAL INSTITUTION, at 3.—The Senses of Primitive Man: Dr. W. H. R. Rivers.

LINNEAN SOCIETY, at 8.—On Botanic Nomenclature: C. B. Clarke, F.R.S.—On the Zoological Results of an Expedition to Mount Roraima, in British Guiana, undertaken by Messrs. F. V. McConnell and J. J. Quelch: Prof. E. Ray Lankester, F.R.S.

CHEMICAL SOCIETY, at 8.—The Chlorine Derivatives of Pyridine. Part V. Synthesis of $\alpha\alpha'$-Dichlorpyridine. Constitution of Citrazinic Acid: W. J. Sell and F. W. Dootson.—The Formation of Heterocylic Compounds: S. Ruhemann and H. E. Stapleton.—The Space Configuration of Quadrivalent Sulphur Derivatives: Methyl Ethyl Thetine Dextrocamphorsulphonate, and Dextrobromocamphorsulphonate: W. J. Pope and S. J. Peachey.—Nitrocamphane: M. O. Forster.

RÖNTGEN SOCIETY, at 8.—Röntgen Rays in Diseases of the Chest: Dr. Hugh Walsham.—Mr. A. Hastings Stewart will show a small Egyptian Mummy and Skiagrams of the same.

FRIDAY, FEBRUARY 2.

ROYAL INSTITUTION, at 9.—Wireless Telegraphy: G. Marconi.

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THURSDAY, FEBRUARY 1, 1900.

A YEAR OF BIOLOGY.

L'Année Biologique. Comptes rendus annuels des Travaux de Biologie générale, publiés sous la direction de Yves Delage, professeur à la Sorbonne, avec la collaboration d'un comité de rédacteurs, Secrétaire de la rédaction Georges Poirault, directeur du Laboratoire d'enseignement supérieur de la villa Thuret, à Antibes. Troisième année, 1897. Pp. xxxv + 842. (Paris: Librairie C. Reinwald, Schleicher Frères, éditeurs. 1899.)

THIS biological annual has improved with each year of its life, and its third volume, which deals with the literature for 1897, commands our admiration and gratitude. There is no denying that the bibliographic lists are fairly full, and that the summaries give the gist of the books and papers reported It fills what was otherwise more or less of a gap in our bibliographic resources, and every biological laboratory throughout the world should make it a point of honour to have the volumes upon the shelves for reference. Furthermore, the work is being so well done that all those who are busy over the general problems of biology should see to it, in their own interest, as well as in that of science, that copies and abstracts of their papers are sent to the editors.

Believing that criticism is the sincerest form of flattery, we would use this opportunity to make a few suggestions. The "Annual" has not only improved every year, but it has grown steadily bigger, and it is now a most inconveniently heavy handful. Can it not be kept within more moderate compass? On this point we have three criticisms: (1) That over 160 pages are given to mental functions, which seems going a long way, seeing that we have *L'Année psychologique* as well; (2) that some of the reports are outrageously long, especially when the conclusion hinted at is that the paper is not worth very much after all; and (3) that the classification adopted favours overlapping and repetition. The last point seems to us so important that we venture to enlarge upon it.

As they stand at present the chapters are:—the cell; sex-elements and fertilisation; parthenogenesis; asexual reproduction; ontogeny; teratogeny; regeneration; grafting; sex, secondary sex-characters, and "ergatogenetic polymorphism"; metagenetic polymorphism, metamorphosis, and alternation of generations; latent characters; correlation;' death, immortality, and the germ-plasm; general morphology and physiology; heredity; variation; origin of species; geographical distribution; nervous system and mental functions; general theories and generalities. Now, as each of these twenty chapters has its bibliography and introduction and summaries, there is bound to be needless printing and overlapping. Can the committee not invent something simpler and more logical? It is too soon to stereotype the arrangement.

Teratogeny and variation overlap; variation and the origin of species overlap; ontogeny and general physiology overlap; latent characters and heredity overlap; and so on. In short, there is a great lack of lucidity in the classification adopted.

Would it not be better to have a more general scheme? *e.g.* (1) morphological analyis:—cell-structure, tissue-structure, &c.; (2) physiological analysis:—cell-function, growth, correlation, death, &c.; (3) reproduction and sex—including chapters 2, 3, 4, 9, and perhaps others; and so on. There is room for much difference of opinion, but twenty chapters are twice too many.

It may be answered that the numerous divisions facilitate reference, but the separately designated subjects would not be less accessible if they were sub-divisions of larger categories. We would press this point on the consideration of the editorial committee the more urgently, since it seems to us that the elaborate classification has sometimes proved a snare. Thus we should like to know why papers by Karl Pearson and others dealing with "spurious correlation," &c., are included in the chapter on physiological correlation. Is not this a misapprehension?

In the same connection we may refer to the editorial note on polymorphism, which we regret our inability to appreciate. Three kinds of polymorphism are distinguished (which are treated of in three different chapters)—(*a*) ergatogenic polymorphism which depends upon division of labour (which should include not only the polymorphic adaptations of an ant-hill, but functional "modifications" as well); (*b*) metagenic polymorphism, associated with alternation of generations; and (*c*) œcogenic polymorphism which results from the action of the environment (a particular case, surely, of environmental "modification"). But why not also add variational polymorphism, which would be a *reductio ad absurdum* of the extended usage of the term?

Many of the chapters present some striking feature of interest, giving a charm of individuality to the workmanship. Thus the chapter on the cell includes an account by A. Labbé of the artificial cells which Ascherson made in the memorable year 1838. With his artificial emulsions he was a pioneer on a path which Bütschli and others have followed up, "and if he sought for homologies where there were but analogies, some moderns are open to the same reproach." The second chapter contains an essay of twenty pages by L. Guignard on chromatic reduction, which is very welcome; but the bulk of it has been printed elsewhere, and it seems far too long to be consistent with the precise scope of this annual. We are ungrateful enough to object also to Pruvot's fine essay on fresh-water faunas as too long and independent for the present publication. The thirteenth chapter is made conspicuous by the essay of Élie Metchnikov on senile degeneration, showing up the organism's seamy side—its imperfect integration, its anarchy, its struggle of parts—of which senility is the *débâcle.* Needless to say, the essay is original and charming; but to our thinking, it should have been published in the *Revue des deux Mondes*, and not here. It is magnificent, but it is not a "compte-rendu." We fear, indeed, lest these introductory essays, if not kept more sternly within bounds, will harm the annual instead of helping it.

As for criticisms of technique, they are not much to our liking, especially since the volume represents a portentous amount of disinterested labour, the results of which are of great value to all biological workers. There has been great improvement, but it must be confessed that there is still need of increased carefulness. Thus, if we take (quite at random) p. 792, we have a paper by Bütschli stated to extend from p. 291 to p. 593 of the *Arch. Entwickmech.*, which is incredible; Haacke's text-book called a Grunddiss; Hertwig's "Streitfragen" wrongly spelt; Hickson's paper on the medusæ of Millepora cited where it seems irrelevant—trivial mistakes all of them, but too many for one page, and it is so elsewhere. All the same, this third volume of "L'Année Biologique" is a fine piece of work, and every biologist will wish it the success it deserves. J. A. T.

AN ARITHMETICAL MISCELLANY.

Exercices d'Arithmétique. Par J. Fitz-Patrick et G. Chevrel. Deuxième édition. Pp. xiv + 680. (Paris: A. Hermann, 1900.)

THIS second edition of a very entertaining book differs from the first by the inclusion of more than 500 new and unsolved examples, and a supplement on commercial arithmetic, which, no doubt, will be found very useful by the French schoolmaster, but is so incongruous with the rest of the work as to recall Horace's well-known parable of the mermaid and its analogues in literature and art.

Apart from this concession to the practical, the authors, largely imbued with the spirit of Edouard Lucas, have provided their readers with a varied store of illustrations of Diophantine arithmetic and of numerous fundamental propositions in the theory of numbers. Their solutions are very clear and simple (though they might, with advantage, have made more use of the notation of congruences), and they will undoubtedly succeed in promoting a more general and intelligent interest in the theory of arithmetic.

Many of the examples are of a very elementary character; but there are some which deserve the attention of expert mathematicians. For instance (p. 366), we have Lucas's determination of *all* the prime factors of $(a^{1260}-b^{1260})/(a-b)$, where a, b are the roots of $x^2=x-2$; the last five of these primes being

125541359, 25215201901, 34449677641, 153790567559, 733268745721.

This result is said to have been verified by M. Le Lasseur. Again (p. 158), the Rev. Father J. Pervouchine, of Perm, has found that $2^{2^{23}}+1$, comprising 2525223 digits, is divisible by 167772161 ($=5.2^{25}+1$), which is prime. Here are mysteries which we must leave to Lieut.-Colonel Cunningham and Mr. Bickmore to unravel.

An agreeable element of humour is supplied by Question 399, on the interpretation of Art. 757 of the Civil Code; that ambiguous drafting is not wholly unknown on the other side of the Channel is a surprise which is not without its consolations.

It would be tedious to detail even the more conspicuous features of this handsome volume; enough to say that every student of arithmetic will find in it something to arouse his interest and extend his knowledge. If he is a novice, the study of this book will help him to appreciate the works of at least the earlier masters, such as Euler and Lagrange; if he is a veteran, he will find recreation in turning over its pages in his leisure moments.

There is one reflection which a perusal of the work can hardly fail to suggest. The province of arithmetic is so definite that one would expect its methods to be marked by a general uniformity. But this is far from being the case; and there is, in particular, an unmistakable contrast between Diophantine arithmetic and the severe, but noble science founded by Lagrange, Gauss and Kummer, which we may distinguish as the analytical theory of numbers. Their points of contact in such things as the elementary theory of congruences and of residues only serve, at present, to accentuate their divergences; it may almost be affirmed that they appeal to different classes of mind. To use a metaphor, we may say that one is the primitive gold-mining of the individual prospector, the other the systematic working of a quartz reef with the help of modern machinery. Just now the analytica method holds the field; there are several reasons for this—the development of the theory of algebraic integers, the influence of function-theory, the general "arithmeticising" of analysis; but a reaction is almost certain to come. It must be remembered that all the available evidence seems to show that Fermat's methods were essentially Diophantine; and there is very good reason to believe that he was in possession of some peculiar analysis, the secret of which died with him and still awaits rediscovery. Whether this is so or not, there can be no doubt that the cultivation of Diophantine methods deserves more attention than it receives. The risk of failure is great; but the chance of finding a treasure island exists, and ought to appeal to that spirit of adventure which dwells in every mathematician who is worthy of the name. G. B. M.

MISSIONARY ANTHROPOLOGY.

In Dwarf Land and Cannibal Country. A Record of Travel and Discovery in Central Africa. By A. B. Lloyd. With an introduction by the President of the Church Missionary Society. Pp. xxiv + 385. (London: T. Fisher Unwin, 1899.)

FURTHER information regarding the dwarfs of the north-eastern part of the Congo Basin is one of the main desiderata in African anthropology. We therefore turned to this volume hoping, from its title and size, for detailed measurements of these dwarfs, convincing evidence as to whether they belong to several tribes or are all clans of one tribe, and for further light on their beliefs and folklore. But we are disappointed, for the book adds practically nothing to our knowledge of this group of dwarfs, and the title is misleading. The book narrates the story of Mr. Lloyd's missionary labours and adventures from July 14, 1894, to the end of 1898; most of these three and a half years were spent in the Uganda Protectorate, and the author's acquaintance with the Congo dwarfs was obtained between October 6 and 15, 1898. The account of his experiences with this people occur only within some seventeen pages, whereas 368 are devoted to "Out of Dwarf Land."

The bulk of the book is occupied with an account of

Mr. Lloyd's voyage from England to Zanzibar *via* the Cape; of his journey from Zanzibar to Uganda by the German road; of his residence in Uganda and of his share in the operations against our unfortunate Soudanese troops, in which he and his colleagues took a prominent part, although, as the author remarks, "the honours and distinctions that were showered upon the military section did not reach the missionaries"; and finally of his plucky march across the Ituri forests to Ugarrowa (where Stanley first met with his dwarfs in this region), and return home down the Aruwimi and the Congo.

Mr. Lloyd's hurried march gave him few opportunities of studying the dwarfs, so that he adds little to the descriptions of Stanley, Stuhlmann, and Burrows. The only point worthy of notice is that his evidence supports the belief that the pygmies have a fetish worship. It is not clear from Mr. Lloyd's account what clan or tribe of pygmies he met with. How much has been lost by Mr. Lloyd's haste can be gauged from his remarks elsewhere on African customs. He looks on anthropological questions from a typically missionary standpoint. He has a low opinion of the "average African," whose universal laziness he deplores. He describes the aim of the Watoro festivals as "the indulgence in all the evil passions of human nature, fighting and murder, lasciviousness and wanton wickedness. Devil dances of a most disgusting character, witchcraft and fetishism are all practised upon these occasions, and it is at such times that one sees the utter degradation of heathenism." The customs of these Watoro "are most barbarous. For instance, they have an extraordinary practice of breaking off all the front teeth in the lower jaw"; this is "a thoroughly heathen practice."

Mr. Lloyd's contributions to the natural history of Central Africa are more startling than numerous. On p. 107 he gives us a photograph of a "boa constrictor" killed on Ukerewe, one of the islands in the Victoria Nyanza.

The main value of this book is its unwilling witness to the vast improvement effected in the Congo Basin since the establishment of the Congo Free State, twenty years ago. For instance, Mr. Lloyd was able to cross from the eastern frontier to the Atlantic in only a trifle over two months; he marched safely through the forests with a party of nineteen men; he found the cannibals of the Bangwa tribe always friendly, and remarks "that a jollier set of black men I never in all my life had to do with." This testimony as to the revolution of social conditions is the more striking because the author is even more critical of the Congo Free State than he is of the militarism of the Germans and the ritual of the Universities' Mission at Zanzibar.

TELEPHOTOGRAPHY.

Telephotography. By Thomas R. Dallmeyer. Pp. xv + 148. (London: William Heinemann, 1899.)

IN this handsome volume all that is at present known about the theory and practical use of the telephotographic lens is brought together. Mr. Dallmeyer, as our readers may remember, was one of the first who tried to discover an arrangement of lenses which would produce an enlarged image of any distant object on the ground glass of a camera without any excessive length of camera, and the success which rewarded his labours is now well known.

It is interesting to remark that the author's attention was first directed to this subject by Dr. P. H. Emerson, who, as we are told in the preface, urged upon him "the necessity of a photographic instrument to enable the naturalist to record incidents that were then only possible by telescopic observation."

In the year 1892 Mr. Dallmeyer published a small pamphlet containing an interesting collection of papers that had been published relating to his new telescopic photographic lens, and he included in this numerous pictures illustrating the application to the photography of distant objects. This we understand is now out of print. The present volume will therefore be very acceptable to all who use, or intend to use, this form of lens, especially when one is reminded by Mr. Dallmeyer that, with the exception of one or two articles on the practical application of the lens by Mr. Lodge, Mr. Marriage, and Dr. Spitta, the subject has not been handled by any other English writer.

The author, in his treatment of the subject, introduces the reader first to the elementary properties of light; he then discusses the formation of images by the pin-hole camera, pointing out some valuable hints relative to the rendering of true perspective effects that may be gained from a study of the images obtained with such an instrument. The next two chapters deal with the formation of images by positive and negative lenses, and these serve as an excellent introduction to the following chapters, in which are described the methods of obtaining enlarged images by employing either two positive lens-systems or a combination of a positive and negative system, which constitutes the telephotographic lens.

From the theoretical the author turns to the practical side of the subject, and in the succeeding chapters he describes the use and effects of the diaphragm, practical applications and working data, concluding with a brief bibliography.

Quite a distinct feature of the volume is the fine series of illustrations, which brings out vividly, and more than mere words can describe, the great practical use of this form of lens, not only to the stay-at-home photographer, but to those whose duties lie in various directions. Nearly all the plates illustrate views taken, for the sake of comparison, with both the ordinary lens and the telescopic lens. Among these we find portraits which illustrate the value of this lens for obtaining correct perspective effects in the studio, enlarged pictures of the human eye, eclipse pictures, glaciers photographed at a distance of ten miles, views of an encampment taken from a balloon at a height of 800 metres, a photograph of a grounded man-of-war taken during war time at a distance of two miles, and lastly, reproductions of Mr. Lodge's excellent studies of birds and their nests. The variety of the illustrations gives one an idea of the numerous useful and valuable applications to which such a lens is specially adapted.

The now great popularity and wide use of the telephotographic lens makes us more than welcome Mr. Dallmeyer's book, which, besides supplying a distinct want, will be found a handsome and valuable addition to any photographic library. W. J. S. L.

NEW DATA FOR THE STUDY OF VARIATION.

Ueber einige Aberrationen von Papilio machaon. Von Dr. J. W. Spengel, Professor der Zoologie in Giessen. Pp. 48. Mit 3 Tafeln und 5 Abbildungen im Text. (Jena: Gustav Fischer, 1899.)

IT would be almost superfluous at the present time to offer an apology for the intimate study of variation in animals and plants. Evolutionists of whatever school of thought must necessarily be agreed upon the importance of variation as a factor in the production of new forms, though they may differ widely as to the means by which fresh species become established. In the present state of evolutionary theory it is of the utmost consequence to gain an insight into the laws which regulate variation, and this can only be done by the accumulation of accurate records of the results of experiment and observation. Many views on the subject are current, not one of which can be said to deserve more than a provisional acceptance, and all require to be rigorously tested in the light of facts. Hence any competent observer who—like Bateson, Standfuss, Merrifield and others—devotes himself to laboriously collecting and carefully recording data for the study of variation, whether natural or artificial, deserves well of all those who are interested in the progress of evolutionary theory.

The present treatise is a useful contribution to the mass of material that has lately been accumulating with reference to variation and aberration in the Lepidoptera. It was long ago pointed out by Bates and Wallace, and has often been insisted on since, that to the students of evolutionary law the wings of butterflies afford an unusually favourable field of observation. The days are gone by when the colour-patterns of insects were regarded as mere elegant curiosities, with no particular bearing on any question of scientific interest; and when deviations from the ordinary aspect of the species might be prized indeed by the collector for their rarity, but were thought to be beneath the notice of the genuine biologist. It is now fully recognised in most quarters that there is no real distinction to be drawn between "external characters" and points of structure; and, further, that while both sets of features are equally under the control of natural law, there are many principles of the first importance whose operation is more clearly discerned and more readily investigated in the former than in the latter. During the last few years much greater attention has been directed to the phenomena presented by colour-patterns than was previously the case; and many observers, both in this country and abroad, among whom may be reckoned Weismann, Eimer, Scudder, Mayer, Haase and Piepers, have attempted, with more or less success, to trace the history of existing patterns, and in some cases to formulate the laws under which certain changes of type have been brought about.

The author of the communication before us has occupied himself for many years with the study of natural variation in the "swallow-tail" group of the genus Papilio. The results of his investigation of over 2000 specimens still await publication; but in the meantime he has here put on record a very exact description of several forms of the common swallow-tail (*Papilio machaon*), mainly from the collections of Staudinger, Kratz, Standfuss and the Hon. W. Rothschild, which come rather under the head of aberration than of ordinary variation. Some of these have been the result of temperature-experiments, but the greater number have occurred under normal conditions in the open. Dr. Spengel makes no attempt to found any theoretical considerations on the deviations they present, but restricts himself to a statement of fact which, in point of fulness and accuracy, contrasts very favourably with the haphazard descriptions at one time thought sufficient. For details, the reader must refer to the treatise itself; but we may here draw attention to the co-existence of structural with colour-abnormality shown in the remarkable aberration described on pp. 9–16.

The figures are good, and greatly assist in the comprehension of the text. The author's system of nomenclature for the elements of the pattern is easily intelligible, and may be followed without difficulty through the pages of description. As a contribution to the stock of material hitherto available, Dr. Spengel's treatise, though limited in its scope, is of considerable value; and his further analysis of natural variation in allied forms will be awaited with interest. F. A. D.

OUR BOOK SHELF.

A. Koelliker's Handbuch der Gewebelehre des Menschen. Sechste umgearbeitete Auflage. Dritter Band. Von Victor v. Ebner. Erste Hälfte. Verdauungs-organe, Respirations-organe, &c. Pp. vi + 402. (Leipzig: W. Engelmann, 1899.)

FOR the first time in its history the "Handbook of Histology" of the famous Würzburg professor of anatomy appears with the name of an editor upon its title-page in place of the octogenarian master whose book, when it first made its appearance in the 'forties, created an epoch in the history of histological literature, and was made familiar to English readers by its translation by George Busk and Thomas Henry Huxley. The work was a mine of original investigation, and served for many years as a quarry which furnished the materials for the building up of many an account of the structure of the body, in which the source of information was too often, it is to be feared, ignored. In later editions the general style of the book became somewhat altered, as it became necessary for the author to refer to facts regarding microscopic structure which were becoming added by others as well as by himself; and it must be admitted that, while the book thereby accumulated a greater amount of information, it became less readable and unquestionably less original. Nevertheless, the parts of this last edition which have already appeared have fully maintained the place which v. Kölliker's "Gewebelehre" had taken as the first authority upon the subject of which it treats.

In Prof. v. Ebner's hands the character of the rest of the work has been so maintained, and even the literary style so closely imitated, that it would be difficult to detect the alteration in authorship. The amount of labour involved in producing a work of this kind can only be roughly guessed at by those who have never themselves undertaken the task, and Prof. v. Ebner is to be congratulated upon the success which has attended his labours, which it would appear from the preface have extended over three years. The added illustrations are singularly true to nature, and as numerous as could well be desired The bibliography is somewhat limited for a work of this kind, and it would have been worth an effort to render the list of works bearing upon the structure of each organ as complete—at least, so far as recent years are concerned—as possible. Nevertheless, important papers are looked for in vain amongst the references. And the lack of an index cannot be too strongly condemned. For it is impossible to understand what object can possibly be served by dispensing with that part of a book the absence of which renders difficult the proper employment of all the rest! Why is it that it is only in German books that we still find this unaccountable tendency to omit the all-important index? Echo can only answer, Why indeed? They do not manage these things better in Germany. But they are beginning to improve.

The Evolution of Geography. A Sketch of the Rise and Progress of Geographical Knowledge from the Earliest Times to the First Circumnavigation of the Globe. By John Keane. Pp. xvi + 160. (London: Edward Stanford, 1899.)

THE second title is more descriptive than the first, which suggests a much more ambitious scheme than the author had before him. This little book makes no claim to originality in matter or method. It is a compilation from accessible sources, and, so far as it goes, is a piece of careful and conscientious work. It is neither critical nor learned, and it would be unfair to review it as if it pretended to such distinction. The chapters are concerned mainly with the history of discovery under the titles of ancient geography, the early Christian ages, the crusading impulse, early and mediæval maps, Henry the Navigator, aids to geographical expansion, and Magellan. The statements of generally acknowledged facts are accurate as a rule, and controversial matters are usually excluded. Mathematical and physical geography do not receive adequate notice, even for so small a scale as is employed.

The first part of the title of the book led us to hope for a philosophical study of the science of geography, and its rise from the earliest times to its present stage of development; but such a work is still to write. Still to write also are studies of early Chinese and Hindu geographical knowledge; indeed, the whole working of the early Oriental mind on geographical problems offers a nearly virgin field, but one that can only be entered by an author well-versed in modern geography and in Eastern languages.

In the present modest work the best feature is undoubtedly the collection of maps, most of them reproduced from previously published English books, but some now shown for the first time in outline on a small scale. It is hard to believe that Magellan's ship, the *Victoria*, really bore her name all along the side in huge letters like a modern light-ship, as the frontispiece shows; but the responsibility for this is relegated to Levinus Hulsius, who published the original drawing in 1602. H. R. M.

First Steps in Earth-Knowledge; being an Introduction to Physiography (Section I.). By J. A. Harrison, B.Sc. Edited by W. J. Harrison. vi + 290 pp. (London: Blackie and Son, Ltd., 1899.)

AS the German term "Erdkunde," or its literal rendering, "Earth-Knowledge," signifies something different from an elementary treatment of the fundamental laws of physics and chemistry, such as Mr. Harrison's book provides, his title is a little incorrect and likely to be misleading. At the same time the author gives what is on the whole a satisfactory introduction to science, such as is included in Section I. of the syllabus in physiography of the Science and Art Department and in the schedule of requirements for pupil-teachers, issued by the Education Department. The book is distinctly attractive, being clearly printed and well illustrated. But certain blemishes have revealed themselves in examining the contents more carefully. We have looked in vain for any reference to the anomalous expansion of water when heated, and no method of determining the temperature at which it possesses its maximum density seems to be given. As so much attention is bestowed upon the construction of thermometers, and the reasons for the employment of mercury are duly tabulated, this omission is rather a grave one. In explaining reflection and refraction of light no reference is made to the simple pin methods of demonstration which are so useful in enabling students to deduce the laws for themselves. The chemistry section would have been improved if a more rational plan of treatment had been adopted.

Die Orkane des "Fernen Ostens." By Prof. Dr. Paul Bergholz. Pp. xii + 260. With 31 lithographed charts, 33 tables, and 7 figures. (Bremen and Shanghai: Max Nössler, 1900.)

THE Kaiser's remark, "Our future lies on the water," has induced Dr. Bergholz, in charge of the Bremen Meteorological Observatory, to devote a great deal of his time to the study of tropical hurricanes, and particularly to those of the Eastern Seas, because, as he states in his preface, the increase of German trade is especially noticeable in Eastern waters, a fact which is demonstrated to Englishmen by the continued transfer of Asiatic steamship lines from the British to the German flag. Dr. Bergholz has summarised all that has previously been written on typhoons, so that the present work is the concentrated essence of our knowledge of these terrible meteors. Every feature in the life-history of a typhoon seems to be carefully dealt with—the origin of the disturbance, its progress, the circulation and the force of the wind, the behaviour of the barometer, the thermometer, the sea, the clouds, and the rainfall. Several special instances are dealt with in detail, and a chapter is devoted to such anomalies as gales unaccompanied by rain, rapid falls of the barometer without increase of wind, strong winds with a slight decline of the barometer, and so on; all which go to prove that old Dampier was right when he declared that the storms of the Temperate Zones, the hurricanes of the West Indies, the cyclones of the Indian Ocean, and the typhoons of the China seas differ only in name. A selection of charts accompanies the work; but while it is permissible to begin the meteorological year with December, in exhibiting the monthly variations of pressure and temperature, there is no sufficient reason why October and November should fall between May and June. The method adopted in drawing the isobars will not meet with the approval of meteorologists, areas of high pressure not being separated in the natural way by areas of low pressure, and *vice versâ*, but merely by a dividing line where contrary winds must meet without any intervening calm space. H.

Volumetric Analysis. By John B. Coppock. 92 pp. (London: Whittaker and Co., 1899.)

THIS fragment of science is intended as an appendage to existing books on qualitative analysis so as to meet the requirements of certain examinations in chemistry held by the University of London and the Department of Science and Art. But recent books on analysis which have already come before our notice have met the contingency to which Mr. Coppock refers. Moreover, this is not the first little book with the same object in view. Mr. Coppock covers familiar ground in a familiar way and is, as far as we have seen, a trustworthy guide.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The University of London Election.

As a graduate of the University in two of its faculties, and as one who has spent a quarter of a century of the best years of his life in the work of scientific education, I may be allowed to feel that I am voicing the higher intelligence of the University in venturing to thank you for putting the present issue so clearly before the constituency in your article in NATURE of January 25.

I look upon all reference to the internal economy of the University in estimating the claims of the respective candidates as so much mere electioneering "dribbling." That work, which has excited so much controversy the last twenty years or so, has produced its happy result, and we may say well of all those controversial matters, "let the dead past bury its dead."

Strange it is that even such a constituency should so far exhibit the inherent stolidness of John Bull as to be unable to face about and view things in their real and ghastly proportion, when all the civilised world is amazed at the spectacle of an invasion of the Queen's Empire (by a race of more primitive civilisation), and the debility of the Empire, with all its wealth and resources, to stem the tide of invasion for weeks and weeks, simply because *science* has been called in to utilise and direct the energies of the enemy.

Looking at the history of the University of London, as constituting one chief factor of the intellectual progress of the Victorian Age, showing even to the "ancient universities" the way to bring scientific studies to the forefront in the academical world, there is no constituency in the country that can speak, and ought to speak, with greater emphasis at this critical stage of our Imperial existence. But it must find (and has, I believe, found in Sir Michael Foster) the man with the tongue of the learned, who can efficiently voice the mind of the University, if it is to cause to ring through Parliament to each remote corner of the Empire the question (which every loyal subject of the Queen is trying to ask), whether in the future the interests and the safety of the English race are to be entrusted to a military system with an *empirical basis* (which snubs scientific studies and drives them into a corner) as in the past, or to a rejuvenised system with a *scientific basis*, such as Germany presents to the world.

A. IRVING.

Floating Stones.

IN reference to Dr. Nordenskiold's communication *re* "Floating Stones" (No. 1577, vol. lxi.), it is a common thing to see grains of sand and small shells floating upon the waters of seas and estuaries, &c., when the surfaces are unagitated. The sand-grains must be dry; they are, therefore, only lifted and floated off by a rising tide after exposure to dry air.

In this way material is being constantly conveyed from one place to another during the *flow* of the tide, and does not return with the ebb.

The grains float as patches composed of fine and coarse material clinging together; the presence of the very fine grains appears to facilitate the flotation of the larger grains and shells. The phenomenon is more frequently seen where shell-sands occur, and is, I suppose, due to surface-tension.

If a few grains of dry sand be placed separately on various parts of a water-surface, they will eventually unite to form a patch; if this experiment be conducted carefully, the surface of the water can be completely covered by sand before any sinks to the bottom of the vessel. The tenacity of a large patch is remarkable; when once formed the vessel may be considerably agitated, and the patch even pressed down by the finger, without the grains becoming disunited.

London, January 24. CECIL CARUS-WILSON.

I AM interested in an article headed "Floating Stones" in your number of January 18, for I have observed the same phenomenon nearer home, namely, at Kimmeridge, where the flaky nature of the beach material renders the appearance of floating stones very common.

The only conditions necessary are a very gently rising tide after a dry day, during which the small flakes of "Kimmeridge clay" have had time to dry thoroughly.

If some of these dry flakes are on a very gently sloping surface of rock, or on top of a smooth stone, or any position where the water can rise and surround the flake gently (of course, this is below the shingle belt, for at the shingle the water is too broken), then the flake rises with the water, and floats away just as a needle will on the surface of water; a few bubbles may cling to the under-surface occasionally, and would, when present, assist the floating.

Since reading the article I have tried pieces of broken roof slate, and I have found that a small piece of dried slate about 1·5 × ·75 cms. by about ·1 cm. floats easily on tap wat r when gently placed on the surface.

R. C. T. EVANS.

9, Heathcote-street, Gray's Inn-road, W.C., January 29.

THE GERMAN ANTARCTIC EXPEDITION.[1]

THE German Antarctic Expedition will leave Europe, in a single ship, in the autumn of 1901. The simultaneous dispatch of a second ship is not proposed, as this does not appear to be necessary, either for the solution of the scientific problems or for the safety of the Expedition. A second vessel would be expedient only if it were intended to carry out oceanographical researches around the Antarctic area at the same time as a southward advance is made by the first ship. This is rendered the less necessary, on account of the work which has been done by the German Deep Sea Expedition in Antarctic waters south of the Indian Ocean, the side on which the German Expedition will endeavour to penetrate the ice.

The designs for the Antarctic ship have been completed with the advice of the Construction Department of the Imperial Navy. The building of the ship has been undertaken by the Howaldt works in Kiel, which, in response to the circular inviting estimates, worked out an admirable plan. In designing the vessel special attention has been paid to seaworthiness, on account of the severe storms and high seas which prevail in the Southern Ocean; and, of course, she will be made as strong for ice-navigation as it is possible to build her. The necessary strength will be secured by a system of internal supports and a triple planking of oak, pitch-pine and green-heart. The hull will not be so much rounded as in the case of the *Fram*, such a cross-section appearing unsuitable for a ship which will have to encounter heavy seas, and the necessary resistance to ice pressure may be obtained with a somewhat fuller form. It need not be said that the vessel will be built entirely of wood. She will be rigged as a three-masted topsail schooner, and will be provided with an engine and two boilers of power sufficient to ensure a speed of seven knots and more if necessary.

The dimensions of the ship have been decided upon after taking account of the number of the scientific staff, officers and crew who will be carried, as well as the time which the Expedition is expected to be absent. The scientific staff will be five in number, and there will be five officers, including the first engineer, and eighteen to twenty men. The Expedition is expected to be absent for two years, but it will be equipped for three in case it should be found necessary to prolong it. These requirements demand a length of 151 feet, and a depth of about 16 feet below the water-line. The cost of building the ship will be about 30,000*l*.

The scientific staff of five, including the doctor, will be so chosen that each important branch of science will be represented. Each member of the staff will be able himself to carry out all the work of his own department; but every one will be capable of assisting in the special work of any other, or if necessary of taking his place.

[1] Translated from Prof. von Drygalski's MS. by Dr. H. R. Mill.

The author of this article, who has been appointed leader of the Expedition, will undertake the physico-geographical, oceanographical and geodetic work; Dr. E. Philippi, of Breslau, will take charge of the geological, palæontological and chemical investigations; Dr. E. Vanhöffen, of Kiel, will act as zoologist and botanist; Dr. H. Gazert, of Munich, will be the surgeon; and the fifth member of the staff, who will have charge of the magnetic and meteorological observations, is not yet selected.

The five officers, including the captain and the first engineer, will be fully occupied with their duties in the management and navigation of the ship during the voyage. But during the year to be passed at the scientific station which will be founded by the Expedition, and near which the ship will remain, the officers will take such part in the scientific work as may be decided at the place and time by the leader of the Expedition. They will probably be occupied principally with astronomical observations at the station, topographical and hydrographical surveys in its neighbourhood, and with pendulum and magnetic observations on the land-journeys and at the station. The crew also, the amount of whose assistance to the scientific staff during the voyage must be regulated by their duties on the vessel, will be allocated, at the winter quarters, to the different members of the scientific staff for training, so that they will become able to lend a hand on occasion. The captain, officers and crew have not yet been appointed.

As indicated above, the work of the Expedition may be divided into two parts; one carried out on board during the voyage, the other on shore at the winter quarters. The projected route of the Expedition is of importance with regard to the first part. It is intended to enter the Antarctic from the direction of Kerguelen, and the details of the route, particularly the deviations from a straight course, are planned with regard to oceanographical, geological and magnetic requirements. The oceanographical considerations are the existing lacunæ in our knowledge of the depths of the sea; the geological are the collection from various island groups of specimens for comparison with those obtained in the Antarctic; the magnetic conditions make it desirable to cut the lines of equal value of the various magnetic elements in as many points as possible. Taking all these conditions into account, I propose not to run directly south from Kerguelen, but first to sail eastwards to about 90° E., and then turn towards the south, as on that meridian deep-sea soundings are wanting. For the same reason the route from Cape Town to Kerguelen would be curved southward between Prince Edward and Crozet Islands, while, on the other hand, on the return voyage the line between South Georgia and Tristan da Cunha will be straight, because it is desirable to investigate the southern extension of the great Atlantic rise.

The point which the German Expedition has in view for commencing the penetration of the Antarctic region is the still hypothetical Termination Island. The British Expedition being intended to follow the northern side of Wilkes Land, the east coast of Victoria Land, the great ice wall, and beyond that to investigate the Pacific side of the Antarctic, the German Expedition is planned to strike southwards from Termination Island in order to discover the western side of Victoria Land, and to clear up its possible connection with Kemp Land and Enderby Land, and ultimately to sail round the Atlantic side of the Antarctic and investigate, wherever it may be possible, the southern extension of the Atlantic Ocean and Weddell Sea. If the two expeditions carry out this common plan, the geographical division of the work gives the best basis for co-operation in all other questions.

The second part of the German programme is the establishment of a scientific station in the Antarctic, at which a full year will be spent in geographical and biological work, and which will serve as a starting-point for longer or shorter land-journeys. It is, of course, impossible to say where this station will be, as the site must depend on the results of the discoveries made in pushing southwards. An effort will be made to establish it on the west side of Victoria Land, where one may expect to find an extensive land surface which will offer a favourable opportunity for carrying on the various researches; such a position would be particularly desirable for magnetic observations, on account of its proximity to the south magnetic pole.

The great Antarctic ice-cap could probably be best reached and explored on an extensive land which might perhaps enable one to travel towards the South Pole itself. An extensive land also offers richer opportunities for the study of plant and animal life, if such exist, and also for geological phenomena, than separate islands; and observations on gravity also are of more value on a large land surface. Briefly, an effort must be made to build the German station on the coast of an extensive land, and for this purpose the west coast of Victoria Land appears the most suitable, as it is the intention of the British Expedition to land some of their party on the eastern coast, and this proximity will afford an opportunity for effective co-operation.

I can naturally only refer briefly to the particulars of the projected expedition, the main plan of which has been sketched above. The fundamental fact is that the scientific preparation will be so complete that every kind of work can be carried out which the present condition of science requires, and for which time and opportunity offer. What will actually be done must naturally be decided on the spot. The members of the Expedition must be so prepared that they can distinguish the important from the less important, the necessary from the merely desirable; in a word, the purely Antarctic, if one may so say, from what could be carried out equally well in other parts of the world. The desiderata of Antarctic exploration are innumerable. It is essential to make a proper choice, and this is the first object to be served by thorough preparation.

For this purpose general instructions likely to be of service will naturally be subject to the initiative of the investigators themselves when they arrive at the field of work.

I shall here only mention a few of the problems with which the German Expedition will be occupied. Amongst these, geographical studies will take the first place, since they supply the necessary foundation for all other investigations. An effort will be made, not only to lay down the coast-lines, but, in some places at least, to follow out the general contour and, wherever it is possible, to study the forms of the land. The ice which gives its special character to the Polar regions will be studied as regards its nature and structure, its temperature, its transport of land-waste, and its movement, and this should permit conclusions to be drawn as to the land which it covers. With regard to the sea, soundings will be made in the regions where they are still wanting along the intended route—that is, in the whole area south of 40° S. and in some places also to the north of that parallel. It has already been pointed out that the route has been chosen with special regard to the regions where soundings are most required. Of course, observations will be made at the same time on the physical conditions of the sea with regard to temperature, density, composition of the water and the deposits, colour, dissolved gases, and circulation. It would be of great value also if pendulum observations could be carried out during the voyage, as it is intended to make this a special feature of the work on shore, and particularly in the neighbourhood of the station.

The geologist's duties will include the study of the samples of deep-sea deposits brought up by the sounding-rod, and also the chemical investigation of the sea-water, the physical properties of which will be studied by the geographer. The geologist will, of course, be busily employed at every landing. He will take part in sledge journeys from the land station, along the coast, and occasionally towards the interior. Special attention will be devoted to fossil plants, if such should be found to exist in the far south, as well as to all other palæontological and petrographical questions which are likely to allow comparisons to be made between the South Polar region and the rest of the world.

The Expedition promises a particularly wide field of work to the zoologist and botanist. His prospective collections should include every form which can be preserved or carried on board the ship, and they will apply equally to the fauna and flora of the land, of freshwater lakes, of the littoral zone and of the deep sea. Special attention will be paid to the seasonal differences in the occurrence of the various animal forms, and to their development. Biological investigations will, of course, be carried out in close relation to the physical; in order, for example, to recognise the dependence of plant and animal life on the conditions of the sea-water and the nature of the currents. For this purpose vertical and closing tow-nets have been planned to be used in the different regions, and from the station at different seasons. By comparing the results and those of surface gatherings at the various seasons, data will be obtained for the study of ocean currents. As the Expedition is not primarily intended for deep-sea investigation, it is not proposed to carry on deep-sea observations to a depth greater than 1000 metres. The gear required for dredging at greater depths would be too cumbrous an addition to the necessary equipment of the ship. This limitation is the less serious since the deep-sea fauna in warmer regions reaches up to within 700 metres of the surface, and in cold regions still higher.

The surgeon of the Expedition will, in addition to the treatment of such illness as may arise, endeavour to collect information on Polar hygiene by a careful study of the state of health of the members of the Expedition. These observations should enable him to advise the leader on many questions connected with the arrangements and manner of life of the Expedition. Further physiological studies will also be carried out, and the surgeon will assist the biologists in observations on the development of various organisms, and especially with bacteriological research.

The magnetic and meteorological work of the Expedition, like that of the other departments, will be the sole charge of one member of the staff, but he will be assisted in reading the instruments and in other mechanical work by members of the ship's company, and the officers will co-operate in the various physical observations at the station.

Regular meteorological observations will be taken during the voyage every four hours, if possible, and at the station three times daily. For wind, cloud, and similar phenomena, it will be desirable to organise a system of continual observation of the sky. Self-recording apparatus will be employed for pressure, wind, temperature, humidity and duration of sunshine, and in case these should become ineffective through extreme cold their place will be taken by as many eye-observations as can be managed. Special observations during the cruise will be required for such questions as the time of the daily maxima at sea, the best arrangement for a rain-gauge on board, twilight phenomena in the open sea, water-spouts, &c. At the station it is intended to carry out observations on the upper regions of the atmosphere, but to what extent and in what manner cannot be decided until the balloon equipment is definitely arranged. A captive balloon will certainly be carried for the purpose of geographical reconnaissance; sufficient gas to fill the balloon about ten times, and a lifting power which will make it possible to raise an observer about 500 metres, seem to be all that is necessary. It appears to be better to carry the hydrogen for filling the balloon in compressed form rather than to prepare it on the spot, that is, if compressed gas can be carried safely on board, a point on which further information is necessary.

The programme for magnetic work is not yet definitely settled. Pending the results of further consideration and advice, the following may be looked upon as likely to form part of it. During the voyage the magnetic elements will be determined at least once a day with the standard compass, the Fox apparatus (dip-circle), and perhaps also with the deviation magnetometer. The magnetic apparatus will be installed upon the navigating bridge of the ship, in the neighbourhood of which no iron will be used in the construction. At the station variation observations will be made with photographic registering apparatus, controlled by direct readings. Magnetic observations will also be provided for on the land journeys.

Particular attention will be paid to the study of the *Aurora Australis*, especially with regard to its form and height, perhaps also as to its spectrum, and the coincidence of auroral displays and magnetic disturbances; but the measurement of earth-currents is considered as beyond the scope of the Expedition.

In connection with the arrangements for magnetic work at the station there will be provision made for seismological observations.

Astronomical determinations of latitude and longitude, and geodetic measurements will, of course, be carried out. During the voyage, and on land-journeys, the former will be fixed by means of the prismatic reflecting circle; but at the station, where a more exact astronomical determination is necessary, a large transit theodolite, and a good telescope for occultations, will be employed. At the points on the shore connected with the station a smaller universal instrument, or a prismatic circle, will be utilised. Continued time determinations will naturally be carried out in connection with absolute observations for latitude and time conversions; pendulum observations will be made as often as possible. Geographical surveys on the scale of about 1 : 50,000 will be desirable in the neighbourhood of the station, and in such other places as may be interesting from a cartographical point of view, or which present important physical phenomena, such as ice-movement or ice-structure, or where the pendulum observations make a special survey desirable. For this purpose the smaller or even the larger universal instrument will be employed, as well as a Stampfer's level with staves. Opportunities may also occur for the use of photographic surveying instruments. Attention will be given to the anomalous refraction which, from the observations of previous Polar travellers, appears to be due to some atmospheric conditions different from any that occur in our latitudes.

This sketch of the German programme naturally does not exhaust the problems with which we have to deal. It was, however, less my intention to give an account of the work which we hope to attempt than to indicate the directions and lay down the limits of our proposed operations, as that will be of service in finally settling the methods of international co-operation. From this point of view, the large number of the problems mentioned does not appear dangerous. It might, however, become so if the Expedition were tied down to definite instructions, and not left free to act as time and opportunity demand. It seems the wisest course to provide a complete equipment for all branches of scientific work, opportunities for doing which may offer themselves, and leave it to the leader of the Expedition to decide on the spot and at the time what work will be done.

I have already pointed out that the basis of international co-operation has been laid in the choice of routes and the consequent division of districts within which the land stations are to be established. The German Expedition takes the Indian Ocean and Atlantic side, and the British the Pacific side of the Antarctic area. An expedition from a third side would find a wide and important field of activity to the south of South America. As regards physico-geographical, geological, biological and gravity observations, scarcely any further co-operation is required than the simultaneous carrying out of observations in the different areas. Should the British Expedition include a second ship, it would be possible to carry on biological deep-sea research round the Antarctic area over a much wider circle than we can attempt with one vessel.

A clearer understanding is still required, in my opinion, for co-operation in meteorological and magnetic research, to decide, in the first place, the scope and the methods of research to be pursued during the voyage and during the year's sojourn at the land station; and in the second place, what additional work beyond that undertaken by the two expeditions it may be possible to arrange. My scheme for the first of these plans is already sketched out as far as regards the meteorological work; the magnetic programme requires still further consideration. The understanding with the British Expedition on this question is now under discussion. For both branches of science the choice of routes and of districts in which the stations will be placed is very appropriate, as observations will be made in the vicinity of the south magnetic pole on two sides, and both stations lie in the probable position of the Antarctic anti-cyclone, which appears to extend furthest north on the Indian Ocean side. The second point, which concerns the organisation of simultaneous observations outside the Antarctic area, is still unsettled. The British Antarctic Expedition has already in view the establishment of a scientific station in New Zealand, while Germany is planning a branch station on Kerguelen. These would furnish valuable data for comparison with the results obtained by the expeditions themselves. Yet, we must go further, but not so far, I think, as M. Arçtowski suggested in his Paper to the British Association at Dover. It is greatly to be wished that during our expeditions the Observatories of Melbourne and Cape Town would undertake similar observations, and it would also be a good thing if a station could be placed near Cape Horn or in South Georgia, as well as one in the North Polar region, say at Bossekop. Thus the problems of the Antarctic regions could be attacked simultaneously from without and from within.

A resolution of the St. Petersburg Meteorological Congress, in August last, in favour of such co-operation was received with pleasure. The International Geographical Congress at Berlin went further, and unanimously approved the appointment of a committee charged with (1) Laying down the scope and the means of investigation for the magnetic and meteorological work of the expeditions; (2) The organisation of similar series of observations on the expeditions, and perhaps also exerting influence for the establishment of observations at other places.

On the German side, the members of this joint committee are Profs. Hellmann, v. Drygalski, Eschenhagen and A. Schmidt; and on the British side, Dr. R. H. Scott, Dr. Buchan, Prof. Schuster and Capt. Creak. The programme prepared on the German side for the meteorological and magnetic work has already been sent to the British members of the Committee to be considered by them, and afterwards discussed and definitely settled by the whole committee. We may expect in this, as in all other points, a complete and useful co-operation between the two expeditions.

Erich von Drygalski.

THE VAN 'T HOFF CELEBRATION AT ROTTERDAM.

Allusion has already been made in the columns of Nature (No. 1575, vol. lxi.) to the celebration of the twenty-fifth anniversary of the doctorate of Prof. van 't Hoff, which took place at Rotterdam on the 22nd of last December. The following further particulars may perhaps be of interest to English readers.

Some eighteen months ago it was decided by a committee of old students that the event should be celebrated in a suitable manner. To this end, in the first place, invitations were sent out to all former students of van 't Hoff, requesting them, if possible, to contribute a paper to a volume to be presented to the savant on his jubilee day. The invitation was responded to most cordially, and before the end of last September some twenty-six papers had been received by the committee. The original intention was to publish these in book form, but, as the result of a later suggestion and the kindness of Prof. Ostwald, the publication took the form of a jubilee volume of the *Zeitschrift für physikalische Chemie*.

The jubilee ceremony itself was held on the date above-mentioned in Rotterdam, the birthplace of van 't

Prof. J. H. van 't Hoff.

Hoff, where by reason of family ties he is usually to be found during the last days of each year. The "Bataavsche Genootschap voor Natuurwetenschappen" had invited a considerable number of Dutch and foreign men of science, as well as all old students of the professor, to a special meeting of the society at 3 o'clock in the afternoon. At the appointed time the hall was crowded with enthusiastic admirers of Holland's great physical chemist, many of whom had travelled far to pay their tribute. Not a few had come from Germany, and in addition Belgium, Switzerland, Austria, Japan and England were represented. Amongst the number present were Profs. Ostwald, Spring, Lobry de Bruyn, Roozeboom, Abegg, Goldschmidt, Hamburger, Hollemann, Lorenz, and Drs. Bredig, E. Cohen, Meyerhoffer, Reicher. Presently, amidst the cheers of the audience, van 't Hoff, supporting his aged mother, entered the hall, followed by the various members of his family. The proceedings were opened by an address from the Mayor of Rotterdam, whose words, however, like those of some of the following speakers, being Dutch, were only intelligible to a limited number of the audience. Suffice to say that van 't Hoff was the recipient of a series of memorials and congratulatory addresses from various scientific corporations. The University of Utrecht, van 't Hoff's *alma mater*, sent a deputation, and the chemical students of Amsterdam, where van 't Hoff till recently occupied the chair of chemistry, were also officially represented. The afternoon's programme concluded with the presentation to the professor of his own biography by Dr. Ernst Cohen, and of the before-mentioned jubilee volume on behalf of former students by Dr. Meyerhoffer. To each of the speakers van 't Hoff replied in a few words, expressing his thanks for the honour accorded to him, in simple and unaffected language.

In the evening a highly successful dinner took place. It was interrupted by continual bursts of applause, as congratulatory telegrams arrived from almost all parts of the civilised world. To the series of toasts proposed in his honour, van 't Hoff replied in his native tongue, making, however, a graceful variation in excellent English to acknowledge his appreciation of the presence of a guest from England at a time of national embitterment.

An account of the jubilee celebration at Rotterdam would scarcely be complete without a reference to the life and work of the man in whose honour it was held. For a complete and extremely interesting account readers are referred to Cohen's biography,[1] which has been consulted by the present writer in this connection.

Jacobus Henricus van 't Hoff was born on August 30, 1852, at Rotterdam, where his father still practises as a medical man. While at school he showed an intense interest for natural science; many of his leisure hours were spent in carrying out simple chemical experiments at home. After passing through the Hoogere Burgerschool in Rotterdam, his parents decided that he should have a technical training, and for this purpose he was sent to the technical school at Delft. Two years' study at Delft sufficed for him to pass his technical examination, whereupon he proceeded to Leyden, devoting most of his time to the study of mathematics and physics. Remaining but one year at the latter University, he was attracted by Kekulé to Bonn, then at the height of its fame as the school of structural chemistry. Later, in the same year, we find him in Würtz's laboratory in Paris.

In September of the following year (1874) van 't Hoff published in Utrecht a pamphlet, the contents of which form the foundation of our present stereochemistry. The proud structure built up on the ideas first expressed in this modest publication is one of the greatest chemical achievements of modern times. The adverse criticisms of Kolbe and other then existing authorities on structural chemistry are historical, but after twenty-five years' subjection to the crucial test of experiment, we can assert that the theory of the asymmetric carbon atom is one of the most firmly established in chemical science.

In December 1874, three months after the publication of his views on chemical structure, van 't Hoff graduated as doctor of mathematics and physics at Utrecht, the title of his thesis being "Contributions to our knowledge of cyanacetic and malonic acids."

That the path of fortune has not always run smoothly for him appears from his experiences during the months following graduation. Repeated attempts to obtain a post as teacher failed, and finally leaving home, he departed to Utrecht with the intention of giving private instruction. During this period he devoted his spare hours to writing "La Chimie dans l'Espace." Finally, in 1876, the desire to devote himself to teaching was gratified by his appointment as lecturer at the Royal Veterinary School at Utrecht.

In October 1877, on the elevation of the old Amsterdam Athenæum to the status of a University, van 't Hoff obtained the post of lecturer on theoretical chemistry, and scarcely a year had elapsed before he was appointed professor of chemistry, mineralogy and geology, a chair he held until the commencement of 1896.

The activity he showed during his connection with the University of Amsterdam is well known. Notwithstanding very onerous routine duties, he continuously produced work of first class importance, and by his inspiration created a distinguished school of chemists.

"Physicam chemiae adjunxit" is the maxim which characterises the life work of van't Hoff. His endeavours to fill up the gap in our knowledge of the connection between constitution and chemical properties led to the production of his "Études de Dynamique Chimique," to the setting up of a most important theory of equilibrium, and to the overthrow of Berthelot's principle of maximum work.

Closely bordering on the theory of equilibrium the problem of affinity next attracted his attention, and the application of thermodynamics to Pfeffer's osmotic experiments brought forth his great theory of solutions, according to which the physical laws (Boyle's, Gay-Lussac's, Avogadro's) holding for the gaseous state, apply equally well to dilute solutions. The most immediate result of this theory was the formulation by Arrhenius of the theory of electrolytic dissociation. The changes thus brought about in the nature of our chemical conceptions have been enormous, and the rapid development of electrochemistry in recent years stands in direct connection with the establishment of van't Hoff's laws of solutions. In 1890 the extension of his theory of solutions to the case of solids enabled him to show the existence of simple laws in solid aggregates, and much of our present knowledge with regard to the solid state of matter dates from this discovery.

In spite of seductive offers on the part of another Dutch University in 1893, and of two German Universities in 1887 and 1894, van 't Hoff remained true to Amsterdam until 1895, when the Prussian Academy of Sciences made him a most brilliant offer. Not only was he elected a Member of the Academy, but at the instance of the latter, the Prussian Government placed at its disposal the necessary funds whereby van 't Hoff is enabled to devote himself entirely to his work as investigator. In this way a foreign Government has recognised his services to science and provided the means for his searching genius to exert itself to its fullest extent.

During the past few years van 't Hoff's attention has been chiefly turned to that province of physical chemistry dealing with transition phenomena, double-salt formation and double decomposition, and his present goal is the explanation of the formation of oceanic salt deposits on the basis of such investigations. Already a great deal has been accomplished, and especially for geologists most important results have been brought to light. From a politico-economic point of view the importance of such research for the great Stassfurt salt industry is obvious.

Prof. van 't Hoff's laboratory is situated in Wilmersdorf, a suburb of Berlin. It consists of some four or five small rooms forming the ground story of an ordinary house. Here van 't Hoff works with at most three or four students. He is in the happy position of a professor not obliged to lecture more than once a week, and not expected to do more than extend the bounds of human knowledge.

H. M. DAWSON

[1] "Jacobus Henricus van 't Hoff." Von Ernst Cohen. Mit einem Porträt und Bibliographie. Price M. 1.60. (Leipzig: Verlag von W. Engelmann.)

THREE NEW BIRD BOOKS.[1]

THE issue of these three works, which have no connection with one another, save as regards the approximate time of their birth, serves to indicate the increasing popularity of ornithology, and a consequent demand for histories of the avifauna of each and every country. As regards Great Britain, systematic treatises on its bird-fauna are, as we all know, to be counted by the dozen; and the chief business of the ornithologist of the future should accordingly be concentrated on the habits and distribution of the birds inhabiting this area. In America, on the other hand, much doubtless remains to be done in the working out of the details of local faunas; and there is accordingly in all probability ample room for the second and third volumes on our list. Although these are primarily intended to popularise the subject, they both possess a certain amount of importance to the systematic naturalist as being, apparently, accurate lists of local faunas. Not that by this statement we intend in any way to disparage the value of the work standing first on the list; we ourselves being at the present day inclined to assign a higher value to treatises dealing with the habits and environment of animals than to those devoted to their taxonomy.

The brothers Kearton appear to have set themselves the task of photographing and describing the nest and eggs of every species of bird known to breed in the British Islands; and although their labours are still unfinished, the issue of the present volume brings them not very far from their goal. To those who have not made the attempt (and, so far as we are aware, the Messrs. Kearton stand alone in this respect) it may be difficult to realise the amount of labour in the task which the author and his brother have set themselves. But when we are told in the preface that the mere railway and steamboat travelling hitherto undertaken totals up to something like ten thousand miles, while many valuable hours and days have been spent in unsuccessful tramps across bog and fell, it becomes evident that the task is no sinecure, either from the point of view of time or expense. Only strong enthusiasm could, indeed, have enabled the author and his brother to have persevered thus far, and it may be hoped that circumstances will permit them to complete their arduous labours.

The volume in which the nests of the commoner British birds were figured was published in 1895; and as the present issue contains figures of the nidification of no less than fifty-seven additional species, it is evident that neither author nor artist have been idle since that date. Exquisite as are the illustrations in the first volume, those in the present issue are in many cases even more successful, and bear self-apparent testimony to the care spent on them by the artist. As an example, we reproduce the figure of Fulmar Petrels nesting. Neither is the letterpress less attractive. Naturally, the brothers met with many adventures during their wanderings, and we may particularly direct attention to the account on p. 109 of the manner in which the great Skua attacked one of them as he approached its nest. Very curious, too, is the habit these birds have of building an additional nest in the neighbourhood of the one in use, to which the eggs or young may be conveyed when the former is flooded or otherwise damaged. The author by no means confines himself to the description of the nests and eggs, but gives an interesting account of the kind of country in which they are found, a view of the scenery distinctive of the habitat of particular species being frequently given.

As already said, the text, from a natural history point of view, is thoroughly satisfactory; but it must be confessed that it is not altogether free from literary blemishes. Take, for example, a sentence in reference to the Siskin (p. 104), which runs as follows:—"The nest has been found sparingly in various parts of England from time to time, but in Scotland it breeds regularly in many of the great pine forests so well suited to its habits."

The foregoing mention of the great Skua reminds us that Mr. Kearton has much to say regarding the efficiency or otherwise of the regulations in force for the protection of the rarer birds and their eggs, his remarks on this subject being well worthy the best attention of County Councils and landowners interested in bird protection. While not one of those who urge that on no account should a comparatively rare species ever be shot, as witness his observations in reference to the Peregrine Falcon, he considers that the present wild bird protection laws are almost a dead letter. After stating that eggs of species specially protected by law are openly hunted for by people of all ages and conditions, he adds: "I have no hestitation in saying that the only real good done in the United Kingdom in the way of bird preservation has been accomplished by private efforts." He then goes on to say that, as a matter of fact, the enforcement of the law as it stands frequently ends in the destruction of the bird it strives to protect by calling attention to the places where it occurs. His remedy is to restrict protective laws to the dozen species or so for which they are most urgently needed, and to afford effective protection to such selected species during the whole of the breeding season by means of reliable watchers.

Commending these important suggestions to those

FIG. 1.—Fulmar Petrels Nesting (from Kearton's "Rarer British Breeding Birds").

[1] "Our Rarer British Breeding Birds; their Nests, Eggs, and Summer Haunts." By R. Kearton. Illustrated from photographs by C. Kearton. Pp. xvi + 149. (London: Cassell and Co., Ltd., 1899.)
"The Birds of Rhode Island." By R. H. Howe, jun., and E. Sturtevant. Pp. 111. Illustrated. Privately printed. 1899.
"The Birds of Eastern North America—Water Birds." Part I. Key to the Families and Species. By C. B. Cory. Pp. ix + 142. Illustrated. (Chicago: Field Columbian Museum, 1899.)

they most concern, we take leave with regret of one of the most attractive little volumes on birds it has been our fortune to peruse.

Of a very different type is the work standing second on our list, although here, too, we have to call attention to some excellent illustrations of the environment of particular species of birds. Apart from the classified list of species frequenting Rhode Island, the leading idea in Messrs. Howe and Sturtevant's little volume seems to be the peculiar nature of bird migration in this district, much of which takes place to seaward of the island itself. Especially interesting are certain local migratory movements, both along the coast and in Narragansett Bay; foremost among which is the westward migration of white-winged Scoters in May. These birds winter in the neighbourhood of Cape Cod, and during their spring migration fly west, it is said in millions, across Rhode Island, and then shape their course in a north-westerly direction for the great lakes, where they breed.

Following a list of the nesting times of the various species breeding on the island, the authors give an interesting account of "Cormorant Rock," which appears to be the favourite bird-haunt. This is followed by the detailed list of species; the special interest of which can be best appreciated by local observers and students of geographical distribution. In reference to the description of "Cormorant Rock," we may point out to the authors that it is somewhat redundant to speak of the "Island of Rhode Island"; and that the "mesa top of the rock" is a phrase of which the meaning is not quite as apparent as it might be.

Of the third member of the trilogy we cannot at present speak very fully, since the part before us appears to be only a small instalment of what promises to be a work of some size and importance. Mr. Cory is already well known to bird-lovers by several works devoted to the avifauna of North America and the West Indies; while to the sportsman his name is familiar as the author of "Hunting and Fishing in Florida."

In the present work it appears to be his object to teach the beginner the external anatomy of a bird (if such an expression be permissible), and then to lead him on to learn how to distinguish and recognise the various kinds of "water birds" found in eastern North America. Although using the latter term in a very wide sense, and including under it such diverse forms as Auks, Gulls, Ducks, Herons, and Snipe, his "keys" appear to be carefully drawn up, and to suffice for the identification by an artificial method of the various species inhabiting the area of which the work treats. The illustrations, although some are on an unduly small scale, are for the most part of a high grade of excellence, and serve to elucidate the technical matter of the text. It is, however, distinctly a subject for regret that the author has seen fit to multiply in a most unnecesssary degree the number of "families" of water birds. He divides the Limicolæ, for instance, into the *Phalaropodidae*, *Recurvirostridae*, *Scolopacidae*, *Charadriidae*, *Aphrizidae*, and *Haematopodidae*, whereas in the British Museum Catalogue the whole of these are included in a single family. Moreover, if such divisions were necessary the term *Himantopodidae* should have been employed, instead of *Recurvirostridae*, for the Stilts and Avocets.

Neither is the author quite happy in some of the statements in the Introduction, as, for example, when he speaks of the extinct New Zealand Eagle (*Harpagornis*) as being the prototype of the "Roc of nursery lore." In all probability the honour of that position belongs to the extinct Malagasy *Æpyornis*, and most assuredly the legend does not owe its origin to the "nursery."

On the whole, however, the work, so far as we can judge at present, appears well adapted for its purpose, and we shall look forward with interest to its completion.

R. L.

THE LONDON UNIVERSITY ELECTION.

EVERY graduate of the University of London who has the advancement of learning and the best interests of his University at heart, will give careful consideration to the address which has been drawn up by Sir Michael Foster's Election Committee, and the accompanying letter from Sir Michael Foster himself. These two documents should completely remove the impression that the return of Sir Michael Foster would mean the neglect of the rights and privileges of private students. The position of such students and the system of open examination for them have already been definitely settled by Parliament, and it is improbable that any change will be made no matter which candidate is elected. It is therefore not reasonable to think that the electors will let this question influence their votes. Sir Michael Foster stands both for external and internal students, and not for any particular party or as the champion of any one section of the graduates. As a man of distinguished eminence, who has shown his regard for the welfare of the University, we claim for him the suffrages of an intellectual electorate. By returning him to Parliament, not only will the progress of the University be secured, and a member be obtained whose best energies will be used to further the interests of all branches of learning, but the existence of a University representative will be justified.

The following correspondence has been sent to the electors:—

1, *New Court*, *Carey Street*,
Lincoln's Inn, *London*,
January 26, 1900.

SIR,—It will soon be the duty of the Members of the Convocation of the University of London to choose a representative in Parliament in the place of Sir John Lubbock.

It is now generally admitted that University constituencies should send to Parliament men distinguished in learning, science, or literature, and qualified therefore to strengthen the Legislature in dealing with those questions which most nearly concern the intellectual interests of the community. This has been recognised of late years in the election of Sir George Stokes, Prof. Jebb, Mr. Lecky and Sir William Anson, in which cases the example set by the University of London in its election of Mr. Lowe and Sir John Lubbock was followed by the older Universities. We hope that the graduates will not now depart from the precedent set on those occasions.

At the present time, when the reconstruction of the University is imminent, it is most important that the representative selected should be a graduate of the highest literary or scientific distinction, able to speak with authority on matters connected with education or research. The new duties which the University will have to undertake must raise questions on which the Government and Parliament will look to the representative of the University for guidance; while the graduates will desire that the claims of the University shall be adequately supported by their member.

So far as the domestic policy of the University is concerned, it should be borne in mind that this is now definitely and permanently settled by the Act of Parliament of last Session, which provides guarantees for the maintenance, in unimpaired efficiency, of the system of open examination for external students. No interference with this settlement on the part of the Legislature or the Government is to be expected or will be required.

Sir Michael Foster, K.C.B., M.D. (Lond.), Senior Secretary of the Royal Society, and now President of the British Association, has, at our earnest request, consented to be nominated for the vacant seat. He holds, in the estimation of the public, as well as in that of scientific men, such a distinguished position—not only among the graduates of the University, but among the leaders of scientific thought in Europe—that it is altogether unnecessary for us to dwell on his qualifications in this respect. We may say, however, without fear of contradiction, that there is no one whose opinion on questions affecting scientific education and research or the study of medicine would have greater weight in the House of Commons. His long academical experience, first at University College, London, and subsequently at Cambridge, together with his full knowledge of University questions, will enable him to be of the greatest service in Parliament. The election of so distinguished a graduate will be an honour to the University.

Sir Michael Foster's claims to your support are not put before you in the interest of any political party. We think it more important that a fit representative of the University, as an institution for the promotion of learning and science, should be sent to Parliament, than that a member should be added to one or the other side of the House. There is, however, one question upon which the country, independent of party, is agreed—that the Government must be supported in prosecuting the present war to a successful conclusion—and on this Sir Michael Foster is at one with the country.

It is of the utmost importance that those graduates who will support Sir Michael Foster should inform the committee at once, and you will please therefore fill up, sign, and post the enclosed card as soon as possible.

We enclose with this a letter from Sir Michael Foster.

We are, Sir,

Your obedient servants,

J. F. ROTTON, M.A., LL.B., Q.C., *Chairman.*
H. J. WARING, M.S., M B., B.Sc.,
H. J. HARRIS, B.A.,
C. E. WILSON, M.A. (Camb), B.A. (Lond.), } *Honorary Secretaries.*

The following letter has been received from SIR MICHAEL FOSTER *in answer to one from the Chairman of his Committee informing him of the steps which were being taken in respect of his candidature.*

January 24, 1900.

MY DEAR ROTTON,—I learn from your letter, and from other sources, that the Members of Convocation on whose behalf you write have been led to invite me to represent them in Parliament because they strongly hold the opinion that the representative of the University should be chosen not on account of his political opinions, but by reason of his fitness to advance in the House of Commons the interests of science and learning and of the University, and because they think that I possess this fitness.

I cannot but be gratified that so many eminent graduates hold me in so much esteem; and, while not so confident myself as they are of my fitness for the post, I feel it my duty to accept the great honour which they offer me in the spirit in which it is proposed.

If my candidature should prove in the end acceptable to the majority of the Members of Convocation, I shall feel that I enter the House, not with a mandate to support this or that political party, but for the purpose of placing at the disposal of the House the experience gained by many years' service in the courts of learning and science, and in more than one University.

Any other position would be impossible for me; and if the Members of Convocation do me the honour to select me, it must be on the understanding that I am not thereby pledged to any political party. Still, the man in the lecture room, no less than the "man in the street," has his political views; and neither would the University expect its Member to take part in the business of the House only when academic questions were being dealt with, nor should I desire to play such a part. Indeed, purely political questions may be brought forward on which, were I elected, I should think it wrong to abstain from recording my vote. Bearing this in mind, I think it right to say that had I been in the House of Commons some years ago, I should have voted against the Irish policy of Mr. Gladstone; and that at the present moment I think, not only that the present war should be vigorously prosecuted until the results so essential to the welfare of the Empire are attained, but that the nation is justified in having entered into it. So far I should support the present Government. At the same time I wish to state plainly that on many other questions my views, and perhaps still more my sympathies, are those which used to be denoted by the term "liberal." Not having, however, looked forward to the honour of entering into Parliament I have never attempted to integrate my opinions into a compact whole capable of being marked with a party sign; and even now I feel a great difficulty in attempting to do so.

As regards the affairs of the University of London itself, Members of Convocation are well aware that such efforts as I have been able to make have been directed towards developing the University in the direction which has often been denoted by the words "teaching University." In this I have been guided by a desire to promote the interests, not so much of teachers, as of teaching and of learning. Though a somewhat long experience as an examinee and an examiner has shown me the weak points of examinations, I owe too much to the University of London in its old form as an examining University not to feel deeply how much good it has done. When called upon as a witness before the Cowper Commission, the only evidence I ventured to give was to emphasise the desirability of enlarging the old University, as against setting up a new one. I thought then, and I think now, that the changes which it is proposed to make, so far from doing any one part of the University harm, will do good to the whole; and that he whom it is proposed to call an "external student" will share, with the "internal student," the benefit which must follow upon the recognition of the principle that the true function of a University, whatever else it may be called upon to do, is not to grant titles, but to develop learning and to promote the advancement and spread of knowledge. If elected, I should regard myself as the representative of the educational interests of external students and internal students alike.

Yours. &c.,

MICHAEL FOSTER.

PROFESSOR D. E. HUGHES, F.R.S.

DAVID EDWARD HUGHES was born in London on May 16, 1831. His parents were Welsh, from Bala, in Merionethshire. He spent his early years in the United States, to which place his parents emigrated in 1838, and he became a citizen of the United States. He never abandoned this citizenship, and this is probably the reason why the English Government never recognised his eminent scientific services. Being a musician, like so many of those who spring from our Welsh hills, he was appointed professor of music in Bardstown, Kentucky, at the age of nineteen. He also held the chair of natural philosophy. At the age of twenty-four he invented his celebrated Roman type-printing telegraph that spread his fame throughout the civilised world. He struck a new line. His instrument was based on synchronism, and each letter was struck by one current. His apparatus was adopted in the United States, but it was very little used there, and he came to England in 1857 to try and introduce it here. He came at an unfortunate time. Telegraphy was in the hands of several private companies, whose capital was locked up in promoting other patents. Competition was excessive and ruinous; but in 1863 the United Kingdom Telegraph Co. took up Hughes's instrument, and on the transference of the telegraph to the State, in 1870, it came into the possession of the Post Office. It was also employed by the Submarine Telegraph Co. for their communications to the Continent, and now the largest Hughes's type-printing telegraph station in the world is probably the cable room of the Post Office in St. Martin's le Grand. In his occasional visits to the General Post Office he never failed to express his delight at the great advances made by the Post Office Technical Staff in the development and working of his beloved child. It was driven electrically, and it worked duplex.

Hughes's instrument was made the international type of apparatus, and every country in Europe adopted it. Honours and wealth were showered on him. Being a man of very simple habits and of few wants, his annual expenditure was small; but his income was great. His riches accumulated, and it is now generally known that he has been most generous in endowing various scientific institutions and hospitals with large sums of money.

On April 13, 1859, a paper was read before the Society of Arts describing not only his apparatus, but an original form of cable, which separated two layers of gutta-percha insulation by a film of semi-fluid viscid oil, so that flaw or punctures in the insulation were automically repaired

This novel and ingenious idea was never practically tried, but it established the fact that Hughes was the inventor of oil insulation.

In 1878 he brought out the microphone. No one who remembers the period can ever forget the sensation produced by his simple apparatus and striking experiments. Bell had just brought out the telephone, Edison had patented his carbon transmitter and invented the phonograph; but Hughes captured the town by causing the footsteps of a house fly to resound like the tread of an elephant.

In 1879 he showed how to eliminate the effects of mutual induction from lateral wires by using a metallic circuit and twisting the wires around each other.

This was followed by his beautiful induction balance, and subsequently by a series of elegant researches in magnetism and inductance. Hughes was essentially an experimenter. His manipulation of rough materials was phenomenal. He scorned the scientific instrument maker. Pill boxes, common nails, sealing wax, bonnet wire, knitting needles, tumblers, cheap copper were enough for him. His cells, galvanometers and telephones were all home-made. He was not a mathematician, nor was he deeply versed in scientific literature; but he had an instinctive perception of truth, and he jumped by intuition to facts which he could speedily verify with his own hands in the crudest fashion and by the homeliest aid. He loved science, and his constant attendance at the Royal Society and the Royal Institution evidenced his interest in scientific progress.

The Royal Society presented him with a Royal Medal in 1885, and he was awarded the Albert Medal by the Society of Arts in 1897. He was President of the Institution of Electrical Engineers in 1886, and was for many years a manager of the Royal Institution.

He was a genial, charming companion, and his presence will be very much missed by many who knew him well.

The funeral of Prof. Hughes took place on Saturday, January 27. The pall bearers were Lord Lister, Prof. A. W. Rücker, Mr. Choate (the United States Ambassador), Prof. S. P. Thompson, Prof. Dewar and Major-General Webber. Among the other men of science present at the special service at All Souls', Langham Place, some of whom went on to Highgate Cemetery, where the interment took place, were Mr. E. Clodd and the Servian Consul, Lord Kelvin, Sir William Crookes, Sir Frederick Bramwell, Dr. J. H. Gladstone, Dr. Johnstone Stoney, Sir Henry Mance, Mr. R. E. Crompton, Prof. Perry, Prof. Meldola, Mr. A. Siemens, Mr. A. B. Kempe, Mr. J. Swinburne, Mr. J. Wimshurst, M. Dæschner (secretary of the French Embassy), the Greek Chargé d'Affaires, Sir F. Abel, Sir H. T. Wood, Mr. A. P. Trotter and Mr. C. E. Spagnoletti. The Duke of Northumberland and Sir W. Preece were represented.

NOTES.

THE Geological Society of France has received a legacy of forty thousand francs from Mme. Beaucourt, for the encouragement of investigations which assist geological progress.

THE *Engineer* states that the War Office is making an allowance of 3000*l.* for the provision of apparatus for use by the electrical engineer volunteers going to South Africa.

THE Institute of France has accepted the conditions of the gift by M. Daniel Osiris of a sum of money for the foundation of a triennial prize of one hundred thousand francs, to be awarded for the most remarkable discovery or work in science, art, or letters.

THE Special Meeting of the Manchester Literary and Philosophical Society for the presentation of the Wilde and Dalton Medals, and for the delivery of the Wilde Lecture on "Flight, natural and artificial," by Lord Rayleigh, F.R.S., will be held on Tuesday, February 13, at 4.30 p.m.

THE death is announced of General Alexis de Tillo, the distinguished Russian geographer, and correspondant of the Paris Academy of Sciences, in the section of geography and navigation. For more than twenty years General Tillo was one of the most active and earnest members of the Russian Imperial Geographical Society, and contributed many papers on the hypsometry, terrestrial magnetism, and climatology of Russia.

BARON LE BAUME PLUVINEL, who has been to Spain on behalf of the French Astronomical Society, to inquire into the weather prospects during the forthcoming solar eclipse at various places along the line of totality, and to make arrangements for the accommodation of the members who will go to observe it, will give an address to the Society on February 7, on the results of his visit.

THE twenty-seventh annual dinner of the old students of the Royal School of Mines was held at the Hotel Cecil on Friday, January 26. Mr. H. G. Graves was in the chair, and was presented with a loving cup, &c., in consideration of his service for several years as secretary, by Mr. H. Bauerman, on behalf of the committee. The other speakers were Sir W. Roberts-Austen, Prof. C. Le Neve Foster, Prof. Perry, Mr. Bennett H. Brough, Mr. H. Hatfield, Mr. Teall, Mr. F. W. Harbord, Mr. E. Woakes, and the present secretary, Mr. H. C. McNeill.

MR. SAMUEL BARBER informs us that a very brilliant meteor was observed at Chesterton, near Peterborough, on January 28, about 5.56 p.m. Attention was drawn to the meteor by an almost blinding flash that resembled lightning. Then the ball of light was observed "travelling across the sky like a large rocket, in an easterly direction, and with a conspicuous trail a few degrees wide on either side of its course. Before vanishing there was a distinct gap left, in which the trail did not appear, *i.e.* between the point of departure of the meteor and the end of the trail. The meteor disappeared instantaneously. No sound was heard."

THE researches undertaken by the Institution of Mechanical Engineers were referred to in the report of the council, presented at the annual meeting on January 26. The fifth report of the research committee on alloys was presented and fully discussed a year ago, and Sir William Roberts-Austen, the reporter, is now at work upon the effect of annealing and tempering on the properties of steel, which will form the principal subject of the next report. The gas engine research has been further advanced by Prof. Burstall, who hopes to be able to present his report early in the present year. The value of the steam-jacket is the subject under investigation by Prof. Beare, who has accumulated further data towards his fourth report. The compound steam-jacketed condensing engine at King's College, London, has been working. Prof. Capper has not yet been able to commence the first series of complete tests, but promises his first report soon.

THE annual general meeting of the Mathematical Association was held at University College on Saturday, January 27, the President of the Association, Sir Robert S. Ball, being in the chair. Papers were read by Sir Robert Ball, Prof. R. W. Genese, and Messrs. R. F. Davis and J. A. Third; and several other papers were received, the authors of which were unable to be present. It was announced that the *Mathematical Gazette* would in future be issued six instead of three times a year. The aim of the Association in publishing the *Gazette* is to supply a journal which is of direct and special interest to mathematical teachers. It is intended that among its special features shall be articles suggestive of improvements in methods of teaching, or covering ground not satisfactorily treated in text-books, and reviews of books of the first importance, or groups of text-books on kindred subjects, giving an elementary presentation of the history and treatment of the subject. Vol. ii., which commences with the present year, will contain a series of articles by Prof. C. A. Scott, on von Standt's *Geometrie der Lage*.

PROF. A. E. WRIGHT describes in the *Lancet* the statistical results of the anti-typhoid inoculations made by him among British troops at a series of military stations in India. It appears that altogether 11,295 men were under observation, of whom 2835 had been inoculated and 8460 had not. The percentage of cases of typhoid fever amongst the uninoculated was 2·5, and amongst the inoculated 0·95, a difference sufficiently great to warrant further extensive trials taking place. With regard to the mortality the results are not so marked. Amongst the uninoculated the percentage of deaths was 0·34, and amongst the inoculated 0·2. A certain measure of protection seems thus to have been conferred by the inoculation of the quantities of dead typhoid culture, and when Prof. Wright's remarks on the conditions under which the inoculations were carried out are considered this conviction becomes intensified. For instance, the inoculated men were, taken as a whole, men who were much more liable to contract typhoid fever than the uninoculated men, for the inoculated consisted to a large extent of young men who had only recently arrived in India, while the uninoculated consisted mainly of older and more seasoned—in other words, of less susceptible—individuals.

THE relations of forest fires to insect ravages, insects to forest fires, diseases of trees to insects, and insects to fungous diseases, are not obvious at first sight, but Dr. A. D. Hopkins shows in a report on the insect enemies of forests in the northwest, just issued by the U.S. Department of Agriculture (Division of Entomology), that there is a close connection, and, to a certain extent, inter-dependence, of all these factors in the destruction of valuable forest products. Trees dying from injury by fires, or weakened in vitality, offer favourable conditions for the multiplication of vast numbers of destructive insects. Moreover, trees which have been killed by insects furnish, in their fallen branches, standing and fallen partly decayed trunks, and dry bark, a most favourable condition for the starting, rapid spread, and perpetuation of forest fires. It is well known that forest trees weakened by disease contribute to the multiplication of their insect enemies; therefore the study of the insects associated with unhealthy forest trees should lead to results of economic importance. As an example of insects contributing to the spread of fungous diseases, Dr. Hopkins reports that the heartwood of the white fir throughout the region examined by him was commonly rendered worthless by decay as the result of wounds in the living bark made by Scolytus bark beetles.

THE *Scientific American* states that one of the most interesting exhibits which will be sent from the United States to Paris for the forthcoming Exhibition will be a huge map of New York city, which is now in progress of construction under the chief topographical engineer of the Board of Public Improvements. It measures 28 feet by 24 feet, and is on a scale of 600 feet to the inch, and includes all the boroughs of the great city and a large part of the adjoining territory. The map shows all the trees, parks, piers, ferries and railway lines, and displays contour lines and elevations of every point in the city; more than 1,000 square miles of the territory are embraced, and all buildings of any importance whatever are indicated.

TWO novel swing-bridges over the river Weaver at Northwich were described by Mr. J. A. Saner at the meeting of the Institution of Civil Engineers, on January 23. Owing to the nature of the foundations in the salt district, which, as is well known, are seriously affected by the abstraction of brine and salt from the subsoil, the design of the bridges presented unusual difficulties. The average subsidence at the Northwich bridge has been about $4\frac{1}{2}$ inches per annum during the last seventeen years, necessitating the raising of the girders to give headway for the river traffic; and it being impossible to raise the streets in the immediate neighbourhood without partially burying or raising the adjoining houses, the road gradients have become as steep as 1 in 11. To obviate this inconvenience, and to provide for the more efficient carrying on of the salt and other trades on the Weaver, and also with the idea of eventually passing coasting vessels with fixed masts, two exactly similar swing-bridges have been built a little distance apart, in order that one may be available in case of a breakdown.

THE superstructure of the two new bridges at Northwich, each of which may be considered as weighing 300 tons, is supported by a roller path and rollers, which in turn are carried upon a set of piles, strongly braced together. Connected with, and exactly under the centre of gravity of, the superstructure is a circular pontoon or buoy, divided into two chambers. This pontoon has the appearance of being suspended from the superstructure, and in reality would be if the water were not present, as it is entirely clear of both bottom and sides of the chamber in which it is placed. Of this large buoy the lower chamber, which has a displacement equal to 250 tons, is perfectly watertight and always submerged, so that its displacement is practically constant. The upper chamber is open at the top, and either serves as an access to the lower chamber; or, by varying the amount of water allowed to enter it, increases or decreases the buoyancy of the whole. It will be seen that the downward pressure on the rollers and paths, due to the weight of the superstructure, is partially counteracted by the upward tendency of the pontoon, and is thus reduced, in the case under consideration, to $300 - 250 = 50$ tons. By emptying the upper part of the pontoon this may be further reduced within certain limits. The difficulty presented by subsidence entailed careful consideration as to the motive-power to be adopted for the bridge. Pressure pipes of any kind being inadmissible, Mr. Saner decided to adopt electrical power, and to use wire rope for turning, as giving the most flexible connection between the bridge and motor. The bridges are moved with remarkable facility, and the consumption of current after they had been working a short time, and all the bearings, &c., were free, only amounted to $\frac{1}{4}$ a Board of Trade unit for the complete cycle of operations, viz. withdrawing wedges, opening and closing the bridge, and replacing the wedges.

WE have received Part i., vol. xi., of the *Indian Meteorological Memoirs*, containing the observations recorded during the solar eclipse of January 22, 1898, at 154 stations, seven of which were in close proximity to the central line of totality. The observations were taken at intervals of five to fifteen minutes, and includes the barometer, thermometer, wind and cloud, and occasionally other elements. These have all been reduced and tabulated in the Calcutta Office according to Madras time, and are, therefore, in this respect, strictly comparable. Beyond this, no attempt is made to discuss the data. In looking over the observations at the stations of greatest obscuration one is struck by the fact of the lull of the wind at the time of total eclipse. For instance, at Seoni, where full obscuration lasted from 1h. 27m. to 1h. $28\frac{1}{4}$m. p.m., the observer remarked, "Everything quite quiet and calm, wind totally stopped from 1h. p.m. to 2h. 10m. p.m." The decrease of temperature amounted to about 5° at several places.

THE Report of the Meteorological Council for the year ending March 31, 1899, has just been issued. The Office continues, as in the past, to collect data relating to the meteorology of the ocean, for which purpose complete outfits of meteorological instruments are supplied to officers of the Mercantile Marine who are willing to take observations. The number of such ships supplied during the year was 114. All ships in the Royal Navy are also supplied with instruments, and the Council receive valuable observations from this source. The results of the weather forecasts issued by the Office show a complete or partial success of 83 per cent. during the year 1898; the average success during the last ten years is 81·4 per cent. The special hay harvest forecasts issued to a number of selected stations attained an average success of 89 per cent., and in the district which includes the south of England the complete and partial success reached the high figure of 96 per cent. The Office continues to subsidise and to retain an intimate relationship with a small number of observatories of the highest class; the information from these is supplemented by observations at stations where the observers are volunteers. Among the miscellaneous investigations may be mentioned those on atmospheric electricity, by Mr. C. T. R. Wilson, of Cambridge, and the diurnal range of rainfall, by Mr. R. H. Scott. An appendix to the Report contains a correspondence relating to allowances made by the Meteorological Council to the Ben Nevis Observatories. For some time past the Council have also had under their consideration the necessity of making systematic provision for superannuation allowances to members of the staff. Such allowances will apparently have to be provided from the vote for meteorological observations, and reductions in some directions will have to be made in order to provide the means for a satisfactory arrangement. It is hoped that this may be effected without any material diminution of the scientific usefulness of the Office.

TWO communications on telegony and the inheritance of acquired characters have recently appeared;—the one, in the December number of the *American Naturalist*, taking the form of a critical review of Prof. Ewart's "Penycuik Experiments," and the other, a paper by Mr. C. J. Bond in the *Transactions* of the Leicester Literary and Philosophical Society, describing some experiments in rabbit-breeding and plant-grafting. While giving his adherence to Prof. Ewart's conclusions, the former writer urges the needs of further experiments on the same lines. Mr. Bond likewise ranges himself on the same side, stating "that the evidence in favour of the transmission of acquired, as opposed to congenital characters, breaks down in that group of cases in which the supposed occurrence of telegony was thought to prove such transmission; that the explanation of this phenomenon is reversion, and that this may also account for certain phenomena following budding and grafting in plants. Many of the remaining results can be explained by the direct action of the pollen on the maternal tissues without inheritance."

IN the above-mentioned issue of the *American Naturalist*, Mr. C. E. Mead makes the important announcement that in New Mexico a beetle of the genus *Collops* has been observed feeding on the larva of the dreaded Colorado potato-beetle. This leads to the belief that the main crop of potatoes in the district in question is mainly saved by the predaceous habits of the *Collops*, whose presence seems worth many hundreds of dollars to the potato-growers of San Juan county. If this be substantiated, steps should be immediately taken to introduce the *Collops* into other districts affected by the Colorado beetle.

THREE papers on Wehnelt's interrupter form a noteworthy feature of the *Atti dei Lincei* viii. (2) 12. Drs. R. Federico and P. Bacei have determined the form and frequency of the interruptions by allowing the current to circulate round a solenoid, by which magneto-optic rotation is produced, and thus obtaining a photograph in which the interruptions are represented by light bands on a dark ground. The conclusions are (1) that the interruptions do not alway occur at equal intervals; (2) the interruptions are of short duration, averaging about one-sixth of the interval between them; (3) during the interruption the current does not absolutely cease, but only falls to a minimum; (4) a magnetic field does not affect the number of interruptions per second, but reduces their duration; (5) the frequency of the interruptions varies with the electrolyte, a solution of bichromate and sulphuric acid giving a frequency 1½ times greater than with a solution of sulphuric acid only; (6) the bichromate solution does not become turbid, and its heating is less than with sulphuric acid. Dr. O. M. Corbino investigates, among other results, the mathematical expressions determining the form of the interruptions as deduced from the equations of mutual and self induction, assuming the phenomenon to be due to Joule's law. In a subsequent paper, Dr. Corbino investigates the dissymmetry of the currents obtained in the circuit of a transformer when the current in the primary is broken by Wehnelt's interrupter.

THE whole of the October number of the *Journal of Comparative Neurology*, comprising 302 pp., and five beautifully coloured plates, is devoted to an elaborate memoir by Mr. C. J. Herrick on the nerve-components of the bony fishes, as exemplified by the cranial and first spinal nerves of *Menidia*. For the benefit of those not familiar with the theory of nerve-components, it may be mentioned that this is an extension to the cranial nerves of what has been already done for those of the spinal system, which (not to refer to the "four-root theory") are divisible into motor and sensor portions. Similarly the cranial nerve-trunks may contain several varieties of sensory fibres, having different functional and morphological relations, certain of which may be present in a single segmental nerve. In spite of many technical difficulties, and our imperfect knowledge of their exact relations, enough has been accomplished to permit of the statement that the several lobes of the medulla oblongata, so characteristic of fishes, may be associated with the respective cutaneous or visceral sense-organs as definitely as the olfactory nerves are associated with the olfactory lobes, or the electric lobes of the torpedo with its electric organs. An excellent example of this association occurs in the so-called "sea-robins," in which certain free rays of the pectoral fins have become modified into finger-like tactile organs, while their sensor nerves, together with the corresponding dorsal nerves of the spinal cord, have been enormously hypertrophied. Although the criteria of the nerve-components are primarily the central and peripheral distribution of the nerves themselves, it has been found in practice that in fishes each component has certain definite and characteristic structural peculiarities, by means of which it may be at once recognised, thus rendering the work of the investigator much easier than would otherwise be the case.

AMONG the several interesting papers contained in the last numbers of the *Izvestia* of the Russian Geographical Society, we notice especially one, by General Tillo. It deals with the results of the meteorological observations which were made for two years in the Lukchun depression of Central Asia, in connection with the expedition of Roborovsky and Kozloff. This depression was discovered, as is known, by the brothers Grum-Grzimailo. Owing to the absence of places in the neighbourhood of the Lukchun, the altitude of which would have been measured geometrically, it is evidently impossible to finally determine the real altitude of the depression; but from three separate comparisons of the observations of the barometer which were made at this place from November 1893 to October 1895 with those made at Barnaul and Irkutsk, as also with the normal isobars, General Tillo comes to the conclusion that the probable altitude of Lukchun must be 17 metres below the sea-level, with a probable error of ± 15 metres. The spot where the barometer was observed is not, however, the lowest part of the depression, as its altitudes are in different places from 36 to 110 metres *below* that place—thus giving negative altitudes as deep as 130 metres ± 15 metres below the sea-level at Tash-tura. A good map of the depression is given with the paper. Besides, the meteorological observations made at Lukchun are most interesting in themselves, as it appears from them that the yearly amplitudes of the barometer are greater at this place than anywhere on the earth—the monthly averages for January being by full 30 mm. in excess of those for July, while the daily amplitudes in the winter are as great as in some tropical lands. The highest temperature observed in July (48° C.) is also one of the highest observed in Continental Asia, and is truly Saharian. So is also the dryness of the air.

A PAPER, on a "New Basis for the Foundation of Geometry," has been issued, bearing the signature "E. G. L," but whose author invites criticisms addressed to Mr. F. Wheatcombe, of Manchester. The writer of the paper is by no means alone in his ideas as to Euclid's treatment of parallel lines, his definition of a plane angle to the exclusion of straight angles and other such matters being unsatisfactory. As he contemplates writing a book on the subject, we only hope that he will first have studied the considerable mass of existing literature upon it; and if the work is to be properly treated the author should be versed in non-Euclidian as well as Euclidian geometry. The persistent survival of Euclid's "Elements" as a text-book on geometry is mainly due to his sequence of propositions, stereotyped and standardised by constant usage, affording teachers a common starting point. Many have tried to improve on Euclid; but as long as scarcely two people think alike as to how this is to be done, so long will their proposals fail to take root.

THE January number of the *Philosophical Magazine* contains a paper, by Dr. C. Davison, on earthquake sounds, a somewhat neglected branch of seismology. The sound is described as generally deep and rumbling, like that of a heavy waggon passing; sometimes it resembles thunder or wind more closely, the fall of heavy stones, or the firing of distant cannon. Near the epicentre of the earthquake, loud crashes are heard by some, but not all, observers at the time when the shock is strongest; further away, it becomes rougher and more grinding at this moment; while at a great distance, the sound is throughout smooth and almost monotonous like the low roll of distant thunder. The neighbourhood of the sound to the lower limit of audibility is shown by the fact that it is heard by some observers, as say, like the rumbling of a heavy traction-engine passing, while others equally alert hear no sound at all. To different auditors of the sound, it also varies in character and duration for the same reason. In this country, practically every earthquake is accompanied by sound, which both precedes and follows the shock; in Japan, the sound is frequently absent even from violent earthquakes, it is seldom heard more than a few miles from the origin, and rarely, if ever, follows the shock. It would therefore appear that the Japanese as a race are inferior to us in their powers of perceiving deep sounds. In strong earthquakes, the sound-area occupies a region surrounding the epicentre; in weak ones, the sound-area and disturbed area approximately coincide, or the former area overlaps the latter; while in certain districts the sound is sometimes heard without any shock being felt. Several instances of these earth-sounds are given, and it is urged that they are merely earthquakes too weak to be felt. Dr. Davison believes that earthquakes are caused by fault-slips, and that the sound-vibrations come chiefly from the margins of the area of displacement. He shows that this theory will account for all the known phenomena of earthquake-sounds.

IN the *Proceedings* of the Liverpool Geological Society (Part 3, vol. viii., 1899) we have an address from the ex-President, Mr. J. Lomas, in which he deals with the characteristic lithological characters of the principal geological systems. In another article he describes and figures "some flint implements found in the glacial deposits of Cheshire and North Wales." Concerning the artificial form of some of these, Mr. W. J. Lewis-Abbott speaks with confidence, whereas Sir John Evans remarks "No. 7 may be artificial. Of the others, Nos. 2 and 3 look the most possible; but the signs are not such as can confidently be relied on. If man existed in pre-glacial times in Britain, it is, I think, probable that his tools would have been of larger proportions." Mr. Mellard Reade describes a great boulder of gypsum which was found at Great Crosby; he also enumerates the Foraminifera found in samples of Cheshire boulder-clay. Mr. G. H. Morton describes his geological map of Liverpool, and Mr. T. H. Cope deals with the gabbro of Llyn Eigiau, above the valley of the Conwy.

THE *Journal de Physique* for January reprints an article on the Phase rule of Prof. Willard Gibbs, taken from the introduction of the work by Mr. Wilder D. Bancroft. In this article, the rule in question is very simply explained.

THE *Bulletin* of the Cracow Academy (November) contains a continuation of M. P. Rudski's researches on the elastic deformations of the earth. It deals with the deformations produced by glacial deposits or by the formation of coral reefs.

ON account of the comparatively dull light of the English climate, the lenses usually possessed by Kodaks and other hand-cameras have too small an aperture to be used for many purposes. Messrs. Taylor, Taylor and Hobson have, therefore, at the request of many photographers, made arrangements for refitting such cameras with their well-known Cooke lenses. As the lenses can be attached to almost any hand-camera now upon the market, their rapidity will soon be widely known.

As in previous years, the "Annuaire" of the Brussels Observatory contains particulars of the principal astronomical occurrences for the current year, geographical information, tables of physical and chemical data, and other statistics of frequent service in scientific work. The articles include a discussion of the meteorological observations of 1899, and of the direction of the wind at Brussels, by M. Lankaster; on the use of the kite in meteorology, with a bibliography of the subject, by M. Vincent; the climate of the Belgian coast, by M. Durieux; the population of Europe, by M. Lankaster; reports on various branches of astronomical and meteorological work carried on last year, and an instructive description of the determination of the co-ordinates of sun spots, by M. Niesten.

MANY workers with the microscope have been guided in their early "dabblings" by the late Rev. J. G. Wood's "Common Objects of the Microscope" (Routledge and Sons), and not a few can doubtless recall their failures in the attempt to mount seeds in Canada balsam and their disappointment that the medium refused to set in six to eight hours. A new edition of this deservedly popular book has now appeared, revised and brought up to date by Mr. E. C. Bousfield. The late Mr. Tuffen West's familiar illustrations appear to have been re-engraved, and fly leaves with lists of the figures are now attached to the plates, while Mr. Bousfield has added two plates of his own drawing illustrative of pond life. The new letterpress includes a brief account of the optics of magnification, and the use of the substage condenser (brought into general use since the first edition of "Wood") in the introductory chapters, and information on fixing, hardening, imbedding, sectioning and staining, also on selecting diatoms, in the chapters on "mounting" now at the end of the book. The number of pages has been increased from 132 to 186.

A NEW method of attacking the problem of determining the degree of ionisation of complex solutions is given by Prof. J. G. Macgregor in the *Transactions* of the Nova Scotian Institute of Science just issued. The number of free ions per unit volume can be studied in the case of the two simple salts separately by means of the conductivity. These numbers are functions of the dilution, and can be expressed graphically in the form of curves. From these two curves, by a neat graphical construction, Prof. Macgregor deduces the concentration of the ions in the solution resulting from the mixture of the two simple solutions, a complicated algebraical process being thus avoided. The method is applied, in a subsequent paper in the same volume by Mr. J. Barnes, to solutions containing a common positive ion, potassium chloride and sulphate. It was found to be possible in this way, given the dissociation theory and data obtainable from simple solutions, to predict the electrical conductivity, specific gravity and surface tension of fairly dilute solutions of potassium chloride and potassium sulphate within the limits of experimental error.

NOTHING can be more striking testimony to the advance of physical chemistry than the manner in which isolated phenomena, long known but previously unexplained, fall into line when attacked by modern methods. An excellent example of this is afforded by the paper of Messrs. Cohen and Van Eijk in the current number of the *Zeitschrift für physikalische Chemie* on physico-chemical studies of tin. As early as 1851 a curious molecular transformation of some tin organ pipes was noticed by Erdmann, and the same fact was rediscovered eighteen years later by Fritzsche at St. Petersburg, the tin crumbling to a grey powder. Since that time this phenomenon has been repeatedly studied by various observers, the causes being variously ascribed to low temperature, effect of shocks upon the crystalline structure, and velocity of cooling of the tin when originally cast. A preliminary dilatometric study of a grey tin showed the existence of a transition temperature at about 30° C., hence a transition element was constructed, having grey tin as one electrode and ordinary white tin as the other. A study of the electromotive force of this cell with varying temperatures showed that the reaction

$$\text{grey tin} \rightleftarrows \text{white tin}$$

was a reversible one with a transition point at 20° C. A careful determination of the same point by the dilatometric method gave the same value. All the observations of early workers are brought into line by this work. The authors point out that, except during a few warm days, all tin is in a metastabile equilibrium, and tends to transform itself slowly into the grey powder modification.

THE additions to the Zoological Society's Gardens during the past week include a Geoffroy's Cat (*Felis geoffroii*) from Paraguay, presented by Mr. W. A. Gillett; a Woodcock (*Scolopax rusticula*), British, presented by Mr. C. E. Lambert; a Common Snake (*Tropidonotus natrix*), British; a Tesselated Snake (*Tropidonotus tessellatus*), a Dark Green Snake (*Zamenis gemonensis*), European, presented by Miss Ash; a Black-headed Lemur (*Lemur brunneus*) from Madagascar, a Blue-tongued Lizard (*Tiliqua scincoides*) from Moluccas, a Bare-eyed Cockatoo (*Cacatua gymnopis*) from South Australia, two Undulated Grass Parrakeets (*Melopsittacus undulatus*, var.) from Australia, two Common Teguexins (*Tupinambis teguexin*) from South America, an Eyed Lizard (*Lacerta ocellata*), European, deposited; a Black-headed Bunting (*Emberiza melanocephala*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN FEBRUARY.

February 2. 6h. 56m. to 7h. 43m. Occultation of κ Piscium (mag. 5·0) by the moon.
2. 11h. 44m. Minimum of Algol (β Persei).
2. 18h. 5m. Transit (Ingress) of Jupiter's Sat. III.
5. 8h. 33m. Minimum of Algol (β Persei).
6. 8h. 36m. to 9h. 24m. Occultation of δ Arietis (mag. 4·5) by the moon.
7. 14h. 3m. to 14h. 49m. Occultation of 56 Tauri (mag. 5·4) by the moon.
8. 15h. 50m. to 16h. 29m. Occultation of η Tauri (mag. 5·2) by the moon.
14. Venus. Illuminated portion of disc = 0·801.
15. 13h. 20m. to 14h. 40m. Occultation of 55 Leonis (mag. 6·0) by the moon.
19. Saturn. Outer minor axis of outer ring = 16″·13.
22. 16h. Jupiter in conjunction with moon. ♃ 1° 31′ N.
25. 10h. 15m. Minimum of Algol (β Persei).
28. 7h. 4m. Minimum of Algol (β Persei).

UNITED STATES NAVAL OBSERVATORY.

CAPTAIN C. H. DAVIS, Superintendent of the United States Naval Observatory at Washington, has forwarded a copy of his report for the fiscal year ending June 30, 1899.

The great equatorial, 26 inches aperture, has been devoted to work beyond the reach of smaller instruments, and in particular to the spectroscopic determination of the motions of stars in the line of sight. Many measures were made of the diameters of Mercury and Venus, to determine the irradiation error, and it was established that this was a function of the magnifying power employed.

The spectroscopic observations were almost all made by the photographic method, the wave-lengths being obtained from measures taken with the large Harkness comparator made for eclipse reduction in 1869. The probable error in the velocity, as determined from a single plate, was about ± 0·71 mile per second. Good plates with well exposed comparison spectra have been obtained of α Tauri, α Aurigæ, α Canis Majoris, α Canis Minoris, α Cygni and ϵ Cygni, but many others have been failures, owing to the difficulties involved in the use of a lens only visually corrected. This has recently been remedied by the purchase of a correcting lens of 2·09 inches aperture, which alters the minimum focus from λ 5270 to λ 4341 without materially disturbing the total focal length from the object-glass. Extensive alterations have been made in the endeavour to remedy the air currents produced in the equatorial building on account of its connection with other rooms. The 12-inch equatorial has been employed in the systematic observation of minor planets, comets, occultations of stars and eclipses of Jupiter's satellites, the whole of which have been reduced and published. This telescope has also been used for the exhibition of celestial objects to the public on Thursday evenings. Including those admitted during day working hours, the number of visitors during the year has been 1623.

Transit observations have been continuously made throughout the year. The 9·14-inch instrument was dismounted on June 5, 1899, the whole observing staff being immediately transferred to the new 6-inch transit circle. The temporary fittings supplied at the installation of the 9·14-inch transit in 1893 are being replaced by permanent ones of new design. A meridian mark has been provided for the 6-inch instrument, and the performance of both this and the new steel altazimuth have given every satisfaction.

The new 5-inch altazimuth and the prime vertical instrument have been employed for determining variations of latitude and the constants of aberration and nutation.

The 40-foot photoheliograph was installed, for obtaining sun pictures, on October 11, 1898, and from this date to June 30, 1899, negatives were taken on 122 days. The sun's disc on these plates is 4·3 inches in diameter. The publications of the Observatory are well in hand. Volumes of observations for 1891 and 1892 are almost ready for distribution, and these will complete the record of work done at the old Naval Observatory. The American ephemeris for 1902 is issued, and it is hoped that the volume for 1903 will be issued in February 1900. In this, the adopted value of the apparent diameter of the sun will be changed from 960"·78 to 961"·50, this alteration being based on the discussion of 35,842 meridian observations made at the principal observatories of the world.

A new departure in the administration of the Observatory was the appointment, in June 1899, of a Board of Visitors by the Secretary of the Navy, whose duty will be to examine and report upon the condition and requirements of the institution.

ON THE BLUE COLOUR IN WOAD.

THE old East Anglian proverb, "As blue as wad," occurs to one visiting the Woad Mill described by Mr. Darwin in NATURE, in 1896 (vol. lv. p. 36), as evidence that woad once yielded a blue dye. As a natural sequence one wonders what sort of blue it was and how it was obtained. A somewhat extended series of inquiries amongst those engaged in the woad industry, amongst those who have written on woad, and amongst botanical, archæological and chemical friends, failed for a long time to elicit the desired information. Curious as it may appear, an appeal to botanical and chemical works, to dictionaries and encyclopædias was equally unsuccessful. The last-named were pretty uniform in their statements about woad, in that it "was formerly used for dyeing blue, but is now superseded by indigo." Many of the books give an account of the woad-vat in which the manufactured woad is used with bran and lime as a ferment to change the insoluble indigo-blue into the soluble indigo-white; but they give no clue as to how woad may be used as a blue dye alone. It has been said that the blueness of woad was more or less a myth, and even if it ever possessed this quality it has long since been lost by continued cultivation.

As some of the facts elucidated in the attempt to find the blue colour may be of interest to others, they are herewith detailed:—

At the present time woad is grown and is manufactured in four places in the Fen country, viz. at Algarkirk, Wyberton, Skirkbeck, and Parson Drove; its use being as above stated, as a ferment in the indigo-vat to dissolve the indigo-blue. This process of dyeing by woad is difficult, cumbersome and expensive, but it yields the most permanent results. A genuine woad-dyed cloth resists sunshine, rain, and sea-air better than any other, but it is so expensive that only the very best articles are dyed in this way. The fastness of woad-dyed cloth is so proverbial that Prof. Hummel, of the Yorkshire College, Leeds, tells me the adjective "woaded" is now applied in the trade to any fast or permanent indigo dye: a woaded black meaning a black that has an indigo ground colour. The wool is dyed before it is woven, and the cloth may be distinguished by having pale blue or yellow threads in the selvedge.

But to return to the plant, many methods have been suggested by which the indigo in it may be extracted. In the earlier years of the present century, when we were at war with France, so great was the difficulty experienced by that nation in obtaining indigo that the Government offered a substantial prize for an efficient substitute. Attention was consequently re-directed to woad, and more than one method was suggested for the separation of indigo from it. However effective these may have proved in France and Italy, with me they failed, and failed so uniformly as to render the very numerous experiments extending over a period of five months unworthy of further notice. Suffice it to say that the experimental material was obtained from Parson Drove, Boston, Cambridge Botanic Gardens, and wild plants from Gloucestershire. Eventually the presence of indigo was demonstrated in these plants by the simple method of Dr. Hans Molisch,[1] who kindly further advised me, in a letter, to examine particularly the younger and expanding leaves. The method consists in keeping the fresh leaves for twenty-four hours in an atmosphere of ammonia, and then for a similar period in absolute alcohol. The ammonia precipitates the indigo in the leaves, while the alcohol dissolves out the chlorophyll: so that by cutting sections one can see the exact tissues in which the indigo ccurs. These are those containing chlorophyll. The fibro-vascular tissue, the hairs, the epidermis, excepting the guard cells of the stomata, are free from it.

The quantity of indigo varies very much in different leaves; some turn a beautiful blue, while others come out of the absolute alcohol showing only a faint trace towards the base of the leaves. As a rule, the younger the leaf the more indigo it contains; some young leaves, however, hardly contain any. Old leaves have practically none in them, and become yellowish-green or greenish-white brittle objects after the above treatment.

The process of separating the indigo is more delicate—perhaps it would be more correct to say it is a process simple enough in itself, but one in which certain precautions must be observed. Prof. Beijerinck, whose paper "On the formation of indigo from woad"[1] is summarised in NATURE, November 16, 1899 (p. 71), gives the following method: The woad leaves are put into a stoppered bottle, which is then filled with hot water, in such a way that all the air is expelled and the stopper put in so that no air bubble is allowed to remain between the top of the water and the lower part of the stopper. The water assumes a pale yellowish tint—the colour of sherry—with a green fluorescence. On the addition of a caustic alkali it darkens and becomes greenish. If a dilute acid be now added the indigo falls as a blue precipitate. The first time this method was tried with Parson Drove woad its success was complete; the long sought-for blue colour fell in abundance. Prof. Beijerinck tells me that in the month of September he obtained ·09 per cent. of pure indigo-blue from plants grown in Holland.

A considerable number of experiments have been made with the Parson Drove woad, the outcome of which may thus be summarised. The elaborate precautions for excluding the air are not absolutely necessary—simply pouring boiling or nearly boiling water on fresh woad leaves, so that they are completely covered, answers well enough. If to the infusion thus obtained caustic potash, caustic soda, strong ammonia or lime-water be added, the colour changes from yellowish to greenish. Any woollen fabric now dipped into this alkalised infusion will, on exposure to the air, pass from greenish to blue—not the dark blue one had expected, but a beautiful pale azure blue. This change takes place at once if the fabric be immersed in any of the dilute mineral acids. The blue colour thus obtained cannot be called fast, as it will not withstand the action of alkalis or even of soap. It is very subject to variation, being often greenish-blue, grey, or even dove colour. This depends on the age and quality of the woad leaves, as well as on the details of manipulation. In brief, the process consists in simply making an infusion and treating it first with a caustic alkali, then with an acid. The following points have, however, to be attended to: the leaves must be young, they must be fresh, the water must be boiling or nearly so, the infusion must not be left too long before the alkali is added, nor must the addition of the acid be too long delayed. The infusion must be cold before it is treated. If these precautions be not observed, instead of the indigo-blue, that peculiar brownish-black compound is formed which is the *bête noir* of the woad experimenter.

In order to determine the quantity of indigo in Parson Drove woad in plants of various ages: half a kilogramme of leaves, 28, 30, 34 and 66 days old, was found to yield respectively 1·5, 2·4, 2·1, and 0·6 grammes of impure indigo.

The indigo obtained from different experiments varied much in colour; one specimen was an exceedingly beautiful light blue; mostly, however, it was dark blue, which became when dry more or less green. When this, however, was powdered and dissolved by the aid of slaked lime and ferrous sulphate, it dyed cotton articles bright indigo-blue. With regard to the time the leaves should be allowed to infuse, a series of experiments in which 30 c.c. of an infusion were examined at the end of 30 minutes, 1½, 2, 3, 6, 9, 12, 24 and 48 hours, showed that the first 30 c.c., *i.e.* at the end of 30 minutes infusion, contained as much indigo as any of the others; while after the 6th hour the indigo-blue was replaced by the black-brown precipitate. It is probable that the agitation of the vessel in pouring off the successive quantities was the cause of this, for I have obtained indigo-blue from infusions at the end of 10 or 12 hours when they have not been disturbed.

May I ask if any of your readers can help me by suggesting the process by which the mediæval dyers got a blue dye from the prepared woad? Indigo was not introduced into Europe as a commercial article till the middle of the sixteenth century, and even then its employment was for some considerable time more or less prohibited by legal enactments. That woad was used in this country long prior to this is shown by the indenture which still exists between the woad merchants of Amiens and

[1] "Ueber das Vorkommen von Indican im Chlorophyllkorn der Indicanpflanzen." ("Berichten der Deutsch Botan. Gesell.," 1899. Bd. xvii. Hf. 6, p. 228, t. xviii.)

[1] "Koninklijke Akademie van Wetenshappen te Amsterdam," October 25, 1899.

the citizens of Norwich, dated June 29, 1286. That the culture and preparation of woad was practically the same in the time of Ruellius (1536), Crolachius (1575), Wedelius (1675), and Ray (1686) as it is now their writings show. It is probable some very simple process was used by the dyers in these olden times, as simple as that by which the blue colour can be obtained from the fresh plant—at any rate, less complicated than the woad-vat Helliot describes in 1750 for dyeing with woad and indigo, and which is given, with variations, in encyclopædias down to the present time.

CHARLES B. PLOWRIGHT.

CONTACT ELECTRICITY.

AT the meeting of the Physical Society, a few weeks ago, when the subject of Contact Electricity was under discussion, the President was asked by his friendly opponents to commit himself to a definite interpretation of the fundamental equation, and to a precise statement as to what quantity he recognised as "contact potential difference." Prof Lodge did not then comply with the request, but he promised to address the Society upon "Contact Electricity" at their annual general meeting on February 9. It is rather a matter for regret that this ancient feud is so near to amicable settlement. The controversy has held its own for a little more than a century, and throughout that time it has acted as a never-failing stimulus to research in the laboratory. Physicists are now retracing the steps of their arguments, revising their definitions, amending their phrases, and trying hard to understand one another's parlance. No scientific dispute can outlive such precautions.

The case for both sides has frequently been stated. Perhaps the best account consistent with brevity is that given in Prof. A. Gray's "Magnetism and Electricity," Chap. xii. This, in common with all modern summaries of the subject, is admittedly derived from Prof. Lodge's British Association Report of 1884. Those who desire to bring themselves into closer acquaintance with the latest developments of the argument should read the article on "Contact Electricity," by Mr. W. A. Price, in the *Electrical Review* of December 29, 1899. Mr. Price seeks to locate the dispute to the meaning of words, and chiefly to the word "potential." He explains that "potential" is essentially a property of a position in space, and that it implies neither the existence nor the absence of matter near or at a point of which potential is predicated. The expression "potential at a point" has *per se* no ambiguity. But when measurements of the potential at a point are required, the methods employed, from their indirect character, necessitate certain assumptions; and the quantity is no longer free from ambiguity. Potential is generally measured indirectly, as the result of an investigation of the electrical force in the neighbourhood of the given point. The value, so obtained, involves therefore the physical qualities of the fluid medium or media associated with the point, and these have no place in the primary definition of potential. There is, in fact, no experimental foundation for the statement that within a conducting body, not conveying electricity, potential has the same value at all points. Hence no conclusions can properly be drawn until physicists agree amongst themselves as to their cardinal definitions; and when this is accomplished, the controversy will have ceased.

AGRICULTURAL EDUCATION.

WE are slowly realising that success in farming depends quite as much upon scientific knowledge as upon practical training. In other countries this fact has been fully appreciated for many years, and elaborate provision for the interests of agriculture forms a prominent feature of their educational systems. Similar provision has become a necessity for England, if we are to compete with them upon anything like equal terms. In furtherance of this object the Agricultural Education Committee, of which some of the most eminent men of science and agriculturists of the day are members, has recently issued certain definite proposals. Foremost amongst these is a recommendation that all the educational work of the Board of Agriculture should, like that of the Science and Art Department, be transferred to the new Board of Education. If the confusion, overlapping and wasteful expenditure of public money, which have resulted from the multiplication of central authorities, are to be avoided, it is essential that one authority alone should be responsible for the agricultural education of the country. It would be the function of this authority, aided by inspectors thoroughly familiar with the needs of the agricultural classes, and with the conditions of rural life, to secure an adequate provision of the various forms and degrees of instruction required by all those who are in any way concerned with the cultivation of the soil.

Such instruction must commence with the elementary school, for that is the foundation upon which the whole superstructure has to be built, and the Committee emphasises the importance of differentiating the curriculum of the rural from that of the urban school. This change is not advocated under the impression that it will stem the tide of migration from the country districts. A variety of social and economic causes combine to drive men from the villages into the towns. At the same time, on the principle that "as a twig is bent, so will the tree incline," it is hoped that if children were familiarised from their earliest years with the simple facts of nature, and encouraged to take an intelligent interest in them, a love of the country might be awakened, and the desire to remain in it certainly be strengthened. No suggestion of teaching agriculture or science as such is put forward: years ago, Prof. Huxley pointed out the futility of attempting to teach either one or the other in an elementary school. A rural curriculum should include elementary science lessons upon the life, growth and structure of plants, the habits of birds, animals and insects, the nature of the soil, and air and water, and the utility of the simpler methods of cultivation. These lessons should be illustrated by experiments, and be accompanied by practical work, appropriate to the agricultural character of the locality, done by the pupils themselves in gardens or on plots of ground attached to the school. They should be supplemented further by occasional visits to well-managed farms, and valuable assistance might be given by circulating amongst the teachers and pupils leaflets, similar to the admirable "Nature-Study Leaflets" issued by the agricultural college in Cornell University. In like manner girls should receive elementary instruction in cooking, domestic economy and hygiene. In either case the child will be developing those faculties, and forming those habits, which enable a boy to become a skilled labourer or a successful farmer, and a girl to become a competent servant or a capable housewife. To meet the difficulties of small schools, several parishes must combine to engage the services of a peripatetic teacher. There can be no doubt that in the grouping of villages and schools for educational purposes the solution of many of the problems of rural education will ultimately be found to lie.

As yet it is not easy to find properly qualified teachers, but the Committee suggests various ways in which they may be trained. At the normal colleges in France theoretical and practical instruction in agriculture is provided for the students by the departmental professors, and there does not appear to be any reason why students at some of the training colleges in England should not be similarly taught by the lecturers of the County Councils. It should be remembered that the rural school does not require an agricultural expert; such a teacher would inevitably give undue prominence to one aspect of elementary education, and it might reasonably be objected that an attempt was being made to capture the schools in the interest of one section of the community only. The rural teacher should have a general knowledge of the principles underlying the science of agriculture, and some practical knowledge of agricultural operations. Men so qualified will be rapidly forthcoming as the demand for them becomes more general. In the meantime existing teachers should be assisted to acquire the necessary experience by County Council lectures, practical demonstrations on farms and in gardens, and courses of instruction at agricultural colleges; special facilities by means of scholarships or bursaries should be offered to rural pupil teachers for a course of some duration at any institution where theoretical and practical instruction might be had.

It is necessary to insist upon the importance of the lower branches of agricultural education in view of the small attention which has hitherto been paid to them. The hope of the future lies in our having a constant relay of pupils from the elementary schools fitted to attend and profit by the more advanced classes and colleges. For the majority of rural children evening continuation schools afford the only opportunity for further instruction, and the Committee recommends that it should be made part of the duty of every county organisation (outside London and the county boroughs) recognised under Clause VII.

of the Directory to organise such schools throughout their county, to receive and supplement the grants made by the Board of Education, and to supply and pay qualified teachers. The instruction should be in such subjects as natural history, botany, and other sciences bearing upon agriculture and horticulture, bee and poultry keeping, land measuring, farm accounts, &c., rather than in such subjects as typewriting, commercial arithmetic and shorthand. Between these classes and the highest agricultural colleges, schools should be established in every county, where lads from the age of thirteen to eighteen might obtain two years' thorough theoretical and practical training. Each of these schools should be developed by its managers upon the lines most suitable to the agriculture of the district. Thus it may be possible to organise a satisfactory system of agricultural education, but, as was well observed by M. Tisserand, Director of Agriculture in France in 1896, in his memorandum for the Recess Committee: "the agriculturists must be made to understand that the improvement they desire depends as much upon themselves as upon the Ministry, if not more so; that the latter must be powerless without their help; that they will receive succour from the State in proportion as they themselves put forth energy and labour; and that it is only by the united effort of all concerned that progress can be brought about."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The practical teaching of physical chemistry is being introduced this term at the Daubeny (Magdalen College) Laboratory. The course of instruction will be given by Mr. Duncan Wilson, who was recently appointed Lecturer in Chemistry to the College, and has studied with Prof. Ostwald.

CAMBRIDGE.—The Allen Scholarship for research, worth 250*l.* for one year, will this term be given for work in medicine, mathematics, physics and chemistry, biology and geology, or moral science. Candidates are to be graduates of the University of not more than twenty-eight years of age. Applications should be sent to the Vice-Chancellor by February 20.

The Faculty of Medicine of the University College of South Wales and Monmouthshire has been recognised for the purpose of medical study outside the University.

Plans and estimates for the new botanical laboratory have been submitted to the Senate. The cost will be over 22,000*l.*

The Mathematical Board have amended in a few details their previous report on the Mathematical Tripos. They now propose that each class in Part I. shall be arranged in two divisions, the names in each being in alphabetical order. They think it important that these divisions should, so far as may be practicable, indicate a uniform standard from year to year. The voting will take place on February 15, at 2 p.m.

Dr. Jackson was on January 26 unanimously elected a member of the Council in the room of Mr. Dale, now Principal of University College, Liverpool.

The present state of war has affected the University in a remarkable manner. Not only have a considerable number of graduates and undergraduates volunteered for active service, but the Vice-Chancellor has summoned a meeting with a view to applying to the Government for an increase of the establishment of the University Rifle Corps. The present strength is 600; it is proposed to increase this to 800, and the recruits are ready. Moreover, it is proposed to place the Senate House at the disposal of the corps for a drill hall, at times when it is not required for University purposes. Colonel Dyke is giving a course of lectures on tactics thrice weekly.

Lord Lister has been appointed an Elector to the Chair of Pathology in the place of the late Sir James Paget.

The State Medicine Syndicate have made a grant of 50*l.* in aid of a course in bacteriology, provided for candidates desiring to obtain the Diploma in Public Health.

THE London County Council have agreed to retain a site in Clare Market, Strand, valued at 14,770*l.*, for the establishment of a school for higher commercial education in connection with the new University of London.

THE Queen's Speech, read at the new session of Parliament, which opened on Tuesday, announced that a measure would be introduced in regard to education in Scotland, and that proposals would be made for better enabling local authorities to aid secondary and technical education in England and Wales.

THE following officers were elected at the annual meeting of the Association of Technical Institutions, held in the Mercers' Hall, London, on Wednesday, January 24:—President, Sir Swire Smith; vice-presidents, Lord Spencer, Sir Bernard Samuelson, Bart., Mr. H. Hobhouse, M.P., Mr. W. Mather; treasurer, Mr. R. F. Martineau (Birmingham); honorary secretary, Prof. J. Wertheimer (Bristol).

IN order to meet increasing demands for space, and to keep pace with modern requirements, the Council of King's College have been obliged to undertake very extensive additions to and improvements in the departments of physiology, bacteriology, anatomy, botany, geology, public health, architecture, and applied mechanics. For these purposes, and for the resulting equipments and adaptations, an expenditure of not less than 18,000*l.* has to be met immediately. The object in view is specially commended to friends of the college and of science by Lord Salisbury and by Lord Lister. Mr. Balfour, M.P., will preside at a special festival dinner in aid of the fund, to be held at the Hall of Lincoln's Inn on Wednesday, February 14. All contributions promised before or at the dinner will be placed on the chairman's list and announced at the festival. Contributions may be sent to the Hon. W. F. D. Smith, M.P., treasurer, at King's College.

MR. W. P. HARTLEY, of Aintree, Liverpool, has added to his many donations to University College, Liverpool, the munificent gift of a completely furnished Botanical Institute. The building, which has been carefully designed to meet all the requirements of modern teaching and research, will be built of Ruabon brick with sandstone dressings, on land specially purchased for it by Mr. Hartley, and situated close to the new chemical laboratories. The building, the architect of which is Mr. F. W. Dixon, of Manchester, will consist of three main floors containing the Museum, Lecture Theatre and Junior Laboratory. Two mezzanines and top floor will provide space for senior and research laboratories, library, experimental physiology laboratory, herbarium and private rooms. The basement will contain store-rooms, heating chambers, lavatories, &c. It is expected that the new laboratories will be ready for occupation early in 1901.

THE first report of the Liverpool School of Tropical Diseases has been issued. The school was formally opened last April, with Major Ross as the lecturer in tropical diseases, and though much time has had to be devoted to organising courses of study, and arranging the material available for research, an abundance of other work has been done. The most important result, however, achieved by the school, was the despatch of an expedition to West Africa to investigate the prevalence there of tropical malaria and other diseases. The expedition, which started at the end of July and returned in October, chose Sierra Leone as the field of their labours, owing to its proximity to Liverpool, the time at their disposal being short. The results of the expedition have been in the highest degree satisfactory, and a report on its labours is now in course of preparation, and will shortly be issued. The expedition brought back a considerable amount of very valuable material for teaching purposes, more especially a unique collection of malaria infected mosquitoes, which have proved exceedingly useful for demonstration purposes. Full recognition by the Government has not yet been extended to the school, and until that recognition is given, the class of students most desired, namely, medical officers about to enter into the service of the Government in tropical colonies, will not be attracted. It is confidently expected, however, that full recognition will shortly be given, and that the medical officers in question will be allowed the option of undergoing their course of instruction in tropical medicine at Liverpool.

A DEPUTATION of the Agricultural Education Committee waited upon the Duke of Devonshire at the Education Department on Friday last, to urge the adoption of certain educational reforms on the lines of a series of resolutions which were adopted a short time ago by the executive of the Committee. Among other reforms, the resolutions suggested that in view of the importance of concentrating the control of agricultural and rural education in the hands of one Government department, the educational work of the Board of Agriculture should be transferred to the new Board of Education; that the staff of the new board should include an adequate number of inspectors well acquainted with the needs of the agricultural classes and the conditions of country life, and that the inspectors should be instructed to see that the curricula of rural schools are differentiated from those of urban schools. It was also recommended that in rural elementary schools there should be a continuous course of rural instruction, beginning in the lower standards with object lessons and continued in the upper standards with lessons in natural history and elementary science bearing on agriculture and rural life. With regard to training, it was suggested that provision should be made at certain of the teachers' training colleges for giving practical as well as theoretical instruction in agriculture and horticulture to those students who desired it. With regard to higher agricultural instruction and evening continuation schools it was recommended that the Board of Education should encourage those county authorities which have not yet done so to provide or to contribute to school and experimental farms and should inspect and report annually on such farms; that in rural evening schools instruction should be given in such subjects as natural history, botany, and other sciences bearing on agriculture, horticulture, bee and poultry keeping, land measuring, farm accounts, and so on, rather than in such subjects as typewriting, commercial arithmetic, and shorthand. The Duke of Devonshire expressed himself in sympathy with the desire of the Committee to give a more useful and practical character to elementary education in rural districts, and mentioned certain steps which the Education Department has taken in furtherance of this object. Full consideration was promised to the various suggestions put forward by the Agricultural Education Committee. The subject is dealt with in an article on p. 332.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, January 26.—Prof. Lodge, F.R.S., President, in the chair.—A paper by Prof. Ayrton and Mr. Mather, on some developments in the use of Price's guard wire in insulator tests, was read by Prof. Ayrton. For insulation tests made by the direct deflection method the guard wire properly applied affords complete protection against surface leakage when the ends of the cable tested are near the galvanometer, so that it is possible to have the wire connecting the conductor of the cable with the galvanometer terminal "air insulated." A difficulty, however, arises when the ends of the cable are at a considerable distance from the testing instrument; this may render air insulation impossible. The authors have overcome this difficulty by applying a guard wire along the entire length of the lead. This is done by using a concentric wire to connect the cable and galvanometer, the inner of the concentric being used as the lead and the outer as the guard wire. The principle can also be applied to determine whether a defective piece of cable is bad throughout or bad owing to one or more isolated faults. In this case the cable is placed in two water tanks, one of which is earthed, and the other fairly well insulated. By a suitable arrangement of the guard wire it is then easy to determine the resistance of the wire in the earthed tank, so that by altering the length of this wire the character of the insulation can be determined throughout the whole length of the cable. In referring to some of the earliest experiments with the guard wire made by Mr. Appleyard in 1895, Prof. Ayrton pointed out that the principle had not been applied completely, and that at one point there was a chance of leakage. Mr. Campbell said that the necessity of having a concentric could be obviated by simply hanging the lead from the guard wire by short lengths of material of fair insulation. Mr. Appleyard said that he quite agreed with Prof. Ayrton that the guard wire ought in general to be applied at both ends of all leads, provided that both ends could be got at. The reason it was used at one end only in the experiments on dielectrics made in 1895 was that the far end of the lead was carried into the condenser box, which was submerged in water in the temperature tank. Special precautions were taken to ensure good insulation of the submerged end of the lead, and tests showed that the leakage there was nil. As the end of the wire could not be got at, no guard wire could be applied. Mr. Appleyard congratulated the authors upon the use of a concentric cable for a lead, and pointed out that such a lead was sufficient for all the routine tests on core; the inner and outer conductors could be used for the purpose of taking the "copper" resistance. Mr. Price expressed his interest in the developments of his principle which had been made by the authors.—Mr. Appleyard then read a paper on a fault-test for braided and other cable-core. This method enables the fault to be found without the removal of braiding or tape. The core is wound on two insulated drums or tanks, the intermediate piece of cable being about ten feet long. One end of the core is left free, the other is connected to earth through a galvanometer and a battery. A guard wire is connected from some point between the galvanometer and the battery to some point of the braiding on the wire between the drums. A wet cloth, connected to an earth wire, is laid on one or other of the drums, over the braiding. The galvanometer deflection is noted. The earth-wire is then changed over to the second drum, and the corresponding deflection is observed. A comparison of these deflections at once indicates upon which drum the fault lies. With the galvanometer still deflected, the core may be run through a suitable contact brush or sponge attached to the guard wire. The instant the fault passes under the guard wire contact, the deflection falls and the fault is located. The paper gives the theory of the method, and indicates how to apply it (1) to localising "distributed" faults; (2) to several faults in a single cable; and (3) to the case of a single fault. One advantage of the method is that at the critical moment, when the fault passes under the guard wire, the galvanometer is short circuited through the fault, and thus completely protected.—A paper on reflection and transmission of electric waves along wires, by Dr. E. Barton and Mr. L. Lownds, was read by Dr. Barton. The waves used were produced by means of an induction coil and an oscillator, and travelled along wires ·15 cm. diameter, 8 cms. apart, and 166 metres long. The ends of the wires were connected by graphite markings on ground glass, so that any wave trains which reached the ends were at once absorbed. Three circular parallel-plate condensers were used, of 15, 9 and 5 cms. radius respectively. The plates were in all cases separated by air, and were placed 1 cm. apart. The needle of the electrometer connecting the wires was uncharged, so that it was always attracted by the charged plates. The positions of the condenser and electrometer could be varied so as to study either the reflected or the transmitted waves. The electrometer produced a negligible disturbance, as it reflected only 0·04 per cent. of the energy incident upon it. The authors have attacked the problem mathematically, using the relations of Heaviside, and have obtained expressions for the reflected and transmitted systems. These expressions consist of two terms, one of which is comparatively unimportant. From the other term certain values have been calculated. A superior limit has then been given to the other term, and the values already obtained have been subjected to a correction on this account. By a suitable arrangement of the condenser and electrometer these calculated values have been experimentally determined, and are in close agreement with the theoretical numbers, falling in many cases between the results derived from the approximate and the corrected theories. The authors have also investigated the stationary wave system produced by interference when the electrometer is placed close to the condenser, and between the condenser and the oscillator. The chairman said that the experiments afforded a satisfactory verification of Heaviside's theory.—A paper on the frequency of transverse vibrations of a stretched india-rubber cord, by Mr. T. J. Baker, was taken as read. In this paper Mr. Baker has investigated the frequency of the note given out by an india-rubber cord of square section when subjected to different tensions. The relation between length and tension is linear over a considerable range. The curve connecting length with frequency shows that while the cord was doubling its length the pitch was rising rapidly, but that further extension was practically without effect. Since the relation between length and tension is linear, while the sectional area is decreasing, it follows that the value of Young's modulus must be changing. The author has shown that the value of Young's modulus is proportional to the square of the stretched length of the cord. Using this fact, the frequency of the note given out by a stretched india-rubber cord is shown to be proportional to a quantity which varies very slightly with increase in length of the cord, and hence the variation in elasticity is given as the cause of the constancy of the note.—Mr. Appleyard exhibited some mirrors produced inside incandescent lamps by the application of voltages much above those for which the lamps were designed, and the consequent deflagration of the filaments.—The meeting then adjourned until February 9.

Chemical Society, January 18.—Prof. Thorpe, President, in the chair.—The following papers were read:—Note on nitrogen halogen compounds, by J. Stieglitz and E. E. Slosson. —On the electrolysis of the nitrogen hydrides and of hydroxylamine, by E. C. Szarvasy. The author has made series of experiments on the electrolysis of solutions of ammonia, hydrazine, azoimide, hydroxylamine, and of their salts; attempts to prepare polymeric nitrogen by electrolysing solutions of azoimide and its salts at high current densities are still in progress.—On the relationship between the constitution of some substances and the fluorescence which they exhibit, by J. T. Hewitt.—Action of fuming nitric acid on α-dibromocamphor, by A. Lapworth and E. M. Chapman. The oxidation of α-dibromocamphor yields camphoronic and homocamphoronic acids, nitrobromocamphor, dibromocampholidid, a substance of the composition $C_{10}H_{16}N_2O_6$ and a lactone which yields a crystalline acid, $C_{10}H_{16}O_4$, on hydrolysis with potash.—Note on Volhard's method for the assay of silver bullion, by T. K. Rose. The precautions to be observed in using Volhard's method are described, and the limit of accuracy is put at 0·1 per 1000.—c-Substituted hydroxytriazoles, by G. Young and E. Witham. The authors have prepared a number of hydroxytriazoles, using the reactions represented by the following equations:—

$$CHR:N.NH.CO.NH_2+O=CR\begin{array}{c}\diagup N.NH \diagdown\\ \diagdown\!-\!-N\diagup\end{array}C.OH+H_2O$$

and

$$R.CHO+NH_2.CO.N:N.CO.NH_2=CR\begin{array}{c}\diagup NH.N \diagdown\\ \diagdown N-\!-\diagup\end{array}C.OH$$
$$+NH_3+CO_2.$$

—Note on the use of a mixture of dry silver oxide and alkyl halides as an alkylating agent, by G. D. Lander. Alkylic derivatives of menthol, benzoin, benzamide and ethylic acetoacetate are obtained by the action of dry silver oxide and alkyl iodides.

Entomological Society, January 17.—Annual meeting.—Mr. G. H. Verrall, President, in the chair.—It was announced that the following had been elected as officers and council for 1900-1901: President, Mr. G. H. Verrall; treasurer, Mr. R. McLachlan, F.R.S.; secretary, Mr. C. J. Gahan; librarian, Mr. G. C. Champion; and as other members of the council: Mr. C. G. Barrett, Dr. T. A. Chapman, Messrs. W. L. Distant, H. St. J. K. Donisthorpe, F. D. Godman, D.C.L., F.R.S., A. H. Jones, R. W. Lloyd, the Hon. Walter Rothschild, and Messrs. E. Saunders and C. O. Waterhouse. The election to fill a vacancy on the council and one in the office of secretary, caused by the resignation of Mr. J. J. Walker, R.N., was adjourned to March 7.—The President delivered an address in which he reviewed the advantages and disadvantages under which entomologists and other men of science now labour as compared with the conditions existing at the beginning of the century. He called attention to certain abuses prevalent, instancing, among others, the hasty and ill-digested nature of much of the work now published, the result, as he believed, of the facilities that are given for publication. Having referred also to the vast increase in the number and variety of the publications which a student must consult in order to be fully acquainted with the work being done in his special branch of study, Mr. Verrall proceeded to suggest that there should be an international agreement for the purpose not only of restricting the number of the publications to be recognised, but of exercising some control over their contents, in order that worthless papers might be excluded. In conclusion, he briefly summarised the reforms which he considered most essential to be effected at the beginning of the new century.

Zoological Society, January 23.—Dr. Albert Günther, F.R.S., Vice-President, in the chair.—Mr. Sclater exhibited a photograph of a young example of the Rocky Mountain goat (*Haploceros montanus*). It was stated that the animal had been captured near Field, British Columbia, in June last, and had lived in captivity ever since. Mr. Sclater also exhibited a collection of birds formed by Mr. Alfred Sharpe, C.B., during an excursion to Fort Jameson in Northern Rhodesia. The collection consisted of 135 specimens, which had been referred to 66 species.—Mr. A. Smith Woodward gave an account of a series of remains of *Grypotherium* and associated mammals from a cavern near Last Hope Inlet, Patagonia, exhibited by Dr. F. P. Moreno. The specimens had been collected for the La Plata Museum by Dr. R. Hauthal, and had already been described in a memoir by Drs. Hauthal, Santiago Roth, and Lehmann-Nitsche. Mr. Woodward recorded some additional observations. He confirmed the reference of the so-called *Neomylodon* to *Grypotherium*, and agreed with the previous authors that the fragments of bones and skin had been left in their present state by man. The associated mammalian remains were in the same condition of preservation, and were referable to *Arctotherium*, a large species of *Felis*, *Onohippidium*, and a large rodent, all of the extinct Pampean fauna. Remains of existing mammals were also found in the same cave, but apparently in another stratum.—Prof. E. B. Poulton, F.R.S., communicated a report, drawn up by various specialists, on the Insects and Arachnids collected in 1895 and 1897 by Mr. C. V. A. Peel in Somaliland. It contained annotated lists of the specimens contained in the collection and descriptions of several new species.—Mr. W. E. de Winton read a paper on an interesting collection of mammals made by Lord Lovat in Southern Abyssinia while accompanying Mr. Weld-Blundell's expedition from Berbera to Khartoum in the beginning of last year. Several of the antelopes were of particular interest: the "Beira" (*Dorcotragus megalotis*), hitherto only known from a few isolated hills in Somaliland, was found to be very plentiful on the banks of the Blue Nile above Roseires.

PARIS.

Academy of Sciences, January 22.—M. Maurice Lévy in the chair.—M. Grandidier announced to the Academy the loss it had sustained by the death of M. Alexis de Tillo, correspondant for the section of geography and navigation.—Presentation of the first publications of the Observatories of Potsdam and Paris relating to the photographic chart of the sky, by M. Lœwy. Two sets of negatives have been taken, one with a long exposure, sufficient to take in stars of the 14th magnitude; the other with shorter exposure, so as to exclude stars of a higher magnitude than the 11th.—M. Zeuthen was elected a correspondant for the section of geometry in the place of the late M. Sophus Lie; and M. Peron, a correspondant for the section of mineralogy, in the place of the late M. Matheron.—Note on the works of Lavoisier, by M. de Vincenzi. A reproduction of a letter of Lavoisier, not previously published, dated January 6, 1793, to Mr. Robert Kerr, the English translator of his *Traité élémentaire de Chimie*.—Observations on the subject of the preceding note, by M. Berthelot. No trace can be found in the archives of the Academy of the new and enlarged edition of the *Traité élémentaire* referred to by Lavoisier in the above letter as being in preparation.—On isothermal surfaces, by M. C. Guichard.—On the degree of generality of any differential system whatever, by M. Riquier.—On the measurement of capacity in a heterogeneous medium, by M. A. A. Petrovsky. An analysis of the method suggested by Borgmann and Petrovsky, in which alternating currents are used. It is shown that a complete compensation can only be obtained in the cases where the compensated system is either a conductor or an insulator. In general, the magnitude of the capacity as measured will be a function of the number of oscillations of the alternating current.—On the liquefaction of gaseous mixtures, by M. F. Caubet. A pressure-temperature diagram is given showing the results of experiments on ten mixtures of carbon dioxide and methyl chloride. The results complete those already published by Prof. Kuenen. —On a phenomenon arising from the use of triphase currents in radiography, by M. Delézinier. The author shows that by the use of the method suggested by him in a previous paper, using triphase currents, the Crookes' tubes will work equally well when the anode of the tube is connected to either pole of the induction coil. The destructive effects upon the bulbs of a changing over of polarity, which occur with direct currents, are avoided if triphase currents are employed.—Transformation of the photographic image of a negative into a lamellar state, and colour phenomena derived from this, by M. A. Frillat. A negative is carefully cleaned and dried and then exposed to the vapours of nitric acid, which dissolves the precipitated silver, and causes the disappearance of the image. The plate is now placed in an atmosphere of moist sulphuretted hydrogen, when the silver is reprecipitated in a lamellar condition, and the image which reappears is vividly coloured. There is, however, no relation between the true colours of the objects and the colours so produced, although by varying the time of exposure to the sulphuretted hydrogen some control is obtainable over the colours.—On the metallic borates, by M. L. Ouvrard. Since the only definite borate of the composition $B(OR)_3$ is the magnesium borate of Ebelmann, attempts were made to prepare other borates of a similar constitution. Cadmium borate, $Cd_3(BO_3)_2$, can be prepared in a pure state by heating together in a platinum crucible potassium and hydrogen fluoride, KHF_2, with boric anhydride, and then adding cadmium oxide.—On a new method for determining aluminium, by M. Alfred Stock. The method proposed depends upon the setting free of iodine and precipitation of alumina from its salts by a mixture of potassium iodide and iodate. The reaction is not complete unless some sodium thiosulphate is added, and the solution heated. The aluminium hydrate thus thrown out is in a much denser form than when precipitated by ammonia, and is easily washed and dried.—On the fauna of the Auvergne, by MM. C. Bruyant and A. Eusébio.—On the seminal teguments of some species of the genus *Impatiens*, by M. Camille Brunotte.—On the geology of Southern China, by M. Leclère. The geological expedition to Southern China occupied from December 1897 to July 1899. and resulted in filling up the gap in the geology of the country between Indo-China and Central Asia.—On some fossil plants of Southern China, by M. R. Zeiller. A study of the carboniferous fossils collected by M. Leclère in the expedition mentioned in the previous paper.—On the structure of the southern portion of the zone of the Briançonnais, by M. W. Kilian.—On a new Miocene rodent, by M. Cl. Goillard. The new rodent, which was found in the Miocene strata of Grive-Saint-Alban, on account of its peculiar dentition cannot be regarded as belonging to any known genus. The molars have some resemblance to those *Brachyuromys Betsileonensis*, now existing in Madagascar, and recall also the dentition of the living species *Tachyoryctes annectens* and *Rhizomys vestitus*. The name proposed for the fossil is *Anomalomys Gaudryi*.—On a crystallised fibrin, by M. L. Maillard. Although admitting the accuracy of the observations of M. Dzerzgowski as to the existence of crystals of calcium palmitate in the deposit from sterile serum, the author still is of opinion that there is also a quasi-crystalline albuminoid material present.—The increase of yeasts, without fermentation, in the presence of a limited quantity of air, by M. A. Rosenstiehl. In the experiments described, the reproduction of the yeast without fermentation would appear to be caused by the presence of tannin, or of some similar substance capable of being coagulated by gelatine.—On the nature of the propagation of a nervous influx, by M. G. Weiss. The experiments made by the author upon the effect of temperature upon the velocity of a nerve impulse are not in agreement with those of Helmholtz, since the velocity would appear to be independent of the temperature, and hence is not so intimately related to a chemical change as is muscular contraction.—New method for measuring the thermal sensibility, by MM. Ed. Toulouse and W. Vaschide. To eliminate the disturbing effects of contact sensations the authors use drops of water heated to known temperatures, and weighing only 0·1 gram, which are allowed to fall on to the skin from a height of 1 cm.—Action of a continuous current upon the respiration of muscle, by M. Th. Guilloz.—On the solar halo of January 11, 1900, by M. l'Abbé Maze.

DIARY OF SOCIETIES.

THURSDAY, FEBRUARY 1.

ROYAL SOCIETY, at 4.30.—A Case of Monochromatic Vision: Sir W. Abney, F.R.S.—Thermal Radiation in Absolute Measure: Dr. Bottomley, F.R.S., and Dr. Beattie.—Electrical Conductivity in Gases traversed by Cathode Rays: Dr. McLennan.—Researches on Modern Explosives: W. Macnab and A. Ristori.—On the Influence of the Temperature of Liquid Air on Bacteria: Dr. A. Macfadyen.

ROYAL INSTITUTION, at 3.—The Senses of Primitive Man: Dr. W. H. R. Rivers.

LINNEAN SOCIETY, at 8.—On Botanic Nomenclature: C. B. Clarke, F.R.S.—On the Zoological Results of an Expedition to Mount Roraima, in British Guiana, undertaken by Messrs. F. V. McConnell and J. J. Quelch: Prof. E. Ray Lankester, F.R.S.

CHEMICAL SOCIETY, at 8.—The Chlorine Derivatives of Pyridine. Part V. Synthesis of αα'-Dichloropyridine. Constitution of Citrazinic Acid: W. J. Sell and F. W. Dootson.—The Formation of Heterocyclic Compounds: S. Ruhemann and H. E. Stapleton.—The Space Configuration of Quadrivalent Sulphur Derivatives: Methyl Ethyl Thetine Dextrocamphorsulphonate, and Dextrobromocamphorsulphonate: W. J. Pope and S. J. Peachey.—Nitrocamphane: M. O. Forster.

RÖNTGEN SOCIETY, at 8.—Röntgen Rays in Diseases of the Chest: Dr. Hugh Walsham.—Mr. A. Hastings Stewart will show a small Egyptian Mummy and Skiagrams of the same.

FRIDAY, FEBRUARY 2.

ROYAL INSTITUTION, at 9.—Wireless Telegraphy: G. Marconi.

GEOLOGISTS' ASSOCIATION, at 7.30.—The President, J. J. H. Teall, F.R.S., will deliver an Address on the Natural History of Phosphatic Deposits.

MONDAY, FEBRUARY 5.

SOCIETY OF ARTS, at 8.—The Nature and Yield of Metalliferous Deposits: Bennett H. Brough.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—A Fragment of the Geography of England: South-West Sussex: Dr. H. R. Mill.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—On Recent Objections urged against the Adoption of the Metric System: Dr. W. S. Squire.—Oil of Carthamus Tinctorius (Safflower Oil): H. R. Le Sueur.

TUESDAY, FEBRUARY 6.

ROYAL INSTITUTION, at 3.—Structure and Classification of Fishes: Prof. E. Ray Lankester, F.R.S.

ZOOLOGICAL SOCIETY, at 8.30.—Notes on the Transformations of some South African Lepidoptera: Colonel J. M. Fawcett.—On Mammals obtained in South-Western Arabia by Messrs. Percival and Dodson: Oldfield Thomas.—On a Small Collection of Decapod Crustaceans from Freshwaters in North Borneo: L. A. Borradaile.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Moving Loads on Railway Underbridges: W. B. Farr.—Note on the Floor System of Girder Bridges: C. F. Findlay.

WEDNESDAY, FEBRUARY 7.

GEOLOGICAL SOCIETY, at 8.—Pala Lake and the River System of North Wales: Philip Lake.—Foraminifera from an Upper Cambrian Horizon in the Malverns: Frederick Chapman.

SOCIETY OF PUBLIC ANALYSTS, at 8.—Note on the Separation of Oleic Acid from other Fatty Acids: Dr. J. Lewkowitsch.—Analysis of a Sample of "Treacle" and of a Sample of So-called "Golden Syrup": C. G. Matthews and A. Hyde Parker.—The Determination of Carbon and Sulphur in Steel: Bertram Blount.—Note on Sour Milk: H. Droop Richmond and J. B. P. Harrison.—Butters from various Countries compared: C. Estcourt.

THURSDAY, FEBRUARY 8.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: The Spectrum of α-Aquilæ: Sir N. Lockyer, K.C.B., F.R.S., and A. Fowler. On Electrical Effects due to Evaporation of Sodium in Air and other Gases: W. C. Henderson.

ROYAL INSTITUTION, at 3.—Modern Astronomy: Prof. H. H. Turner, F.R.S.

CHEMICAL SOCIETY, at 8.30.—Victor Meyer Memorial Lecture: Prof. T. E. Thorpe, F.R.S.

SOCIETY OF ARTS (Imperial Institute), at 4.30.—The Projects of Railway Communication with India: J. M. Maclean.

MATHEMATICAL SOCIETY, at 8.—A Formula in the Theory of the Theta-Functions: Prof. A. C. Dixon.—Some Elementary Distributions of Stress in Three Dimensions: J. H. Michell.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Standardisation of Electrical Engineering Plant: R. P. Sellon.

FRIDAY, FEBRUARY 9.

ROYAL INSTITUTION, at 9.—Symbiosis and Symbiotic Fermentation: Prof J. Reynolds Green.

ROYAL ASTRONOMICAL SOCIETY, at 3.—Anniversary Meeting.

PHYSICAL SOCIETY, at 5.—Annual General Meeting.—Address by the President, Prof. O. J. Lodge, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Underground Sources of Water-Supply: D. E. Lloyd-Davies.

CONTENTS.

THURSDAY, FEBRUARY 8, 1900.

FARADAY AND SCHÖNBEIN.

The Letters of Faraday and Schönbein, 1836–1862; *with Notes, Comments and References to Contemporary Letters.* Edited by Georg W. A. Kahlbaum and Francis V. Darbishire. Pp. xvi + 376. With two frontispiece portraits. (Bâle: Benno Schwabe. London: Williams and Norgate, 1899.)

THE correspondence which has passed between the great pioneers of modern science must always be of interest to the present generation of workers. The interest is enhanced for us in the present case through the circumstance that one of the correspondents was our eminent countryman, Michael Faraday. The custom which has grown up of late years of allowing our illustrious dead to speak for themselves through their own letters is in every way a good one—particularly when the correspondence enables us to trace the history and follow the development of discoveries which have now become incorporated in the general stock of scientific knowledge. There is a living reality about a man's description of his own work, which inspires the reader to a degree quite incapable of being produced by any bald text-book statement or formal lecture-room utterance. Such correspondence is even as valuable in some cases as the original memoirs in which the final results are set forth, because we are enabled to follow the actual working out of the various lines of thought, and to stand at the elbow of the investigator as he gropes his way towards the truths which he finally gives to the world.

The present volume contains 155 letters, of which eighty-one are by Schönbein; the whole correspondence covers a period of over a quarter of a century. Some of Faraday's letters have been published in Bence Jones's life of that philosopher, but the majority have never been made public before. Much of Schönbein's correspondence also has been published, because Faraday was in the habit of communicating to the *Philosophical Magazine* results of scientific importance announced by Schönbein in his letters. But the value of the present work is in no way impaired by this circumstance, because we have now the whole correspondence brought together chronologically, the letters being left intact as originally written, and made more valuable by a most complete series of explanatory notes giving references to the papers alluded to, as well as short biographical notices of people mentioned in the correspondence. The care and trouble which has been bestowed upon this most essential adjunct to a set of letters containing references to memoirs which for us represent the scientific literature of a former generation, has thus resulted in a distinct contribution to the history of science, and the editors have laid all workers in the domains of physics and chemistry under a debt of obligation.

The human side of Faraday's nature has been so thoroughly dealt with by his biographers, Bence Jones, Tyndall and Gladstone, and, more recently, by S. P. Thompson, that very little new light is thrown upon his character by these letters. It is painful to be reminded so frequently of his failure of memory, and of his bad health leading to periodical removals from London and temporary cessation from all work. As in the case of another of our illustrious countrymen, Charles Darwin, one can only marvel at the magnitude of the labours achieved under such disadvantageous conditions.

On comparing the letters of the two correspondents, it will be found that from the social point of view both Faraday and Schönbein are equally communicative; but while the Swabian chemist gives his scientific thoughts and results in such fulness that they are in many cases capable of being published as written, Faraday, on the other hand, does not give much detailed information about his work, but only alludes incidentally to his discoveries when these appear to him to be of sufficient interest to mention to his correspondent.

We are thus enabled to follow Schönbein's work in a very systematic manner, and the development of the leading discoveries with which his name will always be associated can be traced from year to year as he unfolds them to the English philosopher. Speaking generally, it may be said that the three main lines of work which engaged his attention were the "passive" state of iron, ozone and hydrogen peroxide, and gun-cotton. Incidentally, many interesting side issues are raised, and passages can be gleaned here and there from his letters which show the wide grasp of, and philosophical insight into, the principles raised by his experimental skill. The first communication refers to "passive" iron (1836), and this subject is brought forward again and again for over six years. The explanation of the phenomenon was obscure to its discoverer, and led to his bringing the subject under the notice of Faraday and other contemporary men of science. Even if Schönbein did not find the true explanation, there can be no doubt that his work in this field had a great influence in directing his thoughts towards the action of the voltaic current and electrolysis in general, as he frequently refers to his speculations on these subjects. With regard to the explanation it may be said, as Kahlbaum points out in the introduction:—

"Even at the present day we have not succeeded in gaining clear insight into the cause from which this phenomenon proceeds."

The first reference to ozone is contained in a long letter dated April 4, 1840, in which Schönbein tells Faraday:—

"The phosphorus smell which is developed when electricity (to speak the profane language) is passing from the points of a conductor into air, or when lightning happens to fall upon some terrestrial object, or when water is electrolysed, has been engaging my attention the last couple of years, and induced me to make many attempts at clearing up that mysterious phenomenon. Though baffled for a long time, at last, I think, I have succeeded so far as to have got the clue which will lead to the discovery of the true cause of the smell in question."

This letter was communicated to the Royal Society on May 7, and an abstract published in the *Philosophical Magazine.* From that time ozone is frequently referred to, and the vicissitudes through which the new "odoriferous principle" passed can be followed with interest throughout the correspondence. At one period Schönbein thought that it was a derivative of nitrogen, viz. that the latter was "a compound consisting of ozone and hydrogen" (letter of April 19, 1844). In 1853 he tells Faraday that the nature of ozone appeared to have been settled in Bunsen's laboratory: "that there is one sort of ozone containing nothing but oxygen, and another that contains some hydrogen" (p. 213). By 1854 he had fully recognised that oxygen could exist in two different states, and this leads him to some further speculations on electrolysis, thermolysis and photolysis, which are well worthy of consideration even at the present time.

Students of the history of chemistry are, of course, familiar with all the points raised in the course of Schönbein's labours on ozone; but the personal recital of the discoverer's views, hopes, experimental results, and his refutation of the criticisms of other chemists will be found most instructive reading. He unbosoms himself freely to Faraday, in whom he found that sympathetic spirit which is so powerful an aid to scientific progress when exercised between co-workers whose greatness of mind and disposition exalts them above the level of all professional rivalry or petty jealousy.

The discovery of gun-cotton is heralded in 1846, when nitrated cellulose is introduced to Faraday with the statement :—

"To give you an idea of what may be made out of vegetable fibre, I send you a specimen of a transparent substance which I have prepared out of common paper. This matter is capable of being shaped out into all sorts of things and forms, and I have made from it a number of beautiful vessels." . . .

"There is another point about which I take the liberty to ask your kind advice. I am enabled to prepare in any quantity a matter which, next gunpowder, must be regarded as the most combustible substance known. So inflammable is that matter, that on being brought in contact with the slightest spark it will instantly be set on fire, leaving hardly any trace of ashes; and if the combustion be caused within closed vessels, a violent explosion takes place. . . .

"A substance of that description seems to be applicable to many purposes of daily life, and I should think that it might advantageously be used as a powerful means of defence and attack. Indeed, the congrevian rockets can hardly be more combustible than my prepared cotton is. What shall I do with that matter? Shall I offer it to your Government? I have enclosed a little bit of that really frightful body, and you may easily convince yourself of the correctness of my statements regarding its properties."

Human nature in 1846 appears to have been pretty much the same as it is now when a "utilitarian" scientific discovery is made; and in another letter of the same year he confides to Faraday, that while his knowledge of the world has been vastly increased by his experience, his "esteem for mankind has not grown in the same ratio." He adds :—

"I could tell you a great many things of an incredible description, but I will not trouble you with detailing facts which I should like never to have become acquainted with myself. So much, however, I must say, that by the occurrences alluded to, my temper, which is usually not much liable to be ruffled, and the placidity of my mind have been suffering these many months" (p. 165).

But apart from these capital discoveries with which Schönbein's name will be always linked, and which are now part and parcel of our modern science, some of the bye-products of that active mind are perfect marvels of scientific intuitiveness. A few of these collateral suggestions have been noted in reading through the correspondence, and readers of NATURE will be interested in having their attention called to some of the more striking passages. Compare, for instance, the present views on the nature of electricity with the statement written to Faraday in 1839 :—

"It appears to me that what we call static electricity is only a state of tendency of something to move in certain direction, and that current-electricity is the actual motion of that something. That motion must not be considered as one of weighty particles, but as a motion of something that is not affected by gravity; as a peculiar motion of the ether, if you like. According to these hypothetical views, we can easily conceive how a vibratory motion might be propagated through a space, or medium, empty of weighty particles, but filled up with some imponderable matter which is capable of being brought into a moving state. The only thing difficult to conceive is the relation of that imponderable agency to the weighty particles in their natural and excited condition; that is to say, the way in which both are acting upon each other. It is possible that a state of tendency to motion may be brought about in ether only by a peculiar action of ponderable particles upon that fluid, and that consequently such a state cannot exist in it without the presence or agency of matter, whilst moving ether of itself has the power to impart motion to ether being at rest" (p. 71).

The question of the colour of oxy-compounds appears to have directed Schönbein's attention towards the subject of colour in general. In 1852 he penned this most significant statement :—

"I cannot help thinking that the colours of substances, which up to this present moment have been very slightly treated (in a chemical point of view), will one day become highly important to chemical science, and be rendered the means to discover the most delicate and interesting changes taking place in the chemical condition of bodies. In more than one respect the colour of bodies may be considered the most obvious *signatura rerum*, as the revealer of the most wonderful actions going on in the innermost recesses of substances, as the indicator of the most elementary functions of what we call ponderable matter."

The letter from which the above passage is quoted contains remarks which—to put the case with the least disparagement to the memory of their writer—show that the then newly developing science of organic chemistry found very little to commend it to Schönbein's mind. Faraday echoes his sentiments in his reply to this letter, in which he says :—

"You are very amusing with your criticisms on organic chemistry. I hope that in due time the chemists will justify their proceedings by some large generalisations deduced from the infinity of results which they have collected. For me, I am left hopelessly behind; and I will acknowledge to you that, through my bad memory, organic chemistry is to me a sealed book."

Again and again does Schönbein declare his attitude towards this branch of science, not only in his letters to Faraday, but also to other contemporary men of science. In a letter to Faraday, written in 1854, he speaks of "cook-like chymists, who are brewing on and on their liquors and puddings without paying much attention to the conditions of the primary matters they are continually mixing together." Even the editor of the present volume finds it desirable to append a sort of apologetic note (p. 225) concerning this "harsh verdict," and pointing out that, although concerned with the chemistry of only one element, this branch of the science has had "great practical value and importance." It is not to be wondered at that Schönbein should have felt some trepidation in meeting his great compeer Liebig, the father of modern organic chemistry, which event is graphically described in a letter written to Faraday in 1853 (p. 216) :—

"Of course, I met Liebig at Munich, whom I knew before little more than by sight, but within the first five minutes we had found out the footing upon which both of us could move comfortably enough. You will laugh when I tell you Liebig asked me to deliver a lecture before a very large audience in his stead, and Mr. Schönbein, though reluctantly, yielded to that strange demand. The subject treated was that queer thing called 'Ozone,' which ten or twelve years ago, as you are perhaps aware, was declared by a countryman of yours and pupil of Liebig's to be a 'nonens.'"

Could the shade of Schönbein revisit the laboratory of a modern worker in organic chemistry, he would find that the latest "Handbook" consisted of four large volumes, containing altogether some 6000 pages of closely printed matter, all compiled by one man (Beilstein). But nature, which endowed the "mighty atom" of carbon with such marvellous potentialities, had her revenge upon the illustrious Swabian during his lifetime, for she placed in his way a discovery which, curiously enough, is just now exciting the greatest interest, viz. the oxygen-carrying power of certain enzymes known at the present time as "oxydases." His first allusion to this is in 1855, when he wrote to Faraday :—

"You know that I entertain a sort of innate dislike to touch anything being in the slightest way connected with organic chemistry, knowing too well the difficulty of the subject, and the weakness of my powers to grapple with it; but, in spite of this well-grounded disinclination, I have of late, and as it were by mere chance, been carried in the midst of that field, upon the intricacies and depths of which I have been used all my life to look with feelings of unbounded respect and even awe. The picking up of a mushroom has led to that strange aberration of mine, and you will ask how such a trifling occurrence could do that. The matter stands thus: What the botanists tell me to be called *Boletus luridus*, with some other sorts of mushroom, has the remarkable property of turning rapidly blue, when their hat and stem happen to be broken and exposed to the action of atm[ospheric] air. On one of my ramblings I found a specimen of the said *Boletus*, perceived the change of colour alluded to, and being struck with the curious phenomenon, took the bold resolution to ascertain, if possible, its proximate cause."

He then describes his experiments in some detail, and comes to the conclusion that this and other Fungi contain an "organic matter" which is "a true carrier of active oxygen." This letter was communicated to the *Philosophical Magazine*, and published in vol. ii. 1855.

As another example of Schönbein's power of grasping and dealing with scientific problems, we may refer to his treatment of "polarisation," which term he used in at least two senses, viz. the electrical sense in which it is now used as indicating the reversal of current by charged electrodes (1838), and later (1859) to indicate "two active kinds of oxygen standing to each other in the relation of + to −." This association of ideas in the philosopher's mind is a good instance of pre-vision, and his remarkable comparison of the opposite states of the two kinds of oxygen to Pasteur's racemic combination of the two tartaric acids (p. 288) is a bold analogy which may even yet find justification. This explanation of voltaic polarisation, given as far back as 1839, is substantially the same as that adopted at the present day. So also his views on the course of chemical change, expressed in a letter to Faraday in 1856, are so much in harmony with modern notions that they are worth emphasising by quotation :—

"Another fact, not quite void of scientific interest, is this, that in some instances I can show, as it were, steps which the oxidation of certain matter passes; . . . it is not impossible that any oxidation is a sort of chemical drama, consisting of different acts, the last of which is real oxidation. . . . Schönbein maintaining that between the moment on which two isolated elementary bodies meet, and that of their chemical associating being finished, there lies a whole world of phenomena, and is very much of which the chemists of the present day have as yet not the slightest notion. There is even within inorganic chemistry something which I might call physiology, and the most interesting and truly scientific object of chemical research lies, to [in?] my opinion, within the short interval of time alluded to, and hence the great difficulty of such an investigation" (p. 271).

The next paragraph in this letter mentions, by the way, a synthesis of formic acid by the oxidation of olefiant gas by ozonised oxygen.

Among the other numerous subjects discussed in the course of the correspondence, "contact action" may be mentioned. In sending a pamphlet to Faraday, published in 1844 by Schönbein, the latter says :—

"There is also a paper in the book treating of chemical effects produced by contact, on which I should like very much to have your opinion. Having these many years entertained strong doubts about the correctness of the atomic theory, and been inclined to consider what is called a 'molecule' of a body *as a centre of physical forces* (italics ours), I have tried to make that view bear upon the chemical actions being produced by contact."

So that we have here the Boscovich notion very clearly set forth. The same letter also contains a paragraph which will go to the heart of many and many a worker in science who reads this notice :—

"Having had no less than nineteen hours to lecture a week in the course of this winter, you may easily imagine that I had no time for making researches: I grow, indeed, impatient of that everlasting schoolmastering, and am longing for being placed under circumstances more favourable to scientific pursuits."

In selecting specimens of the correspondence from the volume before us, we have necessarily given Schönbein the greater prominence. Faraday, as already explained, was not so communicative of his scientific results. The latter, moreover, may be assumed to be more familiar in this country than the original papers and memoirs of the Swabian chemist. But scanty as are the English philosopher's references to his work, the chronological sequence of his main discoveries can be traced, and these appear to have been eagerly followed by his correspondent. Of particular interest at the present time is Faraday's statement, in 1845, that he had failed to liquefy oxygen at – 140° F. under a pressure of 60 atmospheres; and in 1852 he asks Schönbein :—"Have you condensed oxygen?—I wish you could tell me what liquid or solid oxygen is like. I have often tried to coerce it, and long to know."

In November 1845 he mentions one of his fundamental discoveries to Schönbein in these words :—

"I happen to have discovered a direct relation between magnetism and light, and also electricity and light, and the field it opens is so large and I think rich, that I naturally wish to look at it first" (p. 148).

Another little list of scientific gossip concerning Crosse's supposed production of insects by an electric current (p. 33) will be found of interest, as also the reference to table-turning (p. 214), concerning which he says :—

"I have not been at work except in turning the tables upon table turners—nor should I have done that, but that so many inquiries poured in upon me that I thought it better to stop the inpouring flood by letting all know at once what my views and thoughts were. What a weak, credulous, incredulous, unbelieving, superstitious, bold, frightened, what a ridiculous world ours is, as far as concerns the mind of man. How full of inconsistencies, contradictions and absurdities it is" (p. 215).

The above and other passages in this letter come as near to misanthropy as anything to be found in Faraday's correspondence. It is obvious from the context that the letter (July 1853) was written during one of his periods of prostration, for he says: "Consider my age and weariness, and the rapid manner in which I am becoming more and more inert."

The extraordinary pertinacity displayed by Schönbein in following up his ideas concerning the "polarisation" of oxygen, and in searching for the hypothetical "antozone," is well brought out in the course of the correspondence. In 1860 he thought he had obtained "antozone" from fluor-spar, and he described his experiments to Faraday, who in his reply raises a question concerning nitrogen in a very remarkable passage :—

"But surely these wonderful conditions of existence cannot be confined to oxygen alone. I am waiting to hear that you have discovered like parallel states with iodine or bromine, or hydrogen and nitrogen. What of nitrogen? Is not its apparent quiet simplicity of action a sham?—not a show, indeed, but still not the only state in which it can exist. If the compounds which a body can form show something of the state and powers it may have when isolated (as in your $\ominus\bigcirc\oplus$), then what should nitrogen be in its separate state?"

The extracts which have been given are sufficient to show that the editors of this volume have made a most valuable contribution to the literature of science. It is out of such materials as Dr. Kahlbaum and his colleague have now provided that the history of the science of the nineteenth century must be built up; and we are glad to have received from this same author other volumes giving the correspondence of Liebig and Schönbein, and a monograph on Schönbein's work, which we hope to notice in due course. Certainly this period of six-and-twenty years during which the intimacy between Faraday and Schönbein began and ripened into the warm friendship which was terminated only by the death of one of the correspondents was one of extraordinary activity and productiveness. The names of the contemporary workers referred to comprise, not only those already mentioned, but also Arago, Berzelius, Becquerel, St. Clair Deville, Frémy, Houzeau, Marignac, De la Rive, Hofmann, Magnus, Nobili, Pasteur, Pélouze, Pettenkofer, Plücker, Poggendorff, Rose, Wiedemann and Wöhler on the Continent; Draper in America; and in this country Airy, Andrews, Brodie, Daniell, Grove, Herschel, Noad, Stokes and Whewell. It is interesting to read that in 1856 Faraday sent a volume of his researches to Schönbein through "Mr. Roscoe, a student under Professor Bunsen at Heidelberg"; while in 1843 he refers to "a magnificent steam electric apparatus" made by Mr. (now Lord) Armstrong.

With respect to the manner in which the editors have performed their task, there are some points to which attention may be called. Dr. Kahlbaum lays down the principle in the preface that in publishing historical documents these

"should be set forth in exact agreement with the original, and in the next place provided with as many suitable comments as possible to explain their meaning."

Regarding the latter statement, we have already pointed out how admirably the editors have done their work. In accordance with the first statement, the letters have been printed, on the whole, exactly as written, and thus any "editing" which was done for the *Philosophical Magazine*, or for the Royal Society, can now be compared by the curious with the original documents. In no case, as far as we have ascertained, has Schönbein's meaning been altered by the editorial process. It must be remembered that Schönbein thought in German and wrote in English, and the letters generally show that his English was excellent. Only in matters of spelling and the use of capitals is there any laxity to be found, and it is perhaps to be regretted that the editors did not leave every word of Schönbein's intact or else have adopted a uniform system of correction throughout. Thus, where they alter the spelling it is generally by interpolating some trivial correction, such as "favorite" to "favo[u]rite," "Alps" to "Alp[e]s," "color" to "colo[u]r," and so forth, while "oxigen," "sulfate," "british," "french," "german," "You," &c., are allowed to pass. The whole result leaves an impression of straining at gnats and swallowing camels; particularly when such spelling as "oxigen" and "german" appears also occasionally in Faraday's letters, possibly through misprints. The volume, we may add, has been printed at Bâle. Faraday's writing also was in some cases so illegible that the editors have been obliged to leave gaps or to suggest interpolations. The portrait of Faraday is the well-known one prefacing Bence Jones's "Life," and that of Schönbein is drawn from a statuette of 1855 and contemporary photographs. The original letters are now, though the generosity of Faraday's niece, Miss Barnard, and Schönbein's daughters, deposited in the University Library at Bâle.

R. MELDOLA.

THE ANIMALS OF BRITAIN AND THEIR ORIGIN.

The History of the European Fauna. By R. F. Scharff, B.Sc., Ph.D., F.Z.S. Pp. vii + 364; illustrated. (London: Walter Scott, Ltd., 1899.)

THE title that we have chosen for this review of Dr. Scharff's volume is really rather more expressive of the scope of the book than is his own title. For he deals at greater length with the fauna of our own country than with that of Europe in general. This is by no means a defect to be urged in considering his statements and arguments; on the contrary, we think that it will add to the interest of the book; and besides Great Britain has a fauna which practically only differs from that of adjacent parts of Europe in its poverty. The reduction of the number of individuals and of species of indigenous creatures was set down by Mr. Wallace to the recent glaciation of these islands, which, occurring, as it was supposed to do, after the land connection with Europe had been broken through, destroyed many forms coming originally from more southern regions. The severance of the land connections hindered a repopulation when more favourable climatic conditions were re-established. Dr. Scharff is one of those who do not believe in great possibilities of migration over stretches of sea for purely terrestrial animals. There are of course such cases on record; but they are really not numerous. Dr. Scharff mentions several that are of recent occurrence. He tells us that Colonel Fielden, when in the Barbadoes, witnessed, or heard of, the arrival of an alligator which must have traversed a tract of ocean of 250 miles. There are also well-known experiments which show that animals *might* be imported in a natural way from distant and transpontine countries. The resistance of certain snails and other molluscs to the effects of sea-water when guarded by their diaphragm has been proved by the classical experiments of Darwin. It is, however, disappointing to learn from Dr. Scharff how dangerous it is to argue from experiments which can so readily be made to the actual phenomena of nature.

Concerning one of these protected and—as it was thought—adventurous molluscs, the author writes as follows:—

"The fact that *Cyclostoma elegans* does not live in Ireland is of particular interest in connection with the floating-theory just quoted, as on all sides of Ireland dead specimens have been picked up on the shore, showing that marine currents carry specimens, and have thus transported them for countless centuries. Nevertheless, the species has not established itself in Ireland."

Equally strong arguments can be derived from the study of other islands, from which a species, that ought to be there, as it were, is unaccountably absent. It has always appeared to the present writer that in deducing results from the faunas of oceanic islands which must have been stocked *de novo* from adjacent mainlands too little weight has been given to involuntary introduction by man. There is no doubt whatever that emigrating man has been a most fell agent in the destruction of faunas by the deliberate introduction of domestic and other animals; it is also probable that much has been done in the way of accidental introduction. There is, however, another possibility—urged by Dr. Scharff himself elsewhere in his volume—that may account for a given species not succeeding in establishing itself in a country which appears to be ideal for its needs. There may be no room for it; the ground may be taken up by an allied form or a creature of similar needs and habits. Here again the problem is indefinitely complicated by human occupation and tillage—in the case of the countries which form the subject of Dr. Scharff's remarks. Another matter of wide zoo-geographical interest, as well as vital to the development of his argument, is dealt with by Dr. Scharff. The peopling of these islands has, he thinks, mainly at least occurred along land routes; but how is it to be decided whence a given animal started in its wanderings towards the British Islands?

The author gives an example where a fair guess may be made as to the original home of the genus.

"The badger," he observes, "inhabits Europe and Northern Asia. It is absent apparently from many parts of Central Asia, but it appears again further south in Palestine, Syria, Persia, Turkestan, and Thibet. West Central Asia would be about the centre of its range. That this corresponds to its place of origin is indicated by the fact that the only three other species of badgers known, viz., *M. anakuma*, *M. leucurus*, and *M. albogularis*, are confined to Asia. If we examine the fossil history of the genus, we find that the two most ancient instances of the existence of badgers have been discovered in Persia, where *M. Polaki* and *M. maraghanus* occur in Miocene deposits."

Failing future discoveries of fossil badgers, this method of argument seems to be valid. But it is not so clear to us that Dr. Scharff is justified in stating that the centre of distribution, *i.e.* the original home of the genus, is to be sought for where the number of species of the genus is at a maximum. There are more species of the Tapir (*Tapirus*) in America than in Asia, where there is only one. But it is doubtful as to whether the genus is of American origin; it is much more probably European. So, too, with the cat tribe; the species of *Felis* abound in Asia and the East generally, and are fairly numerous in America, but Europe again would seem to be the place of dispersal.

From these general considerations, which are put forward with clearness and supported by a proper treatment, so far as we can judge, of the geological evidence, the author proceeds to discuss in detail the actual homes of our British animals, laying most stress upon, or at least dealing more at length with, the mammalia. Naturally this is the most important group in attacking the problem, since our acquaintance with fossil invertebrates, and even of other vertebrates, is less extensive. The fauna of this country, as everybody knows, is a mixture of various and apparently incongruous elements.

The facts brought forward by Dr. Scharff show incidentally how very little influence temperature seems to have, and to have had, in the limiting or encouraging the migrations of mammalia. The tiger barred and the leopard are at home in tropical forests and in the colder regions of Asia. The polar bear, *par excellence* an Arctic animal, endures with comfort the temperature of London in the summer—and, indeed, more than endures it—as is shown by the fact that an individual lived for thirty-seven years in the Zoological Society's gardens. Dr.

Scharff distinguishes three main lines of migration to these islands—the Siberian, the Arctic (which he carefully separates), and finally the Oriental. Besides these three trunk routes, so to speak, a considerable quota of our fauna has arrived here from such centres of dispersal as the Lusitanian area. It is often put forward that the fauna of Europe show more likenesses to that of Africa than to that of Asia—"Oriental" Asia, that is to say. Dr. Scharff does not omit to notice this view, but will not allow an African origin for any part of our fauna. On the contrary, he is disposed to think that the spreading of animals has been in a exactly opposite direction, and that Africa has been partly peopled from Europe.

We can distinctly commend this book, which is agreeable reading as well as a repertory of important facts. Its value is considerably increased by a short summary at the end of each chapter of the line of argument pursued and the results arrived at. Numerous engravings and maps, all of them in the text, add to its usefulness; while a selected bibliography will enable the non-expert reader to pursue his inquiries further into any particular matter not treated at length in Dr. Scharff's book.

F. E. B.

OUR BOOK SHELF.

Le Cidre. Par X. Rocques. Pp. 171. (Paris: Gauthier-Villars, 1899.)

IN a country where the technical difficulties of the wine-grower and the brewer have been considered worthy of the attention of such a man as Pasteur, it is not surprising that the cider-maker should receive help from science. That this is so, is rendered very evident by M. Rocques in the small volume before us, where we find in a condensed, but very readable form, an account of the valuable aid French men of science are giving to the cider industry. In England we are, of course, behindhand in such a matter, but there is, perhaps, some excuse in this case, as cider has not the economic importance here that it possesses in France. In that country, where the mean annual consumption of cider is twelve million hectolitres, representing one-fifth of the alcoholic beverages consumed, economic considerations affecting its production are naturally very great, and the importance of scientific help proportionately large.

But, according to the author, one point in connection with the cider industry tends to hinder somewhat the adoption of scientific methods by the manufacturers, and this is the remarkable fluctuations in the apple crop compared with the fluctuations in the other leading agricultural crops of France. The proportion of the minimum wheat crop to the maximum is 1 to $1\frac{1}{2}$, and of wine, 1 to 2; but in the case of cider there is the very great difference of 1 to $8\frac{1}{2}$. It appears, in fact, on taking the average of the last twenty-five years as a guide, that a good apple crop can only be expected one year in two. Such uncertainty in the crop, no doubt, tends to hinder rapid progress in the art of cider-making; but, on the other hand, progress is assisted by the growing custom of establishing well equipped breweries, which are supplied with apples from the smaller growers who previously made their own cider on a small scale with poor appliances, and in the old rule of thumb style.

About 40 per cent. of the total production of cider in France is now made in these breweries, much to the comfort and advantage of the consumer, who is not provided by nature with a stomach equal to the action of the acid liquid so often produced by the small farmer.

In the cider breweries working on a sufficiently large scale to permit the adoption of suitable plant and skilled supervision, scientific methods appear to be adopted freely. The diffusion method, employed so largely in the beet-sugar industry, is utilised for the extraction of apple-juice for the production of certain classes of cider, but the old method of extraction by pressure is still found desirable for full-flavoured, sweet ciders, the diffusion process producing a beverage of a drier character.

Hansen's well-known researches on the pure culture and selection of yeasts, which influence so largely the zymo-technical processes of to-day, are also made use of by the advanced cider-maker for the purpose of improving his produce. A composite yeast of the well-known organism, *Saccharomyces apiculatus*, together with another selected yeast derived from the apple, *S. Mali*, is found to give good results. As apple-juice, unlike a beer wort, cannot be sterilised by heat in order to provide a clear field for the development of a selected yeast culture, the plan adopted is to nurse the selected yeast growth to such a vigorous state that when used it is capable of crowding out the undesirable saccharomyces naturally present in the apple-juice.

For the purpose of improving and increasing the flavour of cider, an interesting use is also made of Jacquemin's researches, by which he showed that various parts of certain plants, including the apple, contain glucosides capable of being split up by fermentative action into sugar, and principles possessing the characteristic bouquet of the fruit used.

We recommend M. Rocques' little volume to all interested in technical cider-making, and also to those interested generally in zymo-technical literature.

A. J. B.

Liverpool School of Tropical Diseases. Memoir I. "Instructions for the Prevention of Malarial Fever." (Liverpool: University Press, 1900.)

THIS booklet is the first of a series of memoirs to be issued by the Liverpool School of Tropical Medicine, and is the outcome of the malaria expedition sent out by that body to Sierra Leone. It deals with measures of prevention suggested by observations made on the spot in a malarious country and with the light of modern theory as to the cause of the disease. There are two drawings of the innocent and noxious mosquito which cannot help but impress the imagination of the reader. The idea of alertness and viciousness suggested by the attitude of the latter should make the most careless observer interested in noting which genus of mosquito it is that infects his neighbourhood.

The memoir, which is clearly and concisely written, contains most valuable information for any one living in the tropics. It is artistically got up, and reflects credit on the school and on the University Press of Liverpool, of which it is one of the first productions.

Our Insect Friends and Foes: how to Collect, Preserve and Study them. By Belle S. Cragin, A.M. Pp. vi + 377. With 255 illustrations. (New York and London: G. P. Putnam's Sons, Knickerbocker Press, 1899.)

THE title of the work is likely to give the impression that it is devoted to economic entomology, whereas it is professedly a text-book on general entomology and "relations of insects," spiders, scorpions, &c., dealing with the common species of all orders found in "the States east of the Rocky Mountains and north of the Gulf States," including useful instructions on collecting, rearing and preserving insects, their anatomy, &c. The book is written almost expressly for young people, who will find it interesting and instructive in many ways. Unfortunately, many of the illustrations are very poor indeed, and this particularly applies to the *Hymenoptera*.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

The Effects of Lightning upon Electric Lamps.

THE accompanying effects were obtained when attempting photographs of lightning, and were rather the result of accident than design; an impending thunderstorm, with a somewhat limited horizon, prevented the camera from being pointed in the direction whence the most numerous of the lightning flashes occurred, without including in the field one or more of the electric arc lamps (Brush) which are the illuminating power of our town. Upon developing the few exposures made, it was noticed that whether or not the picture *took in* the flash, and in many cases this did not appear at all, there was exhibited upon the films the light of the permanent lamps, and that from them a flow of electricity proceeded towards the ground in an irregular line. Ground or summer lightning, as it is frequently called, produced the same effect upon the lamps, but when neither was present an exposed film only showed a sequence of white dots or perpendicular short strokes in the places occupied by the lamps, as seen by the naked eye at night. The result was sufficiently curious to invite further experiments in the same direction, but this could not be done upon the same lines as before, for the electric system varies with the months upon the sea front at Dover. In autumn, winter and spring the usual lighting is considered sufficient for all purposes, but during the visitors' season an additional illumination is provided by festoons of smaller glow lights from standard to standard, with occasional cross festoons over the roadway, the whole producing a charming effect at night; but, as will be seen in No. 6, the detail as to these becomes confused to any one not acquainted with the relative position of the lamps.

The first impression these photographs gave me was that the electric discharge in the heavens produced an instantaneous one also from the lamps, and that in this way the circuit was completed: but other causes beyond these must have been in action from the disjointed and irregular display from the lamps as opposed to that of the lightning.

Sir George Stokes, who has kindly interested himself in the matter, appends his views, and I need only add that I hope when a thunderstorm visits a town illuminated by electricity, photographers will, both in daylight and after dark, expose a few plates for the elucidation of the thoughts suggested to us. I say in daylight, for the camera will often record impressions that our eyes cannot see by reason of other external surroundings, as instanced by my noticing upon one occasion with the unaided eye a stream of electricity descending from an arc lamp towards the earth which I should assuredly have never seen had I not learnt from these photographs that such a phenomenon did exist. SYDNEY WEBB.

Dover, October 1899.

I WISH to add a few remarks to Mr. Webb's description of the way in which his remarkable photographs were obtained, my object being to point out certain features which seem likely to lead towards an explanation of the discharges which take place, simultaneously with lightning flashes in the sky, in the neighbourhood of the electric lamps.

Fig. 1 represents a photograph which was taken looking westwards before the installation from the ornamental glow lamps was set up for the season. The three roundish luminosities represent the normal illumination due to four arc lamps. If these, taken in order along the street, be called Nos. 1, 2, 3, 4, their order in the picture, from left to right, will be 1, 2, 4, 3, but Nos. 3, 4 are so nearly in the same line of sight that the images of their normal luminosities are blended into one. The lamps are twenty-one feet above the ground, and the distance from lamp to lamp is about ninety-two yards. Towards the upper left is seen a flash of lightning in the sky. Simultaneously with the flash, electric discharges took place between the lamps and the ground, which are recorded on the photograph.

It is to be noted that though the lamp-posts were of iron the discharge did not take that course to the earth, but went in a curved path which must have been thirty feet or so in length. Its course led towards the high-tension cable, which ran underground along the esplanade; but whether the cable had anything to do with it, there is not sufficient evidence to show. The different paths are remarkably similar, almost identical in form. A striking feature of the discharge is its beaded or stratified character. The intensity of the discharge and the closeness of the stratification are both greatest near the lamp, and decrease as we approach the ground.

Another photograph (2*a*), not here reproduced, was taken under the same circumstances, but with a different flash. The general features are the same, but the form of the curves is

FIG. 1.

different. Instead of a curve convex outward, as in Fig. 1, we have curves first convex, then concave, then convex again, and as in the former case similar to one another. The negatives of these show a feature which does not appear in the reproduction (Fig. 1), nor even in positives taken with sufficient exposure to show the fainter portions of the discharge. In the negative of 2*a*, the images of lamps 2, 3, 4 show each a pair of short straight dark lines, indicating special luminosity, like two "l's" parallel to one another and nearly vertical, the base of the right being nearly on a level with the top of the left. No. 1, which is much nearer, has too much darkened the negative to show more than a trace of one of the l's. The discharge in 2*a*, which shows the stratification, is seen issuing from the top of the right-hand upper l in a nearly horizontal direction. The negative of Fig. 1 shows a similar strong luminosity, only here the l's, if they are distinct, are nearly horizontal, and run one into the other. In this feature, again, we observe as before similarity from lamp to lamp, difference from flash to flash.

Four photographs were taken looking east along the shore. Three of these are here reproduced (Figs. 2, 3, 4). In one only of these is the flash, which gave rise to the discharges, seen in the field (Fig. 2).[1]

The three figures all show one arc lamp which is tolerably

[1] It should be mentioned that in this case, and in this case only, the flash was strengthened by hand on the back of the negative to make it print better, so that the picture of the flash cannot be altogether trusted as to minute details.

near, with the discharges connected with it, and the discharges belonging to several very distant arc lamps, of which five are seen to the right and a few to the left of the former. Fig. 3, which points a little more to the north, takes in an arc lamp at an intermediate distance. These figures, as before, point out very strikingly the similarity of the discharge from lamp to lamp, and the difference from flash to flash.

Thus, in Fig. 2, we have a nearly vertical discharge from the near lamp, and also from the distant lamps, whereas in Fig. 3 we have the corresponding discharges nearly horizontal, somewhat resembling parabolas in a horizontal plane. In these cases, unlike that of Fig. 1, there is a discharge of curious form which is more conspicuous than the discharge between the lamp and the ground.

FIG. 2.

The finer beading naturally cannot be shown in the reproduction, though it appears in very many cases in the positive copies, and still better in the original negatives. After an examination of the actual photographs, one is disposed to regard the beading as a normal feature of this kind of discharge, though for different reasons it cannot always be traced.

Fig. 5 was taken towards the sea, facing the installation for ornamental incandescent lamps just opposite to Mr. Webb's house. The flash which occasioned the local discharges is seen in the field. Some luminosity is seen at the top connected with the mounting of the ornamental lamps, and delicate discharges going obliquely downwards. But the chief luminosity would seem to have relation to the high-tension cable below, and it may be also to one or both of the horizontal wires above, across which the lamps are hung, and which are charged through transformers to a much lower tension.

FIG. 3.

The complicated Fig. 6 represents five flashes, all apparently in the field, and the local effects due to them. At the risk of a digression, I would point out the character of one of the flashes—that shown in the middle of the field—though what I am about to say can hardly be gathered from the reproduction, but appears in a positive photograph, or, better still, in the original negative. The actual photographs give strongly the idea of a spark-discharge, the path of which is the right-hand boundary in the picture, followed by a transverse flow, or arc-discharge, from right to left, all over the path of the spark; then a second spark-discharge, parallel to and less strong than the former, followed by a second transverse flow. Previous photographs taken with a moving camera had shown a duration of luminosity after the spark-discharge, which would naturally be interpreted to indicate either a sort of phosphorescence of the air, produced by the spark-discharge, or else an arc-discharge proceeding along the path opened up for it by the spark. But Mr. Webb's photograph, the original of Fig. 6, seems to indicate pretty plainly an arc-discharge proceeding, with a variable intensity, from the different points of the path of the spark, but flowing in a direction *transverse* to that path.

The local effects, which form by far the greater part of the luminosity represented in Fig. 6, are naturally very complicated, on account of the number of flashes; too much so to be convenient for individual discussion. We may notice, however, in a general way, the repetitions of the same form and the beading. A prominent object is the very formidable-looking discharge shown in the left half of the picture, traces of the beading of which may be seen even in the reproduction.

In several cases the photographs indicate pretty plainly a local discharge of the form of tape striped across. The tape in its course is liable to be bent or twisted, or both. In places where the plane of an element of the tape is in the line of sight, the striping is not usually seen, as the bright and dark stripes would overlap unless the axis of the tape happened to be roughly perpendicular to the line of sight.

In connection with the phenomena presented by the electric lamps in a thunderstorm, as revealed by the photographs, several theoretical questions present themselves. Do the lamps act merely in consequence of the tall iron lamp-posts, so that the effect would be the same if the dynamos at the works were not in action, or is the artificial electricity concerned in the production of the effects? What is the nature of the action of the flash of lightning in bringing about the discharges? What determines the course of the discharge, and why is it so different from flash to flash, while for a given flash it is nearly the same for lamps ranging over a space of some hundreds of yards? What is the nature of the beading or striation?

As the lamps are wanted for public lighting, the experiment could not well be made of disconnecting one from the works when a thunderstorm was impending in the evening, and seeing whether the one disconnected would give a discharge like the others. In default of experiment I can only say that from my theoretical notions I think that the electrical action of the lamps is required.

FIG. 4.

When the lamps are in use there is a very steep gradient of electric potential about them. I am informed that there is a difference of about 50 volts between the carbons of the Dover arc lamps, and this entails steep gradients in the air about them. If, then, there were something to cause a sudden change of potential-gradient irrespective of the lamp, this, when compounded with the normal gradient due to the working of the lamp, would give a gradient in some places greater and in some less than the normal. A path might thus be opened for a discharge different from the normal one from pole to pole, and this might pass away from the lamp altogether, and even go to the ground, provided there were a sufficient gradient to continue it when it had got to a distance from the lamp; and such a gradient might naturally exist in thundery weather. Or, again, if there were something to cause a sudden diminution in the resistance of the air, a similar effect might be produced.

The striking of a flash would no doubt be accompanied by a sudden change in the atmospheric electric potential. But I rather incline to the other view, and to regard the phenomenon as what I may call a case of Nature's wireless telegraphy. This view would make it depend on electromagnetic waves propagated from the flash. The flash would take the place of the sending instrument, the resisting air that of the coherer, the gradient of potential, whether artificial (that due to the electric works) or natural (that existing in thundery weather), would take the place of the electromotive force of the battery or cell which tends to send a current through the coherer, while the electromagnetic waves would open a path for the current in the air as in the coherer.

The close similarity of the discharges from lamps three hundred yards or more apart points to a distant cause, or at least one which is much the same at places 100 or 200 yards apart in a horizontal direction. This is not incompatible with the supposition that the path, when the discharge is fairly launched from the lamp, depends on the atmospheric variation of the atmospheric electric potential, which may very well be on an extensive scale; and such a similarity of path is what might have been expected beforehand if the paths depend on electomagnetic waves coming from the flash; and it may well depend on a combination of these two conditions. The difference from flash to flash would seem to be in this way most easily accounted for. For not only might different flashes, though close together in time, come from different parts of the sky, but even if they came from nearly the same quarter the mode of the transverse ethereal vibrations would be pretty sure to be different. Now the facility for the passage of a current afforded by an electromagnetic disturbance would naturally depend jointly on the direction of vibration and the direction in which the current tended to pass, that is, on two independent vector quantities, the pre-existing potential gradient and the ethereal vibration; and further, the vibration might very well resemble that in common rather than that in plane polarised light; so that there is abundant room for complexity, and for variation from flash to flash, as regards the path of the local discharge.

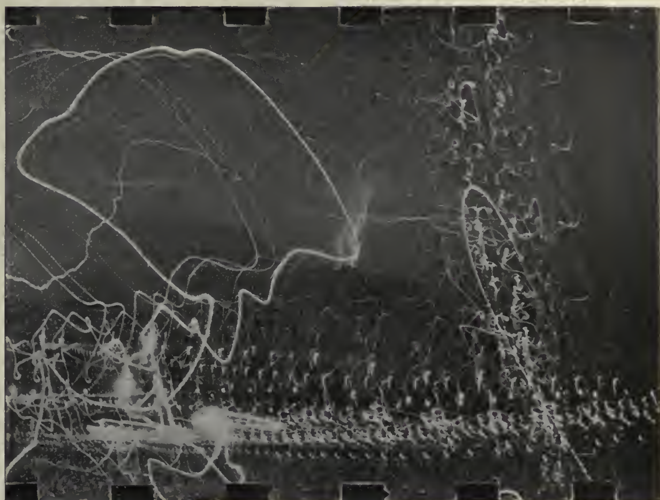


FIG. 6

The striation or beading of the discharges remains to be considered. The Dover lamps are worked on the alternate current system, and it might at first sight be supposed that perhaps the beading may have something to do with the alternation. But, as was pointed out to me at the Dover electric office, this could not be. For the period of the current is about the hundredth of a second, and if we counted the beads we should arrive at a duration of discharge much too great

FIG. 5.

to be allowed. Two ideas presented themselves to my mind as to the possible origin of the beading. One was that it might have something to do with the way in which the path crossed a series of electromagnetic waves, like those of light, except as to the scale of wave-length. Another, which seems more probable, is that they are of the nature of the stratified discharge in exhausted tubes. This supposition indeed is not free from difficulty, though I do not think the difficulty fatal. In an ordinary tube it requires a very good exhaustion to get strata as much as an inch thick. But here, at full atmospheric pressure, we have strata a foot or more in thickness. However, in a Geissler tube the strata are closer in the capillary part, where the current is concentrated, than in the broad part. It may be that in the discharges, for example, represented in Fig. 1, which are unconfined laterally, these wide strata are possible, and if so, the density of the current is small. It has already been remarked that the intensity decreases as we go from the lamp to the ground. It seems that the current is gradually spent in electrifying the air. If this explanation be correct, the local discharges represented in Mr. Webb's photographs may not be so dangerous as some of them look. Still, until we know more about the subject, it might be prudent in a thunderstorm to keep a little away from arc lamps in a street.

If the wireless telegraphy theory which I have ventured to throw out be the true account of the Webb discharges, it seems that by imitating with any necessary modification the receiving apparatus, and introducing a telephone, as has been done with great advantage by M. Turpain in his researches, it might be possible simultaneously to see and to hear a flash of lightning.

Cambridge, January. G. G. STOKES.

The Mathematical Tripos.

ON February 15 the recommendations of the Special Board for Mathematics on the Mathematical Tripos will be voted on by the Senate of the University of Cambridge. With regard to the changes proposed in the general arrangement of the examinations there can be scarcely any difference of opinion. About twenty years ago the advances in mathematical science had reached such a pitch that it was impossible to cover the whole range of mathematics in a single examination, and many a promising mathematician found himself seriously fettered by the necessity of having to confine himself to those parts of the subject which would best enable him to obtain a high place in the examination, and to spend his time in attaining proficiency in rapidly solving certain classes of problems rather than devote himself to specialising in the higher branches of mathematics. It was under these conditions that the Tripos was divided into two parts, the first covering the less advanced subjects, and the second enabling a candidate to specialise in those portions of higher mathematics for which his enthusiasm and ability best qualified him. The further developments of the last twenty years have necessitated an extensive reconstruction of the schemes, and the framers of the present regulations have been at great pains to bring the Mathematical Tripos into line with modern requirements. At the same time it is becoming daily more and more evident to those competent to judge that a sound training in mathematical methods is of paramount importance in the study of applied science, and the regulation allowing candidates to take Part i. in their fifth term should prove of great value to those who wish to study mathematics as a preparation for the subsequent study of physics or mechanical science or even, nowadays, chemistry.

The abolition of order of merit in Part i. is a logical outcome of the fact that this part does not represent the highest knowledge of mathematics. In late years the title of Senior Wrangler, which is often regarded in the outside world as the highest honour which Cambridge can confer, has often been bestowed on men who have proved unequal to the task of securing the highest place in Part ii. The announcement that a lady had been placed "above the Senior Wrangler" caused the greatest excitement throughout the country; but the fact that on another occasion the only candidate who secured a first division in Part ii. was a lady passed almost unnoticed. Still, it cannot but be regretted that because the Senior Wrangler has not always subsequently proved himself the best man of his year, the University should contemplate altogether abolishing the old title of Senior Wrangler, and that even "wranglers," "senior optimes" and "junior optimes," may soon be a thing of the past. When the Tripos was first divided into two parts, one of the mathematical authorities best qualified to judge considered it desirable that the title of Senior Wrangler should be given to the best candidate in Part ii. This was not done, and hence the position of Senior Wrangler has for many years been an anomalous one, and we have been irresistibly drifting in the direction of abolishing the title altogether. But why should not the first division in Part ii. be called "Senior Wranglers?" The number who obtain a first division in any year is very small, often not more than two, and these are surely no unworthy successors to the senior wranglers of the past. Moreover, by this means the competition for place would be avoided, each candidate being judged on his merits irrespective of whether he was in a strong year or a weak one, and the present anomaly of the second or third or even lower wranglers in a strong year being better than the senior in a weak one would be obviated.

Such a proposal is not inconsistent with the changes in the examinations proposed by the Board. The plea for the retention of the old titles is no question of sentiment. The mathematical school of Cambridge has, under the "coaching" system, taken a unique position in the educational system of the country, and it is but right that Cambridge honour-men should retain the marks of distinction which at present distinguish them from graduates of modern Universities. These marks of distinction are well known to the world at large, and may enable their possessors to carry greater weight in insisting on the importance of providing efficient mathematical teaching in our schools, and adequate endowments for the mathematical schools of our provincial University Colleges. Too often these schools and colleges are controlled by councils and governors consisting of business men, with whom the name "Senior Wrangler" carries weight, but who only look to the "main chance," and who see no use in encouraging mathematics because they do not understand it and think it "unpractical." In encouraging the purely experimental side of science there is a danger of neglecting that training which is needed to enable logical conclusions and practical applications to be deduced from experiments. It is, therefore, important that the old titles should be retained, not only to enable their bearers to point out that they have been trained in the same school which has produced so many of our best physicists, including a Maxwell and a Kelvin, and has thus contributed so greatly to the advancement of Applied Science, but also to encourage others to submit to that rigorous mathematical training without the fruits of which even the most practical of "practical men" would soon come to a standstill. G. H. BRYAN.

Floating Stones.

THE correspondence on "Floating Stones" brings to my mind a phenomenon I often noticed about ten years ago, when my work caused me to spend a good deal of time on the upper reaches of the River Mersey, of patches of earth floating down the river on the surface of the water. This occurred during the early part of the ebb tide and on water obviously contributed by the river. I concluded that this earth was detached from the banks during the quiescent period of high water, and that the surface tension of the water was so increased by the strength of the effluents from the manufactories and other sources, that lumps of earth, often several inches in area and of appreciable thickness, were enabled to float. Unless the conditions have since changed, no doubt the same thing may still be observed.

Coopers Hill, February 3. A. W. BRIGHTMORE.

ENGINEERING AT CAMBRIDGE.

ON Friday, February 2, a large and important addition to the Engineering Department of the University of Cambridge was inaugurated by Lord Kelvin, as a memorial to the late Dr. John Hopkinson, and his son, John Gustave Hopkinson. In August 1898, only a few days before the terrible accident by which he lost his life, Dr. Hopkinson had discussed with Prof. Ewing the rapid growth of this department, and the urgent need for its extension, and had expressed his intention of starting a fresh movement among engineers to secure the necessary funds. In October of the same year, Mrs. Hopkinson communicated to the Vice-Chancellor of the University the desire of herself and her son and daughter to give

5000*l.* towards the extension of the laboratory, regarding this as a "peculiarly fitting memorial" to one who from the first had been warmly interested in the school, and who had so lately expressed a strong desire to assist in furthering its development.

A site was at once available, as a plot adjoining the existing laboratory had previously been assigned to the department. The design of the new buildings was entrusted to Mr. W. C. Marshall, of Messrs. Marshall and Vickers, and on November 29, 1898, the Senate of the University authorised a syndicate to proceed with the erection of the new wing at a cost not exceeding 5000*l.*, and decreed "that the gift of Mrs. Hopkinson and her family be applied to this purpose, and that the wing be called the Hopkinson Memorial Wing." It was at the same time agreed that 500*l.* should be provided by the University to cover the cost of certain structural alterations to the existing laboratory and other subsidiary works. It is understood that the whole of the work now completed has, if at all, only slightly exceeded the estimate of 5500*l.*

The Hopkinson wing is a block about 92 feet long and 40 feet wide. On the ground floor is a large laboratory, which has been assigned to elasticity and hydraulics, and a smaller room, which will be used as a dynamo room. On the first floor is the new lecture theatre, with preparation room adjoining, and a large room, which at present is occupied partly as an additional lecture room and partly as a supplementary drawing office. On the third floor, three smaller rooms, adapted to purposes of research, have been provided. A wedge-shaped space between the old building and the new has been roofed over with glass, and forms a very useful addition to the large elasticity laboratory.

The opening ceremony on Friday last was presided over by the Vice-Chancellor (the Master of Emmanuel), and was attended by a large number of residents, by a considerable gathering of well-known engineers, and other friends of the late Dr. Hopkinson, and by many present and former students of the department. The Vice-Chancellor, in opening the proceedings, referred to Dr. Hopkinson's distinguished career at Cambridge, and conveyed to Mrs. Hopkinson, on behalf of the University, "the assurance of their sympathy and of their gratitude to her and to her children for the noble benefaction with which they have enriched the University in the name of husband and father."

Lord Kelvin, in his address, spoke of Dr. Hopkinson's rare power of grasping a scientific truth and of applying it practically to mechanical art for the use of mankind. He illustrated this power by reference to his work on dynamo-electric machines and on methods of distribution of electric light and power, to his discoveries in nickel and steel alloys, and to his group-flashing light, "a splendid application of scientific optics now in use in lighthouses and light-ships all over the world." Touching on the growth, at Cambridge, of the study of physical science, both on its theoretical and its practical side, he mentioned that when Dr. Hopkinson was an undergraduate, less than thirty years ago, the only experiments he had an opportunity of seeing were those with which Sir G. Stokes illustrated his lectures. Since then matters had progressed, and we had seen, on the one hand, the development of the Cavendish laboratory, founded by the late Duke of Devonshire, and conducted by Clerk Maxwell, by Lord Rayleigh, and now by Prof. J. J. Thomson; and, on the other hand, the establishment of the engineering workshops by Prof. James Stuart, and their development under Prof. Ewing into an organised school for the study of scientific engineering and of engineering laboratory practice.

Lord Kelvin further made reference to the great value of Prof. Ewing's work, to his researches in magnetism and electricity, and in many other branches of science, to his admirable text-books on steam, on strength of materials and on magnetism, to his untiring energy in developing the work and resources of the engineering department, and to the excellent research work now being done in it under his direction. In conclusion, Lord Kelvin announced that he was commissioned by the directors of the Linotype Company to offer, for the acceptance of the University, a bust of Dr. Hopkinson.

In proposing a vote of thanks to Lord Kelvin, Prof. Ewing expressed his sense of obligation to the many friends, both in the University and without, who, by gifts of money, had made it possible for a laboratory to exist, and by gifts of apparatus that assisted so much in its development and growth. He announced that he had received by telegram the promise of a valuable set of polyphase plant from the British Westinghouse Company. The vote of thanks was seconded by Principal Hopkinson, of Owens College, Manchester.

The Master of Trinity then unveiled an excellent portrait of Dr. Hopkinson, painted by Mr. T. B. Kennington, and presented to the laboratory by subscribers. This has been hung in the principal room of the new wing, and a replica has been presented to Mrs. Hopkinson. For this, thanks were returned to the subscribers by Mr. Bertram Hopkinson. A vote of thanks to the Master of Trinity, proposed by Sir Douglas Fox, President of the Institution of Civil Engineers, closed the formal proceedings. Prof. and Mrs. Ewing afterwards held a reception in the laboratory, and the guests were enabled to examine at leisure the large collection of apparatus with which both the old and the new parts of the building are furnished.

A short account of the growth of the Engineering School in Cambridge may not be out of place. A professorship of mechanism and applied mechanics was founded in 1875, and the first holder of the chair, Prof. James Stuart, established workshops, which afterwards became the property of the University. In these, practical instruction was given in pattern-making, forging, turning and fitting. About the same time an examination in mechanism and applied science was established as one of the special avenues to the ordinary B.A. degree.

Prof. Ewing was appointed to succeed Prof. Stuart in 1890, and at once took up the task of forming an engineering laboratory, and of organising a more complete school of applied science. A site was granted by the University; a sum of 5000*l.* was raised, largely by the efforts of a strong committee of prominent engineers; and this, with an additional 1000*l.* granted by the University, was applied to adapting and extending the buildings of the old Perse School. At the same time a great impetus was given to the work of the department when the University sanctioned the granting of honour degrees by the establishment of the Mechanical Sciences Tripos. The new laboratory, which was opened by Lord Kelvin in 1894, though sufficient for the seventy students then in attendance, soon became overcrowded, until, during the last few years, a considerable proportion of the lectures have been delivered in rooms borrowed from other departments. The growth of the department may be seen at a glance at the following table:—

Year.	Number of Students.	Amount paid in fees. £
1892	39	546
1893	71	1269
1894	73	1541
1895	84	1706
1896	88	2043
1897	103	2338
1898	112	2534
1899	123	2915
1900	150 now in attendance.	

The work of the department has been carried on mainly on the lines of the syllabus for the Mechanical

Sciences Tripos Examination as established in 1893. Regular courses of lectures are given in mathematics, mechanics, principles of mechanism and machine dynamics, strength of materials and theory of structures, heat and heat engines, and applied electricity. Instruction is also given in geometrical and mechanical drawing, and in graphic statics. In the laboratory there are regular courses in mechanics, elasticity, heat, the testing of steam, gas and other heat engines, applied electricity, and hydraulics. In the summer term there are lectures and field-work in surveying. Practice in the use of tools for wood-work and metal-work forms a regular part of the course, and at the same time the workshops, in which a considerable staff is employed, constitute a very useful adjunct to the laboratory.

During the past few years research has been taking a more and more prominent place in the work of the department, and with the larger space and special rooms now available further development in this direction may be looked for. At present a number of research students are at work in the elasticity, the electrical, and the steam laboratories. Evidence of the value of this work may be found in the current volume of the Royal Society's *Transactions*, where two papers, one, by Prof. Ewing and Mr. Rosenhain, on "The Microscopic Structure of Metals" (the Bakerian Lecture), the other, by Mr. J. Muir, on "The Recovery of Metals from Overstrain," deal with work which has been entirely carried on in the department.

The University grants an annual sum of between 1200*l.* and 1300*l.*, from which are paid the salaries of the Professor and the two University Demonstrators (1000*l.* in all), part of the wages of the workshop staff, and some other expenses. From the students' fees, which form the main source of revenue, are paid the salaries of four or five assistant demonstrators and lecturers, as well as the greater part of the wages of the workmen and laboratory attendants.

Many valuable gifts of apparatus have been made to the department during the past six years, and many pieces of heavy machinery have been supplied by engineering firms on specially favourable terms. A high speed compound combined engine and dynamo set, on which regular tests are made, was presented by Messrs. Mather and Platt in 1894. Recently a coupled set of two dynamos arranged for the Hopkinson test has been given by Messrs. Siemens Brothers and Company, and a gas engine of about ten horse-power by the Forward Engineering Company of Birmingham. A very valuable microscope, specially designed for the microscopic study of metals, was lately presented by Mr. Thomas Andrews, F.R.S. Among other recent additions are a five-ton testing machine by Messrs. Buckton and Co., presented by past and present pupils; and a set, comprising turbine, motor and pump, supplied by Messrs. Mather and Platt. Towards the further equipment of the laboratory a sum of 1200*l.* has recently been subscribed, and there is now on order from Messrs. Robey and Co. a compound horizontal engine of about fifty horse-power, specially arranged for testing purposes. This will form a very useful addition to the steam laboratory.

There can be no doubt that the Engineering Department has established for itself, under Prof. Ewing, a firm foothold among the scientific schools of the University. At the same time, if it is to take, as it may reasonably aspire to do, a foremost place among British Schools of Engineering, it must look to provide a wider curriculum. The laboratories necessary for the proper teaching of such subjects as mining, metallurgy and naval architecture, as well as for keeping abreast of the latest developments of the subjects already represented, cannot be founded or maintained without an endowment of an amount far exceeding the sums already so generously contributed.

While it is admitted that the establishment of the department was looked upon by some with misgiving, as an encroachment on the more purely academic studies of the University, it is certainly true now, as the Vice-Chancellor said on Friday last, that the great majority of resident members welcome the establishment of the department, and rejoice in its flourishing and successful state; and it is also true that the growth of this cordial recognition is due in no small degree to the support which has been so freely given by the engineering world outside the University. This view of the matter is supported by the *Times* when it says, in reviewing the inauguration we have just described, that "it is pleasant to see one of our old Universities, while remaining faithful to all the traditions of its venerable past, at the same time displaying an intelligent appreciation of the wants of the future, and affording to the most modern forms of learning the nurture and support which for many centuries it has afforded to those forms with which alone our forefathers were familiar."

THE NATURAL HISTORY OF THE SHORES OF BARENTS SEA.[1]

IN the summer of 1895 Mr. H. J. Pearson and a party of fellow naturalists visited the Barents Sea to study the birds that nest upon its shores. The party landed on Kolguev and Novaya Zemlya, and at one of the promontories on the Murman Coast. Many interesting observations were made on the natural history of the region, but work was hampered by the small size and limited coal capacity of their yacht, the *Saxon*. Two years later Mr. Pearson returned in a larger and more powerful vessel. The main object of the second journey was the investigation of the avifauna of the coastlands of north-eastern Russia, between the Pechora and the Urals, an area which the author describes as "ornithologically unknown." In the summer this country is accessible only from the sea, owing to the vast extent of flood and swamp. Mr. Pearson accordingly chartered the *Laura*, and, accompanied by Colonel Feilden and Mr. F. Curtis, left Tromso for the Pechora coastlands in June, 1897. The scheme was to land near the mouth of the Karataikha River. But the *Laura* could not approach nearer than twenty miles from the mouth of the river, and it was not considered safe to leave the steamer in the open bay for eight hours while the entrance was reconnoitred in the launch. Mr. Pearson was therefore reluctantly compelled "to abandon the chief object of the expedition as impracticable from the sea." The steamer was turned northward, and the rest of the season was spent in visits to Dolgoi Island, "Waigatch" and Novaya Zemlya.

"Beyond Pechora Northward" would therefore have been a more accurate title for the book, as except at the port of Habarova, the expedition did not alight on the mainland east of the Pechora. But in the islands of the Barents Sea, Mr. Pearson and his colleagues did excellent work, some of the results of which have been published in the *Ibis* and the *Journal* of the Geological Society. Mr. Pearson's book gives a detailed narrative of the two cruises, with appendices on the botanical and geological results by Colonel Feilden, Prof. Bonney and Messrs. E. T. Newton and A. C. Seward. It is no disparagement of Mr. Pearson's work to say that the appendices contain the greater amount of new information, as this is one of the indications of the more advanced state of ornithological knowledge. Owing to the wide range of the Palæarctic fauna, the discovery of new birds was not to be expected. There was even

[1] "Beyond Petsora Eastward: Two Summer Voyages to Novaya Zemlya and the Islands of Barents Sea." By H. J. Pearson. With Appendices on the Botany and Geology by Colonel H. W. Feilden. Pp. xiv + 335. (London: R. H. Porter, 1899.)

little scope for collecting hitherto unknown eggs, as Mr. Popham had in the same season already found the nest of the curlew sandpiper, thus, according to Mr. Pearson, gaining the "blue ribbon of the oological world." The main zoological object was the observation of new facts relating to the habits and nesting plumage of the birds that breed round the Barents Sea. The results are illustrated by a valuable series of photographs, including those of nests of the dotterel, red-throated diver, little stint, peregrine falcon and purple sandpiper, and the young of the rough-legged buzzard. The first young Bewick swans brought to England were collected during the expedition, which also obtained many eggs of the little stint. The finding of the first nest of this bird Mr. Pearson describes as one of those "few joyful moments that stand out clear and sharp in the memory, and will never be forgotten while life lasts." The largest egg collection made was of Brünnich's guillemot; 440 specimens were obtained from one small cliff. The series showed extreme colour-variation, and as the birds were feeding on the same food and the eggs were laid under identical conditions, Mr. Pearson thinks that "it is scarcely possible these abnormal variations can serve any useful purpose." He commends this problem to other naturalists, as "this subject of the coloration of eggs is truly one of which we may be said to know nothing yet." Unfortunately no material contribution to such problems is made in this book, as short dashes on shore from a steamer do not offer much opportunity for their study.

The same conditions have limited Colonel Feilden's work on botany and geology. An extensive series of plants was collected, enabling Mr. Burkill to make some collections and additions to the floral lists of this region. The physiological problems of the Arctic flora, such as those discussed in Ekstam's paper on the flora of Novaya Zemlya, require careful study on a small area, rather than rapid collecting during a lengthy cruise. Geological progress in this region also now requires continuous work on shore. The general outlines have been long well known. Thus, the mapping of the eastern side of Dolgaya Bay, where Colonel Feilden corrects the Russian Index Map (1892), was correctly represented in Keyserling's map of 1846. Rapid reconnaissances from the sea cannot now yield such important results as zonal collecting in the palæozoic rocks, accurate mapping of small areas of the Archæan series, and careful analyses of the glacial gravels. The only point in the book open to serious criticism is the lack of system in the spelling of the proper names. As so much of the literature on this region is in Russian, it is a pity to add uncertainty regarding names to the existing difficulties. Some words, such as Habarova, are rendered phonetically; others, such as Waïgatch (Pearson) or Waigats (Feilden) may be concessions to convention; but others, such as Petsora and Matyushin, appear inexplicable. The two authors

Brünnich's Guillemots. (Nameless Bay.)

use different renderings of the same name, and one at least of them has no consistent system. Thus, one island appears as Meshdoshapsk in the map and text, and as Meshdusharsky in the appendix; the name of a well-known Russian geologist appears as Chernysheff and Tscherneyschew (p. 288); the letters, which are translitered (p. 266) as "aya" in the case of Novaya, are abridged to "a" in the name Dolgaya, which therefore appears as Dolga. Belootchia and Belushja are no doubt renderings of the same word. But nomenclature is after all a matter of detail, and Mr. Pearson and Colonel Feilden are to be congratulated on a valuable contribution to the natural history of one of the least known regions of Europe. J. W. G.

INTERNATIONAL COMMITTEE OF WEIGHTS AND MEASURES.[1]

THE International Committee of Weights and Measures at Paris issue from time to time "Travaux et Mémoires" with reference to the investigations and comparisons undertaken at their Bureau during certain periods. Ten such volumes have been published since 1881—Tome i. to Tome xi.—and during last year a further volume, Tome ix., was distributed. This latter volume contains the final account by Dr. J. René Benoit and Dr. Max Thiesen of the comparisons made at the Bureau of forty standard kilograms, "Prototypes nationaux" with the "Prototype International K," which is kept at the Bureau. These national standard kilograms have long since been forwarded by the Committee to the several High Contracting States who (including Great Britain) have joined the Metric Convention of 1875; and the introductory account of the comparisons of these standards was given in Tome viii. (1893), the final account having only now been issued, although it deals with comparisons made so far back as 1884.

The unit of mass of the kilogram is determined by a solid piece of metal, iridio-platinum, in the form of a cylinder (of the height and diameter of 30 millimetres), and the comparisons of the forty cylinders included weighings in air and in water; the numerous observations made by Dr. Thiesen being stated in detail in Tome ix., the observations and reductions of the hydrostatic weighings alone occupying 229 pages of this large volume. The balances used were made by M. Bunge, of Hamburg (1879), and more recently by Messrs. A. Ruprecht and H. Schoss, of Vienna. Of the Bunge Balance an illustrated description is given in Tome ix., and of the original Ruprecht Balance in Tome i. of "Le Travaux et Mémoires." The balances were so designed that any two kilograms under comparison could be automatically interchanged from one side of the balance to the other without disturbing the balance-case, and any minute weights could be added to either pan by the observer without approaching the case. The results appear to have been highly satisfactory, the probable error of a final comparison of two kilograms not exceeding 0·002 mg. Such comparisons are inexhaustible, and therefore it is not surprising to find that no two of the kilograms were found to be absolutely alike.

The final density of the standard kilogram, No. 18, forwarded to Great Britain, appears to have been 21·5454, corresponding to a volume 0° C of 46·414 millilitres. The actual difference of No. 18 from the true kilogram was found to be:—No. 18 = K + 0·070 mg.

By the Weights and Measures (Metric System) Act, 1897, it is provided that "No. 18" is to be the legal standard of this country, from which all other metric weights and all measures having reference to weight are ascertained; and its precise equivalent in terms of the pound avoirdupois has been found to be 2·20462234 lb., or the pound equals 0·45359243 kg.

The investigations of this Bureau as to modes of weighing and methods of reduction, have attracted the attention of all engaged in exact metrological inquiry, the results of the investigations being referred to in modern text-books on physical science; and in the present volume the several corrections and reductions found to be necessary in the precise weighings made by Dr. Thiesen during the years 1884-8 are fully stated in his excellent account.

[1] "Travaux et Mémoires du Bureau International des poids et mesures." (Paris, 1898.)

NOTES.

THE poll for the election of a Parliamentary representative of the University of London, in succession to Sir John Lubbock, opened on Tuesday morning, and will close on Saturday. The result will be declared at the University on Monday next, at noon. On Tuesday evening the number of votes recorded for each of the candidates was officially declared to be: Sir Michael Foster 255, Dr. Collins 156, and Mr. Busk 119, and we trust that when the poll is declared next Monday the numbers will be of the same relative order of magnitude. Graduates of a University which promises to become in the near future an even more powerful means of promoting scientific interests and encouraging intellectual activities than it has been in the past, should see for themselves that the return of any other candidate than Sir Michael Foster would be disastrous. It is unfortunate that sharp electioneering practice induced a number of the graduates to give their names as supporters of Mr. Busk and Dr. Collins before Sir Michael Foster entered the lists; but if they have the courage of their convictions they will seriously consider whether a promise made without a knowledge of the candidates who would contest the seat should not be withdrawn. Petty differences of opinion and individual grievances ought to be put on one side upon an occasion like the present, and the electors should vote for the candidate who would have the greatest influence upon the advancement of the University as a whole.

SOME weeks ago we expressed surprise that the Highland Agricultural Society of Scotland had not contributed towards the cost of Prof. Ewart's experiments on telegony and other subjects of special interest to breeders. From a contemporary we learn that the Society last week voted 200*l.* in aid of the very costly investigations, and that the former chairman (Sir John Gilmour), in a letter urging the secretary to make a grant, stated that he intended sending a donation of 50*l.*, and expressed the hope that others would follow his example. As there was some danger of the work collapsing for want of funds, this is altogether satisfactory. Though science in the past, to the great loss of the nation, has too often been systematically ignored, better times may be coming, for the new century may bring with it a higher appreciation of scientific methods, and thus keep us abreast with the spirit of the age.

IN his lecture at the Royal Institution on Friday last, Mr. Marconi made a statement as to the use of his system of wireless telegraphy in connection with the war. He is reported by the *Times* to have said that six of his assistants have been sent out to South Africa. The War Office intended that the wireless telegraph should only be used at the base and on the railways; but the officers on the spot, realising it could only be of practical use at the front, asked if the assistants were willing to go to the front, and accordingly on December 11 they moved up to De Aar. The results at first were not altogether satisfactory, owing to the want of poles, kites, or balloons, which are needed to elevate the vertical wires; but the difficulty was overcome by the manufacture of kites, in which work Major Baden-Powell and Captain Kennedy, R.E., took part. It has been reported that the difficulty was due to the iron in the hills, but, as a matter of fact, iron has no more destructive effect on these Hertzian waves than any other metal, and Mr. Marconi has been able to transmit messages across the high buildings of New York, the upper stories of which are iron. However, when kites were provided, it was easy to communicate from De Aar to Orange River—some 70 miles—and now there are stations at Modder River, Enslin, Belmont, Orange River, and De Aar. Two of the assistants volunteered to take instruments through the Boer lines to Kimberley, but the military authorities would not grant them permission, as probably too great risk was involved. It seemed to Mr. Marconi regrettable that installations were not established in Ladysmith, Mafeking, and Kimberley before the commencement of hostilities, but he found it hard to believe that the Boers had any workable instruments. Some intended for them, which were seized at Cape Town, were of German manufacture, and not workable, and Mr. Marconi said that as he had supplied no apparatus to any one, the Boers could not possibly have any of his instruments. In conclusion, he said he did not like to dwell on what might be done in the immediate or distant future. But he was sure that the progress made this year would greatly surpass what had been accomplished during the last twelve months, and, speaking what he believed to be sober sense, he said that by means of wireless telegraphy telegrams would become as common and as much in daily use on the sea as they are at present on the land.

THE Government have placed a number of commissions in the army at the disposal of the Chancellors of all the British and Irish Universities, and some of the Colleges of University rank.

THE Turin Academy of Sciences has awarded the Bressa prize of 10,000 lire (400*l.*), for the best scientific work published during the past four years, to Prof. Ernst Haeckel, of Jena.

PROF. MITTAG-LEFFLER has been elected a correspondant of the Paris Academy of Sciences in the section of geometry, and M. Bienaymé has been elected a correspondant in the section of geography and navigation.

THE two candidates whose names have been submitted to the Minister of Public Instruction by the Paris Academy of Sciences for the chair of comparative embryology at the College de France, are M. Henneguy and M. Roule, the former occupying the first place.

PROF. RÖNTGEN, who has accepted the call to the University of Munich, has been appointed director of the State institute of physics and metrology.

ANNOUNCEMENT is made in the *London Gazette* that, after the expiration of forty days from February 6, it is proposed to submit to Her Majesty in Council the draft of an Order in Council providing that acetylene, when in admixture with atmospheric air or with oxygen, shall be deemed to be an explosive within the meaning of the Explosives Act, 1875, and that it shall not be manufactured, imported, kept, conveyed, or sold.

THE New York correspondent of the *Times* announces that the British Ambassador and the Secretary of State signed the new Nicaragua Canal Convention on Monday, and it will be sent to the Senate at once for ratification. In connection with the Convention, England asks for nothing for her concession of the right of objection to the canal. Both nations treat the matter as of deep importance to the whole world. The canal is to be neutral. The United States will build and manage it, but their position will be much the same as that of England in reference to the Suez Canal.

THE sixty-eighth annual meeting of the British Medical Association will be held at Ipswich on July 31–August 3. The president-elect is Dr. W. A. Elliston. An address in medicine will be delivered by Dr. P. H. Pye-Smith, F.R.S., and one in surgery by Mr. F. Treves. The scientific business of the meeting will be conducted in thirteen sections as usual.

THE *British Medical Journal* states that the sum of 98,000 dollars left by Mrs. C. B. Croft for the furtherance of the systematic study of cancer has now been paid to the Harvard University, and will be administered by the Department of Surgery of the Medical School of that University. Dr. E. H. Nichols has been appointed to an office under the trust, and will shortly visit English and continental laboratories for the purpose of investigating the work now being done in them.

THROUGH the enterprise of Prof. Conway M'Millan, a Botanical Art Gallery has been commenced during the past season in connection with the University of Minnesota. It consists of a collection of photographs from nature intended to illustrate the flora of the State, and is at present limited to portraits of the plants themselves in their habitats, and ecological groups.

LARGELY through the exertions of Mr. Thomas Meehan, we learn from the *Botanical Gazette*, the City of Philadelphia has acquired the dwelling and a part of the grounds which belonged to James Logan, one of the founders, along with William Penn, of the State of Pennsylvania. Logan was a distinguished botanist, the genus *Logania* (and natural order Loganiaceæ) having been named after him. The property will be known as Stenton Park.

THE Herbarium of the New York Botanic Gardens has acquired a collection of plants made in the Yukon Territory by Mr. R. S. Williams, which is believed to be the first made in the Klondike region.

FOUR botanical organisations will meet in New York during the last week in June:—the Botanical Society of America, the Botanical Section of the American Association for the advancement of Science, the Botanical Club of the same Association, and the Society for Plant Physiology and Morphology.

ON Friday last Mr. William Whitaker, F.R.S., President of the Geological Society, was elected President of the Geologists' Association. Never before have the two presidential chairs been occupied by the same individual. It is announced also that the ex-President of the Geologists' Association, Mr. J. J. H. Teall, F.R.S., is the President-elect of the Geological Society.

THE replies which the Duke of Devonshire and Mr. Ritchie gave to the deputation which waited upon them on Monday, to present a memorial asking for the continued maintenance of the Buckland Museum of Economic Fish Culture, were as satisfactory as could be expected. The deputation had two main objects; first, to ask that the museum should be permitted to remain where it is now, in the Victoria and Albert Museum at South Kensington; and next, that it should be placed under the Fishery Department of the Board of Trade. With regard to the first point, the Committee appointed by the Treasury, and the more recent Select Committee of the House of Commons, reported against the retention of the museum in its present position. There is no question as to the value of the collection—the only doubt is whether it is rightly situated; and in replying to the deputation, the Duke of Devonshire expressed the opinion that a change of position would be desirable. The place in which the museum is situated is, however, not such an important consideration as the means for keeping it in good condition, adding to it from time to time, and making it a scientific laboratory in which experimental pisciculture can be systematically carried on. At present no such funds are available; for, as the Duke of Devonshire frankly remarked, "It has not been thought necessary for the Government to do so much for the fishing industry of England as is done by a great many foreign countries, notably by the United States, or even as much as is done for Irish and Scotch Fisheries." If the Treasury will provide the means by which the museum may be properly housed at South Kensington or elsewhere, Mr. Ritchie said the Board of Trade would undertake the working of it. The interests of science will be served if, in whatever changes are made, it is borne in mind that "the museum is not for the purpose of exhibiting models, or attracting the attention of the curious, but a means to an end, the end being proper investigation and research into the habits of fish, and other matters, with a view to developing the industry in the way it ought to be developed."

WE learn from the *Lancet* that the president of the Board of Agriculture has appointed a departmental committee to inquire and report as to what regulations may be made by the Board in regard to the standards of quality of milk and cream. The difficulty in connection with proceedings taken under the Sale of Food and Drugs Act has been to differentiate exactly between abnormal milk, or milk which has been watered or from which cream has been abstracted. It is to be hoped that the long-vexed question of what is and what is not genuine milk or cream may be decided by this committee by recommending a system of fair standards. The committee will consist of the following gentlemen:—Lord Wenlock (chairman), Mr. George Barham, Mr. George Cowan, Major Patrick George Craigie, Mr. S. W. Farmer, Mr. Shirley Murphy, Prof. Thorpe, and Mr. J. Augustus Voelcker. Mr. R. H. Rew (of the Board of Agriculture) will serve as secretary to the committee.

WE regret to learn that Sir Thomas Grainger Stewart, the well-known Edinburgh physician, died last Saturday. He will be missed by a large circle of friends and pupils, who will find it difficult to replace their loss. Sir Thomas received his education, both scholastic and collegiate, in Edinburgh; at the completion of his medical curriculum he travelled abroad, and studied in Berlin, Prague, and Vienna. He gave during this time especial attention to medical pathology, and was fortunate to be in this branch of learning a pupil of Virchow and the veteran Rokitansky. The late professor's most important contribution to medical literature was the book published by him in 1868 on "Bright's Disease of the Kidneys" The book is a thorough and extensive description of the various renal affections comprehended under this term, with many plates illustrating from cases under the author's observation, the pathological anatomy of this malady. Chemistry and physics, since the publication of this work, have shed considerable light upon the subject. The book also contains supplementary chapters upon other renal affections. In 1884 Prof. Stewart published a small work, entitled "An Introduction to the Study of the Diseases of the Nervous System," being the subject-matter of a course of lectures delivered by him. In 1888 Fasciculus II. of his clinical lectures on important symptoms, entitled "Albuminuria," appeared. This is a carefully written and instructive monograph, comprising several lectures, upon the varieties of albuminuria, the cause and clinical significance of this symptom. In 1893 an important clinical paper on "Grave's Disease" was published by Sir Thomas in the Edinburgh Hospital Reports. In 1882 Dr. Stewart was appointed Physician to the Queen in Scotland, and in 1894 received the honour of Knighthood, being nominated by Lord Rosebery. In addition, he received many honorary degrees from English and foreign universities and learned societies. He was frequently to be seen in an official capacity at congresses and medical reunions, and invariably shone in their environment. His private practice was large, and he will be greatly missed by many who owe to his care and skill their health and happiness. In Edinburgh he was active in connection with medical mission work, and this organisation will find it difficult to replace him.

THE death of M. Marion, professor in the faculty of sciences in Marseilles University, and director of the natural history museum there, was recently announced. M. Marion was a correspondant of the Paris Academy, in the section of anatomy of zoology. At Marseilles he gathered round him numerous students, and created interest in zoological researches. In the Endoume marine laboratory he investigated the organisms of the Gulf of Lions, and questions relating to pisciculture. He took part in all the dredging trips of the *Travailleur* and the *Talisman*, and collected much valuable material for study. The investigations made by his pupils and himself are described in the *Annales du Museum de Marseille.*

THE annual meeting of the Anthropological Institute was held on Tuesday, January 30. The treasurer's report showed an improved financial position, and an increased membership. The President, Mr. C. H. Read, delivered an address, in which he discussed the progress of anthropological studies during the year, with special reference to the problems which have been more especially subjects of discussion. He explained the prospects, and mode of working, of the proposed bureau of ethnology, and indicated the directions in which increased activity is to be expected or encouraged in the near future, concluding with an eloquent tribute to the memory of the late Sir W. H. Flower, one of the most valued supporters of the Institute, and a past president. The election of officers for 1900 resulted in the appointment of Mr. Read as president, Mr. A. L. Lewis as treasurer, and Mr. J. L. Myers as secretary.

THE Berlin correspondent of the *Standard* announces that the Royal Prussian Meteorological Institute in Berlin is about to make arrangements for the systematic examination of the higher strata of the atmosphere by means of special apparatus. In the grounds of the Aeronautical Observatory at Tegel—a suburb of Berlin where Alexander and William von Humboldt were buried—registrations of the atmospheric conditions at a height of three to five thousand metres will be carried on, if possible, day and night, with kites and kite-balloons. The registering apparatus, which automatically records the pressure, temperature, humidity, and wind velocity, at these heights, is taken up by a kite-balloon connected with the earth by piano wire. An elevation of four thousand five hundred metres has been attained by a train of kites even without balloons, when there was sufficient wind.

MR. W. H. MALLOCK has versified parts of Lucretius—the Roman poet of science—in the metre employed by FitzGerald in Omar Khayyâm's "Rubaiyat." The following two stanzas, which we quote from the *Academy*, bring to mind Tennyson's inspired lines on the same themes:—

> Globed from the atoms falling slow or swift
> I see the suns, I see the systems lift
> Their forms; and even the systems and the suns
> Shall go back slowly to the eternal drift.
>
> Those blue and shining seas in delicate haze
> Shall go; and yonder sands forsake their place;
> And where they are, shall other seas in turn
> Mow with their scythes of whiteness other bays.

THE *Photogram* directs attention to the fact that February 11 is the centenary of the birth of William Henry Fox Talbot,—the father of photography. To obtain for Talbot's work fuller recognition than is usually given, the *Photogram* has commenced the publication of a series of articles on the early history of photography. Our readers may remember that a proposal has been made, and has received some support, to restore the chancel of Lacock Church, Wiltshire, as a memorial to Fox Talbot. There is, at present, no other monumental record of him than a short inscription on his gravestone in the Lacock cemetery. Subscriptions in aid of the proposed memorial, the cost of which is estimated at 1000*l*, should be sent to Mr. C. H. Talbot, The Abbey, Lacock, Chippenham, or to the Fox Talbot Memorial Fund, Capital and Counties Bank, Chippenham.

THE proposal to generate electricity on the Canadian side of the Niagara and to sell electric power on the American side, has caused a flutter of excitement among American electricians. The New York *Electrical Review* states that the question has been raised whether foreign-made electricity is not subject to a duty of ten per cent *ad valorem* as an "unenumerated manufactured article." This question has produced a flood of debate, and while it is purely hypothetical as yet, the Merchants' Exchange of Buffalo and the Niagara Falls Power Company, have gone so far as to pass resolutions opposing such taxation. Those who desire discrimination in favour of home-made electricity argue that electric power is a vendable and valuable product of manufacture; that it can be measured easily and accurately, and that foreign-made electricity should pay duty equally with foreign-made cloth or wine. Those who believe in free trade in electricity point out that it is not an article, that it is not valuable or sold or saleable, that it has no power to do work, but only serves as a means of transmitting power, and that it is utterly impossible to import it because it instantly returns to its source.

AN address which Dr. H. R. Mill delivered before the Royal Geographical Society on Monday last, and which will no doubt appear in due course in the *Geographical Journal*, should be brought before the attention of every local scientific society. The subject was the geography of south-west Sussex, and the object was to show how the geological and topographical structures, the meteorological conditions, agricultural products, industries, and distribution of population are related to one another. With the Ordnance Survey maps as a basis, the district was subjected to minute geographical analysis, and many interesting connections were brought out. Geologically, the area examined is made up of the low-lying Tertiary clays, marls, sands, and pebble-beds on the coast, the chalk forming the South Downs a few miles behind, and the Greensand and Weald Clay north of it. As an example of the different characteristics and productive capacities of these three divisions, the following tabular statement is instructive :—

	Plain.	Hill.	Valley,
Average elevation	30 ft.	400	150
Formation	Tertiary	Chalk	Greensands
Rainfall	27 in.	36 in.	34 in.
Woodlands	4%	30%	20%
Pastures	26%	50%	48%
Arable land	60%	20%	32%
Wheat (bushels per acre)	40	35	36
Density of population (per square mile)	400	10	200

The numbers are only approximate, but they serve to exhibit the chief differences between the three areas. The comparison suggests that, in this case at all events, the geology of the district is the controlling influence, but Dr. Mill pointed out that just as striking differences could be found in areas of a single geological formation, and that it was the function of geography to discover the causes, geological or otherwise, which produced them. His survey was a model which should inspire others to inquire into the causes of the relations between the natural and economic conditions of their own districts, and thus provide material with which to construct a geography of the British Isles on scientific lines.

A MEMOIR on the Geology of Belford, Holy Island, and the Farne Islands, by Mr. William Gunn, has just been issued by the Geological Survey. The region is one with which the late George Tate, of Alnwick, for long was intimately associated, until his death in 1871. The work of the Geological Survey was for the most part carried on subsequently, but there has unfortunately been considerable delay in the publication of the memoir. It deals mainly with rocks of Lower Carboniferous age, and contains a full account of the various coal-seams which have been worked in that series. Lists of Carboniferous fossils are given, and there are notes on the Whin Sill and on the Glacial and post-Glacial deposits.

ONE of the most gigantic sanitary works of the day was brought into operation at the beginning of January, when the water was turned into the great drainage canal through which in future the sewage of Chicago is to flow instead of into Lake Michigan, the source from which the city's water supply is drawn. This canal has been seven years in construction, and has cost about 6,000,000*l*. It is 29 miles in length, and has been excavated through glacial drift and solid rock, the width at the bottom through the rock being 160 feet and the depth 22 feet. The flow of water through the canal is to be regulated to 300,000 cubic feet a minute, and the volume of sewage will be 4,200 feet a minute. The constant depth of water in the canal is to be 22 feet, and the rate of flow is to be regulated so as not to exceed one mile an hour, and it has been constructed with the intention that it shall hereafter be used as a ship canal, rendering navigation possible from Lake Michigan, by way of the Illinois and Mississippi rivers, to the Gulf of Mexico. The watershed of this part of America is situated at the head of Lake Michigan, the water from which ultimately flows down the Saint Lawrence, and that to the south of the Lake by the Mississippi to the Gulf of Mexico. This diversion of the water and the question as to what effect it may have in lowering the level of the lake and so affecting the navigation and other water rights have been the subject of considerable discussion and investigation. The general opinion arrived at is that the quantity of water flowing down the canal cannot lower the water in Lake Michigan more than three inches.

THE passage of electricity through rarefied gases forms the subject of a paper by M. E. Bouty in the *Journal de Physique* for January. The author differs from Prof. J. J. Thomson's view (1893) that rarefied gases behave like electrolytes, and in this connection arrives by a different method at conclusions agreeing with those of E. Wiedemann. According to M. Bouty the conductivity of the gas is related in some manner to its luminosity. In studying the electrical properties of gases we have to consider (1) the dielectric equilibrium in the case of fields of force of less than a certain critical intensity; (2) the modifications produced by electric discharges due to a field exceeding the critical intensity; (3) the determination of the limits separating the two phenomena. The last of these points forms the subject of M. Bouty's present investigations.

THE Summary of the *Weekly Weather Report*, showing the rainfall and mean temperature for the year 1899, and for thirty-four years, 1866 to 1899, has recently been published by the Meteorological Council. The principal features during last year have been the small amount of rain in the summer months, and the high temperature that has persistently prevailed in most districts throughout the year. Over the British Isles generally, the deficiency of rainfall, compared with the mean of thirty-four years, only amounted to 0·6 inch; the greatest deficiencies were England E., 2·8 inches, Midland Counties, 2·6 inches, England S., 2·4 inches, England N.W., 2·9 inches, England S. W., 3·8 inches. In Scotland N., there was an excess of 6·9 inches, Scotland W., 6·3 inches, and in the east of Scotland and south of Ireland there was also an excess of 2¾ inches. In the south of England the rainfall has been below the average during the last five years. The excess of temperature was greatest over the southern portion of the kingdom, although in the northern districts it was also considerable; in the neighbourhood of London the temperature was nearly 2° above the average of fifty years (1841-90). For the British Isles generally, it has been above the mean during the last seven years, with the exception of 1895, in which, it will be remembered, the prolonged frosts of January and February occurred. There was an excess of sunshine over the whole country; in the south of England it amounted to about 350 hours.

WE have received the Report of the Northumberland Sea Fisheries Committee for 1899, in which two points seem worthy of special notice. In regard to flat-fish, the Report shows the gratifying state of affairs that an increase took place during the first five years that trawling excursions were instituted, and that the numbers of fish has since remained fairly constant. It is quite true that the increase has not been as large as was expected. But what has been learnt in regard to the spawning migrations affords the required explanation; and there is no doubt that the protection extended to the immature fish, as well as to their adult brethren which spend a portion of their lives in-shore, justifies the closure of the territorial waters to trawling. If such were again permitted, the destruction of immature fish in off-shore waters would be intensified, while the in-shore fish would be practically exterminated. The second point is the advisability of establishing on different parts of the coast beds of mussels for use as bait.

THE anatomy and development of Reptiles receive a large share of attention in part i. vol. xxviii. of the *Morphologisches Jahrbuch*; Dr. E. Göppert, of Heidelberg, contributing a paper on the larynx, while Herr H. K. Corning writes on development of the muscles of the head and limbs. Both papers are of a highly technical nature.

THE *Morphologisches Jahrbuch* also contains the first instalment of an important memoir by Dr. S. Paulli on the pneumaticity of the mammalian skull, as developed in the olfactory region, this part dealing only with Monotremes and Marsupials. It is shown that whereas in the Australian Duckbill the porous (ethmoid) bones in the nasal chamber are so slightly developed that there is not even a division between the olfactory and the respiratory portions, in the Echidna the same structures attain an extraordinary degree of complexity and specialisation. The difference is doubtless due to the aquatic habits of the one animal as compared with the terrestrial mode of life of the other.

THE greater portion of the first part of vol. lxvii. of the *Zeitschrift für Wissenschaftliche Zoologie* is taken up by an elaborate memoir on the structure and development of the crystalline lens of the eye in Mammals, by Herr C. Rabl, of Prague.

APPENDIX IV. for 1899 of the *Kew Bulletin of Miscellaneous Information* consists of a classified catalogue of the additions to the library received during the year 1898, covering fourteen pages.

A SERIES of articles on "Present-Day Leaders of Science" is running through *Good Words*. The January number contained an appreciation of Lord Kelvin, by his successor at Glasgow, Prof. A. Gray; and in the February number, Prof. Ramsay's scientific investigations—especially those referring to argon, helium, and other gases recently isolated—are described by Prof. Dobbie.

MR. C. L. WRAGGE writes to us with reference to the weather charts of Australasia issued by him, and mentioned in a note in our issue of November 9, 1899 (p. 40). He informs us that "the charts are regularly published daily, Sundays and holidays excepted, and are thus kept up to date. They are afterwards lithographed for general circulation within three days of the original issue. . . . Although the isobars are extended seawards, and the dotted lines over north-western Australia, where, except along the north-western coast, or data are limited, long series of observations over the land in connection with data from the Northern Territory, Tasmania, New Zealand and New Caledonia, prove that they closely approximate to the truth, and ship's logs repeatedly confirm the oceanic contouring of the isobaric lines."

Science Abstracts has become indispensable to all who wish to keep in touch with the progress of work and thought in any branch of physical science, whether pure or applied. The number for January, with which is issued the index to last year's volume, excels all previous ones both in the extent and interest of the information given as to recent advances of knowledge. It consists of 168 pages of abstracts of scientific papers, concisely written and well arranged. The scope of the journal has been considerably extended, more especially in the direction of steam plant, gas engines, oil engines, and motor cars. The practical man, as well as the student and investigator, cannot afford to neglect such a serviceable publication. The publishers are Messrs. E. and F. N. Spon, Ltd.

THE development of the practical teaching of physics has led to the production of simple apparatus and cheap materials by several scientific instrument makers. Messrs. J. J. Griffin and Sons have just published a catalogue, which shows they have adapted themselves to the new conditions. The catalogue contains classified price-lists of apparatus and materials described in several text-books of general elementary science and practical physics, and also required for the teaching of physiography, and for the complete equipment of a physical laboratory and lecture-room in a School of Science or other institution in which a systematic course of instruction in science is given. The catalogue should secure the attention of teachers who already possess laboratories, as well as of those making arrange ments for experimental work by students.

SOME years ago Bernthsen published experiments to show that hyposulphurous (or hydrosulphurous) acid had the formula $H_2S_2O_4$ and not H_2SO_2. Though the evidence on which this conclusion was based has never been contradicted, the formula has not obtained general currency, and some doubt has lately been thrown upon it. Bernthsen has, therefore, returned to the subject, and, in conjunction with M. Bazlen, publishes, in the current number of the *Berichte*, an account of the preparation of crystallised sodium hyposulphite. The salt was prepared by taking sodium bisulphite, zinc dust, and sulphur dioxide in quantities corresponding to the following equation:—

$$2NaHSO_3 + Zn + SO_2 = (Na_2S_2O_4 + ZnSO_3) + H_2O.$$

Milk of lime is added to the solution to precipitate the zinc and the sulphites, and on adding common salt to the solution, sodium hyposulphite is salted out. Analysis and other evidence show the crystallised salt to have the formula $Na_2S_2O_4 + 2H_2O$. The original view of Bernthsen is thus established, and hyposulphurous acid must be held to correspond in its stage of oxidation to the oxide S_2O_3.

ALTHOUGH but a short time has elapsed since the discovery of the elements radium and polonium by M. and Mme. Curie, a considerable amount of work has already been done upon the properties of the rays emitted by these substances. M. Henri Becquerel has already shown that there is a fundamental difference between the rays emitted by polonium and radium, in so far as a portion of the radium rays are deviated by a magnet. In the current number of the *Comptes rendus* is a further contribution by M. Becquerel on this same subject, in which, after showing that the deviation is the same in air and *in vacuo*, by an ingenious arrangement it is shown that the rays given off by different preparations are similar in nature, differing only in intensity. The salts were placed in small leaden cups upon a sensitised plate wrapped in black paper, and isolated from each other by screens, no effect being produced upon the plate until the magnetic field was excited. In a strong field the radiation is bent down on to the plate, which, when developed, showed that the deviations were equal, although of different intensity.

THE exact value for the atomic weight of nitrogen, in spite of its importance, is still liable to some uncertainty. The mean value derived from the researches of Stas, Penny, Marignac, Pelouze and Hibbs, by methods exclusively chemical, is 14·034 (oxygen = 16); whilst the value calculated from the practically identical densities of Lord Rayleigh and Leduc is 14·006. The February number of the *Journal* of the Chemical Society contains further work on this subject by Mr. G. Dean. Silver cyanide was obtained in a state of great purity, and the ratio Ag : AgCN determined, from which the value 14·031 is deduced for the atomic weight of nitrogen, a number practically identical with the mean above quoted, 14·034. Further work is clearly necessary to explain this considerable discrepancy, nearly 0·2 per cent., between the results obtained by physical and chemical methods.

THE additions to the Zoological Society's Gardens during the past week include two Common Marmosets (*Hapale jacchus*) from South-east Brazil, presented by Mrs. Nigel Cohen; a Black-eared Marmoset (*Hapale penicillata*) from South-east Brazil, presented by Mr. Hamilton Coffey; a Rhesus Monkey (*Macacus rhesus*) from India, presented by Dr. R. Cox; a Small Hill-Mynah (*Gracula religiosa*) from Southern India, presented by Mr. W. Brindley; two Dwarf Chameleons (*Chamaeleon pumilus*) from South Africa, presented by Mr. H. Way; a Lesser White-nosed Monkey (*Cercopithecus petaurista*, ♂) from West Africa, an American Bison (*Bison americanus*, ♂) from North America, two Great Anteaters (*Myrmecophaga jubata*, ♂ ♀), a Blue-fronted Amazon (*Chrysotis aestiva*) from South America, deposited; a Hog Deer (*Cervus porcinus*, ♂) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

COMET GIACOBINI (1900*a*).—A telegram, received February 3, from the Centralstelle at Kiel, announces the observation of this comet by M. Javelle, at the Nice Observatory, in the following position:—

R.A. 2h. 57·7m. } 1900 January 31d. 7h. 3m.
Decl. −7° 55′ } Nice Mean Time.

A later telegram, received February 4, gives the following position:—

R.A. 2h. 49m. 51s. } 1900 February 3d. 7h. 25·8m.
Decl. −6° 40′ 10″ } Nice Mean Time.

Daily motion in R.A. = −2·6s.
" " " Decl. = −25″.

The comet, when discovered, was about 2° north-east of the 4th magnitude star η Eridani, and according to its observed motion is at present following a north-westerly path through Cetus.

SECOND NEW ALGOL VARIABLE IN CYGNUS.—It is announced, in the *Astronomische Nachrichten*, No. 3614, that Madam Ceraski, of the Moscow Observatory, has detected another variable during the examination of plates taken at the Observatory by M. Blajko. From the light variation observed, it is considered to be of the Algol type. Its position is the following:—

	R.A. h. m. s.	Decl. ° ′ ″
1855·0 ...	19 40 59·7 ...	+32 21 6
1900·0 ...	19 42 43·4 ...	+32 27 34

The period is calculated to be

6d. 0h. 9·4m.;

an epoch of minimum being

1899 December 15d. 23·3h. Greenwich Mean Time.

The normal magnitude of the variable is 10, its value at the minimum being about 12.

A small chart of the neighbouring stars is given in the paper to facilitate its recognition. The star makes almost an equilateral triangle with the stars B.D. 32°·3559, and B.D. 32°·3560.

THE COMPUTATION OF OCCULTATIONS.—There is a considerable number of methods for calculating the times of occultations, and until quite recently that of Bessel was the most generally employed. In these computations, in order to obtain results accurate to some seconds of time, the values resulting from the first calculations were only taken as a first approximation and used as a basis for a second computation, which latter gave the times with greater precision. In the year 1896 Dr. Carl Stechert published a new method (*Tafeln für die Vorausberechnung der Sternbedeckungen*) which dealt directly with the apparent and not the true time of conjunction, and at the same time allowed of certain simplifications being made. Curiously enough we have received from the Director of the Observatory of Rio de Janeiro, Mr. L. Cruls, a description of a method which results in an equation similar to that obtained by Dr. Stechert, but obtained by a line of reasoning essentially different. This method, which only involves one computation, and is based on the exact knowledge of the instant of the apparent conjunction of two stars, is fully described in the publication referred to, the text being arranged in parallel columns in the Spanish and French languages. The accuracy of this method may be gauged from the results of ten computations compared with the observed values. The mean error of a single isolated observation was found to be ± 11s·5 while that of the whole of the sixteen observations (including immersions and emersions) was ± 3s. The method is accompanied by numerous tables and diagrams for facilitating the reductions of equations involved.

LIGHT CURVE OF CERASKI'S FIRST ALGOL VARIABLE.—In the *Astronomical Journal*, No. 475, Mr. J. A. Parkhurst gives the results of forty-five observations of this variable during the period 1899 June 15 to September 12. Comparisons with four neighbouring stars give the normal magnitude as 8·75, and the minimum as 11·4. Forming the light curve from the observed times and magnitudes, the epoch of an August minimum was found to agree more closely with Prof. E. C. Pickering's value (*Harv. Coll. Obs. Circular*, No. 44) than with that of Prof. Ceraski, so that the author supports Prof. Pickering's extension of the period to 4d. 13h. 45m. 2s.

REDUCTION OF STAR PHOTOGRAPHS.—Mr. A. R. Hinks, who has recently undertaken the work of stellar photography with the new photographic equatorial refractor at the Cambridge Observatory, discusses, in the *Astronomical Journal*, No. 475, the method he proposes to adopt in the reduction of the plates. The telescope is to be devoted to determinations of stellar parallax, measures of star clusters, &c., and it is important for the ultimate value of the work that the measures as published should be comparable with others obtained elsewhere. Of the many possible methods of reduction, the author considers it most advisable to adopt a system based upon that devised for the work of the Astrographic Catalogue by Prof. H. H. Turner (*Monthly Notices*, *R.A.S.*, 1894, vol. liv. p. 489). In thus publishing the measures in the rectangular co-ordinates from the plates themselves, there may be some doubt as to their being comparable with older work published in the usual spherical co-ordinates of right ascension and declination. This the author proceeds to investigate by applying the new method of reduction to Dr. Frank Schlesinger's measures of the Rutherford photographs of the Praesepe cluster. In working out the equations of condition, both the rigid least square solution and the simplification devised by Mr. Dyson are given. From the values of the residuals it appears that determinations of parallax, &c., from photographs, may with advantage be carried out entirely in rectangular co-ordinates, and the results thus published. In addition, the approximate method of solution of the equations of condition is but little inferior to the rigid least square solution. A great advantage of the adoption of this plan would be the tendency to equalise the time of obtaining and reducing the photographs.

TECHNICAL INSTRUCTION IN RELATION TO INDUSTRIAL PROGRESS.[1]

What are the new industrial conditions which we now have to meet ?

WE have long known of the enormous progress being made in Germany, especially in those branches of manufacture of the more scientific kinds. Thus, most of the electric plants installed throughout the continent have been made in Germany, and German firms are building practically all the large lighting and traction plants in South America. In steam engineering and in shipbuilding we know how efficient Germany has become. The phrase "made in Germany" was intended to imply that the goods so marked were not equal in quality to British made goods, but the phrase no longer carries this meaning, and it will be remembered that when the *Kaiser Wilhelm der Grosse* made a record passage from New York to Southampton, having beaten the best English record, she sailed into port with large white letters painted on her side, "MADE IN GERMANY." I was in Germany myself just as this happened, and heard the story passed round, to the great amusement of the Germans.

In South Africa the same progress has been made by the Americans, who have supplied most of the machinery used in the South African mines, and the engineers engaged there are nearly all young Americans who have received a good technical training as engineers and electricians. Again, many of the principal electric light and power plants in our own country are equipped throughout by American firms in competition with the best home companies, and erected at our very doors, notwithstanding that the American plant has to be carried so many thousand miles before it reaches its destination.

It is frequently stated that this is owing to our own firms being so full of work that they have orders two years ahead, but the question is whether England has more work than she can do, or whether the rate of production of that work is what it might be if the plant employed in our various manufactories were of a more up-to-date type. In any case it is clear that the higher grades of the metalworking trades are no longer a speciality of this country, but, on the contrary, both America and Germany can compete with us on our own ground.

But there is another direction in which, quietly but surely, a revolution is being effected in methods of manufacture, not only in engineering works of all kinds, but in many industries which have never until recently used machinery, and this revolution is being brought about by the introduction of the American Machine Tool. The characteristics of this machine tool are its high quality, its adaptability to all kinds of special work requiring automatic appliances, and the method of working the tool so as to produce with great accuracy an indefinitely large number of interchangeable parts by working to standard gauges.

To give an illustration of the way in which these changes are being brought about by the introduction of the American machine tool: A few weeks ago I visited the newly-erected machine tool factory of the Ludwig Loewe Co. in Berlin, one of the largest factories of the kind in the world, having cost, I believe, nine million marks to build and equip. The firm was founded in the first place about thirty years ago for the purpose of making sewing machines, but before it could make sewing machines it had to buy American tools with which to make them. Then after a time the American machines required to be repaired, and they had to start a small engineers' shop for the purpose of repairs, and more American tools were purchased to equip the engineers' shop. But this small engineers' shop proved so serviceable and so successful that the sewing machine trade was stopped, and the machine tool instead began to be manufactured. From this beginning a great machine tool business was gradually built up. The tools made were of the newest and most approved American patterns. The head engineer and works' foremen employed were Americans. This business has now reached such enormous dimensions that it includes not only the machine tool works above mentioned, but also Arms and Ammunition works and Electrical Appliance works, the whole employing, I am told, something like twelve thousand men.

From these works are passing out from time to time skilled men with practical experience of up-to-date machine tools, who become foremen in the various works and manufactories, and the result is that, wherever they go, they soon introduce the highest class of machine tools, and rapidly a great change takes place in the amount of business done by the firms. America, as is well-known in engineering circles, is doing an enormous trade on the continent of Europe and with England also in improved machine tools of the highest class.

We have, of course, good machine tool makers in this country, but few, if any, who have made a speciality of one single type of machine tool, as is the case in America, which tool they claim to be the most perfect of its kind, while they leave other types to other manufacturers. By thus confining themselves to one class of tool they greatly reduce the working costs of manufacture as compared with firms who make any and every class and size of tool.

A London Daily recently said, "there is no question that the commercial interests of the United States are growing by leaps and bounds. Europe is beginning to be inundated with American goods, and American firms are getting contracts at the expense of European rivals all the world over. This would not be accomplished except for the fact that American manufacturing plants are maintained by the universal use of high-class machine tools, operated by well-paid workmen, while by far the greater number of shops in this country are equipped with tools many of which are of the most antiquated type."

It is probable the German workshops, generally speaking, are in no sense better equipped than our own. In fact, we have in this country, especially in connection with our great Railway Companies, shops which are probably superior to anything else of the kind in the world, also our textile machinery is superior to that of any other country, but the Germans are waking up to the fact of their deficiencies as compared with the machine tool equipment of the general American manufacturer. They recognise that trade follows the machine tool, and the financiers of Germany appear to be encouraging the rapid introduction of a better class of machines for general works' practice. A similar tendency is at work in this country, and the result is that the industrial conditions are rapidly changing, and a new and more efficient class of men to carry on our mechanical industries is becoming more and more an absolute necessity.

What we require in order to meet these conditions successfully and to maintain our industrial position as a community of metalworkers in competition with our rivals.

It is clear from what has been already said that we need the means of securing a steady supply of skilled machinists and tool makers, with a competent knowledge of up-to-date methods of turning work out, and of the best types of machine tools; men, in fact, who are competent to become, in course of time, leading men and works' foremen.

There are, of course, works' foremen in England second to none in the world, but every one knows, who has any knowledge of works, that such men are singularly scarce, and when a vacancy occurs, extremely difficult to replace. These men are the brain of the workshop, and upon their skill depends very much of the true success of any manufacturing concern. Almost any man in the works could be more easily replaced than the skilled works' foreman.

Incompetent foremen are not only incapable of improving methods of production, but they will not encourage the introduction of new machines, which they themselves have not the ability to understand and use. Such men initiate little, and they continue to demand the same kind of tool and methods that their forefathers used. But the deficiency in the supply of

[1] Abridged from a paper on "Metal Work as a Form of Manual Instruction in Schools," read at a conference of science teachers on January 11, by Prof. W. Ripper, University College, Sheffield.

men of the more competent type is becoming more serious every day, because the demand for skilled mechanicians increases with the introduction of improved machine tools, and the problem is, in what way can we hope to insure a supply of thoroughly well-trained competent machinists.

It will of course be said by a certain class of critics that the workshop is the only place in which such a training must be obtained, but this is not the opinion of some of the best-informed American engineers.

A movement is on foot in America for securing a special training, by the founding of schools for the purpose of training machinists thoroughly from the earliest stages upwards. On this point a most valuable paper has recently been contributed to the American Society of Mechanical Engineers on "The Education of Machinists, Foremen, and Mechanical Engineers," by Prof M P. Higgins, of Worcester, Mass., U.S.A., in which, after recommending the formation of workshop schools, he says, "America has made a strong beginning as an export nation of high grade machines. There are many evidences of keen interest amounting to surprise and alarm on the part of our European rivals. It is interesting to note their efforts to discover the cause of this sudden uprising of a new and evidently powerful rival in a field heretofore all their own.

"The cause of our supremacy," he says, "has not been altogether the superiority of our high-class engineers, for they also have highly educated engineers. But it has largely resulted from the superior character and make-up of our *mechanics*, which has come from the chance which America gives the workmen, and in the liberal and wise provisions to train American boys, giving each a fair field and open path to rise from one plane to a higher one, as his abilities and circumstances may warrant.

"We must not allow ourselves to rest secure in the belief that our Old World competitors will be slow to discern this cause or slow to profit by the example. Therefore, what more potent steps can we take for our protection than to keep this path open from the bottom, and to better our methods all the way up through the successive stages?"

In what way may the schools help to more effectually prepare our youths for the task which lies before them?

The Elementary School.—I begin at the elementary school because the problem before us is one which can only be solved by laying a good foundation at the very beginning, and proceeding upwards by a properly organised system of training towards the result which we desire to obtain.

Our British system of elementary school training is probably equal to that of any country in the world, but we have to regret the very early age at which the majority of boys pass away from the influences of the school. This is in part due no doubt to the feeling on the part of parents, especially of the lower classes, that after having passed the ordinary standards there is no necessity for any further stay at school, as the subjects taught are assumed to have little or nothing to do with the immediate requirements of life outside the school.

The opening in many large centres of Higher Grade Schools, in which pupils who have reached the higher standards may receive instruction at low fees, in science and in manual work, has been generally productive of much good, by retaining in the school pupils who would otherwise have left at an earlier age; and in these Higher Grade Schools pupils of exceptional ability, as tested by the ordinary system of examinations, have been selected, and in many cases specially trained, for scholarships or for examinations admitting them to the universities. But an idea is beginning to dawn upon us that perhaps, after all, there may be, among the very large majority of boys who are never among those selected to receive any special training to pass university examinations, and who have no special aptitude in the direction of acquiring book knowledge, much real ability in other directions, in fact, that they may be, as it were, a kind of unworked mine of possibilities and resources.

Hitherto they have been looked upon as the wasters of the school, but it is almost certain that the great inventors and mechanicians of our time have not usually come from the class of boys who are looked upon as the most successful students. Usually the "clever boy" is the one who, by his ability, in the particular direction by which the schools measure ability, succeeds in escaping from the workshop and in doing, as he would consider, better for himself by obtaining other employment.

Every Higher Grade School in which work is carried to the extent of providing school laboratories for, say, chemistry and physics, which, by the way, is a very good and necessary provision, should provide also an alternative course in a school workshop for the type of boy well known to teachers whose tendencies are more mechanical than scientific, who would be likely to make much more progress if trained in a workshop than in a chemical laboratory; and who would certainly pay for such training.

Every teacher who has had experience with the teaching of science to boys knows that the class consists of two distinct types; first, those who are fitted by careful training to become successful students, and to take a more or less high position in public examinations, who in fact are aiming at passing some examination as a means to their future progress; and secondly, those who have no prospect of such success, and whose future success will depend, if they succeed at all, upon other qualifications.

Now this latter class includes the majority of the pupils. They contain also the class from which will be drawn in the future the workers, and in some cases the leaders, in our industries, and these boys have, equally with the other boys, a reasonable claim upon all that the school can do for them to prepare them for their future. To meet then the case of these boys the workshop course should be an altogether different course from that hitherto provided. It should be equipped with as much care and as much completeness in its way, for the purpose of training this type of boy, as is the chemical or physical laboratory, and the educational value of such training need be in no sense inferior to that of any other course of study.

It is assumed that boys in such a school have already done a woodwork course, and if so they would here receive an ironwork course in a workshop supplied with a good selection of tools, including some small but good types of machine tools driven by a gas engine or electric motor. The effect of providing such a course of instruction would be to select, by a natural system, the type of boy likely to profit by the training received, and to retain these boys for a much longer period than would otherwise be possible. But the success of such school workshops would depend largely upon the course of instruction given, and upon the quality of the teacher giving it. The course should include practical work in the shops, the arithmetic of machines, geometry, machine drawing and design, and elementary applied mechanics. Each of these subjects is capable of indefinite extension, but it is of great importance that the early teaching should lay a good foundation upon which the future may be built, and that nothing should be learned which will afterwards require to be unlearned.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

IT is announced that a copy of the charter and statutes which are to govern the new University of Birmingham, has been laid on the table of the House of Commons. This contains a list of honorary and other officers covered by the terms of the charter, but only three persons are mentioned who have been definitely appointed to positions in the new University. The first Chancellor will be Mr. Chamberlain. No name is associated with the office of Principal, which is to be a Crown appointment, made through the Lord President of the Council, but the Vice-Principal nominated is Dr. R. S. Heath, who has been acting Principal of Mason University College. The appointment of the first Dean of the Faculty of Medicine has been conferred on Dr. B. C. A. Windle, F.R.S.

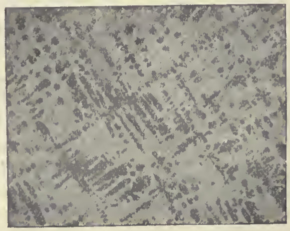
SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 7, 1899.—"Gold Aluminium Alloys." By C. T. Heycock, F.R.S., and F. H. Neville, F.R.S.

The freezing point curve for mixtures of gold and aluminium consists of seven branches, each branch corresponding to equilibrium between liquid and the first solid which forms as the system cools. Seven substances can also be detected by a microscopic examination of the solid alloys. They are gold, Au_4Al, Au_5Al_2 or perhaps Au_8Al_3, Au_2Al, a body which is probably AuAl, Roberts-Austen's purple $AuAl_2$, and aluminium. With the exception of $AuAl_2$ the compounds are white in colour. The bodies Au_2Al and $AuAl_2$ are indicated by well-marked summits in the curve, their freezing points being 625° C. and 1062° C. respectively, the latter identical with the freezing point of gold. The lowest melting point is that of an alloy containing only 3·6 per cent. by weight of aluminium; this alloy melts at 527° C.

The photomicrographs accompanying the paper show that the minute structure of the alloys repeats itself at corresponding points of each branch of the curve. For example, near the summit of the branch corresponding to the pure alloy, Au_2Al, the photograph shows us more or less hexagonal polygons of this substance almost entirely filling the field, and only separated from each other by very fine lines of impurity. If we take a section of an alloy a little way below the summit, we see the polygons of Au_2Al surrounded by a ribbon-like network of mother substance. Still further down, the crystals of Au_2Al are scanty, and arranged in such regular patterns, generally in lines at right angles to each other, as to render it certain that they crystallised freely while surrounded by liquid. Finally, at the bottom of the branch, that is at the eutectic point, the large crystals of Au_2Al are absent, and the whole field is full of the



mother substance, which is sometimes, but, as we explain in the paper, not always a eutectic mixture.

If, leaving the eutectic point, we ascend the next branch, these phenomena repeat themselves, but the primary crystallisation (that is the matter which solidified first) is now of a different substance.

The photograph reproduced is of an alloy which, taken as a whole, would have the formula $Au_{70}Al_{30}$. The darker part consists of Au_2Al, which crystallised first. The lighter ground, or mother substance, is in this case the pure body Au_5Al_2, and is not a eutectic mixture. The pattern is typical of a point on the curve situated a little way above a eutectic angle. (Magnification 45 diameters.)

Royal Microscopical Society, January 17.—Annual meeting.—Mr. E. M. Nelson, the President, in the chair.—The President announced with deep regret the death of the Treasurer, Mr. W. T. Suffolk. He was an old member of the Society, having joined it in 1863. In addition to acting as Treasurer for some years, he had examined and catalogued the slides, about 7700 in number, in the Society's cabinet, and had remounted a great number of them, which had been found to be leaking or otherwise imperfect.—A resolution expressing the great sympathy of the Council with Miss Suffolk, and also acknowledging her gift to the Society of her uncle's cabinet of slides, was read to the meeting, and at the request of the President the Fellows present endorsed the action of the Council by show of hands.—After the report of the Council for the past year and the statement of accounts had been read and adopted, the President announced that the following had been elected as officers and Council for the ensuing year:—President: Wm. Carruthers; Vice-Presidents: A. W. Bennett, G. C. Karop, A. D. Michael, E. M. Nelson; Treasurer: J. J. Vezey; Secretaries: Rev. Dr. W. H. Dallinger, Dr. R. G. Hebb; Ordinary Members of Council: J. M. Allen, Conrad Beck, Dr. R. Braithwaite, E. T. Browne, Rev. E. Carr, E. Dadswell, Sir Ford North, H. G. Plimmer, T. H. Powell, C. F. Rousselet, Dr. J. Tatham, G. Western; Curator: C. F. Rousselet.—The President then delivered the annual address on the work done during the past year in connection with the Society, including the standardisation of the substage and eye-pieces, and concluded by reading a paper, which was a continuation of the optical subjects dealt with in his previous addresses, and had special reference to the aplanatic oil immersion front and the construction of the Huyghenian eye-piece.—Mr. Michael proposed a vote of thanks to the President, not only for the address, but also for his eminent services to the Society during the time he had occupied the chair.—In this period he had given a series of addresses which will form an admirable record of the practical application of the principles upon which the optical part of the microscope was constructed.—Dr. Braithwaite having seconded the vote of thanks to the President, it was put to the meeting, and carried unanimously.—The President then introduced his successor, Mr. Wm. Carruthers, who, having taken the chair, gave a short address to the meeting.—Mr. Rousselet exhibited a mounted specimen of *Stephanoceros eichhorni*, a rotifer which is very difficult to kill with its cilia fully extended; but after many trials, Mr. Rousselet has succeeded in overcoming the difficulty, and the specimen exhibited presented a very life-like appearance.

Linnean Society, January 18.—Dr. A. Günther, F.R.S., President, in the chair.—Mr. J. C. Hill, of Sydney University, exhibited some photographs of specimens and drawings of Monotreme and Marsupial embryos, obtained by him in Australia. Of special interest were those of a newly-hatched *Ornithorhynchus*, showing a nasal caruncle and the presence of a medium maxillary tooth, the function of which is at present undetermined. Chief among the Marsupial series were photographs of *Dasyurus* embryos *in situ* and showing the free condition of the allantois. The Zoological secretary gave an account of a paper by Mr. H. M. Kyle, incident to an extended investigation of the flat-fishes now progressing. The author records in these and certain other Teleosteans the existence of "Nasal Sacs," originally observed by Owen, and more recently by Solger in the stickleback. He shows them to be secretory in the less specialised Pleuronectidæ, paired and non-secretory among the soles. Mr. George Massee read a paper on the origin of the Basidiomycetes. He remarked that Juel, a Danish mycologist, had recently demonstrated that *Stilbum vulgare*, hitherto regarded as a typical Hyphomycete, is a true Protobasidiomycete. Following up this hint, the majority of the species of *Stilbum*, some of which are the known conidial phase of species of *Sphaerostilbe*, and others existing without any known higher form, were examined, with the result that the conidial condition of *Sphaerostilbe microspora* and *S. gracilipes* proved to be identical in structure with *Stilbum vulgare*, in other words, true Protobasidiomycetes. This discovery reveals the fact that the conidial condition of an ascigerous fungus may be a true Protobasidiomycete. Similar discoveries had been made with forms of *Tubercularia* and *Isaria* known to be the conidial stages of ascigerous fungi.

MANCHESTER.

Literary and Philosophical Society, January 23.—Prof. Horace Lamb, F.R.S., President, in the chair.—Mr. C. E. Stromeyer read a paper on the origin of granite, in which he suggested that, as the melting temperatures of solids are either raised or lowered by pressure, and as the melting temperatures of felspar and hornblende are certainly raised by pressure, it may be found that the melting temperature of quartz is lowered under such conditions; if that were seen to be the case, a satisfactory explanation would be afforded why the order of crystallisation of granite-forming minerals is the reverse of the order of their melting temperatures, because at the depths below the earth's surface where these melting temperatures are reached the pressures are sufficiently great to account for variations of melting temperatures of several hundred degrees. Clerk Maxwell even assumed that the melting temperature of these minerals would be so materially raised that the earth's centre must necessarily be solid. No experiments having as yet been made on quartz, the author suggested that, if sufficiently small specimens of this mineral were experimented upon in Prof. Joly's meldometer, the molecular pressure—which for water is said to be 5000 atmospheres—would affect the melting temperature very materially, and by this means the question as to the origin of granite would be advanced one step.—A paper, entitled "Notes on some Jurassic plants in the Manchester Museum," by A. C. Seward, F.R.S., was communicated by Prof. F. E. Weiss. The late Prof. W. C. Williamson collected from the inferior oolite rocks exposed in the cliff sections south of Scarborough a number of fossil plants, of which he sent drawings and descriptive notes to Prof. Lindley, who figured a number of them in the classic "Fossil Flora." Some of these plant-remains, now in the Manchester Museum—to which they were presented by Prof. Williamson—Mr. Seward has subjected to a renewed critical examination, with the result that he finds many of them identical with fossil plants described previously under other names by Brongniart. Thus, *Sphenopteris arguta*, Lindley and Hutton = *Coniopteris hymenophylloides*, Brongniart; *Pecopteris dentata*, L. and H. = *Todites williamsoni*, Brong.; *Otopteris cuneata*, L. and H. = *Sagenopteris phillipsi*, Brong. Some other specimens figured by Lindley and Hutton under one name are, according to the author, identical with other plant-remains which had been differently identified. Thus, *Thuites expansus*, figured on Pl. 167, is specifically identical with *Brachyphyllum manillare*, figured on Pls. 188 and 219 Other Jurassic plant-remains in the Manchester Museum were also described by Mr. Seward, and their systematic position critically discussed.

CAMBRIDGE.

Philosophical Society, January 22.—Mr. Larmor, President, in the chair.—Experiments on the periodic movement of plants, Miss D. F. M. Pertz and Francis Darwin. The first part of the paper is practically a continuation of the authors' research on the artificial production of rhythm in plants, published in the *Annals of Botany*, 1891. The second part deals with a new example of periodic movement. If a "sleeping" plant is placed in a dark room after its leaves have assumed the nocturnal position, it will "awake" next morning, *i.e.* its leaves will return to the diurnal position, in spite of the darkness. In the experiment described, the procedure was varied by exposing the plants to one-sided illumination; in these circumstances the leaves are well known to assume certain characteristic oblique positions. The point of the experiment is that if a plant is darkened after having responded in the above manner to one-sided illumination, it returns to the oblique position on "awaking" next day in complete darkness.—Wealden plants from Bernissart, A C. Seward. A brief account was given of a collection of plants in the Natural History Museum of Brussels which was obtained from argillaceous rocks at Bernissart, a locality rendered famous by the discovery in 1877 of more than twenty complete skeletons of *Iguanodon*. The beds containing the Iguanodons and plants occupy a gorge, 250 m. deep, bounded on either side by carboniferous strata. A short list of species of Bernissart plants was published in 1878 by M. Dupont (*Bull. Ac. R. Belg.*, vol. xxvi. [2] 1878, p. 387), the identifications being made by the late Marquis of Saporta. Through the courtesy of M. Dupont, the Director of the Brussels Museum, the writer has recently examined the collection, which consists of numerous small fragments of typical Wealden species. The flora is represented by fragmentary samples which appear to have been transported for a considerable distance, and finally deposited in a fine freshwater argillaceous sediment. A striking feature of the flora is the scarcity of Gymnosperms; nearly the whole of the material consists of fragments of fern fronds, *Weichselia Mantelli* being by far the commonest species. The evidence afforded by the plants points unmistakably to a Wealden age, nearly all the species being identical with those described from the Wealden rocks of the Sussex coast, the north German area and elsewhere.—On the biology of Bulgaria polymorpha, R H. Biffen. The life-history of this fungus has been studied in detail by means of cultures grown on blocks of sterilised oak-wood.

EDINBURGH.

Royal Society, January 22.—Prof. Copeland in the chair.—Dr. Peddie, in a communication on the torsional constants of iron and steel, stated that he obtained for steel results similar to those already obtained for iron. A linear relation was found to hold between log b and n, where x and n are the parameters in the oscillation equation $yn(x+a)=b$, in which x is the number of oscillations reckoning from the commencement of any experiment, and y is the amplitude of oscillation. The line representing this linear relation varies in inclination with the state of fatigue of the wire; but, for the same wire, these lines all pass through one point. This gave a quantity which might be regarded as measuring a definite elastic quality of the metal. The results showed that iron was, as regards elastic properties, about six times worse than steel.—Prof. Kuenen gave a simple proof of Gibbs' phase rule, that a system of n independent substances existing in r phases in equilibrium is capable of $(n-r+2)$ independent variations. It was first shown that the total number of variables was $(n-1)r+2$. Then, by a simple application of the second law of thermodynamics to the conditions of equilibrium, it was shown that these conditions were $(r-1)n$. The difference of these two expressions gives the phase rule.—Prof. Kuenen also read a paper on the change with temperature of the coefficient of absorption of a gas in a liquid. Several experimenters had obtained evidence that in some cases the coefficient of absorption passes through a minimum as the temperature rises. Having been asked by Prof. Ramsay if the phenomenon might not be connected with the approach to the critical point, he had looked into the question, and by a comparison of the vapour-pressure curve for a mixture with the curve for the solvent in the case of hydrogen and carbon dioxide he found that the coefficient must increase as the critical temperature is approached. Then, the coefficient of absorption being in the vast majority of cases high at low temperatures, it follows that it must pass through a minimum as the temperature rises.—Mr. W. B. Blaikie exhibited his "Cosmosphere," which consists of a terrestrial globe surrounded by a concentric celestial sphere of celluloid. The instrument is useful for demonstrating a great variety of problems in astronomy and navigation. From the cosmosphere in its complete form had been evolved a slide-rule, which solved by inspection many of these problems. It consisted of two celluloid sheets inscribed with projections of the hemisphere with longitude and latitude lines. The hemispheres were accurately superposed, and the upper one could be rotated and clamped in any position relatively to the under. Mr. Blaikie demonstrated the value of the slide-rule by solving with great ease problems requiring, as usually treated in books, a considerable amount of intricate mathematics. The solutions were correct to about a quarter of a degree.

PARIS.

Academy of Sciences, January 29.—M. Maurice Lévy in the chair.—Contribution to the study of the radium radiations, by M. Henri Becquerel. Different preparations of radium salts emit rays which are equally deviated in the magnetic fields, differing only in intensity. The results are independent of the presence of air.—Note on the crystalline and volcanic rocks of Southern China, by MM. Michel Levy, A. Lacroix and Leclère. The results of an examination of the specimens collected by M. Leclère on his recent expedition in China. From Hien-Bai to Tali-Fou the rocks are chiefly felspathic and micaceous schists. In the stanniferous region of Ko-Tioú the granitic schists are traversed by tourmaline pegmatites, whilst the line of fracture of Khin-Gan is marked by the appearance of a coarsely crystalline granite containing biotite.—The Gard coal basin, by M. Marcel Bertrand. The author combats the generally accepted view that the break between the upper and lower coal-measures (Stephanian and Westphalian) is the chief fact dominating the history of the chain, and puts forward a view co-ordinating and explaining in a simple manner all the anomalies of the basin.—On the molecular volumes of some camphor derivatives, by MM. A. Haller and P. Th. Muller. The results of the densities of eighteen camphor derivatives, partly pure, and partly taken in toluene solution, are tabulated and the results compared with those calculated by Traube's formula —Materials of topological study for Algeria and Tunis, by M. Bassot. Remarks on the tenth volume of the "Cahiers du Service géographique de l'Armée."—M. Mittag-Leffler was elected a Correspondent for the Section of Geometry, and M. Bienaymé for the Section of Geography and Navigation.—The President announced to the Academy the loss by death of M. Marion, Correspondent for the Section of Anatomy and Zoology, and of Mr. D. E. Hughes.—Remarks by M. Milne-Edwards on the work of M. Marion.—Observation of the Leonids of 1899 in Russia, by M S. de Glasenapp. Although the conditions were unfavourable, owing to the state of the sky, observations of 745 Leonids were made, 394 of which were seen during the night of November 14.—On the proper motion of stars near the sun, by M. Duponchel.—On some partial differential equations, by M. H. Duport.—On the existence of second differentials of potential, by M. Henrik Petrini.—On the law of the resistance of the air to the motion of projectiles, by M. Paul Vieille. A comparison of the resistance per square centimetre observed for a cylindrical projectile, having a plane face at right angles to the direction of motion, and calculated from the formulæ of MM. Riemann and Hugomot, shows that these are practically identical. The temperature corresponding to various velocities is also calculated, and lead to the conclusion that the temperatures of meteors, even taking into account the low pressure of the medium traversed, are amply explained by the law of propagation of discontinuities.—On the decomposition of a luminous motion into simple elements, by M. Ch. Fabry.—On the constitution of white light, by M. Gouy.—Polarised light emitted by a Geissler tube submitted to the action of a magnetic field, by M. R. Dongier. The intensity of the red ray of hydrogen is distinctly reduced in a magnetic field; similar effects, but less marked, are observed with tubes containing chlorine, nitrogen, carbon dioxide, carbon monoxide and argon, the spectrum of the latter undergoing curious modifications in the magnetic field.—Time of establishing the electric spark, by MM. H. Abraham and J. Lemoine. The duration of the Kerr effect in carbon bisulphide is divided into three parts, the duration of the establishment of the luminous intensity of the spark, the time of discharge, and the time during which the carbon bisulphide preserves its doubly refracting power after the electric field has disappeared. Each of these phenomena, taken singly, has a duration of less than 1/100,000,000 of a second.—On the detection of silver in presence of mercury amido-chloride, by M. F. Leteur. From a mixture of silver and mercurous chloride it is not possible to extract the whole of the silver salt with aqueous ammonia, since when the silver chloride is small in proportion to the calomel, nearly the whole of it is retained by the mercury amido-chloride formed, even after repeated digestions with ammonia.—Action of copper upon acetylene; formation of a condensed hydrocarbon, cuprene, by MM. Paul Sabatier and T. B. Senderens. Acetylene, passed over copper heated to 200° undergoes a complicated transformation, giving a liquid hydrocarbon and a mixture of ethylene, propylene, butylene, ethane, and hydrogen. At the same time the copper becomes coated with a solid deposit, of the composition $(C_7H_6)n$, to which the name of cuprene is given.—Acidimetry of the polybasic organic acids, by M. A. Astruc.—On isopyromucic acid, by M. L. J. Simon. The author has succeeded in obtaining good yields of the isopyromucic acid discovered by Limpricht, the existence of which has been denied by Oliveri and Peratoner, by the dry distillation of a mixture of mucic acid (350 gr.) and potassium bisulphate (550 gr.). The exact constitution of the acid is not yet worked out.—Genesis of terpene compounds in lavender, by M. Eugène Charabot.—On a new method for the extraction of india-rubber contained in the bark of divers plants, especially of *Landolphia*, by MM. A. Arnaud and A. Verneuil. The bark, finely powdered and ground up with warm water, gives up the whole of its india-rubber, no chemical reagent being necessary.—Defence of the organism against the injurious effects of glandular secretions, by MM. Charrin and Levaditi.—The intestinal reabsorption of sugars, by M. E. Hédon.—The peripheric organs of the sense of space, by M. E. de Cyon.—Photogrammetric focimetry in microscopy, by M. V. Legros.—On the endomorphic transformations of santoxin andesite, under the influence of calcareous enclosures, by M. A. Lacroix.—On the non-existence of the hexagonal system, by M. Fréd. Wallerant. The author concludes from the discussion of the crystallography of nepheline, potassium sulphate and arragonite, that the hexagonal system has no real existence in nature, and has only a theoretical importance.—The geology of Southern Australia, by M. Jules Garnier.

DIARY OF SOCIETIES.

THURSDAY, February 8.

Royal Society, at 4.30.—The Spectrum of α-Aquilæ: Sir N. Lockyer, K.C.B., F.R.S., and A. Fowler. (1) On the Production of Artificial Colour-blindness by Moonlight: (2) On the Relation of Artificial Colour-blindness to Successive Contrast: G. J. Burch.—On Electrical Effects due to Evaporation of Sodium in Air and other Gases: W. C. Henderson.—On Electric *Touch* and the Molecular Changes produced in Matter by Electric Waves: Prof. J. C. Bose.

Royal Institution, at 3.—Modern Astronomy: Prof. H. H. Turner, F.R.S.

Chemical Society, at 8.30.—Victor Meyer Memorial Lecture: Prof. T. E. Thorpe, F.R.S.

Society of Arts (Imperial Institute), at 4.30.—The Projects of Railway Communication with India: J. M. Maclean.

Mathematical Society, at 8.—A Formula in the Theory of the Theta-Functions: Prof. A. C. Dixon.—Some Elementary Distributions of Stress in Three Dimensions: J. H. Michell.

Institution of Electrical Engineers, at 8.—The Standardisation of Electrical Engineering Plant: R. P. Sellon.

Camera Club, at 8.15.—Steam Turbines, Land and Marine: A. A. Campbell Swinton.

FRIDAY, February 9.

Royal Institution, at 9.—Symbiosis and Symbiotic Fermentation: Prof. J. Reynolds Green.

Royal Astronomical Society, at 3.—Anniversary Meeting.

Physical Society, at 5.—Annual General Meeting.—Address by the President, Prof. O. J. Lodge, F.R.S.

Institution of Civil Engineers, at 8.—Underground Sources of Water-Supply: D. E. Lloyd-Davies.

Malacological Society, at 8.—Annual General Meeting.—Also, Lecture on the Pearly Nautilus: Dr. Arthur Willey.

MONDAY, February 12.

Society of Arts, at 8.—The Nature and Yield of Metalliferous Deposits: Bennett H. Brough.

Camera Club, at 8.15.—Mountaineering in Switzerland and Scotland: Prof. Norman Collie.

TUESDAY, February 13.

Royal Institution, at 3.—Structure and Classification of Fishes: Prof. E. Ray Lankester, F.R.S.

Institution of Civil Engineers, at 8.—*Papers to be further discussed:* Moving Loads on Railway Underbridges: W. B. Farr.—Note on the Floor System of Girder Bridges: C. F. Findlay.——*Paper to be read, time permitting:* Corrosion of Marine Boilers: John Dewrance.

Royal Photographic Society, at 8.—Annual General Meeting.

Anthropological Institute, at 8.30.

WEDNESDAY, February 14.

Society of Arts, at 8.—The Diffraction Process of Colour Photography: Prof. R. W. Wood.

Essex Field Club (at Bishopsgate Institute), at 7.—Some New Sections in, and Contributions to, the Fauna of the River Drift of the Uphall Estate, Ilford: J. P. Johnson and G. White.—The Stalk-eyed Crustacea, their Families and Genera; with especial reference to the Essex Species: Edward Lovett.

THURSDAY, February 15.

Royal Society, at 4.30.—*Probable Papers:* The Genesis and Development of the Wall and Connecting Threads in the Plant Cell. Preliminary Communication: W. Gardiner, F.R.S.—Total Eclipse of the Sun, January 22, 1898. Observations at Viziadrug: Sir N. Lockyer, F.R.S., Captain Chisholm-Batten, and Prof. A. Pedler, F.R.S.—Photographs of Sound Waves: Prof. R. W. Wood.

Royal Institution, at 3.—Modern Astronomy: Prof. H. H. Turner, F.R.S.

Linnean Society, at 8.—Photography of British Plants: J. C. Shenstone.—A New Land Planarian from the Pyrenees: Dr. R. F. Scharff.

Chemical Society, at 8.—(1) Ammonium Amidosulphite; (2) Products of Heating Ammonium Sulphites, Thiosulphates, and Trithionate: Edward Divers and Masataka Ogawa.—Note on the Refraction and Magnetic Rotation of Hexamethylene: Dr. S. Young, F.R.S., and Emily C. Fortey.—The Combination of Sulphur Dioxide and Oxygen: Edward J. Russell and Norman Smith.—Note on the Estimation of Gases containing Sulphur: E. J. Russell.—(1) Apiin and Apigenin. II. Note on Vitexin; (2) The Yellow Colouring Principles of various Tannin Matters, VII.: A. G. Perkin.

FRIDAY, February 16.

Royal Institution, at 9.—Life in Indo-China: H. Warington Smyth.

Epidemiological Society, at 8.30.—Insanitary Property and Workmen's Dwellings in Liverpool: Dr. E. W. Hope.

CONTENTS.

THURSDAY, FEBRUARY 15, 1900.

ORIENTAL HISTORY FROM B.C. 850 *TO B.C.* 330.

The Passing of the Empires. By G. Maspero. English Edition. Pp. xiv + 814. (Society for the Promotion of Christian Knowledge, 1900.)

THE appearance of the third and concluding volume of the English translation of M. Maspero's "Histoire ancienne des Peuples de l'Orient" will be welcomed by many, for this section of the work deals with a period which is full of interest for every student of the records of the past. In the centuries which passed between the rise of the Assyrian kingdom under Assurnasirpal and the advent of Alexander the Great, vast empires sprang into being and decayed, mighty dynasties in Babylonia, Assyria, Elam, Persia, Syria, Palestine, and Egypt rose and fell, and the balance of power among the nations of Western Europe and North-East Africa changed so frequently, and in changing produced such unexpected results, that the history of that period in the world's life is as remarkable as that of any which has come down to us. Moreover, the mass of material which is now available for constructing a connected account of the last great Semitic Empires which developed and flourished before the birth of Christ is very large, and we are enabled, by means of the documents now before us, not only to read the narratives of the events which occurred in that comparatively remote period, but also to understand many of the motives which prompted the policy of some of the greatest Oriental despots to whom Providence deputed the sway of empire. Indeed, more is known of the military prowess of the kings of Western Asia than of their civilisation; but we must hope that masses of tablets inscribed in cuneiform still lie buried beneath the mounds in Mesopotamia, and that when the excavations, which will certainly be conducted in future years, have been successfully concluded, and the newly-discovered texts have been fully investigated, we may learn fuller details of the daily life and interests of the peoples whose victories in war, though only made known to us twenty-five centuries after they were won, fascinate us by their glory, and indicate by their frequency the vigour of the power which could strike so quickly and so hard.

M. Maspero divides the volume of his work now before us into seven chapters, each of which is tolerably complete in itself. The first deals with the rise of the great Assyrian Empire of Assurnasirpal, and the struggle for the possession of Northern Syria and Palestine between that king and the warlike, powerful tribes of people whose ancestors had, centuries before, withstood the might of Rameses the Great of Egypt. Assurnasirpal and his son, Shalmaneser II., once more made the Assyrian power predominant in Syria, and they gained possession of the lands over which their ancestor, Tiglath-Pileser I., about B.C. 1100, had hunted the lion of the desert and jungle, but not without a series of fierce fights. The second chapter discusses the development of the Assyrian rule under Tiglath-Pileser III., about B.C. 740, and describes the downfall of Babylon and the collapse of the Jewish power, which had been long foreseen by thoughtful Jewish politicians. By the end of the eighth century B.C., the whole of Western Asia was in the hands of the "great king, the King of Assyria.' To many the third chapter will appear the most interesting in the book; for it treats of the rise of Nineveh, and of the subjugation of Palestine by Sennacherib, and of the siege and fall of Jerusalem. The foolish idea of obtaining support from the kings of Egypt led Hezekiah and his governors of cities hopelessly astray, and this fact M. Maspero has well brought out. Had Hezekiah seen as clearly as the shrewd Isaiah, he could never have failed to discover that sooner or later his "buffer" kingdom must be crushed between those of his great neighbours Assyria and Egypt. When once Sennacherib had shown that it was possible to overrun Syria and Palestine, and to march on to the frontiers of Egypt, his successors, Esarhaddon and Assurbanipal, were not slow to follow in his footsteps. In the fourth chapter the deeds of the last two kings are described at length; and by means of their annals we can watch their victorious progress until we find Assurbanipal actually appointing Assyrians to be governors of some of the greatest cities in the delta of Egypt! But two hundred and fifty years of conquest had enriched Assyria, and made it greater than the greatest of its ancient kings had ever succeeded in making it; and under the vigorous rule of Assurbanipal, Nineveh became the centre of all the known arts and sciences, of literature, and of luxury and wealth. The warlike tribes on the eastern and southern frontiers of Assyria watched with eagle eyes the gradual relaxation of the hold which the last of its kings kept upon his tributary peoples, and they silently made ready to claim their independence when the opportunity for doing so should arrive. They had not long to wait, for before the close of the seventh century before Christ we find that the eastern portion of the Assyrian Empire had been seized by the Medes, and that Babylon and all the rich land about it had become the possession of Nebuchadnezzar II., whose character has suffered so much at the hands of the writer or editor of the Book of Daniel. Under the hand of this last-named king the Jews lost their kingdoms in Palestine, and the glory of Israel was transferred to Babylon, where it introduced a new element into the cosmopolitan population of Babylon. But Nebuchadnezzar's empire was doomed not to last, and in the reign of Nabonidus, who seems to have been interested in the archæology of his country, if we may judge by his annals, it fell into the hands of Cyrus, who captured Babylon about B.C. 538. Under the rule of the Persian or Achæmenian kings the Babylonians and Assyrians enjoyed great freedom, and the liberal-minded Cyrus gave the Jews the opportunity to rebuild their temple at Jerusalem. At the beginning of the fourth century we find the Persian rule becoming as lax as was that of the Assyrians in the days of Nabopolassar, the father of Nebuchadnezzar, and all the nations that were nominally subject to it anxiously looked for the appearance of a king who would protect their fast vanishing interests and lead them in successful battle. About the same time the power of Egypt was crumbling away, and towards the period of the birth of Alexander the Great her once mighty empire was presided over by a king who, if we may believe tradition, spent more time in studying magic than in ruling his kingdom. It is quite clear, when we look at the history of the period, that the kingdoms of the Medes, Persians, Babylonians, Assyrians, and Egyptians had become effete, and that the time for the coming of the Macedonian hero had arrived. As soon as Alexander began to attack them they fell before him like corn before the sickle, and the Oriental nations, exhausted by centuries of luxury, formed a comparatively easy prey for the warlike Greeks.

Such, in brief outline, is a sketch of the contents of M. Maspero's interesting volume. In the limits of a short notice it is impossible to discuss details, much less differences of opinion, and now the work is done it is easy to see where improvements could have been made. In matters relating to Egyptology, M. Maspero's opinion is generally sound; but it goes without saying that when he finds it necessary to refer to cuneiform literature, he is obliged to do so at second hand. There is no discredit attaching to him for this necessity when discussing native records of Babylonia, Assyria, and Persia; only the reader of the work before us must remember that M. Maspero merely repeats what experts in cuneiform have written in their books. The references are full and are honestly given; and if the reader seeks further information, it is only necessary for him to consult the authorities whose names are given in the notes, when he will be in a position to judge for himself. Whether it was wise for M. Maspero to attempt to cover such a vast field of study—a work which to do successfully involves a good knowledge of several difficult Oriental languages—is a matter which we do not care to decide; but there is no doubt that he has written an interesting book, and one which will give the reader a good general view of a most eventful period in the history of the world.

AMERICAN ICHTHYOLOGY.

The Fishes of North and Middle America: a Descriptive Catalogue of the Species of Fish-like Vertebrates found in the Waters of North America, North of the Isthmus of Panama. By David Starr Jordan and Barton Warren Evermann. Part I. Pp. lx+1240 (1896). Part II. Pp. xxx+1241–2184 (1898). Part III. Pp. xxiv+2185–3136 (1898). (Washington: U.S. National Museum.)

THIS work forms No. 47 of the *Bulletin* of the United States National Museum; the third volume reached this country last year; and a fourth, which will contain a complete table of contents of the whole work, addenda, and a representative selection of illustrations, is still to come.

The present work is, in some measure, a revision of the "Synopsis of the Fishes of North America," which the senior author published in conjunction with Dr. Gilbert in the year 1882 as No. 16 of the *Bulletin* mentioned, and which, up to the present time, has been of such great service to the student of North American fishes. In this "Synopsis," however, all fishes were excluded from south of the boundary between the United States and Mexico, and no distinct attempt was made to draw a line between the marine fishes of the Southern States and those of the West Indies. The present work has a much wider scope: the marine fauna is extended southwards to the equator, and that of the freshwater to the Isthmus of Panama; the whole of the West Indies, the Caribbean Sea, the waters of the Gulf Stream, and the Galapagos Archipelago are included. Towards the north, the fishes not only of the Alaska Sea, but also those which are known from Kamtchatka and the Kurile Islands, form part of the work. Thus, the number of species that had been described in the "Synopsis" is nearly doubled, and amounts to 3127 in the present catalogue, besides about a hundred which are added in a supplement at the end of the third volume. The pagination runs continuously throughout the three volumes, a plan the advantage of which is doubtful, as, in referring to a species, it will not enable us to dispense with noting the volume in addition to the page. Some 260 pages of the last volume are taken up by an artificial key to the families of "true fishes," a glossary of terms, and a general alphabetical index; the latter seems to have been prepared with great care, and has never failed us on the occasions we had to refer to the work.

The mode of treatment of the subject is uniform throughout the work. A diagnosis is given of each of the genera and higher divisions, and followed by a key to their constituent parts. The species are concisely, sometimes more fully, described, either from actual specimens or from previously published accounts, with a few notes on their geographical range or their economic importance. We shall subsequently refer to the synonymy.

It will be apparent from these notes that the work initiated by Dr. Jordan was a serious and very laborious undertaking. It could be successfully carried through only by men who through long and patient inquiry and study had acquired an intimate acquaintance with both the fishes and the literature of their country, who had at their disposal the large accumulations of specimens in the museums of the United States, and who at the same time possess in a rare degree the gifts of methodical work and energetic application. These conditions were amply fulfilled in Dr. Jordan and his coadjutor. Dr. Jordan seems to have commenced his ichthyological studies as far back as 1875, and we see from a list dated 1890 that in the intervening fifteen years he published more than two hundred papers on North American Ichthyology, many of them of considerable extent. Of his pupils and colleagues he imbued some with his own love of ichthyology, and when we consider that his duties as President of the Indiana, and later of the Stamford University, and as Commissioner of the Fur Seal Fisheries, must have taxed his time to the utmost, we cannot be surprised that he found it beneficial for the progress of the work under review, to join forces with Dr. Evermann, himself an author of many original papers on American fishes.

Two features of the work characteristic of American Ichthyology, to which the European student, at any rate, the writer of this notice, will be scarcely reconciled, obtrude themselves too forcibly to be passed over in silence. One is the excessive subdivision into families and genera: the 3127 species are relegated to no less than 223 families and 1077 genera, leaving out of consideration the subgenera which are not numbered, and which we are afraid to count. Then, the authors have adopted a set of rules which, when applied to ichthyology, make the greatest possible disturbance in previously accepted nomenclature. So-called rules of priority are made retrospective, uniformly and pedantically: reasons which induced elder authors to select certain names for their genera are set aside, and not even Linnæus himself is allowed to change his own names; no regard is to be paid to the character and spirit of a work in which the names take their origin; a name by a Rafinesque or Swainson deserves as much consideration as one given by Cuvier or Rüppell. Both these methods result in a nomenclature which is more or less difficult to grasp by a European systematist.

Finally, we have to refer to the manner in which the authors have dealt with "synonymy." This seems to us too scanty to satisfy the wants of the student either of systematic ichthology or of the American fauna. The authors announce as the principle by which they have been guided, to give "enough synonymy to connect this work with other descriptive works, and no more"; and of such works they mention the first descriptions that have been given of supposed new species or genera, the "British Museum Catalogue of Fishes," Jordan and Gilbert's "Synopsis," and "other works in which special information is given." No objection could be taken to the adoption of this principle, but we fail to see that the authors have strictly adhered to it. What we expect in a work specially devoted to a fauna, is full reference to every paper in which our knowledge of the species of that fauna has been advanced in some respect. Considering the vast amount of ichthyological literature scattered through the American periodicals, a more perfect collection and arrangement of references would have been of great benefit to the student, though, we admit, a work of considerable labour.

We will mention only one case to show that the scantiness in their references may even cause inconvenience to the student. The ichthyological parts of the Reports of the United States Survey Expeditions were prepared by Charles Girard, and published about the middle of the present century; they form a considerable portion of those quarto volumes, and were very liberally illustrated. A great number of forms were described in them, and we learned from them at any rate that a large contribution to our knowledge of the American fauna had been made in the collections of those expeditions. Unfortunately, the treatment of the subject by the naturalist mentioned was not satisfactory, and it seemed most desirable that the typical specimens should be re-examined and the descriptions revised. What position, now, do these reports take in the "Fishes of North and Middle America"? Indeed, the names of the Girardian species appear therein without exception, many as synonymous with other species, a part as valid species, but reference to an examination of the several types is made only in some of the cases. Thus, of eighteen species described by Girard as *Alburnops* and *Moniana*, reference to a type is made only in eight. Further, the authors refer only to preliminary descriptions in the *Proceedings* of the Philadelphia Academy, rarely to the enlarged edition in the "Reports," and almost every mention of the numerous illustrations prepared and published at the expense of the United States Government is omitted. Probably, a great number of those types, which were deposited in the Museum of the Smithsonian Institution, are lost by this time, thus depriving the identifications made by Drs. Jordan and Evermann of much of their authoritative value or finality. Possibly, the authors consider those reports, or at least the illustrations, not reliable enough to be safely quoted: an opinion expressed by the writer of this notice some thirty years ago; but it would have been well if the authors had given some explanation of the matter in their preface or introductory note.

A work like the one under review, composed at it is of an immense amount of technical details, which only too frequently have to be gathered from imperfect or even misleading sources, cannot fail to lay itself open to criticism on points of minor importance. But it would be most unjust to the authors to allow such real or supposed imperfections to detract from the high merits of their work. It was one of the greatest desiderata in Ichthyology. It is a faithful representation of our present knowledge of American fishes, and will form the basis for all researches in that field for some time to come. For how many years? Those are, in our experience, the most useful systematic works which most stimulate the activity of new workers, and, as a natural consequence, soonest yield their position to the progress of discovery and the accumulation of new fact. We anticipate that the "Fishes of North and Middle America" will prove to be one of those works, and hope that, when once a new edition will be required, the strength and knowledge of the authors will still be available for this task. Next to the authors, science is greatly indebted to the Secretary of the Smithsonian Institution for having undertaken the publication of such an extensive work, following so soon the appearance of "Oceanic Ichthyology." The publication of these two monumental works in Ichthology stand now to the credit of the Smithsonian Institution. A. G.

ASTRONOMICAL PHOTOGRAPHY.

Die Photographie der Gestirne. Von Dr. J. Scheiner, a.o. Professor der Astrophysik an der Universität Berlin, und Astronom am Königl. Astrophysikalischen Observatorium zu Potsdam. Pp. iv + 382; 1 plate and 52 figures, with an atlas of 11 plates. (Leipzig: Engelmann, 1897.)

DR. SCHEINER'S book has been before the public for some time, and it is to be regretted that we have not had an earlier opportunity of calling attention to its contents and expressing an opinion on its merits. For a book of this character cannot but grow out of date as processes become obsolete, and as improved methods are adapted. Astronomical photography is essentially a progressive science, and when Prof. Scheiner compiled this book, many of the methods employed were admittedly tentative and not accepted beyond dispute. The direction of the further development of photographic practice was not decided, and even the instrumental equipment best adapted to its ends was, and still is, no settled with certainty. This is no proof that such a book was not needed, nor does it imply that Prof. Scheiner's attempt was hasty and ill-advised; but it does affect the point of view from which the book is to be regarded at the present day. A second edition is needed to bring the matter up to date in all particulars, and this will no doubt be forthcoming; but in any case the book will stand as a valuable record, supplied by an expert, of the methods in which the problem of photographic production and measurement was applied before familiarity and experience had shaped the most suitable method of treatment. The author is already favourably known as a writer of high-class text-books dealing with practical work in the observatory, and we can have no hesitation in saying that this book will add to his reputation and that of the Potsdam Observatory, whose staff have from time to time issued a welcome series of manuals.

Dr. Scheiner treats his subject under three divisions. First, the production and utilisation of photographs; secondly, photographic photometry and the nature of the photographic image; and thirdly, the history of astronomical photography and its results. This arrangement seems satisfactory, and permits the author to group his facts clearly about the main points at issue, but we doubt whether in the future so much importance will be attached to photometrical measurement, as the prominence here given to that subject seems to intimate. There are not wanting signs that we shall be content to guess the magnitude of a star from its appearance on the film, just as we judge of its brilliancy in the telescope, though there will always remain specialists who will be content to gather their facts much more slowly, and possibly with greater accuracy, by rigorous measurement of the disc.

In the first part we have some valuable remarks on photographic technique, in which the author s practical knowledge is shown to great advantage. Of the different methods of development to produce definite results, probably we know as much as we ever shall, but it is not easy to convey the necessary information by precept. No student would, however, content himself with mere book knowledge, but would have recourse to actual manipulation in the laboratory, and the value of this preliminary chapter would be forced upon his attention. The second chapter contains a discussion of the ordinary forms of object glasses and mirrors suitable to photographic work, and attention is called to the errors that arise, whether from the construction of the optical parts, or from the manner in which the image is received on the sensitised film. The remarks are clear and pertinent; but if the chapter were to be written anew, it would probably be felt desirable to dwell more on the photographic doublet, and to contrast the amount of its distortion with that of the ordinary object glass. The peculiarities and advantages arising under certain circumstances from greater variation in the focal length to the aperture might have to be considered, and the peculiar forms of cœlostat now in use would demand more attention.

In the next and most important chapter, on the methods of measurement and reduction, the author has adhered perhaps rather too strictly to the historical than to the practical side of the question. It would have been, we submit, of greater service to the astronomical student to have possessed in the fullest detail that method which experience has shown to be of the greatest utility, illustrated by a numerical example, than the reproduction of a variety of processes which have not met with general approval. And since Dr. Scheiner has already published no insignificant portion of the catalogue of that part of the sky allotted to him by the International Committee, his experience would have enabled him to speak with authority on this vexed question of reduction. Or, disliking this method of selection, he might have worked out an example by the different methods, and thus furnished us with the means of exercising our judgment on this important question. The historical student may hereafter be very grateful to him for collecting the methods, which were suggested in the early days, before the photographs existed in any considerable numbers and ingenuity could run riot, untrammelled with the weight of the heavy numerical calculations that must come after. He may choose to weigh and contrast the methods of Bakhuyzen and Jacobi for rectangular, with that of Gill, arranged for polar, co-ordinates. He may linger over the ingenious device of M. Lœwy, or take refuge in the more practical method due to Prof. Turner; but in any case he would have been more grateful to the author if he had introduced a uniform notation, and so made the different methods more easily comparable. By simply reproducing the methods as they are given in the original memoirs, Dr. Scheiner has missed an excellent opportunity for rendering an essential service to the cause of clearness and order. This section is apparently complete up to the time of compilation, but various improvements have been suggested since, which could not possibly find a place here. We are probably far from hearing the last word on this subject of reduction, and possibly still further from the adoption of any method that will commend itself to all the participants in the international scheme, and ensure, or at least attempt, a uniform standard of accuracy. In the last chapter of the first section the author deals with the automatic registration of star transits and of latitude determinations by means of photography. These attempts are admittedly in an experimental stage, and some of the instruments by which it s proposed to compass the desired end still exist only on paper. The Observatory of Georgetown appears to be leading the way, but we have no figures by which we can judge of the measure of success that has attended the application. Prof. Turner's proposed form of photographic transit is apparently of too recent a date to obtain a critical notice; the same remark applies to Sir R. Ball's telescope at Cambridge.

On the subject of photographic photometry, which forms the second section of the book, the author is quite on his own ground, and, writing with authority, he gives us the most complete exposition of the methods which has yet appeared. It is a subject which early attracted attention, when photography first attacked the question of astronomy of position, since many of the decisions of the International Committee were founded upon more or less imperfect knowledge of the growth of the image, and the relations between the time of exposure and the magnitude of a star photographed in a given time. Much information, not all of which was consistent, was rapidly accumulated, and the author deals with this mass of material very satisfactorily. Some of the formulæ which have been suggested, and which are here quoted, for determining the radius of the star image, or deriving the photographic magnitude, were admittedly only convenient methods of interpolation, and any attempt to show that such formulæ possess a physical basis is of doubtful policy, and will hardly be everywhere accepted; but the practical value of the chapter is high, and gains immensely from the fact that the author incorporates much of the results of his own original investigations.

In the history of photography we come naturally upon more popular ground. We have an instructive, and on the whole complete, picture of the achievements of photography applied to the heavens. The section treats each object, such as the moon, the sun, &c., separately, the history of each being treated independently of the others. The later results obtained from recent eclipse expeditions are of course wanting, and possibly a little too much space is given to the Transit of Venus. The photographic reproductions that illustrate this section are excellent, and make a handsome addition to a very valuable treatise. A bibliography accompanies the work, which already needs extension, so frequent are the contributions to this attractive development of astronomy.

OUR BOOK SHELF.

Euclid's Elements of Geometry. By Charles Smith and Sophie Bryant. Pp. vi + 127. (London: Macmillan and Co., Ltd., 1899.)

THIS book deals only with Euclid's Books III. and IV. Although the original order of the propositions has been maintained, there are many divergences as regards the treatment of his methods. In the modern teaching of Euclid's propositions the student is not so restricted as to particular methods of solution as long as the method he employs is accurate. The learning of propositions by heart is, we hope, a relic of the past, and the compilers of this work encourage the ingenuity of the student. In Book III. the method of superposition is used with advantage. In addition to numerous exercises, the appendix contains many interesting and important theorems and problems. As a school course this edition should be found useful.

A First Book in Statics and Dynamics. By Rev. J. R. Robinson. Pp. viii + 98. (Longmans, Green and Co., 1899.)

THIS book is intended only for beginners, and specially for those who are preparing for the matriculation in the University of London and for the elementary stage of South Kensington examination. For this reason only a limited knowledge of Euclid, algebra and trigonometry is assumed in the treatment of the subject, and the text is accompanied by numerous representative examples. The author's large experience in teaching the subject has enabled him to place clearly before his readers portions which are usually stumbling-blocks for the beginner, and the numerous clearly-printed diagrams add greatly to the explanations in the text.

Life and Happiness. By Auguste Marrot. Pp. 90. (London: Kegan Paul, Trench, Trübner and Co., Ltd. Paris: Libraire Fischbacher.)

HAPPINESS is too much a matter of temperament for the perusal of these chatty little essays on the laws of health, the development of the mind, and similar subjects, to very much affect the reader's share of this desirable possession. But there can be very little doubt that the observance of some of the rules for the preservation of health here laid down will do a great deal in removing definite causes of physical discomfort—and in this way unhappiness may, at least, be diminished.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

On the Carriers in the Kathode Rays.

IN a former communication to these columns of NATURE (January 19, 1899), I showed that an upper limit for the density of the matter composing the kathode rays can be deduced from the fact that a shaft of rays emitted from a plane kathode retains its cylindrical form. The result arrived at was that the density must be small compared with 10^{-15} grams per cubic centimetre. In a subsequent note (February 16), I called attention to some results of E. Riecke, which seemed to indicate a value as low as 10^{-20} grams per cubic centimetre.

The researches of Prof. J. J. Thomson have now put us in possession of information as to the mass of the individual carriers. Using the value which he has given (*Phil. Mag.* December 1899) for the mass of a "corpuscle" in connection with the above estimate of the density of the stream, we can obtain a limiting value for the number of corpuscles per cubic centimetre. I find that this leads to a number very much smaller than that indicated by the kinetic theory for the average number of molecules per cubic centimetre in the vacuum tube.

We have, in round numbers, 2×10^{-20} for the charge on a corpuscle in electromagnetic units, and 6×10^{6} for the ratio of charge to mass, giving $\frac{1}{3} \times 10^{-26}$ grams for the mass. If then, the density is small compared with 10^{-15} grams per cubic centimetre, the number per cubic centimetre must be small compared with 3×10^{11}. In Meyer's "Kinetic Theory of Gases" (English translation, p. 333) the number of molecules present in a cubic centimetre of gas at atmospheric pressure is given as 60×10^{18}, so that in the vacuum tube the number would be of the order of 10^{16}. Thus the carriers in the kathode stream are very sparsely scattered as compared with this average.

Another point which may be worth mentioning arises in connection with Prof. Thomson's suggestion, that the mass of the corpuscle may be of electrical origin. He shows (*loc. cit.*, p. 563) that, in order to account for the effective mass in this way, the radius of the corpuscle, supposed spherical, would require to be of order 10^{-13} centimetre. The various lines of argument employed to arrive at an estimate of the size of a *molecule*, or of the "molecular sphere," agree in making its dimensions comparable with 10^{-7} centimetre. In order that a molecule of this size should be built up of, say, two atoms, each consisting of a complex of even a thousand corpuscles of radius 10^{-13} centimetre, these ultimate elements of a molecular structure would require to be very widely spaced in proportion to their dimensions. W. B. MORTON.

Queen's College, Belfast, February 6.

Drunkenness and the Weather.

NATURE, in its issue for November 16 (1899), did me the honour of devoting considerable space to a modest publication of mine, "Conduct and the Weather," a fact to which I feel free to allude, since the reviewer found so little to praise. One remark of his, however, was suggestive to one "bound hand and foot by the demon of statistics." In commenting upon the indicated excesses of arrests for assault and battery during the hot summer months he says, "In our own ignorance we were rather tempted to attribute these lapses of good conduct to too free indulgence in alcoholic beverages in the hot weather." Here was a cue worth following out. The data were available, why not use them?

The plan followed was the same that found so little merit in the eyes of the jocular reviewer, but even at the risk of tempting him to again couch his lance, I shall outline it somewhat in detail. The general plan is that of comparing the normal daily prevalence of any abnormality of conduct with its prevalence under definite weather conditions. It necessitates a daily record of the crime to be studied, and some daily record of the weather conditions.

In the study of drunkenness, the data were taken from the records of the New York City Police Force. From them were copied the exact number of arrests for that crime for each one of the 1095 days of the three years 1893-94-95; 44,495 in all (males). The necessary meteorological data were obtained at the New York City Station of the United States Weather Bureau. There were copied the mean temperature, barometer and humidity, the total movement of the wind, the character of the day and the precipitation for each of the days of those same three years. Then, by a somewhat laborious process of tabulation, excesses or deficiencies in the occurrence of arrest for drunkenness were determined. In the accompanying diagrams these are shown for the different months of the year, and for definite conditions of temperature. In each, the heavy horizontal line represents the normal occurrence, distances along the abscissa line the months of the year and definite temperature groups, while ordinate distances show excesses or deficiencies in percentages of the expectancy. The extremes of the temperature curve are omitted where the probable error equalled or exceeded the discrepancy in occurrence.

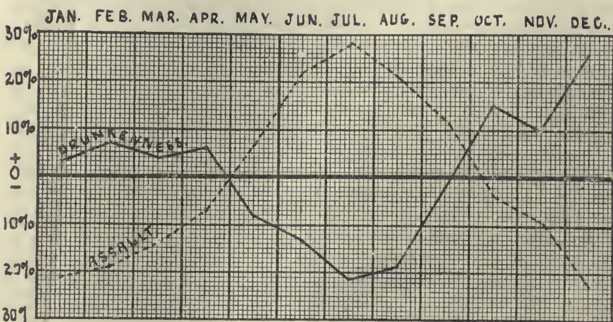


FIG 1.

As may be seen from both of the diagrams, the surmise o the reviewer with respect to the use of intoxicants is erroneous. In fact, their showing is somewhat surprising. As shown by Fig. 1, the prevalence of intoxication during the cold months is much in excess of that for the warm ones, December giving the police-court 47 per cent. more business from its use than did July. The physiological problem which this fact might suggest, as to the effect of equal quantities of alcohol taken under different conditions of temperature, I do not here attempt. If there is not a marked difference in this respect, our figures would indicate that much more liquor was drunk in the City of New York during the colder months of the years studied than during those of the other extreme of temperature. We claim no broader bearing for the problem; but even this is interesting.

The difference might be due either to social or meteorological influences. Under the first we may consider the effect which certain holidays might have upon the prevalence of drunkenness. Undoubtedly some days of the year are made the occasion of a drunken debauch by persons so inclined, and Christmas is one of them. But the 4th of July is perhaps just as much of a favourite for such diversion to us in America, a fact which would swell the numbers for that month. This, however, fails to show any such effect. In fact, a careful inspection of the record, although showing a slight increase of drunkenness for the festivals mentioned, proves it to be too small to account for the monthly showing. The excesses for the cold months are due to a large daily occurrence, and the deficiencies for the cold ones to the reverse conditions.

Another social condition which might effect the results is the exit from the city for the summer of some who are brought with some regularity before the bar of the police-court during the rest of the year. My study of assault and battery would, however, lead me to believe that the influence of this exodus is not great. It would be reasonable to infer that arrests for these crimes and for drunkenness would, for the most part, be made from the same social stratum, and that social conditions which would influence the prevalence of one would have the same effect upon the other. That is, if public drunkards were gone in any numbers from the city, public brawlers would be also. Yet this is precisely the reverse of what our study of assault has shown. Upon Fig. 1 I have shown, by means of a dotted curve, the arrests for this crime for the same years. It shows as marked excesses for the warm months as we have deficiencies for drunkenness for that season, a fact which would lessen the validity, if not entirely negative the weight of any migration theory which might be brought to bear upon the problem.

The third hypothesis is that of the direct effect of the peculiar meteorological conditions, and it seems to be the most plausible. Of these, temperature is the only one which we shall here consider. As shown by Fig. 2, the relation between expectancy and occurrence was worked out for each of the temperature groups indicated at the top, and represented by the curve. Low temperatures made business for the police judge, and high ones lessened his labours. Of course, if our conclusions in the preceding paragraph on occurrence were erroneous, those from this figure would be also. In that case, deficiencies for high temperatures shown here would be but concomitant variations.

The summer is hot. If there be but few arrests for drunkenness during the summer, there can be but few during high temperatures. On the other hand, if high temperatures so affect the individual that less stimulant is demanded than during those which are lower, we have here the cause of the peculiarities shown in Fig. 1. There are many reasons for believing that this is the case. In the first place, there is every reason to believe that the vitality of the body is lower in cold weather than during that which is moderately warm. This in itself would influence the demand for stimulant. A "wee drappie" is taken when *needed*, and for many this means a drunk. No doubt many of the *habitués* of the police-court as prisoners struggle against their tendencies to drink, knowing the consequences. When vitality is great, they do so with success. For days, and perhaps weeks, they are winners, but the time comes when the fight is too severe, and they succumb. That was on the day when vitality was at its lowest ebb, and the cold contributed to that condition. The poor fellow was cold; he was weak. The stimulant would give him immediate though temporary relief. He took it, and our figure shows the result.

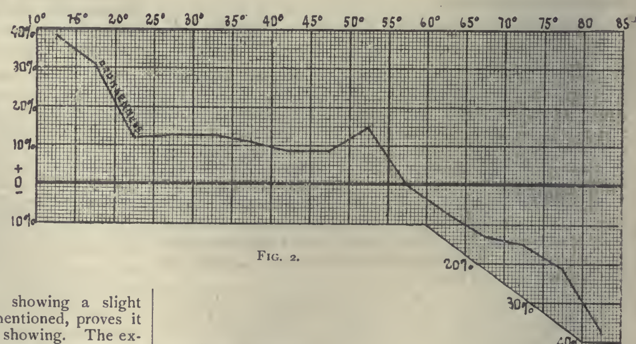


FIG. 2.

In conclusion, I would say that I recognise the limitations of this method of study. By its very nature, each meteorological condition is treated as if the others were not at the same time present. This would, however, introduce no error unless two or three tended to vary concomitantly. In that case, the effects of one might be imputed to another. We recognise, too, that a study of drunkenness does not have quite the bearing upon the drink problem that one based upon the consumption of liquor would have, but perhaps is not entirely without value. It certainly is not if it tends in the slightest way to throw the temperance problem into the hands of social reformers. Better heated tenements, warmer overcoats, and more nourishing food may have more to do with it than we think.

EDWIN G. DEXTER.

IF the writer of the notice, by any remarks of his, has given annoyance to Prof. Dexter, whose industry and careful compilation of facts have never been called into question, he would greatly regret it. But in so far as that notice has been the means of procuring from the author a most interesting letter, he can only congratulate himself.

One might call attention to many significant conclusions that could be drawn from Prof. Dexter's curves; but perhaps the most prominent is that, apparently, the greatest number of assaults are committed when the populace is the most sober. This is an entirely unexpected conclusion. In this country, we have been repeatedly told that drunkenness is the main cause of crime, especially of crimes directed against the person; and yet a careful elaboration of statistics, compiled by an eminent authority, completely demonstrates the fallacy of such an argument when applied to the City of New York.

THE WRITER OF THE NOTICE.

Deceptive Bibliographic Indications.

AUTHORS' reprints of scientific papers are indeed a boon to the worker in science, especially to him who is distant from a large library. But their usefulness to the recipient who is himself a writer of works, and not a reader only, depends to a large extent on whether the reprints are or are not provided with correct and complete bibliographical indications of their origin. Occasionally one gets a reprint without date, with no reference to the original volume, page, and plate numbers, and even it may be without the name of the periodical from which it is an extract. But in the majority of reprints distributed nowadays, an attempt has been made to give the requisite information. Success is not often attained, it is true; still one is grateful for the good intention.

The imperfections hitherto mentioned are only too easily observed, and the task of making them good, though wearisome, is not impossible if one lives long enough. But among the reprints sent to me during the last two months are numerous instances of an error more difficult to detect, and more annoying in its results. To all appearance the reprints in question give the requisite bibliographic indications, their paging seems to be that of the original, and the type shows no signs of having been disturbed. But in each case one or more of these appearances is a specious falsehood. Here are some of the misstatements observed. A reprint paged 141–147 originally appeared on pp. 142–148. A paper that occurs on pp. 170–175 of the publishing society's *Bulletin* has had the type spaced out so that the pagination of the reprint is 170–176. A reprint has the original pagination carefully given in [ ] on each page, and runs from 367 to 370; the original pages were 367–371, and half of every page has been shifted to the preceding. Sometimes the wrapper of the reprint gives one set of numbers, while the pages themselves bear another set, each purporting to be the original.

The last case is not so objectionable, since it is clear there is a mistake somewhere. But in the other cases it is only by chance that one detects the error. Each seems trivial in itself, and a single instance hailing from some petty local club would be passed over with a laugh and a grumble. But examples have come to me alone, during a few weeks, from the publications of the German Geological Society, the Zoological Society of France, the Natural History Museum of Paris, the International "Congress of Zoology," the Geological Survey of Canada, and the *Geological Magazine*.

This contempt for veracity is chargeable to the printer, not the authors; and the remedy lies in the hands of the editor. If the editors of our scientific publications would but realise the perpetual inconvenience that is caused by a little want of thought, and would but give clear and definite instructions to their printers to place the required bibliographic indications at the head of each reprint, to retain original pagination, and never to shift the type without duly stating the fact—then the amount of time saved by the numerous workers who have to rely upon authors' copies would be far greater than most people have any idea of.

F. A. BATHER.

January 31.

Specific Heat of Marble.

IN 1898 we published, in the *Proceedings* of the American Academy of Arts and Sciences, a paper containing a discussion of certain mathematical problems arising in the study of the flow of heat in prisms, together with an account of an investigation of the conductivities of a number of specimens of glass and of marble.

In this paper we called attention to two groups of fine-grained marbles, which have conductivities (nearly independent of the temperature within wide limits) of 0·0068 and 0·0076 respectively, while Carrara Statuary marble and many of the British marbles—as Messrs. Herschel, Lebour and Dunn have shown—have conductivities of only 0·0051.

Within a few weeks we have found time to determine the specific heats of all our marble blocks, and have obtained the results given in the table which follows.

These specimens, each of which is described in our former paper, had been lying untouched in the warmed laboratory for about ten months, and were, therefore, neither abnormally moist nor abnormally dry.

Variety of Marble.	Sp. Gr.	Conductivity.	Average sp. ht. between 25° C. and 100° C.	Sp. ht. per unit volume.
"Carrara Statuary"	2·72	0·00501	0·213	0·579
" "		0·00509		
"Mexican Onyx"	2·71	0·00556	0·211	0·572
"Vermont Statuary"	2·71	0·00578	0·210	0·569
"American White"	2·72	0·00596	0·214	0·582
"Egyptian"	2·74	0·00623	0·212	0·581
"Sienna"	2·68	0·00676	0·215	0·576
"Bardiglio"	2·69	0·00680	0·218	0·586
"Vermont Cloudy White"	2·75	0·00681	0·210	0·578
"Vermont Dove Coloured"	2·74	0·00684	0·208	0·570
"Lisbon"	2·75	0·00685	0·211	0·580
"American Black"	2·68	0·00685	0·214	0·574
"Belgian"	2·75	0·00755	0·206	0·567
"African Rose Ivory"	2·75	0·00756	0·212	0·583
"Tennessee Fossiliferous"	2·71	0·00756	0·214	0·580
"Knoxville Pink"	2·73	0·00757	0·212	0·579
"St. Baume"	2·70	0·00761	0·210	0·567

The results of twenty-two determinations made between different temperature limits with a number of pieces of Carrara Statuary marble artificially dried at a temperature a little above 100° C. are well represented by the following formula

$$Q = 0{\cdot}1848(t-25) + 0{\cdot}00019(t-25)^2,$$

in which Q represents the amount of heat in calories required to raise one gramme of this *dry* marble from 25° C. to the temperature t.

Jefferson Physical Laboratory, Harvard University, U.S.A.

B. O. PEIRCE.
ROBERT W. WILLSON.

The Coccidæ of New Zealand.

MR. H. FARQUHAR, in your issue of January 11, p. 247, has some interesting remarks on the Coccidæ of New Zealand, which, however, need to be slightly modified in the light of recent researches. The genera of Coccidæ peculiar to New Zealand are as follows:—

(1) *Phenacoleachia*, Ckll. (type *Leachia zealandica*, Maskell). One species. This is an extremely distinct genus, and may be regarded as the type of a distinct subfamily (Phenacoleachiinæ), differing from the Coccinæ by the compound eyes of the male, wherein it is allied to the Ortheziinæ.

(2) *Coelostomidia*, new name (*Coelostoma*, Maskell, not of Brullé, 1835, nor *Coelostomus*, McLeay, 1825). Five species. All the supposed species of *Coelostomidia* found in Australia belong to *Callipappus*.

(3) *Lecanochiton*, Maskell. Two species. A very distinct genus.

The two following genera were thought peculiar to New Zealand, but are now known from elsewhere :—

(1) *Eriochiton*, Maskell. The only species referred to this genus from elsewhere than New Zealand is *E. cajani*, Maskell, which is in reality a *Ceroplastodes;* but Mr. E. E. Green (in litt.) tells me that he has just received a genuine *Eriochiton* from Australia.

(2) *Solenophora*, Maskell. This is now known from North America and Ceylon.

I have no doubt at all that *all* of the truly native *species* of New Zealand Coccidæ are strictly endemic. The only apparent exception is that of *Eriococcus multispinus*, Maskell, which is said to occur in Australia on *Acacia ;* but the Australian form was separated by Maskell as a distinct variety (var. *laevigatus*), and is doubtless a valid species. T. D. A. COCKERELL.

Mesilla Park, New Mexico, U.S.A., January 26.

The Fitting of the Cycle to its Rider.

THERE is much interesting theory in your paper on the bicycle fitted to the rider in crank and gear, by Mr. Crompton (p. 87). But what is the practice ? I agree with Mr. Crompton's theories, if a slight modification be made. I think that the crank-length should be proportional not only to a man's thigh-length, but to the weight of a man's leg. The loss of power in a bicycle, as soon as it travels fast, arises from the loss of momentum at each up and down stroke of the leg according to the well-known equation :—

$$M = m.v.$$

Where M = momentum.
m = mass.
v = velocity.

A slender-built man with a light, thin (even although long) leg, can afford a higher value for v because his constant for m is low.

Not so the strongly-built man with a high constant for m. He must keep his velocity down, or M rises in value and there is a loss of power at each stroke when travelling fast.

Let me give an illustration. A few days ago I was riding an 8″ crank and 84 gear machine rather fast on a down grade. I travelled swiftly but easily. In front of me was a low-geared cyclist, his feet flying round at a high speed, the bicycle frame quivering with the velocity of his strokes, the cyclist breathing hard with his exertions. As I overhauled him I heard a pedestrian remark against his scorching. Certainly he was scorching in the sense of strongly exerting himself, but his exertions were mainly expended in the lost momentum of each stroke. The only remedy for this is a high gear.

Admitting the advantage of a high gear, the necessity for long cranks follows, otherwise the cyclist has not the power to face hills, winds, or bad roads. Two inches increased crank-length gives an enormously increased power of propulsion. I find that with 8″ cranks and 84 gear I can climb hills easier than with an ordinary roadster, say with 6½″ cranks and 64 gear.

The increased comfort and safety on a bicycle fitted as Mr. Crompton recommends are very remarkable and pleasing. The ampler free motion does away with most leg-weariness and saddle-soreness. The long, powerful cranks give one a command over the bicycle that is equally satisfactory up-hill or down-hill. One gets over the ground with a long, easy swing. Compared with the ordinary bicycle, it is like the outside edge and the inside edge in skating ; or like rowing with sliding or fixed seats.

For track riding it seems possible that short cranks and high gears may give the best return for the muscular power exertion expended, since v is kept down by the high gear, and m probably represents the limb of an active young athlete weighing perhaps 10 stone. And, since there is little resistance to be overcome, the long crank may represent an unnecessary high lift of the leg.

Conversely, the greatest advantage is to be derived from long cranks and high gears in a hilly and difficult country, or where the winds are strong, as here at the Cape, and when the rider has a heavy, powerful leg.

Long cranks and high gears necessitate an alteration to the frame of the bicycle that is troublesome to makers. And hence, I suppose, the curious tabooing of the subject in the too-often interested bicycle literature of the day. D. E. HUTCHINS.

Kolàra, Kenilworth, nr. Cape Town, January 7.

Telephones and Lightning Discharges.

IN NATURE of February 8, Sir G. G. Stokes suggests an arrangement for hearing a lightning flash in a telephone. To hear the corresponding earth current, it is only necessary to put a telephone in connection with the gas and water pipes of a house. These pipes seem to suffice to entrap the corresponding earth currents, which practically enable the listener to hear the lightning. Flashes invisible in the daylight are quite noisy in the telephone. A. R. HUNT.

Southwood, Torquay.

THE GEOGRAPHY OF EUROPE.[1]

EUROPE is undoubtedly the most refractory of the great divisions of the earth to get within the limits of a geographical treatise. The mass and variety of data of high scientific accuracy are so overwhelming that it is impossible for any one man to make himself acquainted with even a small fraction of the whole, and the compilation of a book on Europe, even on the generous scale which two volumes permits, cannot in the nature of the case be much more than a compilation of earlier compilations. In unskilled hands it could not fail to become a heterogeneous collection of facts ; but Mr. Chisholm has brought to bear experience and expert knowledge in the choice and co-ordination of his material, and the result is a credit to British geography. It shows a great amount of reading amongst original, and sometimes not very accessible, works in many languages, which few compilers would have considered it necessary to undertake in preparing a volume in a popular series. Numerous references are given throughout to the sources of information, and we hope that the second volume will be furnished with a bibliography of the best works dealing with Europe as a whole, and with its larger regions.

The plan of the "Compendium" has always been to take the country rather than the continent as the unit, and by doing so its scientific character has suffered, because the only possible element of unification has been ignored. Mr. Chisholm has endeavoured, with considerable success, to improve the plan of his volume by an excellent introductory chapter dealing with Europe in general, although this, to our mind, is too short ; while the individual countries appear to be described in disproportionate detail. In a series obviously intended to convey information rather than to inculcate geographical principles this disproportion is, however, inevitable, and it is doubtless recognised more fully by the author than by the critic.

The guiding principle which has been kept in view throughout all the descriptions of countries is that the character of a country at the present time is due to the influence of the physical structure of the land upon the historical development of the nation. Hence a good many geological and historical facts are mentioned ; but they are mentioned, not as facts for their own sakes, but as working causes accounting for the present adjustment of peoples to lands. The application of this principle has led Mr. Chisholm to commence his detailed description with Italy, which he treats with great fulness on account of its historical importance. He gives to the central Mediterranean peninsula nearly twice as much space as to Russia or France, and a third more than to the German empire. Interesting as Italy is, and vast as was its influence on all Europe, we confess that we should

[1] Stanford's "Compendium of Geography and Travel (New Issue), Europe. Vol. I. The Countries of the Mainland (excluding the North-west)." By Geo. G. Chisholm, M.A., B.Sc. Maps and Illustrations. Pp. xx + 736. (London: Edward Stanford, 1899.)

hesitate to give it so marked a pre-eminence from the geographical point of view.

Considerable stress is laid upon the importance of town-sites and the growth of towns. This is as it should be; and we would gladly have seen the peculiarities of every important town-site made clearer by means of small plans, such as are employed in Reclus' great work, and in a few modern atlases. There are excellent general and local maps, in some cases specially prepared, in others adapted from old maps, and in these instances bristling with unnecessary and sometimes mis-spelt place-names, and over one hundred pictorial illustrations, most of which are well chosen. The photograph we reproduce shows the site of Amalfi, concerning which Mr. Chisholm says, in explaining its commercial supremacy over Naples in the Middle Ages: "one may conjecture that in those troubled times merchants felt more secure on a site so well defended by nature on the side of the land as Amalfi." The disastrous landslip which occurred since the book was published gives a hint of the price exacted by nature from the posterity of the merchants who acquired this defended position.

Fig. 1.—Amalfi.

Not the least interesting part of the book is furnished by the footnotes and parentheses, which abound in curious or illustrative statements in the tersest form. These are often explanations of the forms of place-names, or the pronunciation of the more uncouth Slavonic consonants, or the briefest comparative statistics. Mr. Chisholm has studied the question of geographical orthography, and introduces some forms of Russian transliteration not usually employed, such as the terminal letter *ñ*. The difficult matter of the rendering of the Russian *e* is not yet fully grappled with, its phonetic value *ve* is not, for instance, given in the case of Ekaterinburg, nor in Kiev. The spelling *Kossack* is surely wrong; if the usual form *Cossack* (which occurs in one place) is departed from, the only reasonable forms to adopt would appear to be *Kossak* or *Kosak*. These, however, are matters which do not affect the quality or the value of the book.

Amongst the larger maps it is interesting to notice one of the geology of Europe, in which the colour-scheme of the International Geological Map is employed. It has a striking and interesting appearance; but its legibility would be improved by the adoption of reference initials, to enable similar colours to be distinguished. The Permian and Devonian, in particular, are very much alike in small patches.

Hugh Robert Mill.

THE UNIVERSITY OF LONDON ELECTION.

The University of London has preserved its dignity by returning Sir Michael Foster as its Parliamentary representative. From the commencement of the contest he led the way, and when the poll was declared on Monday the numbers were: Sir Michael Foster, 1271; Dr. Collins, 863; and Mr. Busk, 586.

That such a large majority should have been obtained, in spite of the fact that Sir Michael Foster entered the field nearly a fortnight after his opponents, is a result which was scarcely anticipated by the most sanguine of his supporters, and is therefore all the more satisfactory. It shows that the majority of the electors are capable of taking a broad view of their responsibilities, and that a University constituency is not influenced by the political practices found successful elsewhere. The graduates may rest assured that Sir Michael Foster will guard their privileges, and promote the progress of Science and Learning in the House of Commons. The following remarks, made by the new member for the University after the declaration of the poll on Monday, as reported in the *Times*, will convince the whole body of graduates that a representative in every respect worthy of the electorate has been sent to Parliament.

Sir Michael Foster said that the graduates had for the first time in the history of the University returned to Parliament one of themselves. He wished to be allowed to state how deeply he felt the honourable and proud position in which they had placed him. He took it that in the main they sent him to Parliament, not that he should add one more unit to this party or to that, but that he should place at the disposal of the House the somewhat special experience which he had gained in science and learning. But the Government of this country was by party, and there were only two sides to the House, on one of which he must sit. Even if he were the superior person he had been called by some newspapers, he could not expect to sit in an isolated chair, and he must respond to the lash of the Whips of one side or the other. He had carefully considered on which side of the House he should sit, and he had come to the conclusion that it was only consistent with the opinions which he had expressed concerning the present war, and with the feelings which he had as to the supreme importance of strengthening the bonds of our great colonies with this little island, that he should first of all, at all events, take his seat among the supporters of the present Government. But he took it that he might so order his ways that he did not sacrifice to party demands, or jeopardise by party action, the opportunities that he might have of forwarding in the House all interests of science, learning and education. He was subject to tradition. As one who was born in the same town as Oliver Cromwell, who was married from the house in which he dwelt, as one whose forefathers—obeying what they thought their consciences — sheltered their friend John Bunyan when he preached outlaw sermons in the woods of Hertfordshire, he felt that tradition wrapped him so about that the war cry of civil and religious liberty always made him prick his ears. Without saying what exact meaning in the new order which had given place to the old might be attached to those words, it at least meant this to him —that the affairs of the nation should not be conducted either to the detriment or to the advantage of any particular set of religious opinions. He believed that that was not his tradition only, but the tradition of that University. The University began as University College, and that college was founded, not simply for local reasons, but to afford the highest academical training to those to whom access was more or less denied to the older Universities. And he had a tradition in the University itself. To the University in its old form he owed all that he had. It had made him what he was. Did they think it was likely, therefore, that he should take any steps which he believed would tend to deny to others the good which he himself had received? He confessed that he did not wholly understand the cry which had been raised of the external student—the cry which had been used, and, if he might say so, skilfully used, to clog the voting in his favour. When he listened to some expressions it seemed to him that the cry meant "We are in possession, and we are unwilling that others should share it with us." But he could not believe that to be meant, because it was a spirit which was wholly repugnant to the spirit of the University. And in any case he himself, looking all round, could not think otherwise than that the great future which he believed lay before the University in its new form would bring good to all alike who took part in it. At all events, he should hold it to be his duty to labour in the House, not for the interests of any particular class of the University, be they doctors or lawyers, men of letters, men of science, or men of business, internal or external students, teachers or taught, men or women, but he should strive to do his best for the common good of all.

NOTES.

THE sum of 3000*l.*, previously allotted for the purchase of plant for the detachment of the Electrical Engineers Volunteer Corps going to the front, is to be increased to 5000*l.*

THE death is announced of M. Emile Blanchard, member of the Paris Academy of Sciences, in the section of anatomy and zoology.

THE introduction of the metric system of weights and measures in Russia seems to be not far off. A scheme to that effect, prepared by the Ministry of Finances, has already received the approval of the Council of State, on the condition that it should be supplemented by a scheme for organising the aid, which different scientific societies and the universities are ready to render, in the verification of the new weights and measures for commerce. This latter scheme is nearly ready, and will shortly be brought before the Council of State. In the military pharmacopœia, published in 1896, all measures are already given in the metric system, which has thus been rendered obligatory for the medical staff of the army.

WE learn that traffic has just been opened on the Trans-Baikalian section, 700 miles long, of the Siberian railway, as far as Sryétensk. This little town, situated on the Shilka, is in the summer the head of a regular steam-navigation along the Amur, and, with the interruption offered by Lake Baikal, which has still to be crossed on a steamer, Sryétensk can now be reached by rail from Moscow, a distance of about 5000 miles.

AT the last meeting of the French Astronomical Society, Baron La Baume Pluvinel gave an account of the results of his inquiry into the conditions for observing the forthcoming total solar eclipse in Spain. He said that the railway service is bad; trains are very slow, and only leave Madrid once a day. The chief party of the Society will make their observations from Alicante, which is situated at the base of a high cliff, crowned by the strong Fort St. Barbara, and on one side sinks sheer down to the sea. A friend of the Society has placed a steamer at the disposal of the observers, free of charge. In addition to this steamer moored off the coast of Spain, another, with a party of astronomers on board, will go to Algiers. Mr. Percival Lowell and Prof. D. P. Todd have already left the United States to proceed to some suitable station in North Africa, from which to observe the eclipse. Mr. A. E. Douglass will make simultaneous observations under Mr. Lowell's auspices in Georgia. Messrs. Cook and Son have arranged a conducted tour to Talavera, where the total phase will be visible. The party will leave London on May 21, and will visit Paris, Bordeaux, Biarritz, and Madrid on the way.

WE learn from *Science* that the American Academy of Arts and Sciences has granted from the income of the Rumford fund 500 dollars to Prof. E. C. Pickering, for the purpose of carrying out an investigation on the brightness of faint stars, by co-operation with certain observatories possessing large telescopes, and 100 dollars to Prof. T. W. Richards, in aid of a research on the transition points of crystallised salts.

MENTION has already been made of many of the congresses to be held in connection with the forthcoming International Exposition at Paris. The following list, prepared by the committee of the Paris International Assembly, the secretaries of which are Prof. Patrick Geddes and Mr. T. R. Marr, shows the dates of some of the more important congresses announced in science and education:—Pure Science: Ornithology, June 26-30; meteorology, July 23-28; physics, August 6-11; mathematics, August 6-11; geology, August 16-28; electricity, August 18-25; anthropology and archæology, August 20-25; psychology, August 22-25; ethnography, August 26–September 1; chemistry, September 20-29; botany, October 1-6. Applied Science and Associated Industry: Horticulture, May 25-27; forestry, June 4-7; mines and metallurgy, June 18-23; vine cultivation, June 20-23; insurance, June 25-30; actuaries, June 25-30; agriculture, July 1-7; testing of materials, July 9-16; steam engines and machinery, July 16 18; applied mechanics, July 19-25; architecture and naval construction, July 19-21; photography, July 23-28; applied chemistry, July 23-31; navigation, July 30–August 4; pharmacy, August 8; economic and commercial geography, August 23-31; tramways, September 10-12; fruit culture, September 13-14; railroads, September 20-29. Medicine and Hygiene: Homœopathy, July 18-21; professional medicine, July 23-28; medicine, August 2-9; dermatology, August 2 9; dentistry, August 8-14; hygiene, August 10-17; hypnotism, August 12-15. Education: Modern language teaching, July 24-29; higher education, July 30–August 3; teaching of social science, July 30–August 5; primary education, August 2-5; secondary education, August 2-5; technical, industrial education, August 6-11; educational press, August 9-11; bibliography, August 16-18; teaching of drawing, August 29–September 1; popular education, September 10-13; agricultural instruction, September 14-16.

THE death is announced of Prof. Thomas Egleston, Professor of mineralogy and metallurgy in the school of mines of Columbia University, at the age of sixty-seven years.

Science announces that Prof. Reginald A. Fessenden, of the electrical engineering department of the Western University of Pennsylvania, has resigned his chair to accept a position in the Signal Department of the United States Weather Bureau, at Washington.

THE Simplon tunnel is now progressing at the rate of sixteen feet per day. It was begun fourteen months ago, and must be finished in five years and a half from its commencement.

THE proposal of the Council of the Royal Astronomical Society, that the meetings should in future be held at five o'clock, was rejected by the annual meeting on Friday last, and the ordinary meetings will therefore continue to be held at eight o'clock. Taylor's Calendar of the meetings of the scientific bodies of London shows that the number of societies which commence their meetings about eight o'clock is more than twice as great as the number of those which meet at four or five o'clock.

WE learn from the *Scientific American* that a special commission has been appointed to report on the ruins of the cliff-dwellers in the vicinity of Mancos and Cortes, Colorado, and also near Aztec, Mexico, with the idea of reserving the lands as a national park. This action has been taken as a result of an agitation in Colorado for the protection of these ruins against vandalist relic hunters. Some of the best preserved ruins have been ruthlessly entered by curio hunters, who have broken through walls and roofs and carried away the relics. It would be a wise policy for the U.S. Government to have these ruins guarded, so that they can be investigated by experts. Fortunately, some of the best of them have not been tampered with as yet.

A NOTE upon recent improvements in the production of electrolytic copper appears in *Engineering*, and the following particulars have been obtained from it. It is a comparatively simple matter to get a good deposit of copper electrolytically, provided always that a sufficiently low current density is used. This, of course, involves a very large and expensive plant if any reasonable output of the metal is desired. With greater current densities difficulties make their appearance, and the deposit, in place of being smooth and homogeneous, becomes granular and lacks cohesion. By certain devices of one nature or another, the troubles referred to above have been largely overcome. The effect of these is shown by the fact that 10 years ago an electrolytic bath for the deposition of copper commonly contained 75 to 100 times as much metal in solution as was deposited in 24 hours. Nowadays these figures have been reduced to one-fifth of the values stated. As a consequence, the proportion of the metal obtained in the wet way has been enormously increased, the world's production being now estimated at 500 tons of electrolytic copper per diem. One of the earlier plans of increasing the output was that introduced by Elmore, in which an agate burnisher was caused to continuously pass over the surface on which the deposit was being made. The resultant metal proved to be of extraordinary strength. In a more recent development, a sheepskin impregnated with animal fat is used as a burnisher. Quite recently Mr. Sherard Cowper-Coles has hit upon another plan, in which the copper is deposited on a vertical mandril, which is caused to rotate at a very rapid rate. The centrifugal force developed and the wash of the electrolyte over the rotatory surface keeps the latter clean and free from gas, and as a consequence a smooth and dense deposit has been obtained with current densities approaching 200 ampères per square foot. An account of the process, together with details of the mechanism used, will be found in a paper recently read by Mr. Cowper-Coles before the Institution of Electrical Engineers.

THE Deutscher Mathematiker Vereinigung, which holds its meetings concurrently with the Naturforscherversammlung, has published the report of its meeting at Munich last year. The meeting was attended by about eighty members, and twenty-two papers were read, including a discussion on the decimalisation of angles and of time. Upon the proposal of Prof. Boltzmann, a committee was appointed to consider the terminology of mathematical physics. The next meeting will be held at Aachen, in September 1900.

OF the six first numerals in the Etruscan language, viz. *maχ*, *θu*, *zal*, *huθ*, *ci*, *s'a*, it has been remarked by Prof. Thomsen, in a communication to the Danish Academy, that we do not know their precise order. M. E. Elia Lattes, writing in the *Rendiconti del R. Istituto Lombardo*, discusses the value of the numeral *θu*, and the examination of old inscriptions in which this word and its derivatives occur would appear in conformity with the view previously expressed that *θu* stood for "two."

IN the *Transactions* of the Institution of Engineers and Shipbuilders in Scotland, xliii. (2), (3), Mr. W. J. Luke discusses the means adapted for moderating the rolling of ships, and in particular Froude's experiments. The principal point brought out by the paper, and the discussion on it, is the efficacy of bilge keels in extinguishing rolling motion, a result no doubt largely due to the discontinuous motion of the water past the sharp edges of the keels in each swing of the ship.

THE *Rendiconto* of the Naples Academy, v. 8-12, contains the abstract of a paper by Prof. E. Ascione, on the properties of conicoids with elliptic points, viz. the ellipsoid, hyperboloid of two sheets, and elliptic paraboloid deduced from projections made by taking an umbilicus as the vertex of conical projection, and a plane parallel to the tangent plane at the umbilicus as the plane of projection. The projections of the focal conics are evidently circles, and the author finds that the projections of the lines of curvature are obtainable by a simple geometrical construction. The method, which includes stereographic projection of a sphere as a particular case, would appear likely to lead to a number of not difficult problems in analytical solid geometry.

THE properties of certain radio-active bodies form the subject of a short note by M. Henri Becquerel (*Comptes rendus*, cxxix. 26, 1899). The nitrate of polonium, of which samples were provided by M. and Mme. Curie, was found to be nearly as active as radium, both in its power of rendering air a conductor, and in its action on a photographic plate; but the radiation from this compound did not experience any modifications in a magnetic field, such as occurred with radium. When the polonium preparation was placed in a magnetic field of from 4000 to 10,000 C.G.S. units, the impressions obtained on a photographic plate were just the same as when the field was absent. On the other hand, the rays emitted by the radium when placed in the field exhibited strong deviations, producing on a vertical plate impressions bounded by spiral curves. The examination of these curves enables an estimate to be made of the velocity of propagation of radium rays. This velocity is comparable with the angular velocity due to a field of 4000 C.G.S. units, and under plausible hypotheses give a velocity of propagation for the radium rays of the same order as those which have been found for the kathodic rays.

SIGNOR G. GUGLIELMO describes in the *Atti dei Lincei*, ix. 1, certain modifications of the common hydrometer and of Nicholson's hydrometer. His first suggestion is a device for attaching movable weights to the common hydrometer without the inconveniences arising from the immersion of these weights in the fluid as in Sikes's form. A wire in the form of an inverted U is attached to the top of the hydrometer, and to its ends, which hang down outside the immersion jar, the movable weights are attached, being disposed symmetrically. The U-shape of the wire is, of course, necessary to ensure stability. In conjunction with Nicholson's hydrometer, Signor Guglielmo recommends the use of a graduated pillar for reading off small differences of density to avoid the difficulties involved in immersing the instrument exactly to a fixed mark. Finally, a "hydrostatic balance" is described, by which is meant, not the hydrostatic balance of our text-books, but a hydrometer adapted for weighing purposes, as a substitute for the common beam balance.

THE Weather Bureau of Washington has just issued a preliminary report (Weather Bulletin, No. 208) on the kite observations of 1898, by H. C. Frankenfield, containing an interesting discussion of the vertical gradients of temperature, humidity and wind-direction at a number of stations in the United States. The report deals with probably the largest amount of free air meteorological observations taken in the same space of time, and is a valuable contribution to the general knowledge of the physics of the lower levels of the atmosphere. The mean rate of diminution of temperature with increase of height, as determined from 1217 ascents to 1000 feet or more, was 5°·0 for each 1000 feet. The largest gradient, 7°·4 per 1000 feet, was found up to 1000 feet, after which there was a steady decrease up to 5000 feet, the rate becoming less as the altitude increased. The gradient up to 5000 feet was 3°·8 per 1000 feet; above this altitude there appears to be a tendency to a slow rise. The relative humidity at and above the surface of the earth differed but little, except at 7000 feet, where the surface humidity was 11 per cent. less than that above. The mean result obtained from all the observations showed 60 per cent. at the surface and 58 per cent. above, a difference only of 2 per cent. The work contains an important introductory paper, by Prof. C. F. Marvin, on the construction and operation of the kite meteorograph.

DR. K. DANILEWSKY has sent to the *Scientific American* some interesting photographs and particulars of the latest improvements he has made in his balloon-flying machine. The experiments were conducted under the auspices of the Russian Government in order to give the inventor an opportunity of demonstrating the practicability of this dirigible air-ship, and its feasibility for use in the Signal Service Corps of the Russian Army. The balloon is shown descending in the accompanying picture. It is filled with pure hydrogen, and its comparatively small size makes it easy to manage, three or four men being sufficient to start it, and half an hour long enough to fill it with

The Danilewsky Dirigible Balloon.

gas. The balloon possesses sufficient force of ascension, or levity, to neutralise the weight of the man and tackle suspended from it. The work done by the aëronaut may thus be entirely devoted to propelling and steering the balloon, apparently by means of wing-systems, which are not described in the *Scientific American*, but may be seen in the illustration. At one of the trials of this flying-balloon, Dr. Danilewsky ascended from a certain place, disappeared from view and remained cut of sight for two hours, and then returned close to the shed from which the balloon started. The experiments have induced a number of Russian experts to state that in their opinion Dr. Danilewsky has presented a practical solution of the problem of aërial navigation.

THE Botanical Garden at Buitenzorg, Java, has followed the example of that at Kew, and those of some of our Colonies, in bringing out a *Bulletin* in addition to the well-known *Annales*. The issue of the *Bulletin* of the Boissier Herbarium at Geneva has been discontinued, and its place will be taken by *Mémoires de l'Herbier Boissier*, to be published at irregular intervals.

WE have received the first number (January 1900) of the *Journal of the New York Botanic Garden*, edited by the Director of the Laboratories, Prof. T. D. Macdougal. It commences with an account, accompanied by an illustration, of the Museum Building, which claims to be "the largest, most elegant, most satisfactorily illuminated, and for its purposes the best adapted, of any similar edifice in the world." A description is given of the structure of the building, of its lecture-theatre, museums, library, and laboratories. The General Museum is designed to exhibit types of all the families and tribes of plants, from the slime-moulds or Myxomycetes to the Compositæ; and an interesting feature of the collection is that fossil plants are shown along with the living ones to which they are most nearly related. Then follow short papers on comparative forestry; on etiolated plants as food; on mycorhizas of orchids, in which it is stated that the roots and underground organs of every one of more than seven hundred species examined were found to be infested by symbiotic fungi; and on colours.

WE have received the fifth number of another new Argentine scientific journal, *Comunicaciones del Museo Nacional di Buenos Aires*. To this part Señor Ameghino contributes an illustrated account of a small skull from the Paranà deposits described last year under the name of *Arrhinolemur*, and now regarded as indicating a new order of mammals allied to the Lemurs. This skull, which is remarkably short and broad, presents the unique feature of having the nasals soldered together and placed in a cleft between the maxillæ and the premaxillæ in such a manner that, according to its describer, there is no nasal aperture! Another peculiarity is the presence of a preorbital vacuity in the cranium, and of an unossificed space on each side of the dentary portion of the lower jaw; in both of which respects it resembles the skulls of certain reptiles and birds. If rightly described, and really mammalian, the specimen is of surpassing interest, and demands the best attention of systematists. In another article in the same journal, Señor Mercerat contributes his quota to the already teeming literature on the "last of the ground-sloths" (*Neomylodon* or *Glossotherium*), in the course of which he severely criticises the determinations made by his countrymen of some of the associated remains of other animals.

THE Report for 1899 on the Lancashire Sea-fisheries Laboratory at University College, Liverpool, and the Sea-fish Hatchery at Piel, drawn up by Prof. Herdman, contains a very important account of the common cockle by Mr. J. Johnstone, who treats his subject both from the zoological and the economical point of view. The anatomy of this mollusc is very fully described, with some excellent figures; but the chief general interest centres on the economical aspect. Cockles form the food of several kinds of valuable fishes, more especially the plaice and the dab, while vast numbers are said to be consumed by the larger sea-birds. And we have a remarkable instance of how protection afforded to one group of animals reacts on another, in the statement that the recent decrease in some of the Lancashire cockle-beds is directly attributable to the increase in sea-gulls due to the operation of the Sea-Birds Preservation Act. The enormous commercial value of the Lancashire cockle-fishery will probably come as a revelation to the majority of our readers. It is stated that 2*s.* per cwt. is a low estimate of the value of the molluscs to the fishermen, since a certain quantity are hawked in the district; but, supposing the greater amount to be sent to market by rail, about 6*s.* per cwt. will represent fairly the price paid by the consumer. In the year May 1899, the total weight of cockles taken in Lancashire was 6685 tons, of which the money value at 2*l.* per ton is 13,370*l.*, and at 6*l.* per ton 40,110*l.*

MR. H F. WITHERBY has sent us an interesting little *brochure*, entitled "Two Months on the Guadalquiver," being a reprint of articles contributed to *Knowledge*. The author made his trip for the purpose of studying the abundant bird-life of the valley. Some of his most interesting experiences were those connected with the Great Bustard. These noble birds were observed among long grass and corn; and from his observations Mr. Witherby was led to conclude that the only season when they could be coursed by dogs would be the period of the moulting of the old quills and the sprouting of the new, since at other times Bustards take at once to their wings and fly strongly.

MR. J. J. SEDERHOLM, director of the Geological Survey of Finland, has been engaged for several years in the exploration of the Archæan rocks of his mother-country. His exhaustive work on this subject, "Ueber eine archäische Sediment-Formation in Süd-westlichen Finland," accompanied by an excellent geological "Uebersichtskarte" of Finland (1 : 2,500,000), another of the Tammerfors region on a larger scale, and numerous engravings, was published, in German, in the *Bulletin* of the Finnish Geological Survey, No. 6, in February last. Mr. Sederholm, using a quotation from Prof. Lapworth's introduction to his memoir, places himself explicitly under the banner of English actualism, and he endeavours to show that the presumption of the followers of Lyell and Darwin in favour of the existence of an immense thickness of pre-Cambrian sediments is fully verified by a detailed study of the pre-Cambrian rocks in Northern Europe. He describes in great detail a typical area of Archæan crystalline schists, which are so slightly metamorphic that their original clastic character can almost everywhere be detected, as also their gradual change into gneiss-like rocks, mainly through the intervention of granite veins. Shortly describing next the Archæan sediments of Eastern Finland, and referring to the former observations of Archæan clastic and effusive-eruptive rocks by Swedish geologists and by himself, the author concludes that his ideas can be generalised so as to hold good for the whole of the pre-Cambrian region of Northern Europe, and thus have a bearing upon the solution of the Archæan problem altogether.

MESSRS. H. SOTHERAN AND CO. have just issued a catalogue of superior second-hand books in natural history which they are offering for sale.

THE current number of the *Geological Magazine* contains a notice of the life and work of the Rev. Osmond Fisher, the well-known author of the "Physics of the Earth's Crust." The memoir, which is illustrated by a copy of a recent photograph, forms one of the series of "Eminent Living Geologists."

THE "Anales de la Oficina Meteorologica Argentina" (Tomo xii.), edited by Mr. G. G. Davis, contains a discussion of the meteorological observations made at Asuncion, the capital of Paraguay, and Rosario, in Santa Fé. The volume is the second part of a work on the climate of these places.

A SECOND edition of Prof. E. Mach's "Principien der Wärmelehre" has just been published by J. A. Barth, of Leipzig. The original work was reviewed in NATURE in April 1896 (vol. 55, p. 529), and few alterations other than necessary corrections have been made. The full page portraits of physicists are better than they were in the first edition.

THE first part of "The Birds of Eastern North America," dealing with water birds, by Mr. C. B. Cory, was noticed in our issue of February 1 (p. 323). The second part, in which the land birds of the same region are described, has since been received, and is similar in character to the previous volume, and of equal importance.

WITH regard to a remark made in the notice of Kölliker's "Gewebelehre," Bd. iii. 1 Hälfte, in NATURE of February 1, as to the absence of an index, we have been informed by the publishers that their intention is to provide an index on the completion of the whole work, which they anticipate will be in about a year from the present time. It may, however, be pointed out that as each part is practically a monograph upon its special department of histology, and as eleven years has elapsed since the appearance of the first part, the absence of an index to each part is a practical inconvenience which it would have been worth a little extra cost to remedy.

THE latest number of the *Bulletin* of the Liverpool Museums, edited by Dr. H. O. Forbes, is a most creditable publication, profusely illustrated and full of scientific contributions of prime importance. Dr. Forbes is sole or joint author of three articles of the four which make up the *Bulletin*. He describes in detail a collection of stone implements in the Mayer Museum, made by Mr. H. W. Seton-Karr, in mines of the ancient Egyptians discovered on the plateaux of the Nile Valley. Numerous excellent illustrations of the implements and the workings where they were discovered, by Mr. Seton-Karr, accompany the article. As further evidence of the noteworthy character of the *Bulletin*, we may remark that there are described in it fourteen new species of birds, one new genus and six new species of reptiles, eight new species of molluscs, one new genus and thirty-three new species of insects, and eleven new species of arthropoda, many of them representing the results of the expedition to Sokotra, organised conjointly by the British Museum and the Liverpool Museum. A special volume on the expedition will shortly be issued, and, judging from the present preliminary contribution, it will be a very valuable addition to science.

THE true molecular weight of sulphur in the gaseous states has been made the subject of numerous researches. In the current number of the *Berichte*, O. Bleier and L. Kohn give an account of their work on the density of sulphur vapour at very low pressures. They hoped to be able to make determinations at such a low pressure that there would be no dissociation, but even for a pressure of 2·1 mm. of mercury the found molecular weight was 251 instead of 256, corresponding to S_8. The results obtained, plotted in the form of a curve, were quite sufficient, however, to show that the true molecular formula of gaseous sulphur, undissociated, is S_8, a value, it is interesting to note, which is in agreement with the conclusions previously arrived at by the application of the freezing-point and boiling-point methods to sulphur solutions.

RECENT discoveries in the space isomerism of nitrogen compounds have led to attempts to resolve into active constituents compounds containing asymmetric sulphur atoms. Two papers bearing on this subject have recently been read before the Chemical Society, by S. Smiles, and W. J. Pope and S. J. Peachey, respectively. In both cases methyl-ethyl-thetine was the starting-point, Smiles attempting, unsuccessfully, to prepare a strychnine or cinchonine salt of the thetine hydrobromide, or a malate of the base. Pope and Peachey succeeded in preparing two salts of the thetine with active acids (dextrocamphorsulphonic and dextro-α-bromocamphorsulphonic acids), but found that no resolution of the asymmetric thetine into optically active components occurs. Hence they draw the conclusion that if sulphur really exists as a quadrivalent element in these salts, the four atoms directly and independently attached to the sulphur lie in the same plane as the latter.

THE additions to the Zoological Society's Gardens during the past week include an Entellus Monkey (*Semnopithecus entellus*) from India, presented by Mrs. E. J. Gaudie; a Red Deer (*Cervus elaphus*, ♂) from Scotland, presented by the Right Hon. the Marquis of Breadalbane, K.G., P.C.; a Spanish Blue Magpie (*Cyanopolius cooki*) from Spain, presented by Mr. L. Ingram Baker; an Alligator Terrapin (*Chelydra serpentina*), a Floridan Terrapin (*Chrysemys concinna*), a Salt-water Terrapin (*Malacoclemmys terrapin*), a Sculptured Terrapin (*Clemmys insculpta*), four American Box Tortoises (*Cistudo carolina*), a Prickly Trionyx (*Trionyx spinifer*), two Reeves's Terrapins (*Damonia reevesi*), a Blue Lizard (*Gerrhonotus coeruleus*), a Three-striped Boa (*Lichanura trivirgata*), two Striped Snakes (*Tropidonotus sirtalis*), a Seven-banded Snake (*Tropidonotus septemvittatus*), four Corn Snakes (*Coluber guttatus*), a Chicken Snake (*Coluber obsoletus*), an American Black Snake (*Zamenis constrictor*), two King Snakes (*Coronella getula*), nine Changeable Tree-Frogs (*Hyla versicolor*) from North America, a Common Boa (*Boa constrictor*), an Annulated Terrapin (*Nicoria annulata*) from South America, eight Adorned Terrapins (*Chrysemys ornata*) from Central America, a Wrinkled Terrapin (*Chrysemys scripta rugosa*) from the West Indies, two Grooved Tortoises (*Testudo calcarata*) from South Africa, a Starred Tortoise (*Testudo elegans*) from India, deposited; two Tcheli Monkeys (*Macacus tcheliensis*, ♂ ♀) from Northern China, presented by Dr. S. W. Bushell; a Vulpine Phalanger (*Trichosaurus vulpecula*) from Australia, presented by Miss Freda Gilder; three Dial Birds (*Copsychus saularis*) from India, purchased.

OUR ASTRONOMICAL COLUMN.

DEFINITIVE ORBIT OF COMET 1897 III.—Herr E. Wessell, of the Helsingfors Observatory, has reduced 168 observations of Perrine's Comet, 1897 III, made at various observatories, and gives the resulting definitive elements of the orbit in the *Astronomische Nachrichten*, Bd. 151, No. 3614, as follow:—

Definitive Elements of Comet Perrine (1897 III.).

T = 1897 Dec. 8·679793 Berlin Mean Time.

$$\left.\begin{aligned} \omega &= 65^\circ\ 53'\ 57''\cdot6 \\ \Omega &= 32\ \ 3\ \ 8\cdot7 \\ i &= 69\ 35\ 58\cdot2 \end{aligned}\right\}\ 1897\cdot0.$$

$$\log q = 0\cdot132477$$

NEW VARIABLE STAR IN DRACO.—Dr. T. D. Anderson, of Edinburgh, has communicated to the *Astronomische Nachrichten*, No. 3618, his recent discovery of the variability of a star having the following position:—

$$\left.\begin{aligned} &\text{R.A.} \quad 17^h.\ 55^m\cdot6. \\ &\text{Decl.} \ +54^\circ\ \ 51' \end{aligned}\right\} 1855.$$

The variation in magnitude is from 9·4 to 10·4. Neither the variable nor the four stars used for comparison are mentioned in the *Bonn Durchmusterung*.

TIME USED IN EPHEMERIDES.—With the current number of the *Observatory* is issued a slip stating that the variable star ephemerides, published in the *Annual Companion*, are given in Greenwich civil time, and not in astronomical time, as heretofore. The day is divided into 24 hours, and begins at midnight. This change was rendered necessary by reason of its having been adopted by M. Loewy in the *Annuaire du Bureau des Longitudes*, from which the data for the variable star ephemerides are obtained. It is thought that this change is responsible for the recent misleading reports as to the adoption by the principal observatories of the civil time reckoning.

LEONID METEORS.—Signor E. Fergola contributes to the *Rendiconto* of the Naples Academy a note on observations of the Leonid shower, made at the Observatory at Capodimonte. The numbers of meteors observed on November 14, 15, 16 and 17 were 15, 30, 32 and 11, and the radiant point, as determined by conjoint observations of Signori Alberti, Tedeschi and Nobili, was in R.A. 10h. 8m., and declination 23° 4s.

THE FUNCTIONS OF THE ENGINEER.[1]

THE success of the modern engineer is due to the fact that he has buried in the depths of oblivion the much-vaunted empirical rule of thumb, and that he has elevated to the heights of science the observations of exact practice and the exercise of pure reason. The principle of doubt, which is the root of all scientific inquiry, forces him to consider every phase of weakness in the materials that he employs in his structures, to examine every possible cause of error in his designs, to anticipate every source of failure in his work. The principle of faith, which is the outcome of the growth of his experience, must be continually illuminated by the light of progress, and controlled by the patient development and consideration of the too-long-hidden laws of nature. The engineer must maintain his acquaintance with ever-growing science so as to be able to fulfil promptly and accurately his duty, which is the application of the great principle of energy and the utilisation of the marvellous properties of matter to the wants, comfort and happiness of man.

In considering the functions of the engineer we have to consider his *practice* and his *making*.

His practice—what has he got to do? The practice of engineering can be divided into three branches: Civil, Military and Naval.

The term civil was originally introduced to distinguish the practical man of peace from the practical man of war. Engineering applied to our wants and comforts is a very different thing to that applied to the destruction of our foes or to protect ourselves from their wish to destroy us. War is waged both on land and sea, and as the conditions involved in attack and defence in modern times have become so totally different in these two cases, the term military has been gradually confined to the operations of our army on land, while the term naval is applicable to the warlike operations of our fleets. England owes her present position as the centre of a great empire to her naval supremacy, and she has acquired this supremacy as much by the inventive, constructive and maintaining powers of her working engineers as by the mighty deeds of her fearless fighting sailors.

Civil engineering aids us not only to build that haven of rest and comfort that we call home, but to surround it with the elements of health—pure air, pure water, pure food, pure light. If we congregate together in towns or scatter ourselves in country districts it supplies us with all possible means of transport by road, river and rail, and of means of intercommunication by post, telegraph and telephone. These means of annihilating time and space are not only inter-urban in our own country but international in our continents, and in a wider sense imperial, cosmical and universal, over the whole earth. The world is knit in one connected whole by wire. We know to-day from that triumph of art, science and culture—the intelligent and free British daily public Press—the history of nearly all that took place yesterday over the whole globe.

The engineer fears not the infinitely great, for the stars in their courses aid him to survey the land and to cross the deep with safety. He spurns not the infinitely little, for the molecules in their mutual actions and reactions supply him with those metals and those elements of purity and strength which give him the means to resist the forces of nature so as to span the broad channel, laugh at the foaming river, build the palace of glass at Sydenham, cover acres of ground so as to display this year in Paris the goods, manufactures, and works of art, industry and utility of the whole world.

[1] An address by Sir William Henry Preece, K.C.B., F.R.S., delivered before the Glasgow Association of Civil Engineers on February 8.

The engineer utilises matter wherever it can be found; he delves into the crust of the earth for ores and minerals which give him wealth, currency, protection and strength; he dives into the sea to survey the bottom as a bed for his cables, and to see that he has secured proper foundations for his moles, piers and breakwaters; he explores the surface of the earth for articles of necessity, of use and of luxury. He irrigates the land, to prepare it for the growth of pure and wholesome food, for the supply of cheering and sustaining drinks, for the maintenance of the stores on the shelves of the doctor, and for those articles of pure clothing that add so much to the comfort, cleanliness and health of man. He utilises for his purpose the great principle in the construction of roads, bridges, aqueducts, canals, river navigation and docks, for internal intercourse and exchange, and in the construction of ports, harbours, moles, breakwaters and lighthouses, and in the art of navigation by artificial power for the purposes of commerce, and in the construction and adaptation of machinery, and in the drainage of cities and towns."

It is difficult to classify the sections of engineers into any logical order; but I have attempted in the following table to arrange methodically the various branches upon the same principle as we draw up a genealogical tree, for every branch emanates by direct descent from the one root, engineering, which is applied science.

ENGINEERING.

- CIVIL.
  - *Domestic.*
    - Bells and Signals.
    - Buildings (Architecture.)
    - Drainage.
    - Lifts.
    - Lighting.
    - Ventilation.
    - Warming.
    - Water-supply.
  - *Municipal.*
    - Electrical Energy.
    - Gas.
    - Housing the Working Classes.
    - Hydraulic Power.
    - Hygiene.
    - Markets.
    - Overcrowding.
    - Parks and Recreation Grounds.
    - Public Buildings.
    - Public Lighting.
    - Refuse-destruction.
    - Sewage and Drainage.
    - Slaughter-houses.
    - Smoke-prevention.
    - Streets.
    - Tramways.
  - *Inter-Urban.*
    - Bicycles.
    - Canals.
    - Motors.
    - Railways.
    - River Navigation.
    - Roads.
    - Telegraphs.
    - Telephones.
    - Surveying.
  - *National.*
    - Breakwaters.
    - Ceramics.
    - Chemical Industries.
    - Coinage.
    - Construction of Machinery and Engines.
    - Docks.
    - Harbours.
    - Irrigation and Agriculture.
    - Lighthouses.
    - Management of Estates.
    - Manufacturing Processes.
    - Metallurgy.
    - Mining and Quarrying.
    - Refrigeration.
    - Signal Stations.
    - Trigonometrical Survey.
  - *International.*
    - Connection of National Surveys.
    - Lighthouses.
    - Posts (Letter Carriage).
    - Steam Navigation.
    - Submarine Telegraphy.
  - *Cosmical (or Universal).*
    - Astronomical Mensuration.
    - Geodesy.
    - Hydrography.
    - Manufactures.
- MILITARY.
  - Fortification.
  - Artillery and Explosives.
  - Surveying and Reconnaissance.
  - Submarine Mining.
  - Signalling and Telegraphy.
  - Barracks Construction.
  - Traction. Road, Railway-making.
  - Search-lights.
  - Ballooning.
- NAVAL.
  - Artillery. Gun Mountings. Explosives.
  - Ship-building.
  - Marine Engineering.
  - Hydrography.
  - Application of Steam Hydraulics and Electricity to the auxiliary machinery of Ships.
  - Torpedoes. Submarine Mining.

of energy, so as to transform it at his will into its various forms of heat, light, electricity, sound, chemism and material motion. By these agencies he transforms crude matter into its various elements, compounds and states, so as to secure permanence, strength and value.

Life is not free from his grasp. He has developed the Empire of Bacteria, and has encouraged the minute microbe in countless armies—to liquefy and purify our sewage, and to become the scavenger of our homes and our cities. He has by defensive measures freed the soil and the river from those ruthless bacterial enemies who invade our frames and bring disease and death in their train.

Engineering is divided into various sections, many of them having their own institutions and their own publications.

The definition of a civil engineer, as given in the charter of the institution, is very comprehensive. This institution is "a society for the general advancement of mechanical science, and more particularly for promoting the acquisition of that species of knowledge which constitutes the profession of a civil engineer, being the art of directing the great sources of power in nature for the use and convenience of man, as the means of production and of traffic in states both for external and internal trade, as applied

The growth of invention in early ages was very slow. Man sheltered himself in caves. How long did it take him to devise a tent, or a hut, or a house? How long to protect himself with clothing? How long to construct weapons of offence and defence, not only to protect himself from wild beasts and from his neighbours, but to secure for himself food and raiment? The first protection from weather was probably the skins of the animals he hunted, killed and ate, and the first art acquired—the making of leather. How long did it take him to obtain a knowledge of the use of fire, and of the means of producing it artificially, so as to cook his food and to bake the plastic clay into pots and pans for drinking and eating purposes?

We have no record of these early stages of the evolution of the human being. The first known picture depicts him as a hunter. Ages elapsed before the conception of a record "engraved upon the rock forever" seems to have occurred to him, and though stone, papyrus, clay, skin and wax gave him material upon which he could record in elementary pictures his victories, his virtues, and his commands, many centuries passed before the greatest invention the world has ever acquired—the alphabet—occurred to some smart Phœnician, probably in the land of Egypt, where picture-writing, hieroglyphy, had reached its acme. It has taken 3000 years to mature this invention. The alphabet we use to-day is a direct descendant of that first Phœnician attempt to indicate the elementary sounds of speech by letters. But what a change has occurred since the next great invention in this direction—printing! The brain is now excited by the publication of every new fact extracted from Nature's storehouse. Inventions spring up like mushrooms. They are published by the Press to the whole world at once. Innumerable minds of all nations are thus set to work to utilise, develop and improve them. Advance is rapid, and progress proceeds at a compound interest rate. I said it took 3000 years to mature the alphabet. It has taken 450 years to perfect printing, but sixty years in our days have matured telegraphy and photography, and only sixty months have been sufficient to apply Röntgen rays to assist the physician to apply his gentle art to restore to health the maimed and wounded. Such is the advantage of publicity!

Why such marvellous constructive skill and scientific progress should have been developed on the banks of the Euphrates and the Nile on the old, and in Mexico and Peru on the new continent, so early in the history of the world, is a mystery of the development of the mind that remains to be satisfactorily explained as much as the persistent conservatism of the negro and the gipsy of the present day. The wicker hut depicted on Egyptian bas reliefs 3000 years ago is the same dwelling-place of the same race in the present day!

The luxurious, roomy, and well-warmed southern villa of their Roman conquerors failed to commend itself permanently to the mind of the unrefined ancient Briton. Nevertheless, the Roman taught us the arch, showed us how to build a bridge, and left us his straight and admirable road. The words arch, pont and street remain in our languages historical memorials of those early colonists.

The rapid progress of modern engineering is phenomenal. Practice grows by leaps and bounds. Take any form of energy and examine its utilisation in any field of industry. Take only one instance of the application of electricity. See how it comes to the aid of the sailor! It controls the rudder, it ventilates the interior and the living space of the ship, it forces the draught and assists the raising of steam, it revolves the turrets, it trains and controls the guns, it handles the ammunition, it purifies the drinking water, it lights up the ship internally, it enables the captain to sweep the horizon with the brilliant rays of the search-light, and to communicate with his tender, or with his commanding officer across space independent of weather, night, season, fog or rain. It would lengthen this address too much to illustrate this point further. Light, sound, heat, chemism and mechanics have been equally active in the service of man, and have helped to specialise in many directions the functions of the engineer.

The Making of the Engineer.—It is idle to ignore the fact that the modern engineer is the outcome of high-class and long-sustained education, either imparted or self-acquired. Education means generally the training of the intellectual, moral and physical faculties of youth, but the education of the engineer never ceases as long as he remains in active practice. I am still in school, and rarely fail to acquire some new fact each day of my life. The first foundation is clearly a broad, solid, general education, not specialised in any way until the pupil has reached the stage when he can work and think for himself. But from the very earliest years—in fact, from infancy—I advocate the cultivation of the powers of observation, a systematic training of the memory, and an encouragement of the exercise of thought. This is, in reality, the scientific method. Many people advocate the early teaching of science, but I do not. I advocate the collection and naming of plants, the love of animals and knowledge of their habits, the observation and explanation of the daily occurrences in the house, the air and the ground. The fire, a candle, the teapot, cooking, blacking boots, the dewdrop, clouds, rain, wind and storm, the ebb and flow of the tide, the performances of tops and bicycles, familiarly explained, excite a love of nature and of science, and train the mind to observe, to think and to remember. Cramming the young mind with ill-digested text-book science, illustrated by experiments that generally fail, excites ridicule—the common accompaniment of ignorance.

The engineer must be a scientific man. Science deals with the facts of nature, their laws and their theory. The engineer applies this knowledge to the uses of mankind. His practice means the correct design and due execution of works. The present President of the British Association, in his inaugural address delivered at Dover, drew no distinction between natural knowledge (science) and applied science (engineering). His illustrations to glorify the former were drawn from the triumphs of the latter. Sciences are *experimental*, such as chemistry, mechanics and physics, and *observational*, such as botany, zoology geology, geography, astronomy, biology, &c. They are very numerous, and, as engineering is only another term for applied science, it is clear that an engineer would waste his time in acquiring abstruse sciences that would be of no subsequent use to him. He must confine himself to those branches of science which will be of service to him in his future career, so as to enable him to apply them to living, industry and commerce. *Mathematics*, the shorthand of thought and the purest form of logic, *experiment*, the handmaid of observation, *measurement*, the instigator of accuracy and precision, and *reasoning*, the organ of common sense, are the tools that shape his store of knowledge which memory brings to his help when he has to practise what he has learnt. The boy who has passed well through the ordinary curriculum of school, and proceeds thence into a university, from which he emerges as a young man not only well imbued with the refining influences of literature and art, but with a well-earned degree of science, is fully prepared to commence his engineering training, and to enter the workshop or the drawing-office, where alone he can acquire that combination of knowledge and skill, and that training of the brain and the hand for mutual aid which is called technical education.

The Institution of Civil Engineers will now admit into their body only those who can produce the certificate of such an educational career as I have indicated above, or who can pass an examination which will give evidence of his possessing similar qualifications. A scientific man can become an engineer only when he has become an expert through practice and experience.

It is not a question between science and practice; it is a question between science and rule of thumb. Practice is always there, but rule of thumb means rule of error, until by repeated failures rule of thumb becomes rule of right, which means the victory of organised common sense. Organised common sense is a very good term for science. Scientific men talk nonsense when they observe differences between science and practice, and so-called practical men act foolishly when they ignore science, and assert that an ounce of practice is worth a ton of theory. Practice based on true science means immediate success and economy; practice based on rule of thumb means error, delay and excess of estimates. The engineer cannot neglect the laws of nature, any more than the scientific man can ignore the success of practice. The science of the Chair has, however, often been obsolete or behind the day. The professor is not sufficiently in touch with the industrial and economical interests of the country. It happens that in my own special branch of the profession practice has always been in advance of theory. The progress of telegraphy and telephony owes nothing to the abstract scientific man. The fundamental principles and natural facts that underlie the practice of electrical engineering are the teachings of actual experience, and not the results of laboratory research or professorial teaching. The science is, however, now established, and those who are academic students have the advantage of acquiring a knowledge of facts and principles in the class-room before they commence their practical career. Their path is thus much cleared and their progress expedited. They start well equipped mentally to grasp and comprehend the art of their profession.

Smeaton, Watt, Telford, Stephenson, Fairbairn, Whitworth, and all our early engineers had to acquire their own natural knowledge by their own individual investigations. They had to seek out and determine first principles for themselves. All that is now changed. The science of to-day is the science of the Victorian era. The engineer is not now required to research as much as his predecessors. There are now physical laboratories where it can be done for him, but this must not tempt him to lessen his enthusiasm in verifying the facts of nature by experiment. Doubt must always be transformed to faith.

The civil engineer of eminence has not only to know thoroughly the science, but to conduct the practical operations of his profession. The lives of human beings are entrusted to his designs. People have faith in the safety of his ships, long tunnels, bridges and railway trains. He is called upon to advise on policy, to deal with commercial management, to act as arbitrator or judge in many important intricate judicial cases, and to appear in courts of law and committee rooms of Parliament as an expert witness. The mental qualities of the engineer must, therefore, be of the very highest order. His scientific training and his world-wide practice have broadened his views and enlarged his mind. Above all, his character must be above all reproach. The honour of the engineer is the honour of his profession. The Lord Chief Justice's Bill was welcomed by every member of the Institution of Civil Engineers. The evil it is desired to suppress is very great and very wide, but it is not the characteristic of the engineer.

Let me, in conclusion, impress on you the antiquity and the universality of the functions of the engineer. Tubal-Cain was an instructor of every artificer in brass and iron, and this before the flood. The very earliest remains of Egyptian, Babylonian and Assyrian temples and monuments indicate a wonderful knowledge of the strength of materials. The Cloaca Maxima of the early Latin King Tarquinius Priscus exists still, though built 2,600 years ago. In the track of war and diplomacy, in the earliest days of history, went trade and commerce. The general became the engineer. Western Asia was covered with roads, not only to facilitate the transport of troops and chariots, but to assist the merchant in the distribution of his wares. Intercourse of all kinds has always been the outcome of civilisation. The balance of power falls to the strong. In days of old it was to the strong physically. In modern days it is more to the strong mentally and financially. The greatest political gift that mind can give to man, the greatest security for peace and comfort, is the ability to wield the great powers of nature so as to destroy human life with the greatest rapidity and at the greatest distance. An overpowering fleet and an efficient army are our insurance for security at home. There is not a habitable spot on the face of the earth that does not bear traces of the presence of the engineer. He is the great civiliser. He not only immediately follows, but he sometimes even precedes the military conqueror. He distributes peace and good-will without the accompaniments of fire, blood and famine. Mr. Cecil Rhodes is opening up Africa with the "wonder-working wire." Khartoum has been brought within seventy hours of Cairo by train, and ere long, when peace is restored in that self-disturbed country, South Africa, Cairo and Cape Town will be in direct and immediate communication by telegraph, and eventually by rail.

The engineer is not only a benefactor to his race, but he is a necessity of the age.

WIRELESS TELEGRAPHY.[1]

WHEN Ampère threw out the suggestion that the theory of a universal ether, possessed of merely mechanical properties, might supply the means for explaining electrical facts, which view was upheld by Joseph Henry and Faraday, the veil of mystery which had enveloped electricity began to lift. When Maxwell published, in 1864, his splendid dynamical theory of the electro-magnetic field, and worked out mathematically the theory of ether waves, and Hertz had proved experimentally the correctness of Maxwell's hypothesis, we obtained, if I may use the words of Prof. Fleming, "the greatest insight into the hidden mechanisms of nature which has yet been made by the intellect of man."

A century of progress such as this has made wireless telegraphy possible. Its basic principles are established in the very nature of electricity itself. Its evolution has placed another great force of nature at our disposal.

We cannot pay too high a tribute to the genius of Heinrich Hertz, who worked patiently and persistently in a new field of experimental physics, and made what has been called the greatest discovery in electrical science in the latter half of the nineteenth century. He not only brought about a great triumph in the field of theoretical physics, but, by proving Maxwell's mathematical hypothesis, he accomplished a great triumph in the progress of our knowledge of physical agents and physical laws.

I cannot forbear saying one word as to the eminent electrician who was placed in his last home as recently as Saturday last, for it is manifest that several years ago Prof. Hughes was on the verge of a great discovery, and, if he had persevered in his experiments, it seems probable that his name would have been closely connected with wireless telegraphy as it is with so many branches of electrical work in which he gained so much renown and such great distinction.

[1] Abridged from a discourse delivered at the Royal Institution, on February 2, by Mr. G. Marconi.

The experimental proof by Hertz thirteen years ago, of the identity of light and electricity, and the knowledge of how to produce, and how to detect these ether waves, the existence of which had been so far unknown, made possible true wireless telegraphy. I think I may be justified in saying that for several years the full importance of the discovery of Hertz was realised but by very few, and for this reason the early development of its practical application was slow.

The practical application of wireless telegraphy at the *present* time is many times as great as the predictions of five years ago led us to expect in so short a time. The development of the art during the past three or four years, and its present state of progress, may perhaps justify the interest which is now taken in the subject. Yet only a beginning has been made, and the possibilities of the future can as yet be only incompletely appreciated. All of you know that the idea of communicating intelligence without visible means of connection is almost as old as mankind. Wireless telegraphy by means of Hertzian waves is, however, very young. I hope that if I pass over the story of the growth of this new art, as I have watched it, or do not attempt to prove questions of priority, no one will take it for granted that nothing is to be said on these subjects, or that all that *has* been said is entirely correct.

The time allowed for this discourse is too short to permit me to recount all the steps that have led up to the practical applications of to-day. I believe it will probably interest you more to hear of the problems which have lately been solved, and the very interesting developments which have taken place during the last few months.

I find that a great element of the success of wireless telegraphy is dependent upon the use of a coherer such as I have adopted. It has been my experience, and that of other workers, that a coherer as previously constructed—that is, a tube several inches long partially filled with filings enclosed by corks—was far too untrustworthy to fulfil its purpose. I found, however, that if specially prepared filings were confined in a very small gap (about 1 mm.) between flat plugs of silver, the coherer, if properly constructed, became absolutely trustworthy. In its normal condition the resistance of a good coherer is infinite, but when influenced by electric waves the coherer instantly becomes a conductor, its resistance falling to 100 or 500 ohms. This conductivity is maintained until the tube is shaken or tapped.

I noticed that by employing similar vertical and insulated rods at both stations it was impossible to detect the effects of electric waves of high frequency, and in that way convey the intelligible alphabetical signals, over distances far greater than had been believed to be possible a few years ago.

I had formerly ascertained (see paper read before the Institution of Electrical Engineers by G. Marconi, March 1899) that the distance over which it is possible to signal with a given amount of energy varies approximately with the square of the height of the vertical wire, and with the square root of the capacity of a plate, drum, or other form of capacity area which may be placed at the top of the wires.

The law governing the relation of height and distance has already been proved correct up to a distance of 85 miles. Many months ago it was found possible to communicate from the North Haven, Poole, to Alum Bay, Isle of Wight, with a height of 75 feet, the distance being 18 miles. Later on two installations with vertical wires of double that length, *i.e.* 150 feet, were erected at a distance of 85 miles apart, and signals were easily obtained between them. According to a rigorous application of the law, 72 miles ought to have been obtained instead of 85; but, as I have previously stated, the law has been proved only to be approximately correct, the tendency being always on what I might call the right side; thus we obtain a greater distance than the application of the law would lead us to believe. There is a remarkable circumstance to be noted in the case of the 85 miles signalling. At the Alum Bay station the mast is on the cliff, and there is no curvature of the earth intervening between the two stations; that is to say, a straight line between the base of the Haven and Alum Bay stations would clear the surface of the sea. But in the case of the 85 miles the two stations were located on the sea-level, and between them exists a hill of water, owing to the earth's curvature, amounting to over 1000 feet. If these waves travelled only in straight lines, or the effect was noticeable only across open space, in a direct line, the signals would not have been received, except with a vertical wire 1000 feet high at both stations.

While carrying out some experiments nearly three years ago at Salisbury, Captain Kennedy, R.E., and I tried numerous forms of induction coils wound in the ordinary way, that is, with a great number of turns of wire on the secondary circuit, with the object of increasing, if possible, the distance or range of transmission, but in every case we observed a very marked decrease in the distance obtainable with the given amount of energy and height. Similar results were obtained some months later, I am informed, in experiments carried out by the General Post Office Engineers at Dover.

In all our above-mentioned experiments the coils used were those in which the primary consisted of a smaller or larger number of turns of comparative thick wire, and the secondary of several layers of thinner wire. I believe I am right in saying that hundreds of these coils were tried, the result always being that by their employment the possible distance of signalling was considerably diminished instead of being increased. We eventually found an entirely new form of induction coil that would work satisfactorily, and that began to increase the distance of signalling.

The results given by some of the new form of induction coils have been remarkable. During the naval manœuvres I had an opportunity of testing how much they increased the range of signalling with a given amount of energy and height. When working between the cruisers *Juno* and *Europa*, I ascertained that when the induction coil was omitted from the receiver, the limit distance obtainable was seven miles, but with an improved form of induction coil included, a distance of over sixty miles could be obtained with certainty. This demonstrated that the coils I used at that time increased the possible distance nearly tenfold. I have now adopted these induction coils, or transformers, at all our permanent stations.

A number of experiments have been carried out to test how far the Wehnelt brake was applicable in substitution for the ordinary make and break of the induction coil at the transmitting station, but although some excellent results have been obtained over a distance of forty miles of land, the amount of current used, and the liability of the brake getting fatigued or out of order, have been obstacles which have so far prevented its general adoption.

As is probably known to most of you, the system has been in practical daily operation between the East Goodwin Lightship and the South Foreland Lighthouse since December 24, 1898, and I have good reason for believing that the officials of Trinity House are convinced of its great utility in connection with lightships and lighthouses. It may be interesting to you to know that, as specially arranged by the authorities of Trinity House, although we maintain a skilled assistant on the lightship, he is not allowed to work the telegraph. The work is invariably done by one of the seamen on the lightship, many of whom have been instructed in the use of the instrument by one of my assistants. On five occasions assistance has been called for by the men on board the ship, and help obtained in time to avoid loss of life and property. Of these five calls for assistance, three were for vessels run ashore on the sands near the lightship, one because the lightship herself had been run into by a steamer, and one to call a boat to take off a member of the crew who was seriously ill.

In the case of a French steamer which went ashore off the Goodwins, we have evidence, given in the Admiralty Court, that, by means of one short wireless message, property to the amount of 52,588*l.* was saved; and of this amount, I am glad to say, the owners and crews of the lifeboats and tugs received 3000*l.* This one saving alone is probably sufficient in amount to equip all the lightships round England with wireless telegraph apparatus more than ten times over. The system has also been in constant use for the official communication between the Trinity House and the ship, and is also used daily by the men for private communication with their families, &c.

It is difficult to believe that any person who knows that wireless telegraphy has been in use between this lightship and the South Foreland day and night, in storm and sunshine, in fog and in gales of wind, without breaking down on any single occasion, can believe, or be justified in saying, that wireless telegraphy is untrustworthy or uncertain in operation. The lightship installation is, be it remembered, in a small damp ship, and under conditions which try the system to the utmost. I hope that before long the necessary funds will be at the disposal of the Trinity House authorities, in order that communication may be established between other lightships and lighthouses and the shore, by which millions of pounds' worth of property and thousands of lives may be saved.

At the end of March 1899, by arrangement with the French Government, communication was established between the South Foreland Lighthouse and Wimereux, near Boulogne, over a distance of thirty miles, and various interesting tests were made between these stations and French warships. The maximum distance obtained at that time, with a height of about one hundred feet on the ships, was forty-two miles. The commission of French naval and military officers who were appointed to supervise these experiments, and report to their Government, were in almost daily attendance on the one coast or the other for several weeks. They became intensely interested in the operations, and I have good reasons to know made satisfactory reports to their Government. I cannot allow this opportunity to pass without bearing willing testimony to the courtesy and attention which characterised all the dealings of these French gentlemen with myself and staff.

The most interesting and complete tests of the system at sea were, however, made during the British naval manœuvres. Three ships of the "B" fleet were fitted up, the flagship *Alexandra*, and the cruisers *Juno* and *Europa*. I do not consider myself quite at liberty to describe all the various tests to which the system was put, but I believe that never before were Hertzian waves given a more difficult or responsible task. During these manœuvres I had the pleasure of being on board the *Juno*, my friend, Captain Jackson, R.N., who had done some very good work on the subject of wireless telegraphy before I had the pleasure of meeting him, being in command. With the *Juno* there was usually a small squadron of cruisers, and all orders and communications were transmitted to the *Juno* from the flagship, the *Juno* repeating them to the ships around her. This enabled evolutions to be carried out even when the flagship was out of sight. This would have been impossible by means of flags or semaphores. The wireless installations on these battleships were kept going night and day, most important manœuvres being carried out and valuable information telegraphed to the Admiral when necessary.

The greatest distance at which service messages were sent was 60 nautical miles, between the *Europa* and the *Juno*, and 45 miles, between the *Juno* and the *Alexandra*. This was not the maximum distance actually obtained, but the distance at which, under all circumstances and conditions, the system could be relied upon for certain and regular transmission of service messages. During tests messages were obtained at no less than 74 nautical miles (85 land miles).

As to the opinion which naval experts have arrived at concerning this new method of communication, I need only refer to the letters published by naval officers and experts in the columns of the *Times* during and after the period of the autumn manœuvres, and to the fact that the Admiralty are taking steps to introduce the system into general use in the navy.

As you will probably remember, victory was gained by the "B" fleet, and perhaps I may venture to suggest that the facility which Admiral Sir Compton Domville had of using the wireless telegraph in all weathers, both by day and night, contributed to the success of his operations.

Commander Statham, R.N., has published a very concise description of the results obtained in the *Army and Navy*, illustrated, and I think it will be interesting if I read a short extract from the admirable description he has published.

"When the reserve fleet first assembled at Tor Bay, the *Juno* was sent out day by day to communicate at various distances with the flagship, and the range was speedily increased to over 30 miles, ultimately reaching something like 50 miles. At Milford Haven the *Europa* was fitted out, the first step being the securing to the main topmast head of a hastily prepared spar carrying a small gaff or sprit, to which was attached a wire, which was brought down to the starboard side of the quarter-deck through an insulator and into a roomy deck house on the lower after-bridge which contained the various instruments.

When hostilities commenced the *Europa* was the leading ship of a squadron of seven cruisers despatched to look for the convoy at the rendezvous. The *Juno* was detached to act as a link when necessary and to scout for the enemy, and the flag-ship of course remained with the slower battle squadron. The *Europa* was in direct communication with the flagship long after leaving Milford Haven, the gap between reaching to 30 or

40 miles before she lost touch while steaming ahead at a fast speed. (This difference between the ranges of communication on these ships was owing to the *Juno* having a higher mast than the *Alexandra*).

"Reaching the convoy at four o'clock one afternoon, and leaving it and the several cruisers in charge of the senior captain, the *Europa* hastened back towards another rendezvous, where the Admiral had intended remaining until he should hear whether the enemy had found and captured the convoy; but scarcely had she got well ahead of the slow ships when the *Juno* called her up and announced the Admiral coming to meet the convoy. The *Juno* was at this time fully 60 miles distant from the *Europa*.

"Now imagine," says Commander Statham, "a chain of vessels 60 miles apart. Only five would be necessary to communicate some vital piece of intelligence a distance of 300 miles, receive in return their instructions, and act immediately all in the course of half an hour or less. This is possible already. Doubtless a vast deal more will be done in a year or two or less, and meanwhile the authorities should be making all necessary arrangements for the universal application of wireless telegraphy in the navy."

The most important results, from a technical point of view, obtained during the manœuvres were the proof of the great increase of distance obtainable by employing the transformer in the receiver, as already explained, and also that the curvature of the earth which intervened, however great the distance attained, was apparently no obstacle to the transmission. The maximum height of the top of the wire attached to the instruments above the water did not on any occasion exceed 170 feet, but it would have been geometrically necessary to have had masts 700 feet high on each ship in order that a straight line between their tops should clear the curved surface of the sea when the ships were 60 nautical miles apart. This shows that the Hertzian waves had either to go over or round the dome of water 530 feet higher than the tops of the masts or to pass through it, which latter course I believe would be impossible.

Some time after the naval manœuvres, with a view to showing the feasibility of communicating over considerable distances on land, it was decided to erect two stations, one at Chelmsford and another at Harwich, the distance between them being 40 miles. These installations have been working regularly since last September, and my experiments and improvements are continually being carried out at Chelmsford, Harwich, Alum Bay, and North Haven, Poole.

In the month of September last, during the meetings of the British Association in Dover and of the Association Française pour l'avancement de Science in Boulogne, a temporary installation was fixed in the Dover Town Hall, in order that members present should see the practical working of the system between England and France. Messages were exchanged with ease between Wimereux, near Boulogne, and Dover Town Hall. In this way it was possible for the members of the two associations to converse across the Channel, over a distance of 30 miles.

During Prof. Fleming's lecture on the "Centenary of the Electric Current," messages were transmitted direct to and received from France, and *viâ* the South Foreland Lighthouse to the East Goodwin Lightship. An interesting point was that it was demonstrated that the great masses of the Castle Rock and South Foreland cliffs lying between the Town Hall, Dover, and the lighthouse did not in the least degree interfere with the transmission of signals. This result was, however, by no means new. It only confirmed the results of many previous experiments, all of them showing that rock masses of very considerable size intervening between two stations do not in the least affect the freedom of communication by ether wave telegraphy. (See *Journal* of the Institution of Electrical Engineers, April 1899, p. 280.)

It was during these tests that it was found possible to communicate direct from Wimereux to Harwich or Chelmsford, the intervening distance being 85 miles. This result was published in a letter from Prof. Fleming addressed to the *Electrician* on September 29. The distance from Wimereux to Harwich is approximately 85 miles, and from Wimereux to Chelmsford also 85 miles, of which 30 miles are over sea and 55 over land. The height of the poles at these stations was 150 feet, but if it had been necessary for a line drawn between the tops of the masts to clear the curvature of the earth they would have had to have been over 1000 feet high. I give these results to show what satisfactory progress is being made with this system.

In America wireless telegraphy was used to report from the high seas the progress of the yachts in the International Yacht Race, and I think that occasion holds the record for work done in a given time, over four thousand words being transmitted in the space of less than five hours on several different days.

Some tests were carried out for the United States Navy; but, owing to insufficient apparatus, and to the fact that all the latest improvements had not been protected in the United States at that time, it was impossible to give the authorities there such a complete demonstration as was given to the British authorities during the naval manœuvres. Messages were transmitted between the battleship *Massachusetts* and the cruiser *New York* up to a distance of 36 miles.

A few days previous to my departure from America the war in South Africa broke out. Some of the officials of the American line suggested that, as a permanent installation existed at the Needles, Isle of Wight, it would be a great thing, if possible, to obtain the latest war news before our arrival on the *St. Paul* at Southampton. I readily consented to fit up my instruments on the *St. Paul*, and succeeded in calling up the Needles station at a distance of 66 nautical miles. By means of wireless telegraphy, all the important news was transmitted to the *St. Paul* while she was under way, steaming twenty knots, and messages were despatched to several places by passengers on board. News was collected and printed in a small paper called the *Transatlantic Times* several hours before our arrival at Southampton.

This was, I believe, the first instance of the passengers of a steamer receiving news while several miles from land, and seems to point to a not far distant prospect of passengers maintaining direct and regular communication with the land they are leaving and with the land they are approaching, by means of wireless telegraphy.

At the tardy request of the War Office, we sent out Mr. Bullocke and five of our assistants to South Africa. It was the intention of the War Office that the wireless telegraph should only be used at the base and on the railways, but the officers on the spot realised that it could only be of any practical use at the front. They therefore asked Mr. Bullocke whether he was willing to go to the front. As the whole of the assistants volunteered to go anywhere with Mr. Bullocke, their services were accepted, and on December 11 they moved up to the camp at De Aar. But when they arrived at De Aar, they found that no arrangements had been made to supply poles, kites, or balloons, which, as you all know, are an essential part of the apparatus, and none could be obtained on the spot. To get over the difficulty, they manufactured some kites, and in this they had the hearty assistance of two officers, viz. Major Baden-Powell and Captain Kennedy, R.E., who have often helped me in my experiments in England. (Major Baden-Powell, it will be remembered, is a brother of the gallant defender of Mafeking.)

The results which they obtained were not at first altogether satisfactory, but this is accounted for by the fact that the working was attempted without poles or proper kites, and afterwards with poles of insufficient height, while the use of the kites was very difficult, the kites being manufactured on the spot with very deficient material. The wind being so variable, it often happened that when a kite was flying at one station there was not enough wind to fly a kite at the other station with which they were attempting to communicate. It is therefore manifest that their partial failure was due to the lack of proper preparation on the part of the local military authorities, and has no bearing on the practicability and utility of the system when carried out under normal conditions.

It was reported that the difficulty of getting through from one station to another was due to the iron in the hills. If this had not been cabled from South Africa, it would hardly be credible that any one should have committed himself to such a very unscientific opinion. As a matter of fact, iron would have no greater destructive effect on these Hertzian waves than any other metal, the rays apparently getting very easily round or over such obstacles. A fleet of thirty ironclads did not affect the rays during the naval manœuvres, and during the yacht race I was able to transmit my messages with absolute success across the very high buildings of New York, the upper storeys of which are iron.

However, on getting the kites up, they easily communicated from De Aar to Orange River, over a distance of some seventy miles. I am glad to say that, from later information received, they have been able to obtain poles, which although not quite high enough for long distances are sufficiently useful. We have also sent a number of Major Baden-Powell's kites, which are the only ones I have found to be of real service.

Stations have been established at Modder River, Enslin, Belmont, Orange River, and De Aar, which work well and will be invaluable in case the field telegraph line connecting these positions should be cut by the enemy.

It is also satisfactory to note that the military authorities have lately arranged to supply small balloons to my assistants for portable installations on service waggons.

While I admire the determination of Mr. Bullocke and our assistants in their endeavour to do the very best they could with most imperfect local means, I think it only right to say that if I had been on the spot myself I should have refused to open any station until the officers had provided the means for elevating the wire, which, as you know, is essential to success.

Mr. Bullocke and another of our assistants in South Africa has been transferred with some of the apparatus to Natal to join General Buller's forces, and it is likely that before the campaign is ended wireless telegraphy will have proved its utility in actual warfare. Two of our assistants bravely volunteered to take an installation through the Boer lines into Kimberley; but the military authorities did not think fit to grant them permission, as it probably involved too great a risk.

What the bearing on the campaign would have been if working installations had been established in Ladysmith, Kimberley and Mafeking, before they were besieged, I leave military strategists to state. I am sure you will agree with me that it is much to be regretted that the system could not be got into these towns prior to the commencement of hostilities.

I find it hard to believe that the Boers possess any workable instruments. Some instruments intended for them were seized by the authorities at Cape Town. These instruments turned out to have been manufactured in Germany. Our assistants, however, found that these instruments were not workable. I need hardly add that as no apparatus has been supplied by us to any one, the Boers cannot possibly have obtained any of our instruments.

I have spoken at great length about the things which have been accomplished. I do not like to dwell upon what may, or will, be done in the immediate or more distant future, but there is one thing of which I am confident—viz. that the progress made this year will greatly surpass what has been accomplished during the last twelve months; and speaking what I believe to be sober sense, I say, that by means of the wireless telegraph, telegrams will be as common, and as much in daily use, on the sea as at present on land.

THE AIR MOVEMENT AT SIMLA AND IN THE WESTERN HIMALAYAS.[1]

IT will generally be admitted that the Meteorological Reports that are issued from time to time by the Indian authorities possess two very valuable features. The work is thorough in its execution, and the result derived is interesting. The present discussion of the air movement at Simla and in the Western Himalayas does not, in either novelty or importance, fall behind the other memoirs which have preceded it, although it presents only a portion of the full investigation, which, when complete, will embrace a similar discussion of the observations made at Darjeeling, a station as characteristic of the Eastern Himalayas, as Simla is of the Western. Two circumstances contribute to the interest attaching to this special inquiry. One is, that our knowledge of the behaviour of the winds in mountain areas is somewhat limited, both on the practical and theoretical side: consequently, a thorough study is particularly welcome. The other is the suitableness of the situation for such an inquiry, since the phenomena can exhibit themselves here on a large scale, and the influence of minor interfering effects be much eliminated. In Indian meteorology we have to deal with large masses of air, subject to periodic laws and partaking of the general movement of the air at the earth's surface. In this particular instance, we have the Indo-Gangetic plain stretching from the North Punjab to East Bengal, some 1350 miles long, and 200 miles in average breadth. The whole of this area is below 1000 feet in elevation, and probably averages barely 400 feet above the sea. From this plain the outer ranges of the Himalayas rise with remarkable abruptness over nearly the whole length. On the northern side, by way of contrast, we have the elevated tableland of Thibet, of which a considerable portion exceeds 14,000 feet in elevation, constituting the great protuberance above the general level of the earth's surface, of which the Himalaya and Karakoram mountains are nothing but the northern and southern borders. In this noble theatre and laboratory, the movements of the air peculiar to mountain areas can be studied with effect, and yet, by some strange perversity, the subject has been neglected. The knowledge which we have gained, and which is repeated in text-books, has unfortunately been derived from wind registers which were either not continuous in their action, or from which partial extracts have been made. The records selected for discussion were made at 8 and 10 a.m. and 4 p.m., consequently, the effect of the night winds, accompanying a fall of temperature, did not come within the scope of investigation. Moreover, the stations chosen for the anemometric instruments represented the characteristics of the air movement across the lower mountain ranges and not the local up and down movements in the deep valleys which lie between these ranges. It is therefore not surprising that the results derived from so partial a source need corrections, or that the accounts given by travellers through these districts, limited as they necessarily are to certain seasons of the year, do not adequately represent the whole of the observed phenomena.

In the opening pages Mr. Eliot briefly reviews the state of our knowledge, and sketches the work of his predecessors in office. The conclusions derived from this haphazard and intermittent kind of observation were to the effect that southerly winds prevail throughout the whole year at the Himalayan hill stations, indicating that in the south-west monsoon the lower air current extends to these elevations; whereas, in the cold weather, the air current giving these winds is the upper movement complementary to the north-westerly winds at the level of the plains. Moreover, the records indicated that the air movement is strongest in the Western Himalayas from January to April, and is feeblest during the monsoon period from June to September. To these statements, which have been frequently quoted, Sir Richard Strachey added, from his own experience and observation, that the most important feature of the air movement in the Western Himalayas was the up and down valley winds, blowing up the valleys during the day from 9 a.m. to 9 p.m. and down them during the corresponding hours of the night.

Mr. Eliot deals with these statements in the first series of tables founded on the records of a large Beckley anemometer, not particularly described. He gives the number of winds recorded under each of eight points of the compass for portions of the years 1893–1896, and derives the constants of the well-known Besselian formula representing the diurnal variation of the winds. The result is to show that the mean monthly air movement is in January and February approximately S.E., and for the remainder of the year is N. 46° E. as opposed to S. 61° W. from the partial records already referred to. Other deductions which come out of this preliminary inquiry show that the air movement is least during the rainy season of July and August, greatest from January to May, and that, since the mean movement is almost as great in January and February as in the hot weather months, it is not a function of the temperature. Mr. Eliot sums up the general conclusions in the following terms:—"The air moment at Simla varies slightly in strength throughout the year, but has two well-marked maxima and minima, in no way related directly to the seasons or to the air movement over the plains in Northern India. These facts alone constitute a strong proof of the inference that the air movement over the Himalayan area is a unique system, independent of the general air movement over the plains in Northern India, and dependent on local conditions and features."

Neither does the *diurnal* variation of the wind, whether in velocity or rotation, partake of that simple character which has been ascribed to it, but within a limited space it is not easy to summarise the results of the analysis applied. For Mr. Eliot

[1] "Indian Meteorological Memoirs; being occasional discussions and compilations of meteorological data relating to India and the neighbouring countries." Vol. vi., Part 5. (Published by order of H.E. the Viceroy and Governor-General of India in Council, under the direction of John Eliot, M.A., F.R.S., C.I.E., Calcutta, 1899.)

not only discusses the broad effects of great seasonal changes, but considers the minuter variations noticeable month by month. Still unsatisfied and fearing that some effects are masked by the fallacious system of averages, into which occasional and irregular disturbances can enter with perplexing and even misleading effect, he finally studies the air movement during normal days in each of the characteristic weather periods that mark the climate of India. In this way, and in this way only, does it seem possible to assign a correct physical interpretation to the various types of air movements that are shown to exist. It is impossible to read this section without acknowledging the presence of a master hand, in the closeness of the reasoning, in the clear marshalling of facts, and in the accuracy of the deductions.

The broad result is to show that there is an upward movement during the day hours from about 8 a.m. to 5 p.m., giving southerly winds with more or less westing, and having their maximum intensity at 2 p.m., and a downward movement during the remaining hours, giving northerly winds with more or less easting. A comparison of the barometric readings, at the hill and plain stations respectively, shows that this observed transfer of air (from hills to plains by night, and plains to hills by day) is accompanied by a similar transfer in the opposite directions in the upper strata of the atmosphere. In other words, there is a complete air circulation between the hills and plains of the Western Himalayas.

From the arrangement of his facts Mr. Eliot passes to a theoretical discussion based on the diurnal variation of the vertical pressure anomalies and of the temperature conditions prevailing in the hills and plains, establishing the existence of horizontal pressure gradients from the plains to the hills in the day hours, and from the hills to the plains in the night time, giving rise to alternating movements, roughly proportional to the diurnal range of temperature in the Punjab plains. The hours at which the gradients disappear are worked out with care, and demonstrate the existence of a see-saw motion. Such alternating movements cannot be without their effect on the temperature and humidity of the air at Simla. In fact, the maximum day temperature over the East Punjab plains mainly determines the maximum day temperature at Simla, while the height of the snow line on the Himalaya range will affect the minimum readings. Into the cloud observations and the humidity conditions we have not space to enter. We can only say that the author leaves untouched no clue that can throw light upon this important feature of day and night alternating currents. The observations at his command do not extend over a very long period, in which it might be expected that disturbances would counteract and destroy each other; but by the careful sifting of the evidence the author has been able to deduce many points of interest, and has left a model which may serve for any future discussion of local air movements.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—An additional year has been granted, in addition to the usual University period of residence, which qualifies for examination in any honour school, to those members of the University who shall have been absent on military service in connection with the war in South Africa.

In a congregation held on February 6, the preamble of the statute instituting the degrees of Doctor of Letters and Doctor of Science was approved, without opposition. By this action the University undertakes to institute these degrees; the exact provisions of the scheme will, of course, be arranged later, but it has been proposed that a candidate for the degree shall submit *published* papers or books containing an original contribution to the advancement of learning or science. (*See* NATURE, vol. lxi. p. 164).

The curators of the University chest are authorised to expend such sums as may be necessary in maintaining the rooms assigned to the new department of geography. A considerable number of students have availed themselves of the opportunities afforded by this new department.

CAMBRIDGE.—The decision of the Senate on the question of remodelling the Mathematical Tripos, is to be taken to-day (February 15). The discussion by means of fly-sheets indicates that the opposition will be strong; but the arguments adduced against the present proposals of the Mathematical Board, point rather to regression towards the old undivided and unlimited examination than to the maintenance of the existing Tripos, with which few persons are perfectly satisfied.

The following have been appointed Electors to the several scientific chairs:—Chemistry, Prof. Dewar; Plumian of Astronomy, Lord Rayleigh; Anatomy, Dr. D. MacAlister; Botany, Zoology, and Agriculture, Sir M. Foster; Geology, Mr. W. H. Hudleston; Jacksonian of Natural Philosophy, Prof. Liveing; Downing of Medicine, Sir T. Lauder Brunton; Mineralogy, Sir G. G. Stokes; Experimental Physics, Prof. Darwin; Engineering, Prof. A. B. W. Kennedy; Physiology, Dr. Gaskell; Surgery, Mr. T. Holmes; Pathology, Dr. L. Humphry; Mental Philosophy, Prof. Sidgwick.

Profs. Liveing, Marshall Ward, Hughes, and Somerville, and Messrs. Warburton, Widdicombe, Adie, and McCracken, have been appointed examiners for the Diploma in Agricultural Science.

BY the will of the late Mr. W. Hiddingh, who died on December 10, 1899, the University of the Cape of Good Hope is bequeathed the sum of 5000*l*. for the foundation of a scholarship to enable young persons to pursue and complete a course of professional study, the scholarship to be tenable for four years. The University is also bequeathed the sum of 25,000*l*. for the purpose of building a university hall and suitable university offices, and a large piece of ground for the site of the building. The South African College will receive the sum of 10,000*l*. for the erection of a students' building.

IT appears from a return just published that the amount expended on technical education, exclusive of the sums allocated to intermediate and technical education under the Welsh Intermediate Education Act, was in 1897–98 860,104*l*., and the estimated total expenditure during the year 1898–99 was 874,611*l*. The amounts raised by loan on the security of the local rate under the Technical Instruction Acts were—in 1897–98 69,333*l*., and in 1898–99 133,583*l*. The total amount of the residue received under the Local Taxation (Customs and Excise) Act by the councils of counties and county boroughs in England, excepting Monmouth, in respect of the financial year 1897–98 was 834,826*l*., of which 759,400 was appropriated to educational purposes, and 75,426*l*. to the relief of rates, the latter sum including 42,108*l*. devoted by the London County Council, to relief of the rates. Of the forty-nine counties forty are applying the whole of the residue, and nine a part of it, to technical education. The total of the residue paid to the thirteen county councils and the councils of three county boroughs in Wales and Monmouth was 40,061*l*., and these local authorities are devoting the whole of it to intermediate and technical education under the Welsh Intermediate Act, 1889. In the case of Ireland the residue is not applicable to technical education. Twelve local authorities expended on technical education during the year 1897–98 5649*l*., and the estimated total expenditure by them during 1898–99 was 4523*l*.

THE Massachusetts Institute of Technology is well known to be among the foremost educational institutions in the United States. The "Annual Catalogue," for 1899–1900, which has just been received, is an instructive volume for any one interested in the methods of technical education followed in America. The equipment of this Institute accords with the view that the foundation of all sound technological education requires, not only thorough theoretical training, but also prolonged, well-directed laboratory drill which shall first give the student the power of close and accurate observation, and then bring him into direct contact with the material problems of his future profession. The laboratories of the Institute are numerous and extensive, the Kidder laboratories of chemistry affording accommodation for more than six hundred students; their equipment is correspondingly ample, and is kept well up to the rapid advances in technical practice. Provision is made for exact general training in the problems of physics and chemistry, for highly specialised work in these and other sciences, and for engineering tests and processes on a practical scale. Great importance is attached to the study of mathematics, both as a means of mental discipline, and as affording a necessary basis for further instruction in the engineering and other courses. The instruction in applied chemistry includes the use of text- and reference-books in both

French and German. Many other instances might be given of the thorough character of the work being done, but those cited will serve to show that the alumni of the Institute receive an education which is of service in assisting the development of American industries.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, February 9.—Annual General Meeting.—Prof. Lodge, F.R.S., President, in the chair.—The following officers were elected to form the Council:—President, Prof. Lodge; Vice-Presidents (who have filled the office of President), Dr. Gladstone, Prof. Carey Foster, Prof. Adams, Lord Kelvin, Prof. Clifton, Prof. Reinold, Prof. Ayrton, Prof. Fitzgerald, Prof. Rucker, Sir W. Abney, Mr. Shelford Bidwell; Vice-Presidents, Mr. Blakesley, Mr. Boys, Prof. Everett, Mr. Griffith; Secretaries, Messrs. H. M. Elder and W. Watson; Foreign Secretary, Prof. S. P. Thompson; Librarian, Mr. W. Watson; Treasurer, Prof. Callendar; other members of Council, Prof. Armstrong, Dr. Atkinson, Mr. W. Baily, Prof. Glazebrook, Mr. E. H. Griffiths, Mr. S. Lupton, Prof. Perry, Mr. Swinburne, Prof. Threlfall and Mr. J. Walker.—Prof. Lodge delivered his Presidential address, on the controversy concerning Volta's contact force. Those who take a metallic view of the Volta contact force are accustomed to deny that the Peltier evolution of heat measures the local E.M.F. existing at a junction; they assert that it measures the rate at which that same E.M.F. varies with temperature. In the thermodynamic equation connecting the Peltier effect with the variation of E with temperature, the E which varies is not necessarily that at the junction considered, but is the total E.M.F. of the circuit. The reversible heat at a specified junction is a measure of the metallic E.M.F. located there. Those who say it is a temperature variation of the E.M.F. beg the question by locating the whole E.M.F. of the circuit at the particular junction they are considering, usually an interface of zinc and copper. At a chemical junction the E.M F. is not purely thermal, and hence is not measured by the Peltier effect; it is chiefly of chemical origin, and is calculable from the energy of combination of the materials on either side of the boundary. At a metallic junction there is no such chemical potentiality. A strong current may be passed across a zinc-copper junction for years and no brass is formed. It is, therefore, improbable that the chemical affinity of zinc for copper is the propelling influence which causes the E.M.F. located at such a junction. In showing the Volta effect experimentally, a trace of liquid can act detrimentally by forming a conducting bridge between the plates, across which the bulk of the electricity passes as the metals are being separated. The safest and clearest mode of expressing the Volta effect is that it consists in an opposite charge acquired by dry zinc and copper while in metallic contact, a charge which results from an E.M.F. of fixed value, and is controlled solely by this E.M.F. and electrostatic capacity. It is undeniable that the order of the Volta force can be calculated from the differential heats of combination of the metals for oxygen, although it is doubtful whether it can be calculated from the heat of formation of brass. The opposing sides of the old controversy used to be called contact theorists and chemical theorists. Now the opposite sides are involved both in contact and in chemical views. It is a question of which of several contacts is the effective one, and what kind of chemical action or affinity is the active cause. Is it the contact and chemical affinity across the metal-metal junctions, or across the metal-air junctions? The opposite sides are thus metallic and dielectric. The metal-air force is of the order volts; the metal-metal force is of the order milli-volts. When a piece of zinc is put in contact with a piece of copper, the oxygen atoms which surround these bodies move slightly away from the copper and approach slightly nearer to the zinc. These slight motions produce the whole Volta effect. All that is necessary for the Volta effect is the inherent film on the surface. All the rest of the gas is mere dielectric, and might be substituted by a vacuum. It was proposed by Prof. Perry and seconded by Prof. Armstrong that a meeting should be held to discuss the address. The meeting was adjourned until February 23.

Mineralogical Society, January 23.—Prof. A. H. Church, F.R.S., President, in the chair.—Mr. E. G. J. Hartley, in continuation of his investigations on the constitution of the natural arsenates and phosphates, gave the results of analyses of beudantite, which lead to the new formula:

$$3PbSO_4.2Fe(P, As)O_4.6Fe(OH)_3.$$

Prof. H. A. Miers found by optical examination that the mineral was probably not uniaxial, but pseudorhombohedral.—Mr. G. T. Prior described rock-specimens from the Little Island of Trinidad, S. Atlantic, which were collected by the Ross Antarctic Expedition. They consisted mainly of phonolites, with nephelenite and limburgite.—Mr. W. Barlow contributed a paper on a new method of deriving the thirty-two classes of crystal symmetry, which, it is stated, is more rigorous and at the same time simpler and more concise than the solutions hitherto given.—Mr. R. H. Solly exhibited crystals of dolomite from the Binnenthal, in which the tetartohedral character was well displayed.—Mr. A. L. Hall described new forms on crystals of copper-pyrites from Cornwall.

Geological Society, January 24.—W. Whitaker, F.R.S., President, in the chair.—Fossils in the University Museum, Oxford: II.—On two new genera and species of Crinoidea, by Prof. W. J. Sollas, F.R.S. The first genus and species are founded on two calyces in the University Collection and three in the British Museum; all the specimens come from the Carboniferous Limestone. The arms and stem are at present unknown. The genus in general character and structure recalls *Platycrinus*, but the incorporation of the costal and distichal plates in the calyx affords a very obvious distinction. The analysis of the calyx, however, suggests the Melocrinidæ, from the members of which it is chiefly distinguished by the comparatively small size of the costal and distichal plates. The new genus is a truly annectant form uniting the Melocrinidæ and the Platycrinidæ, and may be indifferently associated with either. The second genus and species are founded on a specimen in the Grindrod Collection, obtained probably from the Silurian rocks, but from a locality not known, possibly Dudley. In general appearance it resembles an elongated form of *Pisocrinus*, particularly in its calyx, but the arms are those of a Heterocrinid. This conjunction of characters, though rendering necessary a revision of the definition of the Pisocrinidæ, cannot be regarded as bringing this family appreciably nearer to the Heterocrinidæ, which are fistulate, while the Pisocrinidæ, so far as known, are not.—Fossils in the University Museum, Oxford: III.—A new worm-track from the slates of Bray Head, Ireland, with observations on the genus *Oldhamia*, by Prof. W. J. Sollas, F.R.S. The curious marking known as *Oldhamia* have not been hitherto recorded from other than the Lower Palæozoic rocks, although they have a wide distribution in space, being found in Ireland, in the Ardennes, in Brabant, in America, and possibly in Norway. While the organic nature of *Oldhamia* was scarcely a matter of doubt in the minds of the earlier writers, there existed a great diversity of opinion as to its place in the organic world, and it was placed by different observers among polyzoa, hydrozoa, and plants, respectively. The microscopical observations made by the author prove that *Oldhamia* is not the remains of an organism, but merely a marking in the rock, though one which might be, nevertheless, of organic origin.—Contributions to the Geology of British East Africa: Part II.—The geology of Mount Kenya, by Dr. J. W. Gregory. The three main zones of Kenya are characterised by different geological features. The long slope of the forest-belt consists in the main of volcanic ash, though the remains of secondary parasitic craters occur in it. The Alpine zone consists of coarser ash, agglomerates, and tuffs, interbedded with lava-flows and traversed by numerous dykes, with the remains of some secondary centres of eruption. The third zone, or central peak, consists of the plug which choked the central vent, of beds of agglomerate, and the thick proximal ends of the great lava-flows.—Contributions to the Geology of British East Africa: Part III.—The elæolite-syenite and fourchites intrusive in the coast series, by Dr. J. W. Gregory. The rocks described in this paper were given to the author by Mr. C. W. Hobley. Mount Zombo, situated in long. 39° 13′ E. and lat. 4° 26′ S., and 1519 feet high, is a massif of coarse-grained elæolite-syenite, consisting of anorthoclase, elæolite, usually allotriomorphic, and ægyrine. The rock must occur in the belt of Duruma Sandstone, unless the fossiliferous Jurassic shales run westward up the low valley of the Umba River. The sedimentary series on the coast-lands of British East Africa and Usambara are provisionally arranged by the author as follows: (5) Pleistocene reefs, limestones, alluvium, and laterites; (4) Jurassic shales and sandstones; Kimeridgian, Oxfordian, and

Callovian; (3) Possibly a pre-Jurassic part of the Duruma Sandstone; (2) Magarini sandstones; ? Triassic; (1) Sabaki shales; Upper Carboniferous.

MANCHESTER.

Literary and Philosophical Society, February 6.—Prof. Horace Lamb, F.R.S., President, in the chair.—On the conditions of propagation of a solitary wave, by R. F. Gwyther. In order to obtain mathematical formulæ capable of expressing in a few terms the equality of surface pressure over the long stretches of the solitary wave, the wave is regarded as being mainly supported by the pressure on the outskirts, any defect in the equality of pressure over the crest being looked on, under certain conditions, as overcome by a slight readjustment of the particles. Taking in $x+iy$ a term of the form $\tan hm\frac{(\phi+i\psi)}{c}$, it is shown that the results agree closely with the experimental results of Scott Russell.—On the motion of the particles in certain cases of steady fluid motion, by R. F. Gwyther. It is shown that the solution of the Lagrangian equations takes the form $x+iy=f(u+ib)$, where u is to be determined in terms of a, b, and t, by a quadrature.—On internal migration in England and Wales, 1881-91, by Prof. A. W. Flux. An account is given of the results of an examination of the net inward and outward movement in each registration district of England and Wales in the interval between the censuses of 1881 and 1891. The movement of the two sexes separately was taken, as differences in intensity and direction for males and females were not infrequent. Of the 54 registration counties (the Ridings of Yorkshire being separately considered), 40 showed net efflux for both sexes, and 7 others for one of the two sexes; of the 632 districts 124 only showed net influx of population taking the sexes together, this figure being reduced to 119 for males and raised to 136 for females. The net movements within the various counties involved a transference of about 304,000 males and 350,000 females from one district to another. Movement from a district in one county to one in another county involved a transference of about 172,000 males and 230,000 females, whilst some 418,000 males and 201,000 females left the country. The previously observed greater migratory tendency of the female seems at any rate partly due to the fact that when migration is tested by records of birth-places, the excess of migratory males are not included, owing to their removal beyond the limits of the kingdom. Measuring intensity of movement by the proportion of net migration to mean population, the absorption is most marked in London suburbs, and in those of some provincial towns in only a slightly less degree, and especially is marked in conveniently situated watering-places at the seaside, Bournemouth heading the list. The absorption into growing industrial towns is less strongly shown than might have been anticipated. These movements indicate some amelioration of the evils of life in crowded cities. The districts from which efflux has been strongest are found in the south-west, in Wales, on the Scotch border, and in north-east Yorkshire and Lincolnshire. A cartogram illustrating the movements was exhibited.

DUBLIN.

Royal Irish Academy, January 22.—Dr Benjamin Williamson, F.R.S., Vice-President, in the chair.—Rev. W. R. Westropp Roberts, F.T.C.D., read a paper "On the Reduction of the Integral $\int \frac{\phi(z)\,dz}{\psi(z)\sqrt{f(z)}}$ to a number of other Integrals of the form $\int \frac{dz}{(z-n)\sqrt{f(z)}}$, where $\phi(z)$ and $\psi(z)$ are rational and integral functions of z and $f(z)$, a polynomial of the degree $2m$." The writer showed, in the first instance, the dependence of the above integral on $2m-1$ Integrals $I_0, I_1, \ldots I_{2m-1}$, and others of the form $L(z, n)$, having previously adopted the notation $I_r = \int \frac{z^r dz}{\sqrt{f(z)}}$, $L(z, n = \int \frac{dz}{(z-n)\sqrt{f(z)}}$, r being an integer. These $2m-1$ Integrals $I_0, I_1, \ldots I_{2-m1}$ are ultimately shown to depend on Integrals of the form $L(z, n)$, in which n is specially related to the roots of $f(z)=0$. The result finally arrived at is that there is but *one* class of elementary Integrals, as the general Integral discussed in the paper can, in all cases, be made to depend on a number of others of the form $L(z, n)$.—Prof. J. P. O'Reilly read a paper on the Epidiorites of Killiney Park, Dublin county. He called attention to the description of the locality given in the Memoir of the Geological Survey of Ireland descriptive of the district, and pointed out that no mention is made therein of these rocks, although reference is made to those met with in Howth and other parts of the district. Considering the fine exposure shown at Killiney Park, and the accessibility of the point, he thought it desirable to make a map of the point where the rocks crop out, showing their connection with the micaschists; which map was submitted with the paper. He also had analyses of the Epidiorite and of the enclosing micaschists made, and gave them in the paper. He called attention to the occurrence of similar micaschists at Bray Head, and suggested the possibility that the Killiney Park rocks may be the same beds as those of Bray Head, but in a much more advanced stage of metamorphosis.

PARIS.

Academy of Sciences, February 5.—M. Maurice Lévy in the chair.—Calculation of the orbit of a comet of which the geocentric movement is considerable, by MM. O. Callandreau and G. Fayet. Although the calculations of the orbits of the minor planets are sufficiently exact to enable the asteroid to be easily traced from day to day, considerable differences arise between the actual and calculated positions of some of the newer comets. A simplification of Olbers' method is suggested, which, with the aid of the auxiliary table suggested by M. Radau, gives very easily a good approximation.—The localisation, elimination and origin of arsenic in animals, by M. Armand Gautier. The amounts of arsenic normally present in 100 grams of the fresh organ are, for the thyroid gland, 0·75 mgr.; the mammary gland, 0·13 mgr.; for the brain, trace or nothing; thymus gland, a distinct trace, not estimated; for skin, milk, and bone, decreasing traces. The liver, kidney, spleen, muscles, testicles, pituitary gland, pancreas, mucous membranes, cellular tissue, salivary glands, subrenal capsules, ovaries, urine and faces contain no trace of arsenic. With the view of ascertaining the possible sources of arsenic in the food supply, various food stuffs were carefully examined for this metalloid: bread, meat and fish contained absolutely none, eggs gave a very doubtful trace. The author discusses the medico-legal aspect of the question.—Attempt at a mechanical theory of mountain formation. Progressive displacement of the terrestrial axis, by M. Marcel Bertrand. The view is put forward that the solid crust to the earth yields slowly to the pressures acting upon it, exactly as a liquid would do, except that the duration of the motion, instantaneous for a fluid, is exceedingly slow in the case of a solid.—On a disease of the grape-vines of the Caucasus, by MM. Prillieux and Delacroix. Previous workers on the outbreak of vine disease in the Caucasus, in 1896, have ascribed the results as due to the fungus of black rot (*Guignardia Bidwelli*), but closer examination has shown that it is another species of *Guignardia*, which corresponds to *Phoma reniformis*, which is the cause of the Tiflis disease, to which the authors attribute the name of *Guignardia reniformis*.—Observations of the comet 1899 IV. (Temple, 1873 ii.) made with the large equatorial at the Observatory of Bordeaux, by MM. G. Rayet, Féraud and Esclangon.—On the second voyage of the *Princess Alice II.*, by S. A. S. Prince Albert of Monaco.—Study of the variation of latitude at the Observatory of Teramo, Italy, by M. Jean Boccardi. The measurements were carried out by the method of Horrebow-Talcott, with an instrument of Troughton and Simms of 75 mm. aperture. For four different pairs of stars the variations of latitude found were 1″ 00, 0″·84, 0″·67, and 0″·98 respectively.—On a class of transformations, by M. J. Clairin.—On the determination of all the algebraic surfaces of double circular generation, by M. Eugène Cosserat.—On anharmonic algebraic equations, by M. Antonne.—On groups of isomorphisms, by M. G. A. Miller.—On vectorial masses of discontinuity, by M. André Broca.—The X-rays and discharge: generalisation of the notion of kathode rays, by M. G. Sagnac. A sealed note deposited July 18, 1898.—Contribution to the study of stratifications, by M. H. Pellat. Some experiments designed with a view to test the hypothesis that the stratifications produced in a Geissler tube are due to the interference of direct and reflected electric waves. The result was to negative this hypothesis, there being apparently neither a reflected electric wave nor electric oscillations.—On the metallic crystallisation by electrical transport of certain metals in distilled water, by M. Thomas Tommasina.—On the surface tension of some organic liquids, by MM. Paul Dutoit and Louis Friderich. Measurements are given of the temperature coefficient of surface energy for a large number of liquids, by Ramsay and Shields' method. The average value of the coefficient found was 2·12, rising to 2·3, for hydrocarbons containing two benzene rings, and to 2·35 to 2·50 for the anilines. The general results confirm the earlier work of Ramsay and Shields on the same subject.—On the volumetric estimation of hydrogen and chemical tensions, by M. Alb. Colson. Precipitated silver oxide, dried *in vacuo* without heating, is readily acted upon by hydrogen, slowly at ordinary temperatures, and more rapidly at 100° C., the absorption being so complete in the latter case that it suffices for the volumetric determination of hydrogen in a gaseous mixture, since methane and ethane are unattacked under the same conditions. The silver oxide behaves as though it had a definite vapour pressure, the hydrogen apparently acting upon this vapour.—Action of strong ammonia solution upon the iodide of mercurdiammonium, by M. Maurice François. By the action of strong solutions of ammonia upon $HgI_2.2MH_3$, the iodide Hg_2NI is formed, the reaction being reversible.—On the borates of the magnesium series, by M. L. Ouvrard. Definite tribasic borates of manganese, cobalt and nickel can be prepared in the dry way, in a state of purity sufficient for analysis.—On the acidimetric value of the substituted malonic acids, compared with those of the corresponding normal diacids, by M. G. Massol. A thermochemical paper.—On the individuality of seminase, a soluble ferment secreted by leguminous seeds during germination, by MM. Émile Bourquelot and H. Hérissey. The presence of the new ferment, together with a little diastase, was shown in germinating seeds of fenugrec and lucerne.—Influence of a parasite upon its host, by M. C. Sauvageau.—On the first fossil plant sent from Madagascar, by M. Ed. Bureau. The fossil is a new species of *Equisetum*, which, as it was discovered by Dr. Joly, is named *Equisetum Jolyi*.—On the phenomena of metamorphism and the production of an iron mineral coinciding with the denudation of the plateau of Haye (Meurthe-et-Moselle), by M. Bleicher.—On a new group of homogeneous enclosures in volcanic rocks, microtinites, andesites and tephrites, by M. A. Lacroix.—Atmospheric optical phenomena observed at the Pic du Midi and at Bagnères, by M. Em. Marchand.—New observations on the relative wind in a balloon, by M. G. Hermite.—On the production of secondary X-rays by the human body, and on an important point of technique in radiography, by M. Th. Guilloz.—The movements of expired air during the formation of speech sounds, by M. E. Gellé. It is concluded, from the experiments given, that the intra-buccal cavity is not inert, and that the buccal cavity does not act as a resonator as is usually supposed.—On the mechanism of audition of sound and on some connected phenomena, by M. Firmin Larroque.—On a granite from the Pyrenees, by M. F. Larroque.

DIARY OF SOCIETIES.

THURSDAY, FEBRUARY 15.

ROYAL SOCIETY, at 4.30.—The Genesis and Development of the Wall and Connecting Threads in the Plant Cell. Preliminary Communication: W. Gardiner, F.R.S.—Photography of Sound Waves and the Kinematographic Demonstration of the Evolutions of Reflected Wave-fronts, with Especial Reference to the Relation of the Wave-front to the Caustic: Prof. R. W. Wood.

ROYAL INSTITUTION, at 3.—Modern Astronomy: Prof. H. H. Turner, F.R.S.

LINNEAN SOCIETY, at 8.—Photography of British Plants: J. C. Shenston.—A New Land Planarian from the Pyrenees: Dr. R. F. Scharff.

CHEMICAL SOCIETY, at 8.—(1) Ammonium Amidosulphite; (2) Products of Heating Ammonium Sulphites, Thiosulphates and Trithionate: Edward Divers and Masataka Ogawa.—Note on the Refraction and Magnetic Rotation of Hexamethylene: Dr. S. Young, F.R.S., and Emily C. Fortey.—The Combination of Sulphur Dioxide and Oxygen: Edward J. Russell and Norman Smith.—Note on the Estimation of Gases containing Sulphur: E. J. Russell.—(1) Apiin and Apigenin. II. Note on Vitexin; (2) The Yellow Colouring Principles of various Tannin Matters, VII.: A. G. Perkin.

FRIDAY, FEBRUARY 16.

ROYAL INSTITUTION, at 9.—Life in Indo-China: H. Warington Smyth.

EPIDEMIOLOGICAL SOCIETY, at 8.30.—Insanitary Property and Workmen's Dwellings in Liverpool: Dr. E. W. Hope.

MONDAY, FEBRUARY 19.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Journeys in the Chinese Shan States: F. W. Carey.

VICTORIA INSTITUTE, at 4.30.—African and Mediterranean River Valleys: Prof. Hull.

TUESDAY, FEBRUARY 20.

ROYAL INSTITUTION, at 3.—Structure and Classification of Fishes: Prof. E. Ray Lankester, F.R.S.

ZOOLOGICAL SOCIETY, at 8.30.—On the Marine Fauna of Christmas Island (Indian Ocean): C. W. Andrews and others.—On the Soft Anatomy of the Musk-Ox (*Ovibos moschatus*): Dr. E. Lönnberg.—On a Species of Earthworm from Western Tropical Africa belonging to the Genus *Benhamia*: F. E. Beddard, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Papers to be further discussed:* Moving Loads on Railway Underbridges: W. B. Farr.—Note on the Floor System of Girder Bridges: C. F. Findlay.—*Paper to be read, time permitting:* Corrosion of Marine Boilers: John Dewrance.

ROYAL STATISTICAL SOCIETY, at 5.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—The Diffraction Process of Colour Photography: Prof. R. W. Wood.

WEDNESDAY, FEBRUARY 21.

GEOLOGICAL SOCIETY, at 8.—The Bunter Pebble-Beds of the Midlands and the Source of their Materials: Prof. T. G. Bonney, F.R.S.—On Further Evidence of the Skeleton of *Eurycarpus Oweni*: Prof. H. G. Seeley, F.R.S.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—Report on the Phenological Observations for 1899: Edward Mawley.—Results of Percolation Experiments at Rothamsted, 1870–99: Dr. Robert H. Scott, F.R.S.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Exhibition of Photomicrographic and Projection Apparatus (with Lantern Illustrations): J. W. Measures.

THURSDAY, FEBRUARY 22.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* Total Eclipse of the Sun, January 22, 1898. Observations at Viziadrug: Sir N. Lockyer, K.C.B., F.R.S., Captain Chisholm-Batten, and Prof. Pedler, F.R.S.—Preliminary Note on the Spectrum of the Corona, Part II.: Sir N. Lockyer, K.C.B., F.R.S.—On the Structure of Coccospheres and the Origin of Coccoliths: Dr. H. H. Dixon.—The Ionisation of Dilute Solutions at the Freezing Point: W. C. D. Whetham.

ROYAL INSTITUTION, at 3.—Modern Astronomy: Prof. H. H. Turner F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Standardisation of Electrical Engineering Plant: R. Percy Sellon. (Adjourned Discussion.)

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Improvements in the Longworth Power-Hammer: Ernest Samuelson.—Portable Pneumatic Tools: Ewart C. Amos.

FRIDAY, FEBRUARY 23.

ROYAL INSTITUTION, at 9.—Recent Studies in Gravitation: Prof. J. H. Poynting.

PHYSICAL SOCIETY, at 5.—Prof. R. W. Wood will exhibit and describe his Photographs of Sound Waves and the Kinematographical Demonstration of the Evolutions of Reflected Wave-fronts: a New Seudoscope: Diffraction Colour-Photographs; Artificial Parhelia.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Bearing Springs: B. Humphrey and H. E. O'Brien.

CONTENTS.

THURSDAY, FEBRUARY 22, 1900.

A NEW DEPARTURE IN CYTOLOGY.

Fixirung, Färbung, und Bau des Protoplasmas. Kritische untersuchungen ueber Technik und Theorie in der neueren Zellforschung. Von Dr. Alfred Fischer, a.o. Prof. der Botanik in Leipzig. Mit einer coloristen Tafel, und 21 abbildungen im text. Pp. x + 362. (Jena: Gustav Fischer, 1899.)

IT is many years since Dr. Routh administered to a youthful aspirant after literary fame the celebrated advice to "verify your references," and no matter what be the branch of learning concerned, the maxim applies, *mutatis mutandis*, with equal force to all. Certainly no one devoted to science can afford to disregard it, since extracts from the difficult text of nature are hardly less liable to errors of transcription than to those of interpretation. And this is especially true in the case of a study such as that of cytology, for not only is the evidence difficult to obtain and the degree of its relevancy to a particular problem hard to decide, but its very authenticity is not to be admitted without full proof.

Prof. Fischer has thoroughly deserved the gratitude of all who are interested in the investigation of cell phenomena, for he has opened up (even if he cannot claim to have originated) a new and fruitful path of inquiry in attacking the very foundations on which our knowledge of cell structure is based. He has, in fact, conducted an extensive investigation into the reactions obtaining between certain well-known proteids (in the widest sense of the term) and the fixatives and stains which are in common laboratory use.

The importance of this procedure becomes at once apparent on reflecting that protoplasm, when killed, becomes in fact something else, yielding, *inter alia*, a complex mixture of proteids, and that it is just these proteids which are so grouped in the dead cell as to produce what we term its structure.

Many of the proteids can be tolerably easily recognised and classified, and it is clearly imperative to learn as much as possible about them and their individual reactions with the substances employed to kill or fix the cell contents. It may be regarded as fairly certain that "fixation" really implies the *precipitation* of substances which, in the living cell, existed under other forms and other conditions. In some cases, *e.g.* when salts of the heavy metals are used, it is probable that the metallic base enters into combination with some, at any rate, of the proteids, whilst in the case of some other fixatives, such a possibility appears to be excluded. But in whatever way the precipitates may be produced, it is obviously a matter of prime necessity to ascertain the extent to which they correspond, in position and in form, with the structural elements of the living cell. An instance in which such a correspondence is probable is supplied by the chromosomes of a dividing nucleus. These bodies can be identified in the living condition, although it is not until after fixing that the finer details of structure become apparent, and for which it would be hopeless to look in the living nucleus. Now it is precisely as to the extent to which we are justified in regarding these details as faithfully reflecting *living* structure that the greatest uncertainty prevails.

Many persons are satisfied by the comparative uniformity exhibited in "well-fixed" specimens when prepared by diverse methods. But can the criterion of trustworthiness be safely sought in exquisite differentiation alone, even though a multitude of reagents should conspire to produce it, unless the specific effects of each fixative be thoroughly understood? Perhaps few reasonably cautious cytologists, thus pressed, would return an immediately affirmative answer, although they could hardly conceal from themselves the fact that it is too often on the tacit admission of some such postulate that many of the current theories and hypotheses depend. Small wonder then if these should sometimes prove untenable when the soundness of their foundations has been insufficiently tested.

Prof. Fischer devotes the first seventy-two pages of his book to the consideration of the reactions of certain selected proteids (*e.g.* albumen, albumose, peptone, nuclein) with the reagents commonly employed for killing and fixing the cell contents. The amount of detail is almost bewildering, and, indeed, throughout the book the reader seeks in vain for short and clear summaries of the many lines of argument.

The results obtained are such as to throw considerable light on the operations of killing and fixing. Some reagents, *e.g.* osmic acid, although they rapidly destroy life, do not precipitate the proteids; and this fact explains why cells killed with osmic acid retain a considerable resemblance to the living condition. But the action of osmic acid in this respect is easily affected by the presence of other substances, *e.g.* acids, in the cell, whereby further changes may be induced. Other reagents, such as acetic acid or alcohol, bring down some of the proteids, the rest being left in solution; whilst, finally, there are still others, for example, chromic acid or mercuric chloride, which have a far greater fixing (*i.e.* precipitating) power.

Again, the nature of the precipitate is often characteristic: witness the coagulum produced in albumen, nuclein, or nucleic acid by treatment with mercuric chloride; whereas, if chromic acid be employed instead, nucleic acid and albumose are both precipitated in a granular form. But the final result is also subject to some amount of modification, depending on the conditions of the experiment. Thus alkalinity, acidity, excess of either reagent, may all affect it, though in a way which can be calculated and reckoned with. A consideration of no little importance attaches to the fact that, in mixtures of proteids, the individual precipitate-form characteristic of each proteid is still retained when they are thrown down by a fixative, and the bearing of this upon the probability of arriving at a correct understanding of the structure of living protoplasm, from a study of fixed preparations, becomes immediately obvious. Indeed, it is extremely probable that much of the so-called "structure" may turn out to be the mere expression of chemical idiosyncrasy—interaction between proteid and reagent—rather than an instantaneous photograph, so to speak, of the true structure of protoplasm. An example will make this clear. Altmann's solution (consisting of potassium bichromate and osmic acid) produces a very constant appearance in protoplasm, consisting chiefly of well-defined granules lying in a spongy framework. But a closely similar image can also be produced by substituting a mixture of serum-albumen and deutero-albumose for the protoplasm, and it is at least open to suspicion that the appearances are *evoked* in the protoplasmic corpse, as they certainly are in the mixture, by the definite action of the chemicals employed.

But, although it may be conceded that the study of fixed (and stained) preparations is, after all, largely one of the structure and relations of precipitates, it would be going a deal too far to regard this as at once invalidating the results which have been arrived at by a careful use of histological methods. Thus in many cases it will readily be admitted that the precipitation-figures indicate and correspond with regions of active and special metabolism within the cell. It may well be, however, that we shall find ourselves on safer as well as on more fruitful ground in investigating the nature of the substances involved in cellular activity rather than in studying the minute details of structure. Some, indeed, have already regarded as illusory many of these appearances which now would seem to have been summoned into existence by the mere act of coagulation or precipitation. Zacharias, as well as Fischer, though working on different lines, has shown how much valuable knowledge can be obtained by micro-chemical methods, and these are still in their infancy.

After dealing with fixatives, the author next turns his attention to staining, and in particular to the effects of the aniline dyes. It is obviously impossible to discuss the whole of this complex subject here. Those who are interested in the matter may turn to Prof. Fischer's treatise itself, where they will find an immense supply of further information and facts.

The author arrives at the conclusion that a chemical (in the ordinary acceptation of the term) interaction between dye and tissue elements is out of the question, and that the process of staining is a purely physical one depending on the "adsorption" or condensation of the dye on the surface of the ultimate particles (micellæ) of the stainable substance. It is pointed out that acid dyes differ in important physical characters, such as solubility, from the basic stains; and it is argued that these differences, coupled with the physical structure of the body to be stained, will account for the particular colour reaction produced in any given instance. These conclusions will come as a shock to those who have been accustomed to pin their faith on the aniline dyes, and who have seen in "Cyanophily" or "Erythrophily" an index of chemical distinction between the various groups of cell-constituents. The evidence brought forward by Dr. Fischer in support of his thesis is based not only on the observations and practice of technical workers; he has himself contributed an elaborate series of experiments designed to elucidate the phenomena of dyeing; and if his results are not always free from ambiguity, some margin, as he himself hints, must be left as a tribute to our imperfect acquaintance with the objects and processes concerned. Nevertheless, so far as the positive evidence goes, it certainly seems to afford confirmation of the physical, rather than the chemical, theory of staining phenomena.

Following the same plan as that which yielded good results in his investigations on fixatives, the author experimented with precipitates of known proteids. He finds that no constant relations exist between the staining capacity of a proteid and its power of forming a precipitate on adding the dye to its solution. Thus nucleic acid, which takes up basic, but not at all acid, dyes, is only precipitated from solutions by the former. On the other hand, albumen, whilst also only precipitated by basic dyes, is stained more especially by acid ones.

It is very well known that it is essential in the case of certain fixatives (*e.g.* those containing chromic acid or platinum salts) to carefully "wash out" the superfluous fixative before staining is possible at all. Prof. Fischer uses these facts to support his views, assuming that just as the stain may be adsorbed, so also, in some cases, the fixative may be attracted and held, leaving no place for the stain until it is thoroughly washed away—a process which is often attended with considerable difficulty. The same peculiarity of inhibiting staining is shared by some other substances, though they may form no precipitate with the dyes employed; thus tannin, which precipitates basic, but not acid, dyes, impartially inhibits the staining power of them all in proteids saturated with it. Again, although platinum chloride precipitates eosin but not acid-fuchsin, a proteid fixed with this reagent and not subsequently washed will not take up either dye; whilst chromic acid, if it be substituted for the platinum salt, although behaving in precisely the same way towards *solutions of these dyes*, does not hinder their staining at all.

As might, perhaps, have been anticipated from the author's own standpoint, the fixative used may modify the primary capacity for stains possessed by the proteid, but this secondary effect is probably to be connected with a changed molecular or micellar form.

Another argument against a chemical explanation is founded on the behaviour of precipitates of even the same proteid towards mixtures of stains. Precipitates of albumose, for example, which contain granules of various sizes, select the stain according to their bulk, the larger granules taking up and retaining the acid (more rapidly diffusible) dye, whilst the smaller ones are coloured by the basic stain. There seems no reason to suppose that the granules differ chemically *inter se*, although this objection has actually been raised in other quarters, and Fischer interprets the effect as being due to the difference in solubility, concentration, and rate of diffusibility of the two classes of stains, coupled with the degree of tenacity with which, when once adsorbed, the molecules of dye are retained on the micellæ of the proteid. The reversals of stain so frequently met with under these conditions appear also to tell in favour of the physical or mechanical hypothesis. But the author by no means confines himself to a study of simple proteids, he also discusses the bearings of his results on the staining reactions of protoplasm itself.

Amongst the more interesting of the latter may be reckoned the characteristic differences exhibited by the nucleus of the male and female gametes respectively. Dr. Fischer regards the cyanophily of the male as due to the dense state of aggregation of its substance, and not at all as indicative of a chemical dissimilarity between it and the erythrophil female nucleus. His case is not weakened by the fact that, in those instances where fusion of the two nuclei is delayed, the male pro-nucleus as it grows and gradually assumes a less dense appearance, approximates more and more in its staining reaction to that of the female pro-nucleus. Nevertheless, it might also be argued that the very state of dense aggregation implies a chemical difference, especially when it is recollected that growth perhaps involves much more than mere expansion of bulk.

But it must not be supposed that the evidence adduced is everywhere immediately favourable to the author's standpoint. There are, in fact, many anomalies, especially in the case of certain basic dyes, which require to be cleared up before Dr. Fischer's views can command universal acceptance. It is, however, as has been already said, impossible to do justice to this part of his book within the limits of a single article. But as the facts adduced will be largely new to most cytologists, it has been thought best to utilise the available space in pointing out a few lines of the argument rather than, by venturing on detailed criticism, to trespass on the domain of the chemist or physicist.

By no means the least interesting part of the book is that devoted to an inquiry into the origin of cell-structure, spindle-fibres, centrosomes, and the like. As regards the spindle-radiations, the results of some remarkable experiments are detailed, and these are quite startling owing to the apparent fidelity with which certain of the most characteristic features of cellular activity have been successfully imitated. Other investigators have produced, ere now, appearances resembling the achromatic spindle, but the figures have never attracted serious attention, as the analogies between them and a protoplasmic structure appeared to be too feeble. In the present case, however, it is very different, since the materials employed *are* akin to those which exist in the cell.

By injecting elder-pith with sundry colloids (albumen, albumose, &c.), and then treating sections of the pith with various fixatives, the author succeeded in obtaining spindle structures closely resembling those exhibited in a preparation showing karyokinetic figures. Not only this, but it has been found possible to ascertain at least some of the conditions which are necessary to their formation.

In the first place, there must be present in the cell some foreign indifferent body which may serve as a centre from which the radiations may start. Such a body is often provided in the dead but persistent fragment of the original cell-nucleus. Secondly, the precipitating action of the reagent must be slower than its penetrative power—it must have completely saturated the fixable substance as far as to the foreign body, before the physical change of precipitation sets in. Unless these conditions are both complied with, no radiations will arise. The importance of the second point at once becomes apparent when one recollects the emphasis laid on *rapidity of penetration* as one of the essentials of a good "fixative," and an analogy between the first condition and the origin of spindle fibres is seen in those multipolar spindles associated with large heterogeneous bodies in the cell protoplasm, which were first pointed out by the present writer in 1893, and which have since been confirmed by Mottier and many other investigators. Similar results were also obtained by allowing fixatives to diffuse from capillary tubes into the fixable proteids; the radiations then started from the surface of the concentrated drop of fixative in such a way as to simulate the appearance of an attraction sphere.

The author exercises an admirable restraint in instituting comparisons between these results and those observed in preparations of cells, but it must not be forgotten that there is reason to believe that substances very similar to, if not identical with, those employed by him do really exist at least in the killed cell.

Naturally much is still left obscure. Why, it may be asked, should the precipitates only take the form of radiations during mitosis? If we attempt to frame an answer temporarily satisfactory on chemical or even microchemical grounds, we should have to trek into regions far outlying the limits of our present knowledge.

A discussion of cytological phenomena and of the various theories of protoplasmic structure and its supposed mechanism, occupies the remainder of the volume. The centrosome in particular comes in for a lengthy criticism, especially as regards those alleged for the higher plants. The author, on good grounds, concludes that these are merely cast out nucleoli, or, at any rate, in no sense to be regarded as special cell organs. He points out the fallacies which have led to the obscuring of the true issues in the past, and he treats the well-known case of *Lilium* with special severity.

It will be apparent that Prof. Fischer's book is not only startling from the novelty of its contents, but it is even almost revolutionary in its tendencies. But the cytologist need not be unduly alarmed, nor fancy that all his tenderly nurtured theories must of necessity dissolve forthwith into vapour. Probably much of the "structure," which was believed in by the extreme adherents of the particulate school may turn out to be due to *post-mortem* effects, and to possess no counterpart during the life of the cell; but the broad distinctions of cytological structure will still hold good, even though they may not be able to support the weight of the theories that have been erected upon them. The chromosomes, the spindle-fibres, the centrospheres (where apparent) all represent definite facts of protoplasmic activity, although the conclusions which have been drawn respecting them may stand in need of revision. But it is well that we have been thus recalled to examine once again, and more minutely than heretofore, the very foundations on which our knowledge of cell phenomena rest. *Diligenter explorata principia ponantur.* J. B. Farmer.

RESEARCH IN PREVENTIVE MEDICINE.

Transactions of the Jenner Institute of Preventive Medicine (*late British Institute of Preventive Medicine*). Second Series. Edited by Allan Macfadyen, M.D., B.Sc., Director. Pp. xv + 253. (London: Macmillan and Co., Ltd. New York: the Macmillan Company 1899.)

During the last year the Jenner Institute of Preventive Medicine has passed through a most notable phase of evolution; with it has become associated the name of the father of modern preventive medicine, whilst its sphere of usefulness has been enormously extended through the munificent liberality of Lord Iveagh, who, in placing at the disposal of the Council a sum of no less than a quarter of a million sterling, has shown an example of keen insight into the needs of scientific investigation in this country that must, ere long, have most important results in raising the standard of experimental research in the field of medicine.

From a perusal of the Second Series of the *Transactions*, published some short time ago, it is evident that the increased facilities offered for the carrying on of investigations in the laboratories have already borne abundant fruit, the papers in the present volume being not only more numerous but also relatively of considerably greater importance than those that appeared in the first volume.

The introduction contains a fairly full descriptive account of the laboratories in the various departments in the beautiful building on the Chelsea Embankment, an account which will be of considerable interest to those who would know what has been the development of laboratory accommodation and apparatus during the last few years.

The first paper, from the pen of Prof. Ehrlich, "Observations upon the constitution of the diphtheria toxin," has great value, especially just at the present, as he describes his "toxin spectrum," a careful study of which promises to throw light on the constitution of these most complicated bodies. Dr. William Bulloch also makes a contribution to the study of diphtheria toxins A new pathogenic streptothrix is described by Dr. George Dean. This organism produces in the horse a disease which might be described clinically as actinomycosis, from which however it differs very considerably in certain important points. He considers that it is much more nearly allied to the bacilli of the diphtheria and tubercle groups than to the moulds, and that actinomycosis is a disease due not to one specific micro-organism, but to a number of allied species. Dr. R. T. Hewlett contributes two papers; one, "Preliminary observations on the occurrence of the bacillus enteritidis sporogenes (Klein) in ulcerative colitis and in the normal dejecta"; the other "On Neisser's diagnostic stain for the diphtheria bacillus." In an article on "the bacteriology of the normal conjunctival sac from a report of 200 cases, and its practical bearing on the utility of antiseptics in ophthalmic surgery," Mr. Arnold Lawson urges the abolition of antiseptics in ophthalmic surgery on the ground that the strongest antiseptic is the healthy conjunctiva itself. He maintains that in order to eliminate suppuration as far as possible from the list of accidents that may occur after operations, only two factors have to be attended to: (1) perfect asepsis on the part of the operator, his instruments, dressings, &c., and (2) the healthy condition of the conjunctival sac. Mr. J. E. Barnard contributes an interesting and ingenious article on photogenic bacteria. He concludes that the different species of phosphorescent bacteria described are probably identical or merely closely allied varieties. They are all markedly pleomorphic, readily undergo involution, and only phosphoresce in the presence of oxygen. The phosphorescent principle may be kept back by a Berkefeld filter, and anything that affects the vitality of the organism affects likewise the production of light. Dr. Alfred Salter writes "on the pathogenicity of the pseudo-diphtheria bacillus, and its relation to the Klebs-Lœffler organism." He finds that the pseudo-diphtheria bacillus has the power of producing a non-toxic but antitoxin-fixing substance, and he argues that this is an additional fact in favour of the pseudo-diphtheria bacillus and the Klebs-Lœffler bacillus being practically identical. Dr. Arthur Harden, in Part i. of a paper dealing with "the fermentation of sugars by bacillus coli communis and allied organisms," gives a short history of the subject and a number of his own experiments, from which he draws the following conclusions: (1) the organisms that he used, when grown anaerobically in a medium consisting of beef broth alone or in conjunction with peptone, produce inactive lactic acid from the glucose, but may, when a very vigorous growth occurs, produce a small amount of the active lævo-rotatory acid. The lactic acid produced amounts to about 50 per cent. of the weight of sugar decomposed; (2) in media containing peptone but no beef broth, a mixture of the inactive acid with the lævo-lactic acid is formed; (3) the gas produced by the decomposition of the glucose consists of 1 to 1·3 vols. of hydrogen to 1 vol. of carbonic acid gas. Mr. Sydney Rowland, writing on the structure of bacteria, puts forward the thesis that in the actively living bacterial cell no reticular structure can be demonstrated, such reticulum only being present except when the cell is progressing either to spore-formation or to granule-formation. In the actively living cells, which consist of cell wall, cell plasma and granules, the cell wall is a progressive formation and becomes finally a rigid structure. The fine refractile granules staining vividly with roseine may participate in cell-division or may be extruded from the cell through the cell wall. These granules are present even in an embryo on emergence from the spore-case. Drs. Allan Macfadyen and Frank R. Blaxall continue their article on thermophilic bacteria, which are specially important as regards the fermentation in ensilage and the digestion of cellulose.

Mr. G. Harris Morris gives a short account of the technical applications of bacteriology. One of the shortest but most important papers in the whole collection is a record of an experiment carried on with the object of determining the etiology and pathology of cancer. All those interested in this subject will anxiously await further and corroborative evidence of the very striking result obtained by Dr. H. Lambert Lack. Dr. Allan Macfadyen records the important symbiotic fermentation, in which pure cultures of a mould, instead of diastase, are used for the purpose of saccharification and fermentation, thus being accompanied by a pure symbiotic fermentation on the addition of yeast. Dr. Macfadyen corroborates many of Calmette's observations on this point. Mr. Joseph Lunt enumerates and describes a series of eleven organisms of the bacillus *Coli communis* group, which he has been able to isolate from drinking water, &c.; and Dr. Arthur Harden contributes a short note on the action of hydrogen peroxide and the oxides of copper on formaldehyde.

A number of interesting "Laboratory Notes" and "Notes on Apparatus" complete a most creditable volume of transactions. The illustrations, both process blocks and photo-prints, which are very numerous, are all well reproduced.

PHYSICAL PRINCIPLES AND MORAL PRECEPTS.

The Scientific Basis of Morality. By Dr. G. Gore. Pp. viii + 599. (London: Sonnenschein and Co., Ltd., 1899.)

DR. GORE is one of the increasing many who feel that much in conventional morality is baseless, while more is only not crumbling because built up on other foundations than those commonly alleged. Driven to look for salvation to that science in which we perforce believe with the conviction of practical life, he too would lay bare the groundwork of the coming ethics of naturalism.

"About the year 1880 the author published a small book, entitled 'The Scientific Basis of National Progress, including that of Morality.' That book has long been out of print, and having been repeatedly advised to write a more complete statement of the relations of science to morality, &c., he has endeavoured to do so."

Unadvisedly.

Such a book as the present must be the despair of a reviewer who sympathises with its object. If extent of reading within certain well-defined limits and a wide range of interest could make a great book, Dr. Gore's advocacy of the naturalistic basis of ethics, and of the maxim that the laws of science are the chief—nay, the only—guides of life, might be what he claims that it is: a book "largely one for the future," "written in some respects in advance of its time," "for those whose minds are in a fit condition to receive scientific truth." As it is, it is a commonplace book in more senses than one. It is not free from the suspicion of bookmaking. It quotes nearly 350 lines, including three stanzas from the hackneyed "Psalm of Life," of Longfellow; more than 200 lines from Pope. It devotes two whole pages in one place to citations from a fatuous print, entitled "Is Science Guilty?" Many familiar sentences are given at second-hand—*e.g.* some of Kant's *viâ* the Archbishop and the Dean of Canterbury. And Dr. Gore is not always either relevant or happy in his quotations. Yet excuse for "the brevity of the treatment" is asked of "those who are competent to investigate the matter" upon the ground of "the great amount of evidence which has been omitted in order to limit the size of the book."

All this notwithstanding, if the kernel of this, which "is not a polished literary treatise, but a scientific production," were of a sound character, we would have to accept it thankfully. But a certain lack of analytical insight makes Dr. Gore's best sections curiously ineffective.

For instance, when our author has pointed out quite correctly that any known or knowable existence must be in relation to us, since it could not otherwise affect us directly or indirectly, and when he has referred with approval to G. H. Lewes, to the effect that there are no relations of the known to the unknowable, though there are to that which is at present unknown, he spoils his effect by announcing that "man is related to all things," a dictum which loses sight of the scepticism implied in all naturalism, and is as dogmatic as the mythology which Dr. Gore rightly rejects. Phenomenalism, which at the limit can admit of no lacuna, may be a belief or a natural hypothesis. It must not amount to a dogmatic denial of all else.

Again, when Dr. Gore has laid down a determinism which satisfies the demands of science, he proceeds to quote writers with approval, whose doctrine is not his own, but an indeterminism with a limited range. And in treating of evil, he fails to follow out his determinism to its logical consequence, viz., that to call the actual either good or evil is absurd. His proof for the relativity of evil is valid for the relativity of good also, but he preaches the essential optimism of science, continuing to call the world process good, perfect and the like. If Dr. Gore chooses to call the actual as such good, and to say that since there is nothing not actual, evil accordingly is non-existent, he may of course do so. But he solves no problems thereby. When, in treating of pain and of ignorance, he sees that relative ignorance and relative pain, viz. ignorance and pain incident to the stage of progress at any moment attained, are necessary, he surely goes beyond his data in taking the ignorance and the pain as good because any other than the actual would be worse. On his own principles anything other would be impossible; but does not that rather prove the indifference of the actual to that ideal point of view from which we use the relative and partial epithets "good" and "evil"?

Again, Dr. Gore is obscure as to the formula under which he conceives the relation of neurosis to psychosis. He tells us that ideas produce tears, and that mind may be viewed as a mode of energy existing only in nervous substance; while he quotes with approval the famous description of thought as the secretion of brain, just as bile is of the liver. In saying that "mind is dependent upon brain because it is not proved to exist without it," our author seems to state a truth with a false ground for holding it.

Once more, Dr. Gore thinks it an additional argument against Paley's stolen illustration of the watch implying a watchmaker, to say that nearly every part of a watch is now made by means of inanimate machinery, and the watchmaker only puts its pieces together. As if the unity of purpose in the process as a whole and the creative activity back of the machinery itself would not satisfy Paley well enough.

Dr. Gore's rules of conduct according to naturalism might be all summed up under the Stoic formula of life according to nature. His economics are opposed to trades unionism and to united action on the part of the working classes in the direction of shorter working hours. The efficiency-theory of wages which Dr. Gore apparently holds does not give ground for this attitude. Dr. Gore's logic lays too much stress on "induction" of the kind which, as a modern teacher puts it, "takes unanalysed concretes as ultimate."

Much of what Dr. Gore has to say would pass as interesting and thoughtful, though not either original or clearheaded, matter, if put forth in a volume one-quarter the size. H. W. B.

OUR BOOK SHELF.

Exercises in Practical Physics. In two parts. By R. A. Gregory and A. T. Simmons. Part i. pp. vi + 200; Part ii. pp. vi + 174. (London: Macmillan and Co., Ltd., 1899.)

THESE two volumes contain a graduated series of physical experiments, compiled with the intention of furnishing a basis upon which teachers may found their courses of lessons. Special attention has been devoted to providing a large and diversified number of exercises exemplifying each of the principles considered, and the authors have also admirably succeeded in bringing together many ingenious experimental methods devised by various teachers of their acquaintance. Throughout both volumes the insertion of numerous illustrations of the apparatus in position is a great help to the correct understanding of the text, and, indeed, the authors state that the descriptive matter has been purposely limited to the amount necessary for the proper working of the experiments.

Part i., constituting the first year's course, embraces experimental work in mensuration, hydrostatics, elementary mechanics, and the first principles of heat. The apparatus necessary for each experiment is first given; then the setting up, observations to be made, and finally, the deductions which are to be drawn from them. The simple methods of demonstrating many of the properties of matter are excellent. Without appearing to be over-critical, it is impossible to avoid regretting that the term "apparent loss of mass" should have been used to denote the change produced on immersion of a solid in water to determine its specific gravity. The change is simply a partial neutralisation of the gravitational attraction on the solid, which is detected by a difference in the weights required to balance it; but this does not suggest that the *mass* of the body has altered. This is a minor point, but the relations of *mass* and *weight* are a real difficulty to the majority of elementary students.

Part ii. is designed to serve for a second year's course, and furnishes experiments illustrating the chief principles of heat, light, sound, magnetism, and electricity. The experiments on heat in Part i. only have reference to the construction and use of thermometers, thermal conductivity, and radiation. To render the second part complete, these sections are repeated in it. A series of tables are given at the end, comprising most of the data required in the working of the course of experiments. The style of originality and simplicity is repeated in this second volume, and the entire course can be confidently recommended to teachers of the subject. C. P. B.

Abhandlung der Dynamik. Von D'Alembert. Pp. 210.
Ueber die mathematische Theorie der electrodynamischen Induction. Von Ricardo Felici. Pp. 121. (Leipzig: Wilhelm Engelmann, 1899.)

UNDER the title of "Ostwald's Klassiker der exacten Wissenschaften," Messrs. Engelmann publish a series of small volumes intended to supply what has been for some time a want in our systems of scientific education, namely, the want of historical knowledge and of a proper appreciation of the great works on which our scientific theories have been built up.

Every student of mechanics has heard of "D'Alembert's Principle," but in these days few take the trouble to ask who D'Alembert was, how he discovered his principle, or where and when he published it. The reproduction of the "Traité de Dynamique" (1743) will do much, not only to enlighten students on these points, but to give an insight into the state of knowledge existing at the time the principle was discovered. Those accustomed to the modern style may, for example, be interested to see D'Alembert's equations written in the form $d^2x = a\,dt^2$. The present volume has been translated and edited by Arthur Korn, who has supplied a biographical notice of D'Alembert and numerous explanatory notes, chiefly mathematical.

The second volume is a translation of the papers published by Felici, in 1854–1855, in the "Annali della Università Toscana." After Faraday's great discovery, he and others confirmed the quantitative law of magnetic induction in a number of cases, and we learn that Felici's chief service to the cause of science was that he was the first (Gaugain following two years later) to verify the laws of induction between two voltaic currents. The present volume has been translated by Dr. B. Dessau, of Bologna, and edited by E. Wiedemann. It is No. 109 of the series, D'Alembert's work being No. 106.

Équilibre des Systèmes Chimiques. By J. Willard Gibbs. Translated by Henri le Chatelier. Pp. xii + 212. (Paris: Georges Carré and C. Naud, 1899.)

THIS is a translation of Prof. Gibbs's paper on the equilibrium of heterogeneous systems, Part i. (chemical phenomena), published in the *Transactions* of the Connecticut Academy in June 1876. It is the second of the three classical thermodynamic memoirs by Prof. Gibbs, and is at the same time the best known and the most important, being the paper in which the well-known "law of phases" was first enunciated. Prof. Le Chatelier has added several explanatory footnotes, and an introduction summarising a few of the principal new laws and notions of experimental interest, for which the foundations have been laid by Prof. Gibbs in the memoir in question. This summary will be useful in giving readers some idea of the phenomena to which Prof. Gibbs's conclusions are applicable, a point of no small difficulty in reading the original paper. Prof. Le Chatelier translates "heterogeneous systems" by "systèmes chimiques" on the ground that "hétérogène" in French refers to a difference of physical rather than chemical state. The translator's own researches are sufficient guarantee of his eminent qualifications for the work that he has accomplished in the preparation of this French edition.

Elementary Trigonometry. Oliver and Boyd's "Educational Series." By A. J. Pressland and Charles Tweedie. Pp. viii + 342. (Edinburgh: Oliver and Boyd, 1899.)

THIS text-book is not intended to meet the requirements of any special syllabus, but is simply an elementary course on trigonometry. On this account, the authors have had a free path to pursue, and they have produced a well-arranged course on the subject, which will be found most useful for those who are getting up this subject. The range of the book may be gathered from the statement that the three parts into which it may be divided deal with, first, the definitions and properties of the trigonometrical ratios concluding with the Addition Theorem; second, the application to computation and to the geometry of the triangle and quadrilateral; and, last, to the inverse functions and other applications. The student is made thoroughly acquainted with logarithms and the application of mathematical tables, and in the explanation of the rule of proportional parts Prof. Chrystal's method has been followed. The examples are numerous and suggestive.

A Century of Science and other Essays. By John Fiske. Pp. vii + 477. (London: Macmillan and Co., Ltd., 1899.)

THE main title of this volume is entirely misleading, for it is only the title of one of fourteen essays. It gives the idea that the advances of science during the present century are dealt with, but what science is in the work is of a very popular character, most of the contents being concerned with subjects which, with the most liberal interpretation, must be placed outside the bounds of natural knowledge, and therefore outside our province of comment.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Lord Kelvin on the Origin of Granite.

IN 1897 Lord Kelvin delivered an address to the Victoria Institute on the age of the earth, Sir G. G. Stokes being in the chair. Incidentally, the address included theories of the origins of granite, basalt and continents, and touched on the question of the inclusion of gases in various rocks.

At the late meeting of the British Association two sectional Presidents referred to Lord Kelvin's theory, both apparently accepting his lordship's conclusions without noticing his premisses.

My old master, William Pengelly, used to teach that as every theory depended on many facts, if but one fact were disproved the theory fell to the ground. From this aspect there are several points in Lord Kelvin's theory which seem to require elucidation.

Lord Kelvin starts from a period in the earth's evolution when a lava ocean forty kilometres deep covered a solid nucleus. The specific gravity of the liquid lava is assumed to be 2·50. It is also assumed, on what seem firm grounds, that solid lava would sink in fluid lava, and on more doubtful grounds, that all minerals crystallising out of lava would also sink. On this assumption the lava ocean silts up, and the surface does not "freeze" until the forty kilometres of the crust (excepting the future ocean basins) are composed of solid crystals set in an interstitial mother liquor.

According to Lord Kelvin, continents arose from the drifting and unequal distribution of the crystals falling like a "snow shower" through the lava; the ocean basins arising from the contraction of the mother liquor in cooling. The theory is brilliantly unfolded, but there are many technical difficulties, *e.g.* Lord Kelvin's granite, besides being an exclusively primeval rock, is composed of drifted crystals of felspar, mica, quartz and hornblende (or some of them) set in a basaltic matrix. The ultimate mother liquor is made to serve the purpose both of basalt and of the matrix of granite. One gas at least, viz. $C.O_2$, treated as original in basalt, might well arise from the calcite which so often occurs in that rock. But the most serious and far-reaching difficulty is involved in the specific gravity of lava minerals. Assuming the liquid lava to be 2·50, there are several minerals which would float in such an ocean, and if there were but one, it would suffice to provide a floating crust or slag which would blanket the glowing lava and entirely upset all heat calculations based on the consolidation of the earth from within to without.

What perplexes me in the matter is that so many philosophers who accept Lord Kelvin's conclusions hold themselves at liberty to reject his premisses.

For instance, the President of Section E, while declaring his adhesion to Lord Kelvin's time-views as against the geologists, entirely ignores both his continental theory and the main premiss as to the specific gravity of the lava ocean. Lord Kelvin assumes the lava to be 2·50, while Sir John Murray assumes the crust to be 2·50, a most fundamental distinction.

Petrologists have fought desperately over the question of the origin of granite, but so far as I am aware they are agreed on all the main points.

I believe myself that every known fact fits most exactly into the grand working hypothesis that granite is a plutonic rock formed by hydrothermal action and pressure out of a previously existing rock, which consisted in the first place of those light aluminous soda and potash silicates which first consolidated on the surface of the primeval lava ocean. To these silicates we have but to add water, in order to form (so far as constituents go) a typical muscovite granite—absolutely nothing more; indeed, less, as we may omit the soda. The constituents of muscovite ($K_2O, 2H_2O, 3Al_2O_3, 6SiO_2$) are simply leucite ($K_2O, Al_2O_3, 4SiO_2$) and water. Introduce sodalite, an even more likely constituent of the primeval crust than leucite, and we have all our materials for ordinary granites, except magnesia, with which, however, Lord Kelvin supplies us by means of eruptions of the basaltic mother liquor.

This is but a working hypothesis, but it will work; whereas Lord Kelvin's novel theory throws the whole problem of granite into inextricable confusion, even starting from the hopeless position of disagreement as to what the term granite denotes, geologically, mineralogically and petrologically.

The whole question seems to turn on one single point, viz. whether the first primeval crust when cold floated on the subjacent lava. According to the elements of mineralogy it would do so; but many physicists have assumed that upon consolidation it would sink. Will not some of the distinguished specialists in mineralogy and petrology pronounce judgment on this question, which is really troubling unlearned and ignorant men who are genuinely seeking information? The conflict of authority is quite overwhelming. A. R. HUNT.

Torquay, February 13.

Effects of Lightning upon Electric Lamps.

I HAVE often seen luminous trails, similar in appearance to those shown in Mr. Webb's photographs (p. 343), in photographs taken at night. That there are any effects in these or Mr. Webb's pictures that cannot be explained by a moving camera, I am unable to convince myself of. The identical form of the discharges from different lamps has been explained by the distance of the discharge causing them. Granting that it is possible to have a discharge, so intricate in character, exactly duplicated at a second lamp (which is scarcely conceivable), their magnitudes in the pictures should be inversely proportional to their distances. But we find that, in the pictures, the scrawls are all of the same size. A lamp close to the camera, and a distant lamp, show the trails *on the same scale.*

The beading of the trails can be easily explained by the alternations of the current, the carbons fluctuating in brilliancy. I am informed that in Dover these periodic fluctuations are very conspicuous. Where a trail turns suddenly, the beads are closer together, due to the motion of the camera being slower when the direction of motion is about to change.

If I remember right, there are one or two cases where we have a very large and brilliant pattern, and several similar ones on a smaller scale. This could be explained by reflection from the inner surfaces of the lens. R. W. WOOD.

London, February 20.

The Fitting of the Cycle to its Rider.

I HAVE read Mr. Hutchins's communication (p. 368) with considerable interest. Mr. Hutchins is at the head of the Forest Department which has been recently established by the Cape Government, and the improved method of riding that he has adopted, in accordance with the views expressed in my recent paper, have evidently been of service to him in traversing the very rough country to enable him to carry out his duties. Mr. Hutchins's experiences so closely agree with my own that I can say little in criticism of his letter. I think, however, that he will find that the gain from the lengthened crank advocated by me cannot be explained by the very simple formula that he gives. My son and I went very carefully into this matter at the time I prepared my paper, and I think if Mr. Hutchins refers to it he will find, if we consider the mechanical advantage apart from the gain in nerve waste, the mathematical analysis of ankling given by lengthened crank both give the only explanation which would be satisfactory to a mathematician. In our explanation the weight of the leg plays a very important part, and it follows therefore that a heavy legged man gets most from our system of riding. R. E. CROMPTON.

Crompton Laboratory, Kensington Court, London, W.

THE point raised by Mr. Hutchins in his letter (p. 368) is worth considering, but Mr. Crompton, who by his wonderful riding has done so much to popularise the use of the long cranks first suggested by Mons. Boulay, is not heavily built. A man who is over fifty cannot move his legs so quickly as when he was younger; and so middle-aged persons, stout or slim, profit greatly by using long cranks and high gears. Most people when in a hurry run upstairs two steps at a time, and bicyclists, whether in a hurry or not, find it an advantage to raise gears and lengthen cranks.

The question is, how far may we go without unduly increasing the weight of our bicycles?

My age is fifty-one, weight 15 stone, height under 6 ft., and, having tried everything between $5\frac{1}{4}$ in. cranks with a 54 in. wheel, and my present machine with $10\frac{1}{2}$ in. cranks and 108 in. gear, I can now travel greater distances and climb steeper hills with less effort on a 42 lbs. bicycle than when riding a 28 lbs. machine fitted with $6\frac{1}{2}$ in. cranks and 66 in. gear. I intend to try 11 in. cranks and 120 in. gear, but this necessitates my getting a longer and heavier machine, and it is probable that I shall lose as much as I gain.

The extraordinary ankle-play developed by long-crank men improves their walking; and, after a long hard ride, the difference between their swinging elastic step and the muscle-bound hobble of the short-crank riders is very striking.

Instead of Crompton foot-plates I have just fixed a flanged clip to each pedal, so that the inner edges of the soles of my shoes can be pushed under the clips; and they are almost as comfortable and efficient as the "Otto" straps of years ago.

WM. H. MASSEY.

Twyford, Berkshire, February 17.

Indian Corn.

IN the "Encyclopædia Britannica," vol. xv. p. 309, it is stated that no mention was ever made of maize by Eastern travellers in Africa or Asia prior to the 16th century A D. Slight doubts about this statement have occurred to my mind lately, while I was reading the Hakluyt Society's "India in the Fifteenth Century." There, in the English translation by the late Count Wielhorsky of the "Travels" of Athanacius Nikitin, the Russian, whose Eastern travels took place about 1470-1474, when the work was written by himself, we read concerning the Indians: "They live on *Indian corn*, carrots with oil, and different herbs" (p. 17). Has this mention of the cereal any weight to countenance the theories which seek to assert that maize was known in the East before the discovery of the Western Continent? Or, does what is meant or translated by the word *Indian corn* here differ materially from *Zea Mays?*

Apropos of these queries, I may mention that A. de Candolle is in error in his post-dating the introduction of maize into Japan on the sole ground that Kaempfer (who was there during 1690–92) does not mention it.[1] According to a native work (Kikuoka, "Kindai Sejidan," 1733, lib. 2, § 4), maize was introduced into the islands about the beginning of the period of Tenshô (1573–91). After Sweet Sorghum (*Sorghum saccharatum*), of earlier introduction with the name *Morokoshi-Kibi* (*i.e.* Chinese-Millet), maize was called *Tô-Morokoshi* (*i.e.* Chinese Chinese-Millet) in the eastern provinces, where, of course, its propagation followed that in the western parts. In the dialect of the latter, where the people were more directly concerned with its introduction, maize was named *Namban-Kibi*, or Millet of the Nambans (Spaniards and Portuguese), who were entirely excluded from the empire since 1639, which thus would stand as latest possible date of the introduction.

KUMAGUSU MINAKATA.

1 Crescent Place, South Kensington, S.W.

The Production of Electrolytic Copper.

IN a note on the production of electrolytic copper, on p. 371 of NATURE of February 15, it is stated that "Mr. S. Cowper-Coles has hit upon a new plan, in which the copper is deposited on a vertical mandril, which is caused to rotate at a very rapid rate. . . . As a consequence, a smooth and dense deposit has been obtained with current densities approaching 200 ampères per square foot." In reference to this I should like to point out that the idea of rotating the kathode with a view to obtaining greater rates of disposition is an old one. We have had in use at the Owens College for the last seven years a copper depositing tank in which the kathode consists of a vertical mandril 9 inches long and 3 inches diameter kept in rapid rotation, and capable of receiving a good copper deposit with a current of 100 ampères. The arrangement was devised by Mr. Henry Wilde, F.R.S., to illustrate the working of his patent, No. 4515, of 1875, and differs little from that used by Mr. Cowper-Coles. The mandril is driven from above, so that a stuffing-box in the bottom of the tank is unnecessary.

CHARLES H. LEES.

The Owens College, Manchester, February 19.

[1] "Origin of Cultivated Plants," p. 392.

THE WEST INDIAN AGRICULTURAL CONFERENCE.

THE second West Indian Agricultural Conference was opened on January 6 in the hall of the House of Assembly, Barbados, under the presidency of Dr. D. Morris, C.M.G., Imperial Commissioner of Agriculture for the West Indies. There were forty representatives present, including the heads of all the Botanical, Chemical and Educational Departments, as well as the representatives of the principal Agricultural Societies in the West Indies. Some of these gentlemen had journeyed for the best part of a week to take part in the two days' labour that awaited them.

The representatives were received in the hall of the House of Assembly at 10.30 a.m. by his Excellency Sir James Shaw Hay, the Governor, who opened the conference with a short address of congratulation to the Department of Agriculture, and of welcome to the visitors from other Colonies.

The President then delivered his address, which summarised the work done by the Imperial Department during the preceding year, and alluded to some of the problems which were expected to be discussed at the conference: the best seedling canes and their record, Imperial aid for co-operative central factories, reducing cost of cultivation, subsidiary industries which have done so much for Jamaica, Trinidad and Grenada, agricultural education and treatment of diseased plants, were subjects that came under review.

Prof. J. B. Harrison (British Guiana) then read a paper, "Notes on Sugar Cane Experiments," the joint production of Mr. G. S. Jenman and himself, followed by one, entitled "Past and Future Work in Sugar Cane Manurial Experiments," by Prof. d'Albuquerque (Barbados). Both papers covered somewhat the same ground, and were followed by a long discussion. It was generally agreed that nitrogen is the constituent of cane manures which chiefly governs the yield; but the experiments upon the use of phosphatic manures have been contradictory in different places. The application of potash and lime to cane fields gives profitable results in soils where these constituents of plant food are deficient. A discussion of considerable length took place upon the best and most economical way to conserve and utilise the nitrogen and mineral constituents of plant food in farmyard manure; and the desirability of extended trial of leguminous green dressing was urged upon West Indian planters.

Prof. d'Albuquerque, in the next paper, explained "A Method of using Control Plots in Experimental Field Cultivation." The method, which is only applicable where small plots of, say, one-thirtieth of an acre are used, partly consists in weighing the crops from a number of small no-manure (control) plots not far apart, and calculating the no-manure yield of the intervening plots on the assumption that in a uniform field the change of fertility is continuous from one control plot to the near next one. The other part of the method depends upon the manipulation of the figures obtained from the manured plots in relation to the calculated no-manure yields, and the interpretation of results.

The same author in the next paper, "The Possibility of Improving the Sugar Cane (*a*) by Artificial Cross-fertilisation, (*b*) by Chemical Selection of 'Seed Cane,'" under the first head argued that crossing different varieties would lead to the production of canes possessing desirable characters derived from both parents, and detailed some methods by which systematic experiments should be carried out. The second part of the paper dealt with the feasibility of increasing the sugar productiveness of a given variety of sugar-cane by propagating it with tops cut from canes richer than the average of the variety; the practical difficulty is to find a sure test of an inherently rich cane, as opposed to a cane rich because it is riper or more favourably situated.

Mr. J. R. Bovell (Barbados), in his papers on "Rotation and Catch Crops on Sugar Estates" and "Green Manuring as a means of Fertilising Cane-lands in the West Indies," illustrated by plants, seeds, tubercles, &c., brought forward useful information on the yields and values of food crops in Barbados, and the capability of sugar estates of self-support in regard to cattle food, and a useful *résumé* on the relative value of different leguminous plants. Mr. E. E. H. Thorne (Barbados), in "Silos on Sugar Estates in Barbados," gave a valuable account of actual results, and a number of useful practical hints. The Hon. F. J. Clarke (Barbados) and the Hon. Francis Watts (Antigua) gave a history for Barbados and Antigua of the efforts of the planters to erect central co-operative factories; both agreed as to the absolute necessity for improved manufacture if the industry is to survive, and as to the difficulty, so long as bounties last, in enlisting any but Government guaranteed capital, notwithstanding the certainty of a very profitable investment even at present prices.

The conference adjourned at 5 p.m., having devoted the entire day to subjects connected with the sugar industry.

A conference dinner was held the same evening at the Marine Hotel, at which about sixty guests were present. The following day, Sunday, afforded an opportunity of visiting the experimental stations, and a pleasant afternoon was spent at the "At Home" given by Mrs. Morris at "Chelston."

On Monday morning, at nine, the labours of the conference were resumed; the day was devoted to educational and general subjects. A long and important discussion took place upon measures for the inspection and treatment of imported plants in reference to plant diseases. The questions submitted were: Shall any or all of the following measures be adopted by legislative enactment?:—

(*a*) Total prohibition in certain cases.

(*b*) Inspection at port of entry, with power to destroy, quarantine or treat infected plants.

(*c*) Certificate from shipper declaring plants to be free from infection, countersigned by an inspector at shipping port; and while no definite agreement was come to, there was a consensus of opinion in favour of the Legislatures giving special powers to their respective Executives.

The papers read on educational subjects were: "Teaching Agriculture in High Schools and Colleges," by Mr. H. Deighton (Barbados) and the Rev. W. Caroll (Trinidad); "Teaching Agriculture in Elementary Schools," the Rev. J. E. Reece, Colonel Hicks, Mr. William Blair, Mr. Collens, Mr. Watkins and Mr. Hudson; "School Plots as Aids in Teaching Agriculture in Elementary Schools," Hon. W. Fawcett (Jamaica); "Experiment Station Work in Trinidad," Mr. J. H. Hart (Trinidad); "Aims and Objects of Experiment and Teaching Stations," Rev. Canon Simms (Jamaica). The subject of teaching agriculture in elementary schools was exhaustively treated. The paper by Canon Simms gave an interesting summary of observations on experimental stations and agricultural colleges in the United States of America and Canada during his recent tour, and very practical suggestions for higher agricultural teaching at Jamaica.

The Hon. Francis Watts, in his "Food Supplies of the Leeward Islands," gave a useful account of the food-growing resources of those islands; urged less importation of food-stuffs and more local production. He pointed out the close connection between cheap food and the abundant cheap labour so necessary in cane-growing countries, and brought forward evidence to show the "irrational" nature of the present diet, and how, by the proper combination of local products, it could be rendered "rational."

The Hon. William Fawcett (Jamaica) read an important paper on "Distribution of Economic Plants in Relation to Agricultural Development"; and other papers were read on "Steps taken at the St. Vincent Botanic Station for the Distribution of Seeds, Plants, &c., after the Hurricane of 1898," Mr. Powell; "Suggestions for Increasing the Usefulness of the Botanic Stations," Dr. Alford Nicholls; "Packing Seeds and Plants," Mr. J. H. Hart; "Bee-keeping in Jamaica," Mr. T. R. Doidge.

During the day the Chemical Section of the Conference presented a report upon uniformity in returning the results of field experiments on the sugar-cane, and upon some minor matters of detail.

A vote of thanks to the President, and the usual compliments, brought the conference to a close about 5 p.m. The representatives embarked the same night.

J. P. D'ALBUQUERQUE.

MODERN LIGHTHOUSE APPARATUS.

THE development of the modern system of lighthouse apparatus and illumination may be said to have originated in the mercury-float mechanism, devised in 1890 by the late M. Bourdelles, Director-General of the Central Lighthouse Service of France. Fig. 1 is a drawing of a lighthouse apparatus fitted with M. Bourdelles' mercury-float mechanism.

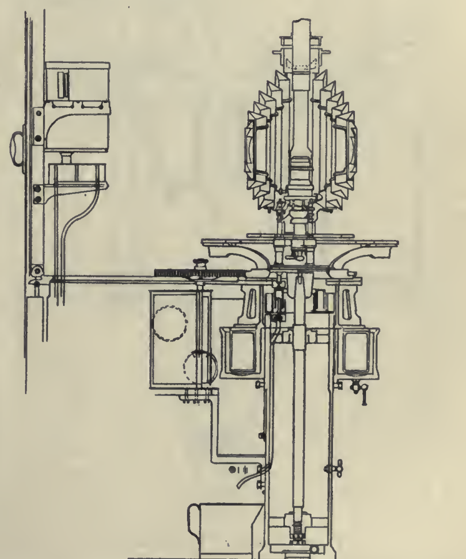


FIG. 1.—Feu-éclair. Third order apparatus. (Section.)

In place of the roller or ball bearings employed in the past for revolving apparatus, an annular trough is employed, in which there floats a second annular trough, on which is carried the dioptric apparatus. In order to steady the revolving superstructure, and to render it capable of a certain amount of adjustment, a vertical spindle projects downwards from the apparatus through the mercury trough to some distance below it, and is supported and guided upon suitable bearings.

Such is briefly the invention of the mercury-float mechanism, and it is clear that with only fluid friction to contend with, the revolution of the apparatus is rendered easy in the extreme, and that a speed and steadiness of revolution is obtained that was impossible with the older forms of apparatus.

Having devised an apparatus capable of such rapidity of revolution, M. Bourdelles was led to the conclusion that by reducing the number of sides in a revolving apparatus, and so allowing of an increased size, it would be possible, with the rapidly-revolving mechanism, to produce flashes of great power, following one another at as short intervals as had been done with the old many-sided apparatus, and hence arose the *feux-éclairs*, or lightning-flash lights, now so generally employed.

This system, it will thus be seen, makes use of dioptric panels of the greatest possible amplitude, which are revolved at a speed limited only by the duration of flash

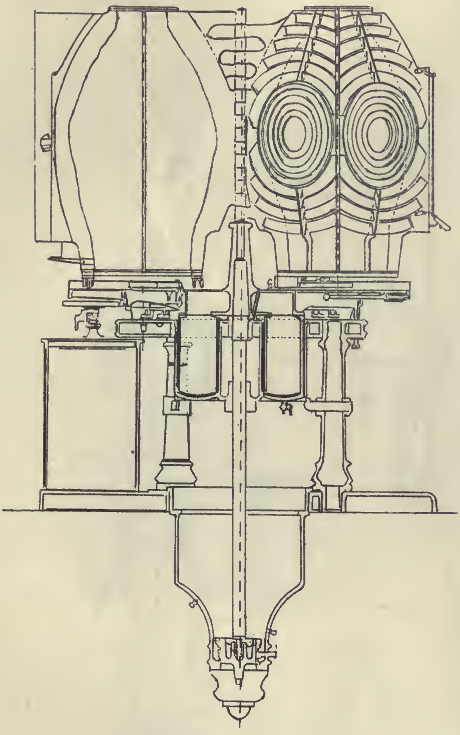


Fig. 2.—Feu-éclair. Twin apparatus.

necessary to give to the eye of the mariner the full perception of the light emanating therefrom. In practice this was found to be about 1/10 of a second for lighthouse purposes.

The first mercury-float *feu-éclair* light which was established was that at Senetose, in the Island of Corsica, in the year 1890.

As a further advance in lighthouse apparatus, the twin mercury-float *feu-éclair* may be mentioned. Fig. 2 is a drawing of this apparatus. Here, instead of the superposed biform, triform or quadraform apparatus previously used, the two apparatus are placed side by side, and are so set that the flashes from one apparatus are parallel to those from the other, so that at sea the beams are in effect one.

Following upon the single and twin *feux-éclairs* of M. Bourdelles come the spindle-eclipser apparatus of the writer. In this system only one—or at most two—dioptric lenses or panels are used in conjunction with an eclipsing device which periodically obscures and discloses the light. Figs. 3 and 4 are drawings of a single panel-spindle eclipser. The action of this form of apparatus is best explained by an example.

Suppose a group-flashing light is required, each group having two flashes; all that is required is to so design the mechanism of the eclipser that it will eclipse the light after two complete all-round flashes, remain closed for the length of time desired for the long dark period between the groups, and then open just long enough to allow the two flashes to be seen once more, and so on *ad infinitum*.

In place of only one panel two can be used; but here it is necessary to have the eclipser in two halves, each

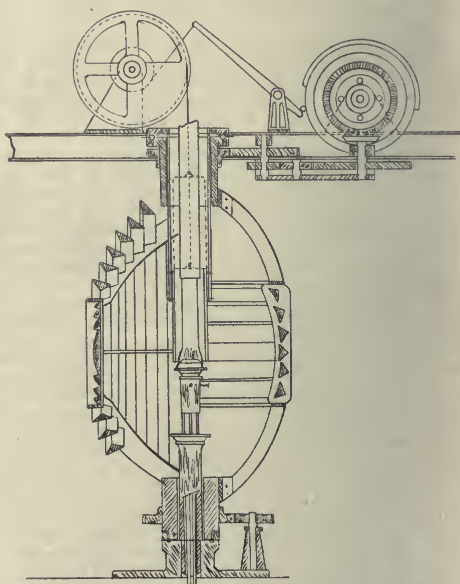


Fig. 3.—Spindle eclipsing apparatus. (Section.)

of which is operated separately, so as to obscure in rotation the light from one panel and then the next.

From what has been said, it is clear that with only one, or at most two, simple dioptric panels and an eclipse it is possible to produce all manner of group-flashing characteristics which in the past demanded the splitting up of the large panels into sections, from each of which a beam emanated. In the new system a complete panel, and that of the greatest possible amplitude, *i.e.* 180 in altitude, and azimuth can be employed, and consequently the most powerful flash is obtainable from this apparatus. As the apparatus do not need to be of large size, the method of mounting them upon upper and lower spindles has been employed merely to render their construction as simple as possible.

In addition to the improvements mentioned above, which deal with the actual lighthouse apparatus as a whole, there are the improved types of lenses for lighthouse apparatus recently invented by Mr. Charles A. Stevenson, which he has termed the equiangular refractor, and that of the writer known as the inverse equiangular.

With respect to the smaller classes of lights, there are the new permanent lights burning for some weeks without the attention of a keeper, which are largely used in

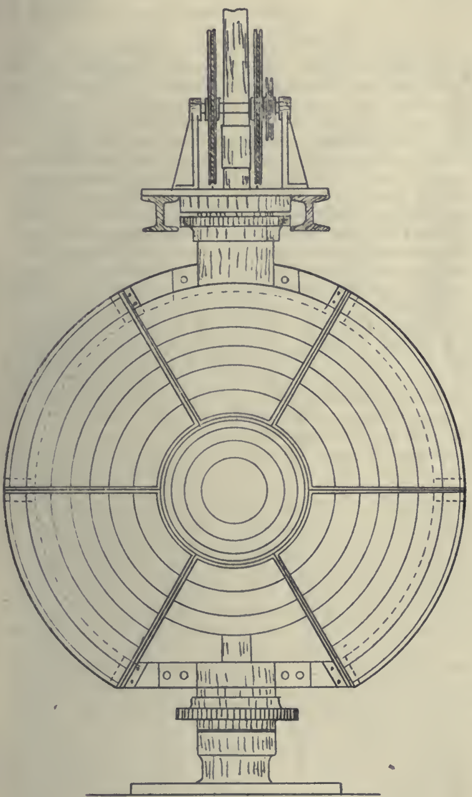


FIG. 4.—Spindle eclipsing apparatus. (Front elevation.)

the French Lighthouse Service. In these lights the upper portion of the wick is carbonised, so that no turning up or down thereof is necessary, and the supply of oil which feeds the lamps is of such a quantity and is so regulated that the lights burn without any attention whatsoever for many days. J. A. PURVES.

MR. BALFOUR ON SCIENTIFIC RESEARCH.

A SPECIAL festival dinner of friends of King's College, London, was held on Wednesday in last week, with the object of directing attention to the want of new laboratories, especially laboratories for physiological and bacteriological research, and promoting the collection of funds to supply the need. Mr. Balfour presided, and he made excellent use of the occasion by advocating the fuller recognition of the value of scientific research, and increased opportunities for carrying on original investigations. The encouragement of scientific research is a national responsibility, which has hitherto not been adequately realised either by the State, by public bodies, or by private individuals. Mr. Balfour's remarks, reprinted below, from the *Times*, will serve to remind people of the influence of science upon national progress and prosperity, and may thus lead to a more liberal provision of resources for assisting the advancement of natural knowledge.

We have all of us, probably, been stirred, either in making speeches or in listening to speeches, in recent years on the subject of technical education—a very loose phrase sometimes used, or misused, to mean education in manipulation or dexterity of hand treatment; sometimes, and I think more properly, used to mean that application of science or of the principles of science to industrial life, which we are more and more beginning to recognise is the increasing need of the age in which we live. It has been found easy, and I hope it always will be easy, to enlist popular interest in anything so useful as the application of scientific method to industrial pursuits. It will be all the more easy because of the fact that we have before us in certain countries striking and admirable instances of the success which attends, or may attend, such application of scientific method to industrial pursuits. An appeal for that purpose is an appeal which touches the heart of everybody nearly or remotely connected with the industries on which this nation as a whole lives, and on which it must continue to live if it is to live at all.

I appeal for something not less necessary, though for something perhaps more remote from the ordinary everyday popular educational interest; for I appeal on the present occasion, not so much for anything in the nature of technical instruction or applied science as for aid to carry out that instruction in science itself and those researches in pure science which lie at the base of that instruction which, from the very nature of the case, can only appeal indirectly and remotely to the great mass of mankind. And yet, after all, science is the essential matter that we have got to consider; its applications will come and must come, will come almost of themselves, must come in the course of time; but you cannot have applied science without having science in the first instance, and if you do not cultivate scientific research and scientific education, it will be in vain that you multiply your technical classes, it will be in vain that you labour to erect a great superstructure where your foundations have been so inadequately laid. I feel it the more incumbent upon me to urge upon you the claims and the glories of science pursued for itself from the fact that they cannot directly appeal to the general interest of the mass of mankind. We ought not to wonder, we ought not to criticise, and we ought not to be surprised that, among the great number of persons deeply interested and astonished at, for example, anything so interesting and sensational as wireless telegraphy, few remember the inventions which have made that telegraphy possible; they neither know of nor take interest in the investigations of a Maxwell or the experiments of a Hertz, which, after all, are at the base of the whole thing, without which any such discovery as wireless telegraphy would not have been possible, but who, as discoverers, had fame and recognition among scientific men capable of understanding their work, yet who have not, perhaps, even now that world-wide reputation, that currency in the mouths of men, which fall to inventors much less than themselves, who have properly built their work on the foundations laid for them by others. Yet to my view it is the bounden duty of every great place of University education that they should keep before them not merely the immediately practical needs of technical or other education, but that they should never permit the ideal of University investigation to be for one moment clouded in their eyes, or to lose interest, or cease to be the object of worthy effort and endeavour.

But that great object must increasingly, in my judgment, require the generous and liberal co-operation of all classes of the community, whether they be immediately interested in science, intimately acquainted with scientific details, or whether they be merely part of the general public. Men of science themselves are not always in a position to give that pecuniary aid necessary to establish the modern laboratory and to equip it with modern appliances; and they are right to call upon all those who take any interest in their subjects to aid them with that pecuniary assistance which in some other countries—many other countries—is extended to them by the Government, but which in this country, rightly or wrongly, by an almost immemorial tradition, has been left chiefly to the energy of private enterprise. King's College will, without question, be one of the great teaching centres of the new London University. It requires at this moment, to enable it to carry out that great function, the assistance of the public to supply it with adequate scientific accommodation, especially, I am informed, in the matter of bacteriological and physiological laboratories and lecture-rooms; and it may be a matter of some consolation to those who take little interest in scientific matters, unless they can see their immediate application, that both bacteriology and physiology have a most immediate and direct bearing upon the life and happiness of mankind. In both branches of study King's College has proved itself rich in teachers of eminence. I am not going to discuss—it would be almost impertinent of me even to touch upon—the enormous interests bound up with the successful prosecution of these two great branches of research; but I may, perhaps, remind you of the enormous practical importance to us, of all people in the world, of some of the more recent researches in bacteriology. Bacteria are a very humble class of organisms, very unjustly abused, as far as I can discover, by ordinary public opinion, in which they suffer, as other classes suffer, by having among them a certain number of black sheep; but for the most part they are not only innocent, but most useful allies to industry, and almost necessary co-operators in some of those great functions which have to be discharged if the health of great cities is to be maintained. But, apart from that, no doubt our chief interest in them lies in the pathogenic members of the group, and we, of all people in the world, are especially interested in treating of those forms of tropical disease which they have produced, since we are engaged in maintaining a number of our population in countries where the diseases born of these bacteria are the greatest scourges. It is, perhaps, to a distinguished professor of King's College more than to any other man in this country that we owe some of the most useful discoveries in these matters. As the last speaker called attention to Mr. Chamberlain's great work in drawing together the bonds of Empire and knitting in closer unity the various elements that make up that Empire, so I may be permitted, in the wholly different subject with which I have to deal to-night, to remind you that he, as Secretary of the Colonies, has done his best to encourage these bacteriological investigations of which I, at all events, entertain such great hopes that science will soon be able to combat, by its discoveries, the inherent difficulties which have hitherto so greatly militated against Europeans in the tropical climates of the world.

WHAT LONDON SHOULD DO.

I do not know that it is necessary for me at greater length to impress upon you the theme which has been committed to my charge; but I confess I cannot conclude without admitting that I think this great city has been somewhat remiss in the support which it has hitherto given to scientific investigation in the commercial metropolis of the world. Technical education, if I may revert for an instant to that subject, has in it almost necessarily some element of competition. We hear it said Germany is doing this, France is doing that, some other country is doing the other, unless you keep abreast of them in your methods of education you will fall behind them in your industrial enterprises. That is a very proper argument; it is a very patriotic argument; it is an argument I myself have used before and shall use again; it is an argument I should think myself justified in using; but I am appealing to you on behalf of a case which has in it none of this element, this inferior and lower element, of competition whatever. Every scientific discovery, wheresoever it be made, be it made in Berlin, Paris, London, New York, Vienna, as soon as it is made is the common property of every man of science. Nations may erect against each other some barrier of tariffs, they may engage in some absurd rivalry animated by I know not what sort of suicidal policy; but men of science wherever they live, to whatever nation they belong, have a cause common to humanity at large, which knows no provincial boundaries, which is not interfered with by any sectional rivalries. To that great common fund of knowledge, the basis after all of your civilisation as it is, the basis after all of the industrial progress you propose to make, I think London should contribute its full share. London takes a well-earned tribute from every discovery made throughout the world for the advancement of civilisation; from all these some section of London gets the benefit. Let those who are dwellers in London feel that they have some obligation to the world at large corresponding to the great, the international position we occupy. Let us do what we can as a community to further that investigation into the secrets of nature, that storming of the citadels of natural knowledge in which all civilised men are, and ought to be, co-operators. Let it not be that, while there are great centres of scientific teaching in every other great metropolis, we have allowed ours for one moment to fall behind in the race.

GENERAL A. A. TILLO.

GENERAL A. A. TILLO, Vice-President of the Russian Geographical Society, who died at St. Petersburg on January 11, was the founder of an *exact* physical geography of Russia, based on correct scientific data. He was born in 1839, and received his education in the Constantine Military School, from which he was promoted officer in 1859. He completed next his education by passing through two military academies, artillery and General Staff, and worked for two years at Pulkova in the Geodetic Department of this last academy. In the years 1879–82, in his capacity as educator of one of the Russian Grand-Dukes, he followed lectures on mathematics in different West European universities, as also a full course of Law at the University of Strasburg. He began geographical work as the head of the surveys of the Orenburg region, by publishing a catalogue of latitudes and longitudes determined in that region, followed by a study of the distribution of magnetical elements, and by a description of the levelling made between the Caspian Sea and Lake Aral. His next works were "On the Byelgorod Magnetic Anomaly," "On the Present Condition of the Science of Terrestrial Magnetism," and "On the Yearly Amplitudes of Variations of Level in the Lakes of Russia," "On the Average Altitudes of the Continents in Both Hemispheres." Settling some five-and-twenty years ago at St. Petersburg, he began to work out in a most systematic way the different portions of a general physical geography of Russia. The surfaces of different parts of the empire having already been calculated by Strelbitzky, General Tillo measured first, with a very great accuracy, the lengths of the rivers of the Russian Empire, their gradients, and the surfaces of their basins, thus correcting many erroneous statements of his predecessors. Then, he worked for years in collecting all documents relative to the altitudes of European Russia, and finally published in 1889 his most remarkable hypsometric map of European Russia, on a scale of 40 miles to an inch, followed seven years later by the same improved map on a still larger scale (27 miles to an inch), in four sheets. This map, by showing the existence of three great depressions amidst the swelling of Middle Russia, completely altered the hitherto current conceptions as to the orography of European Russia. His next work was a most elaborate atlas of isobars in Russia and Asia altogether, and it was followed by still more elaborate works on the distribution of magnetic elements on the surface of the earth, "Variation séculaire et éphémérides du Magnétisme terrestre," "Loi de la Distribution du Magnétisme moyen à la Surface du Globe," "Atlas des Isanomales et des Variations séculaires," and "Tables fondamentales du Magnétisme terrestre," which won for Tillo a wide European reputation. His smaller contributions to the publications of the Russian Geographical Society were countless. He was a member of both the St. Petersburg and the Paris Academies of Sciences. His extreme modesty and willingness to undertake any amount of calculations to work out the results of observations made by explorers in Asia, made of him one of the most sympathetic figures in the Russian Geographical Society, in which he presided over the Physical Geography Section. A pamphlet containing an obituary notice of General Tillo, and a full list of his works, has just been published by this Society.

NOTES.

SIR GEORGE STOKES has been elected an Associate of the Paris Academy of Sciences.

WE learn that the name of Dr. William Osler, F.R.S., at present superintendent of the Johns Hopkins Hospital at Baltimore, is being mentioned in connection with the vacancy in the Chair of Medicine at Edinburgh.

AN extra meeting of the Chemical Society will be held on Thursday, March 8, when a lecture, "On Recent Researches on Nitrification," will be given by Prof. Warington, F.R.S. The chair will be taken at 8.30 p.m.

THE Paris Geographical Society has awarded its annual grand gold medal to Major Marchand, and silver and bronze medals to other members of his expedition.

ON the 28th inst. Mr. Robert H. Scott will retire from the post of secretary to the Meteorological Council. At the end of the year 1899 Mr. Scott had completed thirty-three years of service in the Meteorological Office, and for the last twenty-five years has acted as secretary of the International Meteorological Committee, which honorary position, we understand, he will continue to hold until the next meeting of that committee in September. Mr. W. N. Shaw, F.R.S., Fellow of Emmanuel College, Cambridge, and hitherto assistant director of the Cavendish Laboratory, and lecturer in physics in the University of Cambridge, has been appointed as successor to Mr. Scott. Mr. Shaw has been a member of the Meteorological Council since May 1897, and will continue to hold that position in addition to that of secretary.

AT the annual meeting of the Russian Geographical Society, on February 7, the great Constantine medal was awarded to A. M. Pozdyéeff for his work, "Mongolia, and the Mongols," and other works upon the same country; the Count Lütke's medal to L. K. Artamonoff for geodetical and geographical work in Caucasia, Persia, and Abyssinia; the Semenoff's gold medal to E. W. Brettschneider for his extensive work, in English, "History of European Botanical Discoveries in China"; the great gold medal of the Society to N. A. Marrusa for his collection of the parables of Wordan; and the Prjevalsky medal to E. E. Anert for his geological work in Manchuria. Three small gold medals were awarded to R. N. Savélieff for meteorological work, N. N. Lelyakin for astronomical calculations, and to V. N. Iochelson for a communication on the nomads of the tundras of North-east Siberia. It is interesting to note that the Semenoff silver medal was awarded this year to Madame M. A. Lyamina for her works popularising the results obtained by the Russian travellers, whose splendid full reports, published in stately quarto volumes, remain, as has often been pointed out in these columns, inaccessible to the general reader. Eleven more silver medals and five bronze medals were given to different persons for minor works.

THE death is announced of Dr. Hermann Schäffer, honorary professor of physics in the University of Jena.

THE March exhibition at the Royal Photographic Society will be provided by the National Photographic Record Association, and will be opened on Wednesday, March 7, by Sir Benjamin Stone, M.P.

DR. SCHWENDENER, professor of botany at Berlin, has been elected a correspondant of the Paris Academy of Sciences, in the section of botany, in succession to the late Baron F. de Müller.

THE meeting of the Physical Society to-morrow (February 23) promises to be of special interest. Prof. R. W. Wood, of the University of Wisconsin, U.S.A., is to describe his recent investigations in optics, and will exhibit some of the apparatus used in those experiments, together with photographs demonstrating the evolutions of reflected wave fronts.

THE committee of the Athenæum Club, acting under the rule which empowers the annual election of nine persons "of distinguished eminence in science, literature, the arts, or for public services," have elected Dr. David Gill, C.B., F.R.S., Astronomer Royal at the Cape of Good Hope, a member of the Club.

AUSTRIAN geology has suffered a severe loss in the death of Mr. K. M. Paul, chief geologist on the Austrian Geological Survey, on February 10, at the age of sixty-two. While his chief work was the investigation of the geological structure of the Carpathians and of the environs of Vienna, his intimate knowledge of the geology of Galicia led to his being regarded as one of the leading authorities on the occurrence of petroleum.

THE anniversary meeting of the Geological Society was held on Friday, February 16. The officers were appointed as follows:—President: Mr. J. J. H. Teall, F.R.S.; Vice-Presidents: Prof. J. W. Judd, C.B., F.R.S., Mr. Horace W. Monckton, Prof. H. G. Seeley, F.R.S., and Prof. W. J. Sollas, F.R.S.; Secretaries: Mr. R. S. Herries and Prof. W. W. Watts; Foreign Secretary: Sir John Evans, K.C.B., F.R.S.; and Treasurer: Dr. W. T. Blanford, F.R.S. The medals and funds awarded, as already announced (p. 279), were presented. The President delivered his anniversary address, which dealt chiefly with the present state of knowledge regarding underground geology in the south-east of England.

AT a special meeting of the Manchester Literary and Philosophical Society, held on February 13, Prof. Horace Lamb, F.R.S., being in the chair, the Wilde Medal for 1900 was presented to Lord Rayleigh for his numerons and brilliant contributions to mathematical and experimental physics and to chemistry. A Dalton medal, struck in 1864, was presented to Sir Henry Roscoe, F.R.S., for his remarkable original researches in chemistry, and for his distinguished services to scientific education. The third award, which was to Prof. A. W. Flux, was that of the Wilde premium of fifteen guineas for two much appreciated papers on "The cost of sea transport in proportion to values of cargoes," and "The fall in prices during the past twenty years." After the presentation of the medals, Lord Rayleigh proceeded to deliver the Wilde lecture, for which he took as the subject, "Flight, Natural and Artificial."

WE learn from the *Electrician* that the late Prof. D. E. Hughes has bequeathed the sum of 2000*l.* for the foundation of a "David Hughes Scholarship" in connection with the Institution of Electrical Engineers. The text of that portion of the will which relates to the bequest is as follows:—I direct and declare that the legacy of two thousand pounds, so bequeathed to the said Institution of Electrical Engineers, of which I am Past President, shall be invested by them in any manner for the time being authorised by law for the investment of trust funds, for the purpose of founding in connection with that Institution a Scholarship Fund, to be called the David Hughes Scholarship Fund. And I direct that the annual income produced by the investments for the time being constituting the fund shall be given each year to a student preparing himself for the career of an electrical engineer, under conditions similar in all respects to those under which the fund now known as the Sir David Salomons Scholarship Fund is administered, but so that if and so often as for any reason the Scholarship hereby founded shall not be for any given year awarded to any student, the annual income of the Fund for that year shall be invested in manner aforesaid and added to the capital of the David Hughes Scholarship Fund.

PROF. H. A. HAZEN, a prominent official of the U.S. Weather Bureau, whose name will be familiar to many readers of NATURE, was, we regret to learn, thrown from his bicycle on January 22, and died on the following day, from the injuries received. Referring to his lamented death, the *National Geographic Magazine* states that he was born on January 12, 1849, in Sirur, India, about one hundred miles east of Bombay, and went to America when ten years old. He graduated from Dartmouth College in 1871, and for some years after was instructor in drawing in the Sheffield Scientific School, New Haven, and later was assistant in meteorology and physics under Prof. Elias Loomis. He received an appointment in the U.S. Weather Bureau in May, 1881, being assigned to special duty on such problems as the investigation of the psychrometer and the proper exposures of thermometers, the study of thunderstorms, and other important questions. At a later period Prof. Hazen was assigned to duties of a broader aspect, including weather forecasting and occasional editorial work on the *Monthly Weather Review*. In addition to his official work in the Weather Bureau, Prof. Hazen was a frequent contributor to meteorological and other scientific journals. He was one of the supporters of *Science* during the years 1882-1889, and of the *American Meteorological Journal*, 1884–1886. Among his larger publications are the "Reduction of Air Pressure to Sea Level" and the "Climate of Chicago."

THE address which Dr. Morris delivered at the opening of the second West Indian Agricultural Conference, of which an account is given in another part of this issue, was a powerful exposition of the aims of the Agricultural Department, and of the success which had attended its efforts during the first brief year of its existence. It is gratifying to find that, with regard to the question of central factories, Dr. Morris gives the great weight of his approval to the representations made by the Barbados Agricultural Society in favour of the establishment of factories on the basis of a division of profits between the planters and the factory. Not the least interesting portion of the address is that dealing with agricultural education. The education which has drawn the Englishman from the soil at home, and so divorced him from agricultural pursuits that, even as an emigrant, he is only a settler in towns, has been copied in the West Indies; and the results, although not so evident perhaps in Barbados, have been identical. Dr. Morris shows that the aim of the Department will be to correct this system, not by refusing education to the agricultural masses, or by restricting their education to purely agricultural subjects, but by expanding the teaching now afforded at elementary schools, so as to embrace a large amount of valuable agricultural knowledge. The ultimate effect of the efforts of the Department in this direction must be the creation of a sturdy and intelligent peasant proprietary in the colony, most adapted to their requirements; whilst the supply of labour on the estates will be affected only in the improved value, not cost, of the labourer.

MANY attempts have been made to construct a compass which is independent of the permanent and transient sources of error to which a ship's compass is subjected. The latest device is the Evoy patent compass, which is so arranged that it can be placed in a position where it is not subject to the magnetism of the ship —that is to say, it is hauled up to nearly the height of the masts, where it is supported on the jumper stay. To determine whether the steering compass of a ship is showing the correct magnetic course, the Evoy compass is hoisted up aloft, given time to settle, and then brought down again, the reading of the steering compass being taken at the same time. It is obvious, however, that in the course of being lowered the overhead compass would come again within the magnetic influences of the ship, and thus be liable to have its reading disturbed before being inspected by the officer on duty. An automatic contrivance is therefore provided which locks the compass card as soon as the lowering is begun. Hence it is possible to check the indications of the compass on the bridge, exposed to the perturbing influences of the ship's magnetism, by those given by the Evoy compass high up beyond their reach. The instrument, which is mounted in such a way as to protect it from the effects of vibration and rolling, has been tested for some time on board a number of vessels, and has, it is stated, given satisfaction to the commanders.

THE recent falls of snow, which have been followed by heavy rains and rapid thawing, have led to disastrous floods in several parts of England. One lesson that is taught, is that homes (usually of the poor) should never be erected on alluvial ground In the *Standard* of February 17, we read that the river Avon at Bath has been greatly swollen, and in the low-lying parts of the city people have been driven into the upper rooms, and have had to be supplied with food by means of boats. Interesting and yet deplorable are the records of the floods in South Devon. The thawing of snow on Dartmoor, accompanied by twenty-four hours' continuous rain, rapidly swelled the waters of the river Dart, and the outflow was checked by high spring-tides. Consequently (as stated in the same newspaper) the alluvial meadows were soon submerged, the floods being the highest within living memory. Many hundreds of sheep, horses, pigs, and other live stock were washed away by the force of the current. From one farm on the borders of the Dart no less than 232 sheep were drowned, and the banks were strewn with dead animals, trees, and other débris. We learn also that at Guildford the ancient town bridge has been completely carried away by a big baulk of timber, which was brought down by the flooded river Wey, from a neighbouring timber-yard.

A BILL for taking the census in Great Britain in 1901 was read for the first time in the House of Commons on Monday. The subject of census-taking and its limitations was brought before the Royal Statistical Society at the meeting on Tuesday, by Mr. J. A. Baines, who pointed out that the main interest of the census from the statistical standpoint lies, of course, in the schedule. The attempt to make the census the vehicle of a plebiscite on any matter of opinion, whether of temperance, volunteering, the empire, or such like, is foredoomed to failure, and tends to discredit the rest of the inquiry. Purely personal facts, such as sex, age, marriage and birthplace are the most important questions, and, luckily, the easiest to answer correctly. On the other hand, they are those which, in the mass, tend to vary more quickly in this country than any others. It is imperative, therefore, that for practical statistical work we should have the two first, at least, revised at more frequent intervals than ten years, and the Statistical Society has fortunately the cooperation of actuaries, sanitary officers, economists, and all social investigators in pressing upon the Government the need of either a permanent quinquennial Census Act, or, at least, the prescription of a quinquennial enumeration in the Bill now under consideration.

PROF. E. H. BARBOUR, professor of geology in the University of Nebraska, has recently given reasons for believing that a rapid decline of geyser activity is taking place in the Yellowstone National Park. If the present rate of decline continues, it seems possible that within a decade many of the well-known geysers will have died out. As a result of an examination of the geyser area, after an interval of four years, Prof. Barbour gives the following instances among others of the diminution of activity which has occurred: The Fountain Geyser, which was such a favourite that the Fountain Hotel was situated at that spot, is now wholly extinct, and a very inferior substitute named the Dewey Geyser has taken its place. The Cascade Geyser, another favourite because of the frequency of its eruptions (about every fifteen minutes), has dropped to an eruption interval of once every twenty-four hours. The Grand Geyser, which used to burst out once a day, was only active three or four times the past season. The Beehive Geyser, active in 1895, is supposed to be wholly extinct. Old Faithful seems as fine as ever, but the interval of eruption is now about seventy-five or eighty minutes instead of once an hour. If it is possible to judge fairly of such matters, there seems to be increasing activity in the ebullition of the water in that greatest of geysers, the Excelsior, which leads to a feeble hope that it may possibly be rejuvenated yet once again. An apparent increase in the activity of the Mud Geyser has also been remarked; but in spite of these cases, on the whole it appears that a distinct decline of activity is taking place.

THE Meteorological Council have just issued a discussion of the diurnal range of rain at the seven observatories in connection with the Meteorological Office, for the years 1871–90. The tables show, *inter alia:* (1) the total monthly and yearly amounts for each hour; (2) the average hourly rainfall for one day in each quarter, and for the whole year; and (3) the frequency of its occurrence for each hour, expressed in percentages; and the tables are accompanied by diagrams. England is represented by three stations—Falmouth, Stonyhurst and Kew; Scotland by two—Glasgow and Aberdeen; and Ireland by two—Valencia and Armagh. The year, as a whole, does not exhibit any well-defined distribution of quantity. The western observatories show that the heaviest rains occur in the early morning, and that the least rain falls in the early afternoon; while the inland and eastern observatories show that the heaviest rains fall in the afternoon. The frequency with which rain falls at the different hours of the day gives more regular results than can be obtained from the hourly distribution. The general conclusion drawn by Dr. R. H. Scott, who has carried out this useful investigation, is that everywhere in the British Islands the forenoon hours, from about ten o'clock, are drier than the rest of the day, and that although the temperature has not then nearly reached its maximum, invalids would be less likely to get wet if they went out in the morning. In the neighbourhood of London, however, there is very little evidence at any season of the year of a maximum frequency of rain.

A DESCRIPTION of an aluminium cable used by the Hartford Electric Light Company as a three-phase line, to convey the current over a distance of more than eleven miles, is given in the New York *Electrical Review.* This is another case in which aluminium has been successfully used as an electrical conductor. The trial stage is now passed, and aluminium conductors have been proved to stand the test of practical working under many different conditions, and for continued periods of time. The high price of copper is responsible for the increased use of aluminium as a substitute for it. The difference in specific gravities between copper and aluminium is as 1 : 3.33 and with a conductivity of 60 per cent. that of copper, there is an actual difference in weight between an aluminium and a copper line of about 50 per cent. This fact was very noticeable in putting up the Hartford wire, it being very much more readily handled in the stringing. An objection has been raised to the use of aluminium from the fact that the diameter is necessarily increased. This is true, but in ordinary circumstances an increase of 20 per cent. in the diameter of a conductor is not of great importance, and the objection applies only to conductors that are carried in ducts or conduits where space is necessarily limited. Official tests have been made under the direction of the Hartford Electric Light Company's experts, and the guarantees have been fully equalled, and in some cases exceeded. The line has worked perfectly from the time the generators were started, and has been accepted by the company. Some of the American plants equipped with aluminium wire are carrying much higher voltages than this particular line, which was constructed for 20,000 volts.

A USEFUL paper by Mr. H. N. Dickson, entitled "The mean temperature of the surface waters of the sea round the British coasts, and its relation to the mean temperature of the air," was recently communicated to the Royal Meteorological Society (*Quarterly Journal*, vol. xxv. No. 112). The paper was based on observations taken during eighteen years, 1880–97, at the instance of the Meteorological Council, with the co-operation of the Coast Guard and the various Lighthouse authorities. The observations, which were taken about sunrise and 4h. p.m., have been carefully sifted by Mr. Dickson, and the monthly and yearly averages calculated, tabulated, and plotted on small charts. The extent of the daily range appears to depend on local conditions, such as the speed and duration of tidal streams, the extent of shallow water, &c. The stations on the west coast give a daily mean range for the year of 0°·7, those in the North and Irish Seas give a daily range of 0°·8. With regard to the yearly distribution of temperature, the average at the entrance to the English Channel is about 54°, on the south-west of Ireland 52°. The mean of 49° persists along the north coast of Ireland and the west coast of Scotland to Stornoway. After leaving the Straits of Dover the mean falls to 50° off Suffolk and Norfolk, declining to 48° off the coast of Northumberland, and to 47° at the Orkneys and Shetlands. A comparison of the mean annual temperatures of air and sea shows that the mean excess of sea over air never exceeds 2°; a difference of 1°·7 is only reached or exceeded off the west coast of Ireland, and the south-east coast of England. On the south coast of Ireland, south-west of England and the extreme north of Scotland, the difference is about 1°; in the Irish Sea and the east coast of Scotland about 0°·5, and on the east coas of England still less. One important conclusion drawn by the author is that the mere presence of Atlantic water is more effective in depressing the summer temperature than in raising that of the winter months. Apart from the value of the paper as a contribution to climatology, it will be of special importance in investigations connected with questions of fisheries.

IN the *Physical Review* for December 1899, Mr. E. H. Loomis describes experiments on the freezing points of solutions, conducted with the object of testing the validity of the van 't Hoff constant for dilute aqueous solutions of non-electrolytes. The method of determining the freezing points of dilute solutions is one introduced by the author in 1893, and has been used to find the molecular depressions of a large number of non-electrolytes in aqueous solution, and it is found that the van 't Hoff constant is exactly verified in all cases examined, except methyl-alcohol, ethyl-alcohol and ether. The experimental value is found to be 1·86.

A REPORT on units of heat, drawn up by E. Warburg for the Naturforscherversammlung in Munich of September last, has been reprinted by Johann Ambrosius Barth, of Leipzig. The report deals with the absolute units, the erg and joule, and their relations with practical units, viz. the "calories" in which water at 0° and at 15° are taken respectively as standards, and the mean water-calorie between 0° and 100°, also the temperature variations of the specific heat of water, especially in the neighbourhood of its maximum.

PROF. J. MASSAU, of Ghent, sends us a lithographed paper on the graphic integration of partial differential equations. It is divided into three chapters, dealing with integration by elements, integration equations of the first and second orders and of simultaneous linear equations by means of characteristics, and applications to variable motion of fluids, under which latter heading may be included finite wave-motion, and the formation of bores. A somewhat analogous problem, viz. the approximate integration of partial differential equations of the first order of the form $p+qf(x, y)=0$, subject to the condition that $f(x, y)$ is real, finite, single valued, and continuous in an assigned region C, and that q is also continuous, is treated by Dr. C. Severini in the *Rendiconti del R. Istituto Lombardo*, xxxii. 19, 20, who shows that the integral of the equation can be represented to any degree of approximation by means of a rational integral polynomial in x and y.

STIMULATED by the disastrous Constantinople earthquake of July 10, 1894, the Sultan of Turkey ordered that observations of earthquakes should be regularly made within his empire, and the Director of the Meteorological Observatory was fortunate enough to secure the assistance of Dr. G. Agamennone, of Rome (*see* NATURE, vol. lii. p. 4). During the years 1895 and 1896, this well-known seismologist created an organisation for the collection of earthquake records over the whole of the south-east of Europe and Asia Minor, and the results for 1895 and the early part of 1896 were published in monthly bulletins, issued by the observatory. For reasons, which are unknown, the authorities refused to continue printing these valuable lists, and, on the departure of Dr. G. Agamennone, the whole organisation was allowed to lapse. Fortunately, a copy of the records for 1896 was preserved, and has recently been published in Gerland's *Beiträge zur Geophysik*. This valuable paper contains a list of more than 400 earthquakes, as well as detailed descriptions of the more important shocks. It is a monument of what can be accomplished, even in a semi-civilised country, by the energy of one man.

DR. D. G. ELLIOT is continuing his studies in North American mammals in the *Publications* of the Field Columbian Museum; the last part with which we have been favoured treating of collections from Oklahoma and Indian Territories. A feature of Dr. Elliot's is the attention bestowed on the habits of animals, the present part describing the nests of the wood-rats (*Neotoma*).

To the *Memorias de la Sociedad Cientifica* "*Antonio Alzate*," issued at Mexico, Prof. R. Manterola contributes a paper on longevity in connection with mental work. The author divides professions into three groups, according to their influence on longevity; and it may be satisfactory to scientific workers to learn that they occupy a high position in the most favoured group. In mental workers the general average of life is stated to be above 68 years, and the average of men of science, lawyers and historians more than seventy.

IN the December number of *Natural Science*, Mr. Barrett-Hamilton draws an interesting parallel between the occurrence of portions of the skin of the "last of the Ground-Sloths" in Patagonia, and of similar remains of Lemmings in a Portuguese cave. The latter animals are now unknown south of lat. 58° 30′, yet the Portuguese remains present the appearance of having belonged to animals recently dead. The inference is that even in comparatively damp climates, the shelter of a cave, with abundance of dry dust, is sufficient to preserve some of the soft parts of animals for very long periods.

WE have received from the trustees of the Indian Museum, Calcutta, a newly published "Guide" to the collection of fishes exhibited in what was formerly the library of the Geological Survey. Dr. A. Alcock is the author of this useful little pamphlet, which not only contains a well-written dissertation on the structure of fishes in general, as well as a classified synopsis of the families, but has a special section on the geographical relations of the marine fishes of India. Among the exhibits are models of deep-sea fishes; and it may be suggested that a similar series would be of great interest if added to our own national collection.

IN the February issue of the *Quart. Journ. Microscop. Soc.*, Mr. J. P. Hill, of Sydney, continues the account of his important researches into the embryology of the marsupials. His discovery of the existence of a distinct placenta in the Bandicoots (*Perameles*) will be fresh in the minds of our readers, and likewise the inference that the retention of such a structure indicates a primitive condition. His subsequent investigations have led the author to the significant conclusion that the urino-genital organs of the Bandicoots are in a condition which may be described as persistently embryonic, and thus much more primitive than in any other known marsupial. Accordingly, all the available evidence points to the view that the marsupials originally developed a placenta, which has been aborted in the more specialised forms. The second part of the present communication deals with the fœtal membranes of one of the Wallabies.—To the same journal Mr. H. M. Bernand contributes a paper on the structure of the retina of the eye in the Amphibia, in the course of which he is led to conclude that the so-called "cones," in place of being important sensor organs, are nothing more than stages in the development of new "rods."

IN these columns mention has already been made of the discovery of a horn of the extinct Aurochs or Ur (*not* the Bison) in a peat bog in Lower Pomerania. This remarkable specimen Dr. Nehring now describes and figures in the *Deutsche Landwirtschaftliche Presse* of February 10. In the course of this article the author mentions that the Aurochs (of which our domestic cattle are the descendants) survived on the Continent till 1627, and that examples of its enormous horns, sometimes mounted as drinking-cups, were preserved in many inns, churches, and castles, especially in South Germany and Alsace-Loraine, till a comparatively recent date. In 1550 Conrad Gesner, for instance, mentions having seen skulls, with the horns, of Aurochs at old hostels in Worms and Mayence. Till as recently as the first French Revolution, two Aurochs' horns were preserved in Alsace, the one in the cathedral at Strasburg, and the other in the cellars of the episcopal palace at Zabern. The first measured 6½ feet in length, while the second held four litres. Since both are now lost, the newly-discovered sub-fossil specimen is of priceless value.

IT appears from the annual meeting, on January 28, of the Russian Institute of Experimental Medicine (Pasteur Institute) that its activity is steadily developing. The number of its provincial branches has been increased this year by a branch opened in Transbaikalia for the study of rinderpest in East Siberia. More than fifty papers, some of which are of great value, have have been read at the meetings by Drs. Nencki, Pavloff, Vinogradski, Semenoff, Lukianoff, Vladimiroff, Dzerzgowski, Schultz, and their pupils. The most important of them was perhaps the paper, read by Prof. A. M. Lévin at the annual meeting, on the bacterial origin of scurvy. No less than 80,000 scurvy patients were registered last year in the provinces which had suffered from famine (755,000 for the last eleven years). The epidemical character of scurvy became well established by the last few years' observations, and Prof. Lévin eventually obtained pure cultures of the bacteria of scurvy. They have the shape of rods, with rounded ends, have no cilia and give no spores. They are similar to diplococci, and belong to the group of bacteria which are well known as the cause of chicken-cholera. Scurvy would thus appear "as a chronic form of this latter disease." During the last year the Institute was also very active in preparing malleine and tuberculine (30,000 bottles), anti-diphtheria serum (33,000 bottles), anti-plague serum (8220 cubic centimetres), anti-plague lymph (400,000 c.c.), and various bacteria-cultures (about 1500). Anti rabic treatment was resorted to in 745 cases, and the grand total of all deaths amongt this large number of patients was only 1 per cent. The Institute has had this year at its disposal a total of 35,000*l.* (350,000 roubles). The subscriptions for a monument to Pasteur now reach a total of 1400*l.*

THE present status of rice culture in the United States is reported upon by Dr. S. A. Knapp in *Bulletin* No. 22 of the U.S. Department of Agriculture (Division of Botany). The United States at present produces about half the quantity of rice consumed. In the case of other cereals, an enormous supply is exported. In the introduction to Dr. Knapp's report, Mr. F. V. Coville points out that this anomalous condition is due to the fact that rice, in addition to its tropical or subtropical character, is a crop grown chiefly on wet lands, where it has hitherto been impossible to use harvesting machinery. The crop must therefore be cut with a sickle, and American hand labour has been thrown into competition with the cheap labour of the tropics, a competition that has not proved profitable to the American. A new system of rice culture has, however, been developed in south-western Louisiana, by which, as now perfected, the elevated and normally or periodically dry prairie lands are flooded by a system of pumps, canals, and levees, and when the rice is about to mature the water is drained off, leaving the land dry enough for the use of reaping machines, shown at work in the accompanying illustration. Under this system the cost of harvesting, and therefore the total cost of productions

Harvesting Rice in South-Western Louisiana.

have been greatly reduced and the industry has undergone a rapid development. It was found, however, that a large proportion of the grains were broken by the steam-reaping and thrashing machines; so the U.S. Department of Agriculture appointed Dr. Knapp as an agricultural explorer, with instructions to visit Japan, investigate the rices of that country, and purchase a stock suited to meet the requirements of the American problem. Dr. Knapp returned in the early spring of 1899 with 10 tons of Kiushu rice, which was distributed to experimenters in south-western Louisiana and elsewhere in the rice belt. The result of the milling tests are now awaited. If the high milling quality of the Kiushu rice is maintained under the new cultural conditions, the last apparent obstacle to the complete success of an American system of rice cultivation will be removed. The action of the Secretary of the Department of Agriculture in thus making an attempt to improve an industry by a scientific examination of the conditions of cultivation is one of many similar examples of a far-seeing policy.

UNDER the title "The Nature and Work of Plants," Messrs. Macmillan and Co. are about to issue a simple introduction to botany, by Dr. Macdougal. It aims at explaining, in a way that beginners can easily understand, the purpose of a plant's different organs, the conditions of plant-life, and the effect of it on other forms of life.

THREE characteristic letters from De Morgan to Sylvester, written in 1856, when Sylvester was professor of mathematics at the Royal Military Academy, Woolwich, appear in the January number of the *Monist*, with an introductory note by Dr. G. B. Halsted.

A COPY of the eleventh issue of the annual volume on the wealth and progress of New South Wales, by Mr. T. A. Coghlan, Government statistician, has been received. The volume runs into nearly eleven hundred pages, and is full of interesting information concerning the natural resources, development, and present position of the Colony.

THE Geological Photographs Committee of the British Association have issued a circular announcing that they are prepared to undertake the reproduction, in platinotype prints, or as lantern slides, of a number of the views in their excellent collection. Such a set of pictures would be of great value to lecturers, teachers and students, both at schools and at higher educational institutions. Curators of museums, also, would find in the pictorial epitome of British geology which the illustrations would furnish, a very appropriate and instructive decoration. Prof. W. W. Watts, Mason University College, Birmingham, will send particulars of the scheme to any one who wishes to have them.

"WILLING'S PRESS GUIDE," or 1900, is a useful list of British, Colonial, and foreign newspapers and periodicals, classified under various heads for convenience of reference. In the classification according to interests, professions, trades, religious denominations, sciences and other subjects, we notice one or two curious entries. For instance, the "Astronomical Observations of the Cambridge University Observatory" and "Astronomical Observations and Researches made at Dunsink" can hardly be designated periodicals. Under the heading of Science, we find *Science and Art*—which has long ceased to exist—a journal of a local scientific society, the Report of the British Association, and a college magazine, but NATURE is omitted, though, we hasten to add, it is included in the alphabetical list. With the exception of this misleading classification of scientific publications, the "Guide" is a well-arranged book of reference to the newspaper press.

THE "Catalogue of Nests and Eggs of the Birds of Australia," by Mr. Alfred J. North, Ornithologist to the Australian Museum, which was published by the Trustees of the Australian Museum in 1889, as No. 12 of their series of Catalogues, is now out of print, and the Trustees have decided to issue a new work in an enlarged form by the same author. There will be representations of about 600 eggs on thirty full-sized plates, and arrangements are being made to have them hand-coloured for those who desire it. Some of the nests and breeding haunts of the birds will also be shown on full-sized plates, but the greater number will be interspersed among the text, where also a large number of the birds themselves will be figured. The photographs, from which the plates representing the nests are made, have mostly been taken by the author personally, many of them *in situ*, and show the actual surroundings of the birds' homes. The black and white drawings of the birds are by Mr. Neville Cayley, so well known for his life-like drawings and paintings of birds. The letterpress will contain descriptions of the birds, their nests, eggs and haunts, and an account of their life history. The preparation of the plates is now well advanced. The work will be issued in parts as fast as the letterpress can be got ready.

VIOLURIC acid has already been utilised in calorimetric investigations in support of the ionic hypothesis, and in the current number of the *Berichte* another physical constant, the electrical conductivity, of this acid now gives rise to some interesting speculations by Prof. Abegg, as to the changes preceding ion formation. Starting with the experimental work of Guinchard on the conductivity, and applying the well-known van 't Hoff formula, the heat of dissociation of violuric acid is determined from the temperature coefficient of its dissociation constant, the values being −3970 calories between 0° and 25° C., and −3470 between 25° and 35° C. This is about ten times the usual order of magnitude for acetic acid and most of the other weak acids, and hence leads to the very plausible assumption that here, as in other cases, the greater part of the heat of dissociation is absorbed in intramolecular reactions which precede the formation of the ions. In support of this is adduced the high value found for the heat of dissociation of hydrofluoric acid (−3550), as compared with the values for the other halogen acids. Here the molecules are known to be H_2F_2, giving first HF molecules, and finally ions. Water behaves similarly.

THE anomalous value obtained for the atomic weight of tellurium, when viewed from the standpoint of the Periodic Law, has led to numerous experimental researches upon this constant. The value found has usually been higher than Mendeléeff's generalisation requires, and some observers have suggested that ordinary tellurium may contain two substances. The February number of the *American Chemical Journal* contains a contribution to this subject by Messrs. Norris, Fay and Edgerley, in which, as a preliminary to atomic weight determinations, the preparation of pure tellurium was attempted. By making use of the properties of basic tellurium nitrate, a metal was obtained free from silver, gold, bismuth, arsenic, antimony, and selenium, a specially delicate method being devised for the detection of traces of the last named. The double chloride of tellurium and potassium was then selected for careful study, being subjected to a series of fractional crystallisations, but no want of homogeneity could be detected in this way. Further attempts are being made upon the dioxide.

THE additions to the Zoological Society's Gardens during the past week include a King Vulture (*Gypagus papa*) from the Rio Purús, presented by Mr. H. A. De Lisle; a Weka Rail (*Ocydromus australis*) from New Zealand, a Common Snake (*Tropidonotus natrix*, albino), British, deposited; two Purple-capped Lories (*Lorius domicella*) from the Moluccas, purchased.

OUR ASTRONOMICAL COLUMN.

COMET GIACOBINI (1900 *a*).—This comet has been observed several times since its discovery at the Nice Observatory, but its faintness will only permit of its observation with the largest instruments. M. Javelle estimates it to be of the 13th magnitude. A telegram received from Kiel on February 19 gives the following position:—

R.A. 2h. 22m. 3s.
Decl. −1° 19′ 27″ } 1900 February 17d. 8h. 2·5m. Nice Mean Time.

The comet has continued its north-westerly movement from Eridanus, the above position being nearly between the stars δ and ο Ceti (Mira).

NEW MINOR PLANET (1899 E.Y.).—Recent observations of this planet have enabled Herr Otto Knopf, of Jena, to revise his elements and ephemeris, and he gives the new computations in the *Astronomische Nachrichten*, Bd. 151, No. 3621.

Elements for 1900 *January* 0·0, *Berlin Mean Time.*

$$
\begin{aligned}
M &= 19^\circ\ 43'\ 24''\!\cdot\!0\\
\omega &= 322\ 58\ 41\cdot4\\
\Omega &= 89\ 55\ 39\cdot0\\
i &= 15\ 13\ 23\cdot9\\
\phi &= 4\ 28\ 33\cdot5\\
\mu &= 668''\cdot1835\\
\log a &= 0\cdot483407
\end{aligned}
$$

Ephemeris for 12*h. Berlin Mean Time.*

1900.	R.A. h. m. s.	Decl. ° ′
Feb. 23	4 22 32	+20 53·5
27	25 43	21 16·0
Mar. 3	29 13	21 38·1
7	32 58	22 0·0
11	37 0	22 21·6
15	41 16	22 42·7
19	45 46	23 3·3
23	50 29	23 23·3
27	55 24	23 42·5
31	5 0 31	+24 1·1

HARVARD COLLEGE OBSERVATORY.—In presenting the fifty-fourth annual report of the Harvard College Observatory, Prof. E. C. Pickering, the director, supplies evidence of an unusually large output of work during the past year. With the photometer mounted on the east equatorial, over twenty-nine thousand measures have been made by Prof. O. C. Wendell, including the photometric measurement of Jupiter's satellites while undergoing eclipse, of the planet Eros, and of variable stars of long period. The west equatorial has been employed for visual examination of variables and comparison stars. Good progress has been made with the reduction of the transit observations made by the late Prof. Rogers in the years 1879–1883.

The new 12-inch horizontal meridian photometer has been used in place of the old 4-inch instrument, which is now in Peru. The director has made with this instrument 65,200 photometric settings on 120 nights, and after the year's trial the instrument has proved extremely satisfactory in practice, it being found that stars as faint as the 13th magnitude can be measured at the rate of one a minute, with an error of only about one-tenth of a magnitude.

Under the Henry Draper Memorial, 744 photographs have been obtained with the 11-inch Draper telescope, and 2395 with the 8-inch. The examination of the spectra on these plates has led to the discovery of 23 new variables, 15 of which showed *bright* line spectra.

At Arequipa, in Peru, 686 photographs have been obtained with the 13-inch Boydon telescope, and 693 with the 24-inch Bruce doublet. It is hoped that the plates of Saturn taken in August 1899 will furnish more accurate data for the orbit of the recently discovered ninth satellite.

At the Blue Hill Observatory the work has been practically confined to obtaining automatic meteorological records of the upper atmosphere by means of kites. The average height reached by the meteorograph was 9650 feet from the ground.

Prof. Pickering makes special mention of the serious consequences to the work of the Observatory which may ensue, owing to the continued fall of interest on the invested capital of the institution.

INTERFERENCE METHOD OF MEASURING SMALL DIAMETERS.—The *Bulletin* of the French Physical Society, No. 143, contains an account, by M. Maurice Hamy, of the application of interference-bands to the measurement of diameters of small celestial bodies. The method, originally suggested by Fizeau in 1868, was put to the test by Stephan in 1873, and has been used by Michelson in 1892, who determined the diameters of Jupiter's satellites with a 12-inch equatorial by this means. M. Hamy's improvement consists in substituting broad slits, allowing more light to pass than the narrow openings employed in previous experiments. For the solution of this problem a suitable formula has been found. The calculated diameters of Jupiter's four principal satellites agree remarkably well with the numbers found by Michelson, and M. Hamy's estimated apparent diameter of the plant Vesta, viz. 0·54″, is exactly the value found by Barnard by micrometric observations with the Lick equatorial.

ON DESERT SAND-DUNES BORDERING THE NILE DELTA.[1]

THE distribution of desert sand-dunes in the neighbourhood of the Nile Delta is remarkable. They form a fringe to the desert (where the latter supplies a suitable sand), the material being piled up in dune-tracts, or dune-massifs, wherever its flow is locally checked by ground moisture. The water seeps up through the sandhill, keeping it moist and compact nearly to the surface. The ground plan of the dune-massif has little relation to the wind, which, however, playing upon the surface, throws it into waves. A typical example of the progressive development of their form appears to be as follows. First, a gently-rounded swell, then the lee side becoming rather steeper and the summit of the swell no longer central, but nearer the lee side: the eddy under the lee slope gathers strength and begins to undercut the bank of sand, causing it to slip, forming a straight cliff. This process continues until the eddy has cut back to the summit of the growing dune, which is then of nearly equal average steepness on windward and on lee side. The windward side is, however, a smooth curve of compact sand, whereas the lee side consists of two portions, the upper a straight cliff of loose sand, the lower a curved surface of tolerably compact sand. It is common to find the central portion of a dune showing the fully-developed, the ends the embryonic form. Where the eddy cuts down to a hard bed, the slipping cliff may constitute the whole of the lee slope.

FIG. 1.—Pyramidal Dune.

The ratio Length/Height of blown ripples of sea-shore sand (which the author found to be about 18 : 1) holds equally for desert sand. Where, however, the air has an upward motion relatively to the surface, the ripples appear to be somewhat steeper, their front is less regular, their crest more nearly central, and they grow to greater amplitude, chiefly by excavation. A tract of small but perfect dunes (formed by the wind blowing upon dried Nile sand) was examined in order to see if there were any systematic connection between height and length, such as exists in blown sand ripples. The individual transverse ridges were markedly undulating, and, the low portion of one ridge not corresponding with the low portions of the succeeding ridges, it was evident that there was no such simple relation of Length/Height as in the case of ripples. A line, however, having been marked out in the up-and-down-wind direction across twenty-three of the small dunes, it was found that the *average* ratio Length/Height along the line was identical with that of the ripples. Wherever a depression occurs, the wind is concentrated, and the depression tends to increase. On the other hand, wherever the amplitude is slightly greater, the eddy is stronger, and increases the amplitude. The measurements show that in these dunes the two processes proceeded at the same rate. Although in this sense equal and opposite, the two processes combine to produce modification of form. Thus, the sweeping round of the sand from two depressions leaves the bare ground on leeward of the intervening part of the ridge surrounded by sands of such shape that the pit looks like the hoof-print of a giant horse. These are the structures known as Fuljes, the origin of which has been much discussed. If the wind continue with diminishing supply of sand, the crescentic dune called Barchan would remain, the windward slope of the Fulj being the lee slope of the Barchan. Barchans, however, are not necessarily, nor usually, formed in that manner.

The author describes the operations of the Suez Canal Company in planting *Casuarina* trees to arrest the drift of sand which at present finds its way into the canal. The *Casuarina* does not require rain, and its roots are capable of drawing moisture from a considerable depth. Indifferent as it is to drought, it can endure with equal indifference an excess of water at its roots, an important matter in the Government plantations on the west of the Delta, where periodical inundation has to be reckoned with. The *Casuarina* grows rapidly, and at Ismailia has attained a height of nearly sixty feet in twenty-five years. The foliage is light and feathery, waving confusedly and cheating

FIG. 2.—*Casuarina* Plantation.

[1] Abstract of a paper read before the Royal Geographical Society, Nov. 29, 1899, by Mr. Vaughan Cornish, published in the *Geographical Journal*, Jan., 1900. The illustrations are reproduced from the *Geographical Journal*.

the wind of its force. It is anticipated that the long lines of plantation bordering parts of the Suez Canal will check the drift of the sand from the west, causing it to pile up in a rampart parallel to the canal. The trees should live and grow even when nearly buried in sand, being nourished by the water at their roots.

The largest of the dunes described by the author are those bordering the old Pelusiac branch of the Nile, eastward of the Suez Canal. The height of these dunes is reckoned at 300

FIG. 3.—A Fulj.

eet and upwards. Once enveloped within the labyrinth of sandhills, however, the dimensions appear to be much greater. Under a low sun the scenery is especially remarkable. The startling contrast of light and shadow, the absence of detail on the smooth surfaces of pure blown sand, the steep slopes and bold forms, together with great clearness of definition and a death-like stillness, combine to produce a mountainous impression. It requires an effort of reason to correct the illusion of being surrounded by mountains of three thousand metres rather than by hills of three hundred feet.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Mr. Frederic Harrison has been appointed Rede Lecturer for the present academical year.

The Chancellor has given official interpretations of certain statutes, respecting which doubts had been raised by the Council of the Senate. It appears that a Deputy Professor is declared competent and bound to perform all the functions of the Professor, and that it is not possible for the latter to reserve or to resume any of his duties during the term for which the Deputy is appointed. It also appears that the statutes give the University no power to forbid Readers or Professors from taking private pupils.

The grace for limiting the scope of Part I. of the Mathematical Tripos was rejected by 151 votes to 130; and that for abolishing the order of merit, and with it the Senior Wranglership, was rejected by 161 votes to 129. A considerable number of non-resident members of the Senate attended to register their votes. The other readjustments proposed by the Mathematical Board, chiefly affecting Part II. of the Tripos, were carried without a division.

WE learn from *Science* that the Regents of the University of California have adopted the policy of giving the professors of the University one year's leave of absence in seven. The Sabbatical year is widely recognised by American universities, and the opportunity it affords the professors of visiting distant countries and fellow-workers is invaluable. The custom could be introduced with advantage in our own universities and colleges.

THE London *Technical Education Gazette* announces that botanical gardens have been laid out in Battersea, Ravenscourt and Victoria parks. Good collections of plants, representing various natural orders, have been obtained, and the more important trees and shrubs in the parks have been labelled. These gardens have been specially provided for the use of teachers and students of botany. Teachers who desire to obtain tickets should apply to the secretary of the Board, 116, St Martin's-lane, W.C., giving their names in full and the name of the school where they are teaching.

AT the distribution of the prizes and certificates gained by the students in connection with the City and Guilds of London Institute, on Thursday last, Sir Douglas Fox, addressing the students, said that to specialise in study too early was a great mistake. The great point was to lay the foundation as wide and as broad as possible. That done, the next thing was to properly apply what had been learned. Mr. Watney afterwards made a statement as to the results obtained during the past year, and mentioned that in one way or another the Clothworkers' Company had subscribed 85,000*l.* towards the maintenance of the institute. At the invitation of the Royal Commissioners appointed by Parliament to reorganise the University of London, the executive committee have recently accepted the position of a "school of the University" for its Central Technical College.

THE results of an inquiry into the development of technical education in connection with English Secondary Schools during the past decade, made by the National Association for the Promotion of Technical and Secondary Education, are given in the current number of the *Record*. It appears from the report that in England alone, since 1889, 81 new public secondary schools have been established, while 215 existing schools have been extended mainly for the purposes of science teaching. As regards the schools in the latter category, the extensions to 195 of them have resulted in the addition of 251 physical and chemical laboratories, 77 workshops for manual training, 76 lecture-rooms, and 50 class-rooms. The total sum of money involved by these developments is 764,449*l.* Of this sum, local authorities have voted an amount of 147,496*l.*, the rating and borrowing powers of the Technical Instruction Acts being utilised to raise 20,707*l.* and the Residue Grant supplying the remainder. Taking *technical* and *secondary* schools together, as many as 664 schools have been affected by the efforts of County and County Borough Councils and other municipal authorities and of responsible public committees. Of this number of *technical* and *secondary* schools, 385 have been or are being established, while there are 279 existing schools which have been or are being extended or adapted. The capital expenditure incurred for these purposes *now* reaches in the aggregate 3,302,221*l.*, of which a sum of 1,896,110*l.*, or $57\frac{1}{2}$ per cent., has been or is being supplied by local authorities from Imperial Funds or from local rates.

SCIENTIFIC SERIALS.

Bulletin of the American Mathematical Society (December 1, 1899–January 2, 1900).—(1) The proceedings of the October meeting in New York City are summarised, and abstracts of some of the twelve papers read are given by Prof. F. N. Cole.—Note on the simply transitive primitive groups, by Dr. G. A. Miller, contains some theorems and corollaries which are closely connected with a paper by the author in the *Proceedings* of the London Mathematical Society (vol. xxviii. pp. 533–544). The same writer contributes a short note on the commutators of a given group. Two theorems given are, every substitution of the alternating group of degree n ($n > 4$) is a commutator of two substitutions of the same group. "If the order of a cyclical group is odd, it is the commutator sub-group of its holomorph, and all its operators are commutators of this holomorph. When this order is even, the commutator sub-group of the holomorph includes half of the operators of this cyclical group, and all these operators are commutators of this holomorph." These results are partly supplementary to those contained in Dr. Miller's paper on the commutator groups (*Bulletin*, vol. iv.).—Dr. Lovett gives an account of Oltramare's Calcul de généralisation. From it we learn that this is the magnum opus of the writer, who is probably the oldest living pupil of Cauchy. It sums up the work done by the Professor during the last twenty years. Several short notices, notes and new publications complete the number.

(2) The number opens with the President's (Prof. R. S. Woodward) address, delivered before the Society at its sixth annual meeting, December 28, 1899. It is entitled "The Century's Progress in Applied Mathematics." We learn from the "Notes" that the address has been printed in a separate pamphlet (25 cents each).—The status of imaginaries in pure geometry, by Prof. Charlotte Scott, is a paper which was communicated at the October meeting. Her text is the works of Von Staudt and Reye. She remarks that "it is one of the axioms of modern mathematics that Von Staudt placed the doctrine of imaginaries on a firm geometrical basis; but logical and convincing as his treatment is, when patiently studied in all its detail, it yet seems to me hardly practicable as a class-room method"; and then she proceeds concisely to examine the writings of the two above-named mathematicians, so far as they treat of imaginaries in pure geometry. The usual matter follows.

Bollettino della Società Sismologica Italiana, vol. v. 1899-1900, Nos. 4, 5.—On the present state of Vesuvius (July 3, 1899) and on the endogenous rising of the new lavic cupola during the months of February and March, 1898, by R. V. Matteucci.—The central explosion of Etna on July 19, 1899, by S. Arcidiacono.—On the activity of the volcanoes Vesuvius, Etna, Vulcano, Stromboli and Santorin in the autumn of 1898, by R. V. Matteucci.—The crater of Etna after the explosions of July 19 and 25, 1899, by A. Mascari. The effects of the explosions on the terminal cone and the internal condition of the crater are described.—New type of seismoscopic clock, by G. Agamennone.—Summary of the seismography of the earthquake of November 16, 1894, in Calabria and Sicily, by A. Riccò. A reprint of a memoir already noticed in NATURE.—Notices of earthquakes recorded in Italy (April 23-July 21, 1898), by G. Agamennone and A. Cancani, the most important being the earthquakes of Tripolitza (Greece) on June 2-3, Rieti on June 28, and Dalmatia on July 2, and earthquakes of distant origin on April 29, May 8 and June 22 and 29.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, January 18.—"Further Observations on 'Nitragin' and on the Nature and Functions of the Nodules of Leguminous Plants." By Maria Dawson, B.Sc. (Lond. and Wales), 1851 Exhibition Science Research Scholar. Communicated by Prof. H. Marshall Ward, F.R.S.

In the continuation of the author's work (see *Phil. Trans.* vol. 192, p. 1, 1899) in the Cambridge Botanical Laboratory, cases have been observed—*e.g. Phaseolus*, *Desmodium*, *Acacia*—in which the filaments containing the organism disappear from the nodules at a very early age: no sharp distinction can be drawn between these and the nodules of *Pisum*, *Lupinus*, &c., where the filaments abound in much older nodules, but the suggestion arises that the mode of growth depends on special adaptations of the organism to the conditions in the cells of the nodules in each host. A marked crystal-layer occurs in the nodules of some genera; in others—*e.g. Desmodium*, *Robinia*—peculiar apple-green, nucleus-like cell contents are found. The organisms are unusually large in *Desmodium*, *Coronilla*, *Psoralea*, and some others; and single rods, isolated from pure cultures, of those from *Desmodium* were observed continuously under high powers in hanging drops, and their growth traced. *The X and Y-shaped bacteroids arise by distinctly lateral branching of the straight rods.* After twelve to fourteen days these break up into shorter rodlets. Pure cultures were made on various media, and the organism was successfully grown on silica jelly with nutrient salts. In seven days, at 17° C., colonies of the *Desmodium* organism were as much as 30 μ in diameter. The author is employing this method for testing the power of the organism to fix nitrogen.

Comparisons of "nitragin" with pure cultures from *Pisum* and *Desmodium* show that all grow readily on gelatine or agar with additions of extract of pea-stems, asparagin and sugar; less readily on potato. Milk is not peptonised. A thick zoogloea forms on a decoction of peas. The organism is aërobic, does not ferment sugars, and may pass through a short motile stage. Other bacteriological characters are also examined, including the influence of temperature on infection of the root-hairs of the pea.

The author's experiments with reciprocal infections of organisms from one genus of Leguminosæ to another, point to there being but one species concerned, but this is probably split up into several culture-races, specialised to the various agricultural and other plants concerned, as in the case of the rust-fungi, yeasts, &c.

Crop-cultures of peas infected with the organism, in sterilised soil, ordinary soil, sand, sub-soils, &c., gave contradictory results. In a few cases a small increase was got by the use of the organism alone; but in other cases where nitrates were used instead the crop was larger. When nitrates as well as "nitragin" are added the crop may be even reduced.

The conclusion derived from the various experiments, however, is that the presence or absence of "nitragin" is but one factor in a complex problem, and that at the same time must be taken into account the complicated physical and biological conditions of the soil and atmospheric environments, as well as the symbiotic action of the host plants, in the removal of the products of metabolism from the field of action of the nodule organisms.

Chemical Society, February 1.—Prof. Thorpe, President, in the chair.—The following papers were read.—The chlorine derivatives of pyridine. Part v. Constitution of citrazinic acid. Formation of $\alpha\alpha'$-dichloropyridine and of $\alpha\alpha'$-diiodoisonicotinic acid, by W. J. Sell and F. W. Dootson.—The formation of heterocyclic compounds, by S. Ruhemann and H. E. Stapleton. Benzamidine and ethyl phenylpropiolate react with formation of an intermediate product, $NH\left\langle\begin{matrix}CO.C:CPh\\ CPh:NH\end{matrix}\right.$, which then condenses, yielding

$$\text{benzalphenylglyoxalidone,}\quad \begin{matrix}CHPh:C-\!\!-N\diagdown\\ \ \ | \qquad\qquad \ CPh\\ CO.NH\diagup\end{matrix}$$

$$\text{and diphenylpyrimidone,}\quad \begin{matrix}CPh:CH.CO\\ | \qquad\qquad |\\ N:CPh-\!\!-NH.\end{matrix}$$

Urea, thiourea and guanidine condense with ethyl phenylpropiolate yielding substituted hydantoins.—The space configuration of quadrivalent sulphur derivatives. Methylethylthetine dextrocamphorsulphonate and dextro-α-bromocamphorsulphonate, by W. J. Pope and S. J. Peachey. The authors have prepared thetine salts of the constitutions

$$\begin{matrix}C_2H_5\\ C_{10}H_{15}OSO_3\end{matrix}\Big\rangle S \Big\langle\begin{matrix}CH_2.COOH\\ CH_3\end{matrix} ;$$

and

$$\begin{matrix}C_2H_5\\ C_{10}H_{14}BrOSO_3\end{matrix}\Big\rangle S \Big\langle\begin{matrix}CH_2.COOH\\ CH_3\end{matrix}$$

containing optically active acid radicles, and show that the basic thetine radicle is not optically active. They conclude that in a thetine the sulphur atom and the four atoms directly attached to it lie in one plane.—Nitrocamphane, by M. O. Forster. The author has prepared nitrocamphane and pseudonitrocamphane, to which he assigns the constitutions

$$C_8H_{14}\Big\langle\begin{matrix}CH_2\\ |\\ CH.NO_2\end{matrix} \quad\text{and}\quad C_8H_{14}\Big\langle\begin{matrix}CH_2\\ |\\ C:N(OH):O.\end{matrix}$$

Nitrocamphane is prepared by reducing bromonitrocamphane, and yields pseudonitrocamphane when its potash solution is acidified.—The absorption spectra of ammonia, &c., by W. N. Hartley and J. J. Dobbie.—Isoamarine, by F. R. Japp and J. Moir. The isoamarine of Feist and Arnstein obtained by heating *s*-dibenzoyl-*r*-diphenylethylenediamine in hydrogen chloride gas is identical with Snape and Brooke's isoamarine.—On the condensation of formaldehyde with ethyl malonate and on the synthesis of pentamethylenetricarboxylic acid, by J. F. Bottomley and W. H. Perkin, junr. In addition to the substances previously described as resulting from the condensation of formaldehyde with ethyl malonate, it is shown that ethyl pentanehexacarboxylate,

$$(CO_2Et)_2CH.CH_2.C(CO_2Et)_2.CH_2.CH(CO_2Et)_2,$$

may also be formed. It is hydrolysed by baryta, yielding propanetetracarboxylic acid, $(CO_2H)_2CH.CH_2.CH(CO_2H)_2$, and by hydrochloric acid with formation of the corresponding acid, which on heating to 200° gives pentanetricarboxylic acid, $CO_2H.CH_2.CH_2.CH(CO_2H).CH_2.CH_2.CO_2H$. — The volumetric estimation of potassium, by R. H. Adie and T. B. Wood. The authors precipitate potassium as its cobaltinitrite,

$$K_6Co_2(NO_2)_{12},3H_2O,$$

and titrate the nitrite with permanganate in acid solution.—On the action of aluminium chloride on camphoric anhydride, iii., by F. H. Lees and W. H. Perkin, junr.

Linnean Society, February 1.—Dr. A. Günther, F.R.S., President, in the chair.—The President announced that on the occasion of the forthcoming International Exhibition in Paris, an International Congress of Botany will be held there from October 1-10, both dates inclusive.—Mr. George Massee exhibited lantern-slides in illustration of his paper on the origin of the Basidiomycetes, the substance of which had been communicated at the last meeting, and recapitulated the conclusions at which he had arrived.—Mr. Cecil R. P. Andrews exhibited two non-British grasses which he had found last year in the Channel Islands—*Phalaris minor*, Retz., from sandy shores and fields in Guernsey and Alderney, and *Milium scabrum*, Merl., from the cliffs of Guernsey.—Mr. J. E. Harting exhibited a specimen in the flesh of the Rufous Tinamu (*Rhynchotus rufescens*) which had been shot near Petersfield, Hants, on January 29, and gave some account of the experiments which had been made to acclimatise this South American gamebird since its first introduction by Mr. John Bateman at Brightlingsea, Essex. No difficulty had been experienced in regard to climate or food, but inasmuch as these birds do not perch in trees like pheasants, but roost on the ground, they are more liable to destruction by foxes, a circumstance which has materially affected their increase.—A report was read on the zoological results of an expedition to Mt. Roraima in British Guiana, undertaken by Messrs. F. V. McConnell and J. J. Quelch in 1898; communicated to the Society by Prof. Lankester, F.R.S., on behalf of the members of the British Museum staff who had prepared it. A previous journey, occupying sixty days, had been made by the same travellers in 1894, their route then being by the rivers Essequibo and Rupanuni. The route selected in 1898, by the Mazaruni river, to the Falls of Macrobah, occupied forty days only, twenty of which were spent in boats. With the exception of the last twenty miles, the entire journey lay through thick forest. Mt. Roraima (8700 feet) was found to have a sloping base clothed with dense vegetation, surmounted by a rectangular mass fifty-four square miles in area with perpendicular walls 2000 feet in height. On the south-west, part of the wall has slipped, and lies diagonally across the face of the upper portion of the mountain. By following the ledge so formed, the summit can be reached without serious difficulty. Amongst the Mammalia collected, a new mouse, described by Mr. De Winton as *Rhipidomys Macconnelli* (resembling *R. microtis* from Columbia, but darker in colour and with larger ears) was found near the summit. Amongst birds a new *Zonotrichia*, allied to *Z. pileata*, which is found throughout the greater part of Central and South America, is described by Dr. Bowdler Sharpe. Mr. G. A. Boulenger furnishes descriptions of some new reptiles (*Neusticurus rudis* and *Prionodactylus leucostictus*) and Batrachians (*Oreophrynella Macconnelli*, *Hylodes marmorata*, and *Otophryne robusta*), the last named being assigned to a new genus Amongst Crustacea, of which a number were collected in the Upper Mazaruni river at an altitude of 2500 feet, Dr. De Man detected a new species of *Palaemon*, which he has named after Mr. Quelch. The collection of Myriopoda was found to contain new species of *Odontopellis* and *Enyurus*, of which descriptions are given by Mr. Pocock, who had already described two new spiders (*Ann. M. N. H.* ser. 6, xvi. p. 140) collected on this expedition. Two scorpions (*Broteochactus granosus* and *B. porosus*) are likewise characterised as new. A new Hemipteron (*Acrocoris perarmata*) and a new beetle (*Exagontus denticollis*) are described respectively by Mr. Kirby and Mr. C. O. Waterhouse, the latter insect being referred to a new genus.

Zoological Society, February 6.—Mr. Howard Saunders, Vice-President, in the chair.—The Secretary called attention to the breeding of a pair of black-headed buntings (*Emberiza melanocephala*) in the western aviary, about the middle of the month.—Mr. Oldfield Thomas exhibited and made remarks on some mounted heads of antelopes obtained on the Upper Nile by Captain H. G. Majendie. Amongst these were specimens of *Cobus maria*, *C. leucotis*, *Damaliscus tiang*, and *Gazella rufifrons*.—Mr. G. E. H. Barrett-Hamilton exhibited skins of the continental and British dormice, which he characterised as distinct, and proposed the subspecific name of *anglica* for the British form.—Mr. Barrett-Hamilton also exhibited skins of the variable hare (*Lepus timidus*, Linn.) from Scotland and Ireland, to show their subspecific characters; and gave a short synopsis of palæarctic variable hares, describing as subspecifically new, under the name of *Lepus timidus ainu*, the representative form of the island of Yezo.—Mr. R. Trimen, F.R.S., communicated a paper by Lieut.-Colonel J. Malcolm Fawcett, entitled "Notes on the Transformations of some South-African Lepidoptera." This memoir was accompanied by a series of careful and characteristic coloured drawings from life of larvæ and pupæ collected by the author during a residence in Natal, chiefly at Ladysmith and Maritzburg. The early stages of seventeen Rhopalocera and thirty-one Heterocera were described and figured. Nearly all of these appeared to have been previously unpublished, and in the few instances where previous publication had occurred, the illustrations had been inexact or insufficient. In several species, not only the variations of the full-grown larvæ, but the changes exhibited at successive moults were well shown, especially in the Natalian species of *Papilio*. Among the Heterocera was specially noticeable the striking series of Saturniid larvæ, and still more the huge and extraordinary caterpillar of *Lophostethus dumolinii*, one of the largest of the Smerinthine hawk-moths, which, in addition to the usual caudal horn, bears many strong branched spines distributed over nearly the whole of the body. Colonel Fawcett's descriptions and drawings were accompanied by notes of value on the distribution, food plants, &c., of the species concerned. Mr. Trimen expressed his deep regret (which he felt the Fellows of the Society would share) that the talented writer of this memoir, who had rejoined his regiment in Natal, was among those officers who were known to have been severely wounded during the siege of Ladysmith.—Mr. L. A. Borradaile read a paper on a small collection of decapod crustaceans from freshwaters in North Borneo. The specimens were referred to four species, of which one was a prawn and three were crabs. Of the latter one was considered to be new, and was described under the name of *Potamon kadamaianum*.—Mr. Oldfield Thomas read a paper on the mammals obtained in South-western Arabia by Messrs. Percival and Dodson during the autumn of last year. Twenty-eight species were enumerated, and the collectors' field-notes upon them were given.—A communication was read from Dr. R. W. Shufeldt on the feigning of death in fishes, based principally on observations made on specimens of *Pseudopriacanthus altus* and *Epinephelus niveatus* in the Aquarium of the United States Fish Commission at Washington.—A communication was read from Dr. A. G. Butler containing a revision of the butterflies of the genus *Zizera* (Fam. *Lycaenidae*) in the collection of the British Museum. According to the author's views the genus *Zizera*, so far as was at present known, comprised sixteen species. These were enumerated and their specific differences were pointed out.

Entomological Society, February 7.—Mr. G. H. Verrall, President, in the chair.—The President announced that he had appointed Dr. T. A. Chapman, Mr. W. L. Distant, and Mr. C. O. Waterhouse as Vice-Presidents.—Mr. O. E. Janson exhibited examples of *Achias longividens*, Walk., a remarkable fly from New Guinea, in which the eyes are set at the end of very long stalk-like processes. The specimens showed great variation in the length of the eye-stalks, which in the most fully developed males considerably exceeded the length of the wings.—Mr. J. W. Tutt exhibited a series of specimens of *Epunda lutulenta*, including several remarkable variations.—Mr. Champion exhibited a large number of Coleoptera collected in Switzerland. He called attention to the great variation in colour of one or two common species of the Chrysomelid genus *Orina*, and said he believed that the forms known as *O. cacaliae*, Schrank, *O. speciosissima*, Scop., and under other names, all belonged to one extremely variable species.—Prof. T. Hudson Beare showed specimens of *Dinoderus minutus*, Fab., obtained from a bamboo-basket in his house at Richmond.—Mr. H. Donisthorpe exhibited a larva-case of *Clythra quadripunctata* taken from a nest of the red-wood ant—*Formica rufa*. He commented upon the unsatisfactory state of our knowledge as to the food-habits of the larvæ of *Clythra*, and said he believed the larvæ fed upon the eggs of the ant.—Mr. Gahan mentioned, in connection with the genus *Clythra*, that these beetles possess a stridulating organ on the meso-notom, not along the middle as in Longicorns and Megalopidæ, but towards the lateral edges, and consisting of two widely separated striated areas over which the edge of the pronotum moves. The stridulating areas were present, he said, in nearly all the genera of Clythridæ, and might almost be regarded as a characteristic of the family. The fact that these beetles stridulate was apparently known to Darwin, who, in the "Descent of Man," erroneously stated that the stridulating area was situated on the pygidium.

DUBLIN.

Royal Irish Academy, February 12.—Dr. Benjamin Williamson, F.R.S., Vice-President, in the chair.—Prof. Charles J. Joly read a paper on the place of the *Ausdehnungslehre* in the general associative algebra of the Quaternion type. He pointed out that the cardinal distinction between quaternions and other systems of space analysis lies in the thoroughly associative and distributive character of the former. He showed that a Grassmann system applicable to a space of n dimensions is equivalent to a very restricted use of the associative algebra of $n+1$ units obeying the laws $i_s^2=-1$, and $i_s i_t + i_t i_s = 0$. In fact, a progressive product is simply the part of highest order in the units in a complete product in the associative algebra. Regressive products are formed by the simple artifice of dividing "products" of order $n+1$ by the product of all the units, and then starting afresh. The point symbol may be considered to be introduced by the artifice of leaving the origin arbitrary exactly as Hamilton has done, but somewhere in the fourth dimension when dealing with Euclidian space.—Prof. Grenville A. J. Cole read a paper on metamorphic rocks in eastern Tyrone and southern Donegal. The gneissic axis north of Pomeroy is shown in this paper to be invaded by granite of the Slieve Gallion type, and the metamorphism of the central region thus occurred, in all probability, prior to the "Caledonian" earth-movements. The gneiss itself, however, rarely shows the effects of pressure, and its structures seem due to the invasion of basic schists by an aplitic granite at some early period. Direct comparison is made between its structures and those that are clearly due to the invasion of the Slieve Gallion granite into schists at Fir Mountain. The large area west of Pettigo in South Donegal similarly shows a foliated granite (the archæan gneiss), which owes most of its foliation to the inclusion and streaking out of masses of pre-existing amphibolite. Bands of micaceous rock are formed from the partial absorption and metamorphism of garnet-pyroxenites and garnet-amphibolites. The latter rocks may bave heen sedimentary, and are now found as great "eyes" and lenticles, round which the pure white gneiss flows, and into which it sends off veins. The boundary between the Dalradian schists and the gneiss is sufficiently obscure in this area for it to be possible that the amphibolites were originally the lower members of the Dalradian series. At any rate, they represent a floor on which the Dalradians were laid down. The gneiss is in no sense the fundamental rock; it is, however, traversed by later granite veins, which belong probably to the Caledonian intrusions. As in some French districts, the metamorphic area of South Donegal shows the effects of igneous intrusion and contact-metamorphism on a regional scale, and dynamic metamorphism has played but a minor part in determining its structures.

PARIS.

Academy of Sciences, February 12.—M. Maurice Lévy in the chair.—The President announced to the Academy the loss it had sustained by the death of M. Emile Blanchard, member of the Section of Anatomy and Zoology.—Researches in the uric acid series, by M. Berthelot. Determination of the heats of combustion and formation of methyl purine, hypoxanthine, 8-oxypurin, and 7-methylhypoxanthine.—On the dispersion of the radium rays in a magnetic field, by M. Henri Becquerel. A continuation of work previously published upon the same subject. The experiments were carried out in a uniform magnetic field, of intensity H, and the radius of curvature, ρ, of the path of the ray measured, $H\rho$ being constant. The lower limit of $H\rho$ was measured when screens of various substances (paper, aluminium, mica, glass, platinum, &c.) were interposed. Some of the phenomena observed are not capable of explanation by any simple hypothesis.—The synthesis of campholic acid by means of camphoric acid, by MM. A. Haller and G. Blanc. The steps of the synthesis are as follows: camphor is oxidised to camphoric acid, and this reduced with sodium amalgam to campholide. This, by treatment with hydrobromic acid and subsequent reduction, yields campholic acid.—M. Schwendener was elected a correspondant for the Section of Botany, in the place of the late Baron de Müller.—Rapid variations of radial velocity of the star δ-Orion, by M. H. Deslandres. Eleven photographs of the spectrum of δ-Orion is taken between December 8, 1899, and January 25, 1900, showed that this star possesses periodic variations in its radial velocity, the period being about 1·92 days.—The dynamical laws of cyclones, by M. Admiral Fournier. The author deduces an expression correlating the barometric pressures at two points, and the corresponding distances from the centre of the cyclone, which will be of practical service in navigation.—On the tangent circles to four isotropic planes; and on surfaces of double circular generation, by M. Eugéne Casserat.—On harmonic equations and isothermal surfaces, by M. A. Thybaut.—On anharmonic algebraic equations, by M. Autonne.—Plausible value of a variable magnitude, by M. Estienne.—On two problems in probability, by M. Andrade. A rectification of a note previously published.—On the method of Neumann and Dirichlet's problem, by M. W. Stekloff.—On the zeros of real integrals of linear equations of the third order, by M. Davidoglou.—On the constitution of white light, by M. E. Carvallo. A reply to the criticism of M. Gouy.—On some consequences of the prism formulæ, by M. A. de Gramont.—A new source of light for spectrometry of precision, by MM. Ch. Fabry and A. Perot. An arc is formed between two metallic poles, one of which is kept in rapid oscillation, the whole apparatus being *in vacuo*. The troubles incident to the production of a continuous arc in a vacuum are overcome by the device of keeping one pole in oscillation.—A comparison of various patterns of the Wehnelt contact-breaker, by M. Alfred Turpain. From the point of view of duration and economy, the form with holes suggested by Caldwell is preferable to the form with platinum wire. For usefulness and rapidity either pattern of Wehnelt interrupter is better than the Foucault contact-breaker.—On thermomagnetic currents, by M. G. Moreau. The author regards his experiments as proving that the Hall phenomenon is due to a deformation of the plate under the influence of the magnetic field.—Complete synthesis of the phorone of camphoric acid, by M. L. Bouveault. From adipic acid α-methylcyclopentanone is prepared, and this, condensed with acetone, gives the phorone of camphoric acid.—On the composition of essence of sandal wood from the East Indies, by M. M. Guerbet. Two isomeric hydrocarbons were isolated, each of the composition $C_{15}H_{24}$, and distinguished as α- and β-santalene. A mixture of alcohols $C_{15}H_{24}O$, an aldehyde, santalal, and two acids were also obtained, further investigations on which will be proceeded with.—Transformation of nitrobenzene into aniline by an organic reducing ferment, by MM. E. Abelous and E. Gérard. The ferment present in the kidney of the horse, which in previous papers has been shown to be capable of reducing nitrates to nitrites, is now found to reduce nitrobenzene to aniline.—Researches on the digestion of the reserves in seeds in the course of germination, and their assimilation by the young plant, by M. Mazé. Seeds containing oil are capable of transforming the group CH_2 into an alcoholic group $CH(OH)$ by taking up oxygen from the air.—New researches on the evolution of the monstrillids, by M. A. Malaquin.—On a form of optically negative anhydrous silica, by M. A. Lacroix. The mineral described consists of anhydrous silica containing a little opal, and is found in widely differing strata. Its density is about 2·5; it is biaxial and optically negative. It is clearly differentiated from quartzine, lutecite and chalcedony, and it is proposed to name it pseudo-chalcedonite.—On some granitic rocks of Cape Marsa, by MM. L. Duparc and F. Pearce.—Examination of a meteorite which fell at Bierbélé, near Borgo, in Finland, on March 12, 1899, by M. Stanislas Meunier.—Specific heats of some organic substances, by M. G. Fleury. The specific heats of cellulose, wool and leather are given.

AMSTERDAM.

Royal Academy of Sciences, December 30, 1899.—Prof. Stokvis in the chair.—Report by Prof. Martin and Prof. Behrens on the paper, presented by Dr. H. van Cappelle, entitled "New observations on the Dutch dilivium, especially with a view to mapping out this formation (II.)." The conclusion arrived at, viz. to insert this paper in the *Transactions* of the Academy, was approved of.—Prof. Kluyver made a communication, entitled "Borel's summation-formulæ for divergent series." In this paper the author discusses a slight modification of these formulæ, which were suggested by Mr. Borel in his "Mémoire sur les séries divergentes," (*Ann. de l'École norm.*, t. 16, p. 77, footnote).—Prof. Van der Waals presented a communication, by Mr. J. D. Van der Waals, jun., entitled "The entropy of radiation." The principle of entropy has had to be constantly extended. Originally, entropy was attributed to conditions of equilibrium only. In accordance with the theorem that a system, which approaches a new condition of equilibrium by a non-convertible process and might do so in various ways, compatible with the given combinations, changes its conditions in such a way that the entropy constantly increases, it has become necessary to attribute entropy to conditions of non-equilibrium as well. If this theorem is to hold good generally, entropy has also to be attributed to radiation. In his H theorem Boltzmann has given a formula for the entropy in the case of material molecules that are not in a condition of maximum entropy and consequently not in equilibrium. The author is endeavouring to find a similar formula for radiation. He considers the action of an electrical force upon electrical vibrators as an analogue of the collisions of material molecules. —Prof. W. Kapteyn presented a supplement to the communication made at the meeting of November 25, 1899, entitled "On certain special cases of Monge's differential equation." —Prof. Winkler presented a paper, by Mr. P. H. Eykman, entitled "A new graphical system of craniology." Instead of the absolute measurements of the skull, Schmidt employs the relative ones, which he obtains by multiplying the absolute ones by $\frac{300}{L+B+H}$, by which their sum becomes constant = 300. Geometrically, the triple system of ordinates is thereby changed into a double one, in the shape of an equilateral triangle. All three measures are equal in it, and this method is adapted for a rough survey of a large group of skulls. Alsatian skulls, published by Dr. Blind (537 in number), drawn in the system, serves as an example.—Prof. Bakhuis Roozeboom presented a paper, by Dr. Ernst Cohen, entitled "On the theory of the transition elements of the third kind (I.)."—Prof. Moll presented a paper, by Miss Tine Tammes, entitled "Pomum in pomo." Within a large apple, presented by Prof. C. A. J. A. Oudemans, there is another smaller apple, which is entirely disconnected from the surrounding one. The entire texture of the inner apple is filled up with a mycelium, while the fungus in the outer one is altogether lacking. The presence of the fungus in the interior of the original, normal apple is the cause of the monstrosity.—Prof. Franchimont presented two papers, by Dr. P. van Romburgh, of Buitenzorg, entitled (*a*) "On the nitration of dimethyl aniline in a solution of strong sulphuric acid"; (*b*) "On the formation of indigo from Indigoferas and from Marsdenia tinctoria."—Prof. Kamerlingh Onnes presented a paper, by Mr. E. van Everdingen, jun., on Hall's effect and the increase of magnetical resistance in bismuth at very low temperatures (I.) (continuation).—Prof. Van der Waals presented a paper, by Dr. P. Zeeman, entitled "Observations concerning an asymmetrical change in the spectral lines of iron radiating in a magnetic field." The observations were made at the request of Prof. Voigt, of Göttingen, who deduced from theory that in weak magnetic fields a triplet tends to become asymmetrical, having the more intense component on the less refrangible side, the component on the violet side being at the same time at a greater distance from the original line than the second outer component. Measurements made on negatives proved the existence of asymmetrics, which in many cases were in accordance with theory. A few exceptions to theory were, however, noticed. All the above papers will be inserted in the Academy's *Proceedings*.

DIARY OF SOCIETIES.

THURSDAY, FEBRUARY 22.

ROYAL SOCIETY, at 4.30.—Total Eclipse of the Sun, January 22, 1898. Observations at Viziadrug: Sir N. Lockyer, K.C.B., F.R.S., Captain Chisholm-Batten, R.N., and Prof. Pedler, F.R.S.—Preliminary Note on the Spectrum of the Corona, Part II.: Sir N. Lockyer, K.C.B., F.R.S.—On the Structure of Coccospheres and the Origin of Coccoliths: Dr. H. H. Dixon.—The Ionisation of Dilute Solutions at the Freezing Point: W. C. D. Whetham.

ROYAL INSTITUTION, at 3.—Modern Astronomy: Prof. H. H. Turner, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Standardisation of Electrical Engineering Plant: R. Percy Sellon. (Adjourned Discussion.)

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Improvements in the Longworth Power-Hammer: Ernest Samuelson.—Portable Pneumatic Tools: Ewart C. Amos.

FRIDAY, FEBRUARY 23.

ROYAL INSTITUTION, at 9.—Recent Studies in Gravitation: Prof J. H. Poynting, F.R.S.

PHYSICAL SOCIETY, at 5.—Prof. R. W. Wood will exhibit and describe his Photographs of Sound Waves and the Kinematographical Demonstration of the Evolutions of Reflected Wave-fronts: a New Seudoscope: Diffraction Colour-Photographs; Artificial Parhelia.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Bearing Springs: B. Humphrey and H. E. O'Brien.

MONDAY, FEBRUARY 26.

INSTITUTE OF ACTUARIES, at 5.30.—Surrender Values and the Principles which underlie their Calculation: F. W. Fulford.

SOCIETY FOR THE PROTECTION OF BIRDS (Westminster Palace Hotel), at 3.—Annual Meeting.

TUESDAY, FEBRUARY 27.

ROYAL INSTITUTION, at 3.—Structure and Classification of Fishes: Prof. E. Ray Lankester, F.R.S.

SOCIETY OF ARTS (Foreign and Colonial Section), at 4.30.—Agricultural Education in Greater Britain: R. H. Wallace.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Corrosion of Marine Boilers: John Dewrance.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—Electricity in connection with Photographic Action: W. Friese-Greene.

WEDNESDAY, FEBRUARY 28

SOCIETY OF ARTS, at 8.—Pneumatic Despatch: Prof. Charles A. Carus-Wilson.

THURSDAY, MARCH 1.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* An Experimental Inquiry into Scurvy: F. G. Jackson and Prof. Vaughan Harley.—The Velocity of the Ions produced in Gases by Röntgen Rays: Prof. J. Zeleny.—Mathematical Contributions to the Theory of Evolution. VIII. On the Correlation of Characters not Quantitatively Measurable: Prof. K. Pearson, F.R.S.

LINNEAN SOCIETY, at 8.—On Botanic Nomenclature: C. B. Clarke, F.R.S.—On some Foraminifera of Tithonian Age from the Limestone of Nesseldorf: F. Chapman.

CHEMICAL SOCIETY, at 8.—Pilocarpine and the Alkaloids of Jaborandi Leaves: Dr. H. A. D. Jowett.—Isomeric Partially Racemic Salts containing Pentavalent Nitrogen, Parts I.–VII.: Prof. F. S. Kipping, F.R.S.—New Synthesis of Indene: Prof. F. S. Kipping, F.R.S., and Harold Hall.—(1) Potassium Nitrito-hydroximidosulphates and the Non-existence of Dihydroxylamine Derivatives: (2) Identification and Constitution of Fremy's "Sulphazotised Salts of Potassium": Dr. E. Divers, F.R.S., and Dr. T. Haga.—Some Acids obtained from α-Dibromocamphor: A. Lapworth and E. M. Chapman.

FRIDAY, MARCH 2.

ROYAL INSTITUTION, at 9.—Malaria and Mosquitoes: Major Ronald Ross.

PHYSICAL SOCIETY (University College), at 4.30.—The Relative Rates of Effusion of Argon, Helium, and some other Gases: Dr. F. G. Donnan.—On the Distillation of Liquid Air and the Composition of the Gaseous and Liquid Phases: E. C. C. Baly.—The Reversibility of Galvanic Cells: T. S. Moore.—On the Damping of Galvanometer Needles: M. Solomon.

SATURDAY, MARCH 3.

ROYAL INSTITUTION, at 3.—Polarised Light: Lord Rayleigh.

CONTENTS.

THURSDAY, MARCH 1, 1900.

JAMES DWIGHT DANA.

The Life of James Dwight Dana, Scientific Explorer, Mineralogist, Geologist, Zoologist, Professor in Yale University. By Daniel C. Gilman, President of the John Hopkins University. With illustrations. Pp. 409. (New York and London: Harper and Brothers, 1899.)

SHORTLY after the death of Dana in 1895, a very admirable sketch of the scientific career of his father, from the pen of Prof. E. Salisbury Dana, appeared in the pages of the *American Journal of Science*; but the numerous friends and admirers of the distinguished man—who for many years was justly regarded as the foremost representative of science in the United States—will welcome the fuller memoir now given to the world by his old pupil and friend, President Gilman.

There appears to be some difference of opinion as to whether the members of the Dana family were descended from an Italian or a French stock, but there is little doubt that there were Danas settled in England early in the seventeenth century, and that the ancestor of the American branch was one Richard Dana, who about 1640 emigrated to Cambridge, Massachusetts. Many bearers of the name have attained distinction as divines, lawyers, or literary men; but the father of the great naturalist was engaged in business in the little town of Utica, New York, and it was only the strong bent towards the study of science, which young James Dwight Dana so early betrayed, that led to his abandonment of commercial pursuits, and his devotion to those studies in which he afterwards attained so much distinction.

In the education of Dana we have a striking illustration of the great results that may follow from the efforts of a teacher possessed of enthusiasm and originality—even when he himself may not be distinguished as a scientific discoverer. Dana's capacity for scientific work would seem to have been detected and encouraged by a Mr. Fay Egerton, a teacher in the Utica High School. We are told that

"Mr. Egerton gave lectures in a moderately-furnished laboratory" (this was in the year 1827, in a little backwoods settlement of only five or six thousand inhabitants!) "successively in chemistry, botany, mineralogy and geology, to classes of the older students, who in turn were required, after a study of the topic, to give back the lecture with its experiments to the teacher and their fellows of the class. He was an enthusiast in his own line of study and instruction. Besides his lectures in the lecture-room, he scoured the country round either with or without his pupils, showing them where to go in pursuit of whatever was instructive or curious, assisted them in the naming and care of their specimens, and inspired them with new zeal for natural science. During the long summer vacations he made long excursions with half-a-dozen or more of his class to different parts of the State or to neighbouring ones, visiting localities that abounded in particular rocks or minerals, and bringing home stores for their own or the school collection. These excursions were made almost wholly on foot, a single horse and waggon accompanying the party to carry their scanty wardrobe and relieve the oft-burdened mineral satchel worn by each of them, until such time as they reached a suitable place for shipment."

Every teacher of elementary science in this country may well find encouragement in reading this description of the labours of Fay Egerton. Who can say that among the bright-faced boys watching the experiments or eagerly scanning the specimens shown to them a future Dana may not be present?

It affords a curious comment on the methods of education in this country if we remember that at the very time when Fay Egerton was labouring in a little back settlement of New York to develop the scientific tastes of his pupils, Charles Darwin and his elder brother were being publicly reprimanded in the Shrewsbury Grammar School for wasting their time in setting up a laboratory in which to carry on their experiments!

In 1830, when only seventeen years of age, Dana left Utica and entered Yale College, New Haven, Connecticut, where he came under the influence of Prof. Benjamin Silliman, whose daughter he subsequently married. After taking his degree in 1833, he became an instructor of midshipmen in the U.S. Navy, and sailed in the warship *Delaware* to the Mediterranean, visiting the coasts of France, Italy, Greece and Asia Minor. It was during this voyage that he wrote his first paper, an account of a visit to Vesuvius, which was published in the *American Journal of Science.*

Returning to the United States, a period of suspense, but not of inaction, followed. While seeking for a scientific post, and acting as honorary assistant to Prof. Silliman, he prepared the first edition of his "Treatise on Mineralogy," a work which, being continually improved and enlarged in the five successive editions that have appeared in the last sixty years, will always remain a monument of Dana's great attainments and vast industry.

In 1838 Dana was appointed one of the naturalists to the celebrated exploring expedition under Commodore Wilkes. It is interesting to notice how curiously the careers of Dana and of Asa Gray, the botanist, were influenced by their mutual friendship. Asa Gray succeeded Fay Egerton as teacher of science in the Utica High School, though it does not appear that Dana was ever one of his pupils. When the United States Government determined to send out an exploring expedition, however, Gray accepted the post of naturalist, and it was by his persuasion that Dana was induced to do the same. But at the last moment Gray withdrew, while Dana, as is well known, accompanied the expedition throughout the whole cruise. Gray and Dana were lifelong friends, and among the most interesting letters in the volume before us is the correspondence that passed between them, especially that portion of it relating to the doctrine of evolution.

The United States exploring expedition consisted of five vessels, and between the years 1838 and 1842 it circumnavigated the globe, visiting the islands of the Atlantic and passing through the Straits of Magellan to the west coast of South America; thence through the Paumotu, Tahiti and Samoan groups to Australia, whence a portion of the expedition proceeded south, and discovered land in the Antarctic Ocean. While at Sydney, Dana first heard of the theory which Darwin had shortly before propounded to account for the origin of atolls and barrier-reefs, and during the remainder of the voyage, which led him by way of New Zealand to the Fiji Islands, the Sandwich Islands, the Kingsmill

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group, and the Carolines, Dana lost no opportunity of testing the theory by application of it to the various islands visited by the expedition. As is well known, Dana, while differing from Darwin on some minor questions, fully accepted the coral-reef theory of the latter author, and remained, to the end of his life, its most staunch and enthusiastic defender. While in Magellan's Straits, the ship to which Dana was attached only very narrowly escaped shipwreck, and, after leaving the Sandwich Islands, the *Peacock*, with Dana on board, was totally lost near the mouth of the Columbia River. After this unfortunate experience, in which Dana lost all his personal effects and many of his collections, he joined a party which crossed the mountains near Mount Shasta, and made their way down the Sacramento River to San Francisco. At San Francisco Dana joined the *Vincennes*, and returned to New York by way of the Sandwich Islands, Singapore, the Cape of Good Hope, and St. Helena.

The next twelve years of Dana's life were occupied in working out the results obtained during the expedition. In 1849 appeared a great quarto volume, with an atlas, on the geology of the expedition, this having been the part of the work which was especially under his charge. But in 1846 he had already issued a large volume, with folio atlas, a "Report on the Zoophytes," dealing with the corals collected by the expedition; and in 1853 two other large volumes, with another folio atlas, his "Report on the Crustacea," made their appearance. How unremitting were his labours in connection with these three reports will be manifest to all who have to consult these volumes, especially if it be remembered that a large part of the drawings in the plates are by Dana's own hands.

In this combination of geological and zoological work, by one who had so many opportunities for original observation during a long voyage of circumnavigation, we cannot fail to be struck by the parallelism between the careers of Darwin and Dana. Unfortunately, we have to add that, while both attained a great age, they were alike, during the later years of their lives, sufferers from ill-health—the result of the hardships they underwent in their long and arduous journeys in the cause of science. Dana and Darwin never met one another, but during many years they maintained a friendly correspondence, some of the letters that passed between them being printed in the volume before us.

In 1850 Dana was appointed Professor of Natural History in Yale College, but in 1864 his duties were restricted and he became Professor of Geology and Mineralogy. There are many interesting pieces of evidence in the work before us of the able and conscientious manner in which he discharged the duties connected with his chair, and of the esteem and love with which he was regarded by his students and colleagues. In addition to his "System of Mineralogy," he wrote a "Manual of Mineralogy and Lithology," and also a "Treatise on Geology," which is widely known and has passed through four editions, and a little work for beginners, entitled "The Geological Story briefly Told."

Another sphere of activity in which Dana was constantly employed was the editing of the *American Journal of Science*, which had been started by his father-in-law, the elder Silliman, in 1818, and has long occupied the foremost place among the scientific journals of the United States. Dana became joint editor of the journal with the elder and younger Silliman in 1846, and during the later years of his life was chief editor of the work—a task which has since devolved upon his son, Prof. Edward Salisbury Dana. *Silliman's Journal* has now existed for eighty-two years, and is widely known for its scientific articles, not only in the United States, but in every part of the British Islands and the Continent of Europe, where science is cultivated. Besides many of Dana's most important original contributions to science, the numbers of the *American Journal of Science* contain a long series of notes and reviews from the pen of its ever active editor.

In spite of ill-health, Dana maintained his scientific activity to the end. During his "Wanderjahr," his attention had been specially directed to the formation of coral-reefs, and in addition to his great monograph upon corals, he wrote a popular book, "Corals and Coral Islands," which passed through two editions. In the controversies on the rival theories of the formation of coral-reefs, Dana contributed a masterly summary and review of the whole question. Another subject which had interested him during his first voyage to the Mediterranean, and later in his visit to the Sandwich Islands, was that of Vulcanology. Since his visit to Hawaii, in 1842, so many changes had taken place in the volcanoes of the island, that in 1887, although he had reached the age of seventy-four, he determined to revisit them for the purpose of settling various doubts and difficulties which had arisen in his mind. His well-known work on "Volcanoes" was the outcome of this expedition.

We have spoken of the remarkable parallelism between the careers of Darwin and Dana. The reader of the interesting volume before us will not fail to notice another resemblance between the English and the American naturalists, namely, their singular simplicity and amiability of character. This is evidenced in the case of Dana by innumerable incidents and many expressions contained in letters in the work before us, which show that by all with whom Dana came in contact he was deeply loved. Dana's long and active life had a very quiet and peaceful ending early in 1895. The memoir is written by one who is evidently full of sympathy and admiration for the man, and he is to be congratulated upon having furnished a vivid portrayal of the characteristics of a naturalist whose memory men of science, all over the world, will not willingly let die.

JOHN W. JUDD.

BILLIARDS MATHEMATICALLY TREATED.

Billiards Mathematically Treated. By G. W. Hemming, Q.C. Pp. 45. (London: Macmillan and Co., Ltd., 1899.)

THIS treatise will be useful to the amateur billiard player who has a competent knowledge of mathematics, though not, perhaps, to the very accomplished player who may have attained to excellence by natural gifts of eye and hand, and by long practice without theory. Mr. Hemming had better state in his own words his views upon this question.

"A rule of thumb," he says, "is as good as a scientific law to a man who has played often and well enough to regard the rule of thumb as a necessary law of nature. Amateurs of less experience than this may find it much easier to obey a law the reason for which they have grasped."

The possible motions of a billiard ball here discussed are five, viz.: (1) Perfect rolling; that is, rotation about a horizontal line through the point of the ball touching the table for the time being. This is the motion assumed by the ball when struck by a horizontal cue in a vertical plane through the centre at a height 7/10 of the diameter. (2) Sliding without rotation. (3) Pure side; that is, rotation about a vertical axis through the centre. (4) Curving motion; that is, rotation about a horizontal axis through the point touching the table, such axis coinciding with the direction of translation. (5) Imperfect rolling; that is, rolling as in (1) combined with any of the others.

These probably exhaust all forms of the motion for gentle strokes. A hard struck ball will probably jump many times before it finally subsides into rolling or sliding, just as a cricket ball neither rolls nor slides much till it is nearly spent.

The most interesting case occurring in practice is that in which the striking ball with perfect rolling impinges on the object ball at rest. The problem of the motion of the two balls after impact involves the determination of the important constants. The constants are:—(1) The coefficient of elasticity, $1-e$, between ivory balls, which, on authority accepted by the writer, is given as about 14/15. (2) The friction, f, between the balls, which is determined as follows:—The object ball, if struck obliquely, acquires from the friction with the striking ball a certain rotation about a vertical axis through the centre. This is proportional to f. With this is compounded a rotation about a horizontal axis due to direct impact, so that the resultant rotation is about an axis inclined to the horizon. And if we can guess the direction of that inclined axis, we can determine f. By using an old red ball, on which are irregular markings, as the object ball, Mr. Hemming says the inclination can be guessed with fair accuracy, and this method gives for f a value between 1/70 and 1/105.

A third possible constant is that of the impulsive friction between ball and cloth, denoted by μ. This Mr. Hemming retains provisionally in his formulæ, but ultimately rejects as inappreciable.

In the case of impact between ball and cushion, the action of the cushion varies so greatly with the speed, as well as with the direction, of the striking ball, that no constant can be determined.

Probably the most useful part of the book to the practical player is Appendix II., on the *margin of error* in billiard strokes, from which even the best player may learn something to his advantage. I select the following instances: in playing a winning hazard, the margin of error is least, and the stroke most difficult, when the object ball is half-way to the pocket. It is found also that the margin of error is smaller in a thin losing hazard than in the corresponding through stroke.—But is not the management of the cue more difficult in the latter case?

Appendix I. treats of the effect of nap on a ball played with side. It raises the question of the nature of rolling friction. According to Prof. O. Reynolds (*Phil. Trans.* 1876), rolling friction may be reduced to sliding friction. When a body rolls on a plane, expansion or contraction takes place in the substances immediately in contact, which, or the subsequent restitution, causes one to slide over the other. Sliding is thus always being created and destroyed by friction as fast as it is created. Mr. Hemming makes a different hypothesis—namely, that the cloth may be regarded as a series of stiff parallel ridges, facing the way of the nap. The rolling ball is instantaneously in contact with two of them, say, at the points P and P′, the line PP′ subtending at the centre a very small but finite angle, which depends on the nature of the cloth. Through P and P′ pass two reactions, which intersect (he says) in the vertical through the centre at the height 7/10 of diameter, and therefore cause the ball to continue perfect rolling. He is not writing a treatise on rolling friction, and does not therefore give any *a priori* reason why the two reactions should intersect at the point stated. *A posteriori* they must do so, for otherwise the ball could not continue perfect rolling as, in fact, it does. It would not be difficult to show, applying what is known as Thomson's theorem, that on Mr. Hemming's hypothesis, as to the nature of the cloth, the ball would pass from the state of rotation round P to a state of rotation round P′ with diminished energy, and so must continue perfect rolling.

S. H. BURBURY.

OUR BOOK SHELF.

A Rudimentary Treatise on Coal and Coal Mining. By the late Sir Warington W. Smyth, M.A., F.R.S. Eighth edition, revised and extended by T. Forster Brown. Pp. vi+346. (London: Crosby Lockwood and Son, 1900.)

NO man did more for the advancement of mining education in this country than the late Sir Warington Smyth. In 1851, when the Royal School of Mines was founded, he was appointed lecturer in mining, and he continued to give his annual course of mining lectures until June 20, 1891, when, sitting with his students' examination papers before him, he passed away—dying, as he had lived, in harness. In 1851 he found the art of mining in the trammels of empiricism; and, thanks to his wide practical experience and his familiarity with continental practice, he was able in his lectures to evolve order out of chaos, and to arrange heterogeneous facts in a comprehensive system. Moreover, his work underground as mineral inspector and adviser to the Crown enabled him constantly to keep his lectures abreast of the times. Unfortunately, he never prepared them for the press. But, while directing the higher education in mining, he was not forgetful of the needs of the elementary student, and was induced in 1866 to write for Weale's excellent series of rudimentary treatises a little book on coal and coal mining. This was eminently successful, and seven large editions were called for. No previous work gave so popular and yet so full and accurate a view of the subject. Written in a delightful literary style, it bore internal evidence of not being a mere extract of books, and afforded attractive reading not only for the unpractised, but also for the experienced mining engineer and geologist.

Since the publication of the seventh edition great progress in mining has been made, and the value of the book has necessarily greatly diminished. It is therefore most satisfactory to note that Mr. T. Forster Brown, an eminent mining engineer, and Sir Warington Smyth's successor as chief inspector of the mines of the Crown and of the Duchy of Cornwall, has edited a revised and extended edition, in which the principal changes and improvements in coal mining are treated. The chief additions made are two chapters dealing with blasting and explosives and with coal washing. In the latter, coke making (a subject usually included in metallurgical treatises) is also discussed. Mr. Forster Brown has very wisely been careful to retain the general character of the book. He has perhaps carried to too great an extent his unwillingness to alter the original text. The prices mentioned throughout the book, for example, refer to the years 1864-6. The Saxon coal production is given in the long obsolete units of *Scheffel;* and references are made to New Granada, a country that changed its name in 1861, and to "the flourishing empire of Brazil," which ceased to exist in 1889. Again, with regard to the speculation that the Palæozoic rocks may be continuous from the Severn to the Rhine, which is described as of little practical importance, no allusion is made to the discovery of coal at Dover. Mr. Forster Brown, too, omits to point out that the statement that there are very erroneous ideas of the overwhelming importance of the American coalfields as compared with those of Europe is no longer accurate in view of the fact that last year the United States produced more coal than any other country in the world. BENNETT H. BROUGH.

Untersuchungen über die Chemischen Affinitaten. Von C. M. Guldberg und P. Waage. Herausgegeben von R. Abegg. Pp. 182 and 18 tables. (Leipzig: W. Engelmann, 1899.)

THIS latest addition to Prof. Ostwald's invaluable series of reprints will be welcomed by all chemists. The work of Guldberg and Waage is now well known, and is abstracted at some length in the larger books on theoretical chemistry; but we have here the complete series of papers with some recent annotations by Prof. Guldberg, and an interesting biographical and critical notice by Prof. Abegg.

The student of chemical history will do well to read this volume in conjunction with No. 74 of the series, which is a reprint of Berthollet's "Recherches sur la loi d'affinité." Berthollet's work was published in 1801; Guldberg and Waage's first paper is dated 1864. Between these years nothing advancing the mathematical theory of the subject had appeared except the unrecognised paper of Wilhelmy on the rate of inversion of cane-sugar, and the papers of Berthelot on estorification. When this is borne in mind it will be realised how great and how sudden was the advance made by the two Norwegians.

The three papers contained in the reprint, and dated respectively 1864, 1867 and 1879, show how, with the progress of time, the ideas of the authors grew in simplicity and generality, until in 1879 we have their theory in a form differing but little from that in which it is employed at the present day. The two earlier papers were very little known up to 1879, and several investigators worked unwittingly in the same field discovering facts a second time. This, however, can hardly be a matter for regret except in so far as it tends to bewilder the student. In other respects it has only served to strengthen the foundations of chemical dynamics.

A. S.

How to Know the Ferns. By Frances Theodora Parsons. Pp. xiv + 215; and plates. (New York: Charles Scribner's Sons, 1899.)

THIS book is intended to serve as a popular handbook to the ferns of the United States. It will probably fulfil its purpose, in enabling the reader to identify the majority of the ferns described by means of their general habit, aided by the form of the sorus. To this result the numerous original illustrations, which are clear and accurate, will largely contribute. An artificial key to the species is provided, in which the authoress depends to a considerable extent on the degree of difference between sterile and fertile fronds to characterise the main groups. It is to be regretted that attention is not directed to the artificial nature of these distinctions, and that the natural arrangement was not adopted in the part devoted to the description of the species. In this we find the species of *Osmunda* separated in two groups, while the *Ophioglossaceae* are placed in the midst of the true Ferns. The brief account of the reproduction of ferns on pp. 30-35 leaves much to be desired. The figures illustrating this are poor, notably the drawing of a sporangium on p. 31, while the description is bald and in places misleading. No mention is made of the peculiar subterranean prothalli of the *Ophioglossaceae.* Had space been found by the omission of irrelevant matter in the opening chapters for a clear, simply written, and well-illustrated account of the life-history of ferns, with special reference to the native species, the book would have been none the less popular, while its educational value would have been greatly increased. W. H. L.

Laboratory Note-Book for Chemical Students. By Prof. Vivian B. Lewes and J. S. S. Brame. Pp. viii + 170 (with alternate blank pages). (Westminster: A. Constable and Co., 1899.)

THE authors of this book, which is essentially one for the laboratory bench, are of opinion that there is room for a small volume containing all the necessary description for the laboratory preparation of gases, &c., together with the reactions of metallic and acid radicles, in a concise form, and some of the more simple quantitative experiments suitable for students. In the treatment of a few technical matters, such as the valuation of fuel, the simple examination of oils, the viscosity of oils, and the characteristics of explosives, the volume is in advance of most similar laboratory manuals, but the plan of interleaving the text with blank pages for the student's own notes cannot be unreservedly recommended. Many teachers find that such an arrangement is conducive neither to neatness nor originality in the pupil's expression of his own observations. The method has, however, its advantages; and the objection to it does not affect the text, which provides a good course of experimental work in chemistry suitable for technical students and others.

The Elements of Co-ordinate Geometry. "The University Tutorial Series." Part II. The Conic. By J. H. Grace and F. Rosenberg. Pp. viii + 315. (London: W. B. Clive, 1899.)

SO many text-books are available to day that the issue of a new one is generally accompanied by an explanation of its *raison d'être.* The one before us is that the present book seeks to develop the subject in a more gradual and more explanatory manner than its predecessors, and to pay more attention to curve tracing. That it succeeds in this endeavour will be gathered from a perusal of its pages, for no pains seemed to have been spared to lead the reader up small but ever rising steps. To gather a general notion of the scope of the book, we may say that, after briefly describing the three varieties of conics, the student is made acquainted with the general equation of the second degree, and the classification of curves which are represented by such an equation. This is followed by more detailed information relating to various properties of curves, taken at first generally and afterwards individually. The exercises are graduated as much as possible as regards difficulty of solution, and are very numerous.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Effects of Lightning upon Electric Lamps.

IN the last number of NATURE, Prof. Wood calls in question the reality of the remarkable phenomenon revealed by Mr. Webb's photographs, attributing the results obtained to a motion of the camera during exposure; laying special stress on the alleged fact that "a lamp close to the camera, and a distant lamp, show the trails *on the same scale*."

To this I reply that the fact is just the reverse, as is well shown in Fig. 4, which exhibits nine lamps which are situated in order of sequence along a strongly curved shore, the pictures of four lying to the left and of five to the right of that of the near lamp. It will be seen that there is a regular diminution of scale in these pictures as we pass from left to right, corresponding to the increase of length of the chords of the bay. I would remind the reader that at the conclusion of his letter (p. 343), Mr. Webb expressly states that on a subsequent occasion he actually *saw* a stream of electricity descending from an arc lamp towards the earth. This was a momentary appearance, obtained by so placing himself as to be protected in a measure from the glare of the lightning.

From my communications with Mr. Webb, and from the photographs themselves, I am satisfied that the camera was lying at rest, except *perhaps* as regards the fifth flash of the picture Fig. 6, which may possibly have struck while Mr. Webb was in the act of removing the camera; a point about which I have written to make inquiry. Should such prove to be the fact, I would withdraw my "digression" (p. 344) relative to the flash in the middle of Fig. 6. G. G. STOKES.

Cambridge, February 24.

Stockholm International Conference on the Exploration of the Sea.

UNDER this title there appeared in NATURE, during November and December last year, several letters from some eminent British biologists containing criticisms of the resolutions of the Stockholm Conference. The principal objections to the conclusions at which the Conference arrived are:—

(1) *That the Conference has not elaborated any definite programme of biological work.*

I fully agree with Prof. Herdman that the biological part of the programme needs further development before it can be put into execution. The Conference has only drawn up the outlines of that part of the programme which regards fishery experiments, marking of fishes, &c., so far as they can be considered applicable to all parts of the area concerned. It is evident that, while the instruction for hydrographic work, deep-sounding, &c., will hold as well for the shallow depths of the southern parts of the North Sea as for the 2000-3000 metres depths of the Norwegian Sea, the character of the biological research and the fishery experiments will be somewhat different in the eastern and western parts of the North Sea, in the Barents Sea, and in the Baltic. It must be left to the specialists and the fishery authorities of each country to propose detailed rules for the experimental and statistical work as regards the most appropriate manner of investigation of the adjacent areas. It will be for the Governments to take care that the initiative thus taken is duly considered and made useful in the organisation of the co-operation, either by instituting the Central Bureau and Council at once, or—as an introductory step to this—by assembling the Commission mentioned under the head H of the Resolution. The most urgent thing at present is to ascertain if the different Governments agree *in principle* to the idea of co-operation or not. The Swedish Government some months ago communicated to the Governments of the North Sea powers and Russia, that it accepted the programme of the Stockholm Conference, and is resolved, in case of agreement on the part of the other Governments interested, to ask from the Riksdag the funds necessary to carry it out. On the same occasion, the Swedish Government requested the Hydrographic Commission to work out a detailed programme for the Swedish part of the investigation, and to calculate the costs. An abstract of this plan will shortly be published in the *Scottish Geographical Magazine*.

The meteorological work is not mentioned in this plan, otherwise than by reference to the detailed instruction contained in section A of the Resolution. The plan of the biological work and fishery experiments is illustrated by two maps. The annual costs are calculated at 3170*l*., or with deduction for ships, coal, &c., 1000*l*. It must be well borne in mind that this plan is liable to alteration, and does not represent what we *are* to do, but what we *propose* to do, in case the co-operation is realised. To the note of the Swedish Government concerning the co-operation proposed by the Stockholm Conference, favourable replies have been received from the Norwegian and the German Governments.

(2) *That the Conference has not recommended to the Governments concerned the use of sea-going, well-equipped steamers for investigations of this kind.*

The necessity of having sea-going ships for such purposes will scarcely need recommendation. Several of the Governments in question, as Russia, Denmark, Norway, Sweden, have already procured, or made arrangements for procuring, steamers excellently fitted for the co-operative work. But the number and size of such ships must be left to the decision of each Government.

(3) *That the area to be investigated ought to have been extended to some part of the Atlantic proper.*

This seems to me to be the most serious objection hitherto raised. It seems, in fact, indispensable to keep some account of the state of the Atlantic W. of the Channel, and S. of the Wyville Thomson and Faroe Iceland ridge.[1] On the other hand, it must be agreed that, if a certain limit must be fixed, the Strait of Dover and the two ridges above-mentioned constitute the only natural boundary for a co-operation of the North Sea powers.

(4) *That the Central Bureau and laboratory proposed by the Conference is unnecessary, and might be substituted by some more elastic organisation.*

When listening to the proceedings of the Seventh International Geographic Congress at Berlin last year, I noticed that international co-operation was recommended almost in every case as the best method of attacking geographical problems. Resolutions were passed to such purpose regarding seismological, hydrographical, meteorological problems, antarctic explorations and others. It struck me that nobody seemed to take into account the difficulties combined with the starting and conducting of such co-operative work. I know that there *are* such difficulties, and I consider that in the present case the difficulties already existing are irrelevant if compared with those which will arise in future, when the organisation shall commence its work. If we only want as much as possible of scientific work of various kind to be done, the elastic (collegial) organisation which Mr. Allen recommends will do; but if we desire unity of work and practical results, we certainly must have a central institution at the head of the co-operation. It is a characteristic fact that this proposal emanated from delegates of most of the countries represented at the Conference. Without entering upon the state of things in other countries, of which I am no judge, I am sure that the prevailing circumstances with regard to fishery matters in my own country are such that we ought gratefully to accept the proposals of the Conference with regard to a central organisation.

(5) *That the Central Bureau, &c., will interfere with the freedom of the specialists and impede the originality of the scientific work at the biological stations.*

It seems not unlikely that the manifold labour of calculating and statistical work incumbent on the Central Bureau will occupy the time of the officials of that Bureau to such an extent that little time will be left for original scientific research on their part; but I cannot realise the possibility that such will be the case with the specialists belonging to the biological stations now existing. The co-ordination of the international research with their scientific work will, of course, be based upon free mutual agreement, wherein all advantages will be on the side of the biologists. Suppose that Mr. A., director of the marine station of X, studies the biology of the halibut, and that Mr. B., of the station Y, is specialist upon the cod or the plaice. Both communicate their wish to get scientific material from the North Sea and Norwegian Sea to the Central Bureau, which requests Messrs. A. and B. to elaborate each a detailed

[1] The position of the British and Danish lines (see the map of the Conference protocols, of which a reproduction has appeared in the *Geogr. Journal*, December 1899) is chosen so as to fulfil this purpose to a certain degree.

scheme with full instructions for the collection of the material desired, and for the counting, measuring, &c., of fishes, fry and eggs. If these schemes are approved by the General Council, the president or secretary of the Central Bureau is authorised to recommend the leaders of the fishery experiments in all parts of the seas concerned to select the material desired from every catch, and to measure, mark and register it in the manner prescribed. Messrs. A. and B. will thus receive preparations or specimens of cod, halibut, &c., of such size and stage of development as they wish to study from every corner of the area investigated. Likewise, they will get analytical data of the salinity, temperature of the water or samples of plankton, stomach contents, gases contained in the water or in the bladder, &c.

The field of research of each specialist will thus be immensely enlarged. Another advantage is that material of purely scientific value can be distributed to public and private institutions, museums, &c., in the different countries.

OTTO PETTERSSON.

Hydrografiska Kommissionen, Stockholm.

Gibbs's Thermodynamical Model.

IN Maxwell's "Theory of Heat" (p. 207) is a drawing showing some of the principal lines on a thermodynamical model suggested by Prof. J. Willard Gibbs, of Yale University. I have been told that Prof. Maxwell had two of these models constructed, one of which remained at Cambridge, England, the other being sent to Prof. Gibbs at Yale. There is also a copy of this model at Clark University, Worcester, the only one which I have seen. While there may be others in existence, these are the only ones which I have known of, and I suspect that very few have ever been constructed.

This year, in connection with a course in thermodynamics, two of my pupils are attempting to construct one of these models, but are met by various serious difficulties, which may interest others. In the diagram to which I refer, the directions chosen for the different co-ordinates are not immediately evident. Even by the aid of the description in the text, I have not been able to locate them satisfactorily. In the attempt so to do, I have been guided by the following general considerations. Using Maxwell's notation, in which v=volume, p=pressure, t=absolute temperature, e=energy, ϕ=entropy, the equation connecting these quantities is

$$td\phi = de + pdv,$$

which, transposed, gives

$$de = td\phi - pdv = \frac{\partial e}{\partial \phi}d\phi + \frac{\partial e}{\partial v}dv,$$

the differential equation of the thermodynamical surface of which the co-ordinates are the entropy, volume and energy, and the slope of which at each point in the principal directions gives the temperature and pressure, by the identities

$$t = \frac{\partial e}{\partial \phi}\;;\; p = -\frac{\partial e}{\partial v}.$$

These are subject to the conditions that t is always positive, and p is usually positive, always so for the gaseous state, usually for the liquid and solid states.

If, then, e is taken vertically downward, and v and ϕ horizontal, passing along a section of the surface by a plane of constant volume, in the direction of increasing entropy, the slope will always be downward, and generally convex, as the addition of heat, that is, energy to a substance at constant volume increases its entropy, and generally its temperature, never decreasing it. A section by a plane of constant entropy will have a slope in the direction of increasing volume, which is in general upward, corresponding to a positive pressure, and in all parts of the model referring to stable states of the substance this will be convex, since increase of volume is then accompanied by decrease of pressure.

I have attempted to determine the choice of co-ordinates by the properties of the critical state. In the two diagrams the broken line separates the parts representing stable or homogeneous states from parts representing unstable or non-homogeneous states. In the pressure-volume diagram, lines of constant pressure, volume, entropy and temperature are drawn. On the other are drawn lines of constant pressure and temperature, taken from Maxwell. In both diagrams these lines are tangent to the broken line. In Fig. 1 the line v=const. cuts sharply through the broken line.

I have attempted to find the behaviour of a line of constant entropy in the following way.

For a substance following van der Waals's equation

$$\left(p + \frac{a}{v^2}\right)(v - b) = Rt,$$

the equation of an isentropic can be shown to be

$$\left(p + \frac{a}{v^2}\right)(v - b)^k = \text{const.}$$

where k is the ratio of the specific heats at constant pressure and constant volume. The slope of this curve is then found to be

$$\frac{dp}{dv} = \frac{2a}{v^3} - \frac{k(p + a/v^2)}{v - b},$$

which becomes, substituting the values of the critical pressure and volume

$$\left(\frac{dp}{dv}\right)_{\text{crit.}} = \frac{2a(1-k)}{27\,b^3},$$

which is negative for real positive values of a and b. Hence the isentropic appears also to cut through the broken line, but less sharply.

Still further, we believe that the line of constant volume does not again pass out of this non-homogeneous or unstable area, while the isentropic may. Hence it has seemed to me necessary

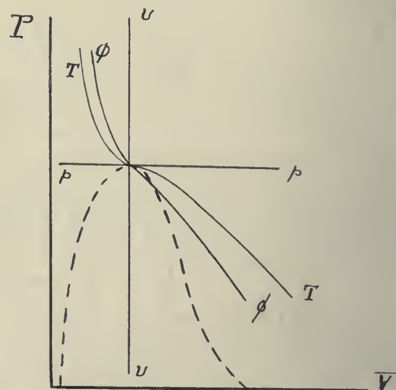


FIG. 1.

to consider the vertical line of Fig. 2 a line of constant volume, and the horizontal line an isentropic, while the critical point lies a little to the left of the vertex of the curve, so that the isentropic slightly cuts through the broken line.

The choice of co-ordinates will then be: energy, vertically downward, in the three-dimensional model, volume, measured to the right, in Maxwell's diagram, and entropy vertically downward in the same diagram. This choice is not inconsistent with the arrows in the upper left hand corner of the diagram. The model, which has been constructed in accordance with these considerations, is shown in the accompanying figure (Fig. 3). It satisfies the general requirements as to slope and convexity. It represents the gaseous or vapour state, as having in general the greatest volume and a great range of pressure, &c.

One property, however, does not seem to be indicated by this model, nor do I see how to satisfactorily change it so that this can be done. It has been deduced mathematically and shown experimentally that if a saturated vapour be expanded adiabatically, or isentropically, it may either become superheated, or partially condense to liquid, in fact both phenomena can be shown with one substance, for instance, chloroform above 127° C. becomes superheated, and below this temperature no visible effect is produced by either expansion or compression. That is, there is an isentropic which is at a particular point tangent to the "steam line," those on one side of it not touching it at all, while those on the other cut both in and out. This particular property is not shown by the model as constructed, with the present choice of co-ordinates. If, however, we had measured entropy horizontally in the diagram, then the isentropics, being vertical, might be tangent to cut through the steam-line. This choice of co-ordinates has, however, seemed impossible for the reasons previously given.

We may if we wish discuss the question by a different method. The lines drawn in Figs. 1 and 2 are all lines through the critical point. In Fig. 1 the lines of constant pressure and

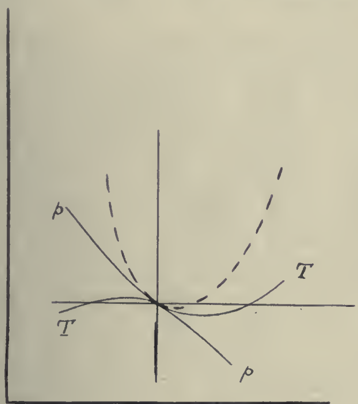


FIG. 2.

temperature are tangent to the broken line; Fig. 2 shows the same property. In Fig. 1 the line of constant entropy cuts the broken line twice, but no other pair of lines has more than one intersection. Fig. 2 does not, as drawn, show the same property. In Fig. 1, passing from the water-line around the critical point in the homogeneous region to the steam-line, one cuts the lines in the following order: water-line, pressure, temperature, entropy, volume, pressure, temperature, entropy, steam-line. Fig. 2 gives the same order, with the choice of co-ordinates, which we have adopted, if we let the temperature lines always

FIG. 3.

slope downward, as do the pressure lines. With this change the two diagrams seem to agree, but otherwise their disagreement seems hopeless.

I shall be very glad to receive from any one any suggestion which will help to remove the apparent disagreement between the two diagrams, or so modify the model that it may more completely represent the possible properties of actual bodies than it now seems to do. W. B. BOYNTON.

The University of California,
Berkeley, Cal., U.S.A., February 1.

To Calculate a Simple Table of Logarithms.

A YEAR ago Prof. Perry drew attention to a method by which a schoolboy knowing how to extract square roots could, with the help of squared paper, construct a table of logarithms (NATURE, February 23, 1899).

It does not appear to be known that it is possible for a boy to make a simple table of logarithms in a few minutes without even knowing square root in arithmetic.

Up to a few years ago the teaching of logarithms in schools was generally deferred until they were required in trigonometry for the solution of triangles, but the general introduction of practical physics into secondary schools has resulted in the teaching of logarithms to younger boys.

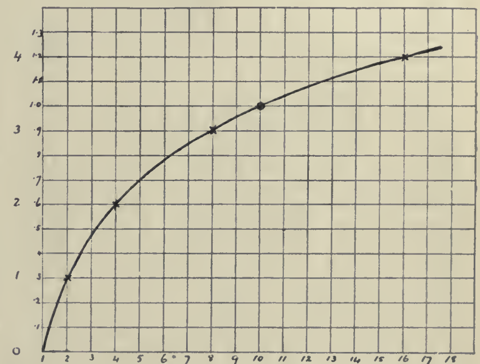
The following method which I have introduced into several Schools of Science in my district has been carefully tested in classes of boys of about thirteen years of age with excellent results.

On a sheet of squared paper ruled in inches and tenths, plot logarithms to base 2: log 2 = 1 : log 4 = 2 : log 8 = 3 : log 16 = 4, and draw a curve.

It will be found convenient to arrange numbers from 1 to 16 on a horizontal axis, taking 1" as unit, and the logarithms on the vertical axis, taking 3" as unit.

From the curve read off the value of $\log_2 10$, which will be found to be approximately $3\frac{1}{3}$. Let us assume that $\log_2 10$ is exactly $3\frac{1}{3}$.

On any system of logarithms log 4 = 2 log 2 : log 8 = 3 log 2, &c. Hence the curve obtained may be used to represent



The left-hand vertical column of figures in the diagram represent scale logs. to base 2, and the right-hand column scale logs to base 10.

logarithms to any base if the ordinates are measured on a suitable scale.

The scale used for measuring logs. to base 2 is a plain scale. To construct a scale for measuring logs. to the base 10, write log 10 = 1 instead of $3\frac{1}{3}$; and as this falls on the 10th line, the distance from 0 to 1 can be at once divided into 10 parts, and numbered 0·1 : 0·2, &c., the finer lines (not shown in the diagram) giving the second decimal place.

Having assumed that $\log_2 10 = 3\frac{1}{3}$, $\log_{10} 2$ becomes ·300 instead of ·301, so that the values from the curve are in error to the extent of 1/300; but this is not greater than small errors due to the freehand drawing of the curve and irregularities in the ruling of the squared paper. ARTHUR DUFTON.

Sheffield, February 13.

THE publication of Mr. Dufton's method will, I think, serve a useful purpose. It is a common exercise in schools to plot on squared paper, numbers and their logarithms to the base 2 (see Blaine's "Methods of Calculating," Spon), to give a general notion of how the logarithm varies as the number varies; but I have never known it to be made a method of calculation. Indeed, I do not think it right to give a boy the idea that he may find log. 10 by interpolation between log. 8 and log. 16. There is a specious appearance of accuracy due to the fact that $\log_2 10$ is so nearly $3\frac{1}{3}$; and Mr. Dufton heightens it by using squared paper on which the divisions are thirds of the unit, so that a boy will have it fixed in his mind that $3\frac{1}{3}$ is exactly $\log_2 10$.

My intention was to give a good exercise on the use of squared paper for interpolation; it happens to be a method of calculating logarithms correctly to as many places as we please. It keeps before a boy the simple notion that a common logarithm is the index of a power of 10. The idea before Mr. Dufton's pupil is much more complex, and he is not likely to find the logarithm of any number correct even to the second figure.

February 19. JOHN PERRY.

RECENT PROGRESS IN PHOTOGRAPHY.

THE progress of knowledge and of skill in its application is often so gradual that although there may be a vast difference between the condition of affairs a few years ago and at the present time, it may be impossible to discover definite steps in the general forward movement. And after a few specific cases of undoubted progress have been singled out, it may be that they, or some of them, will subsequently prove to be only side issues of comparatively trivial importance. On the other hand, a circumstance that is quite obvious to the scientific student may be worked upon by a commercial firm and so advertised that a method of work becomes largely modified, and a practical advance effected without any addition to our knowledge.

It has been known from the earliest of photographic times that sensitive surfaces require a certain minimum of exposure before any change in them can be detected. But the abolition of so-called dark rooms for printing by development, and the employment of the same light for development as for exposure, was a possibility almost neglected until the American "Velox" paper was introduced. Of course, for exposure the printing-frame is held very near to the light, and during development the print is shaded. This method of work may be only a passing fashion, but it has revolutionised the printing arrangements of many an amateur, and been so appreciated that several firms have put slow papers and lantern plates on the market for working in the same manner, and other makers are seriously discussing whether it is desirable to do so.

A modification of pigment printing that has recently been introduced by Mr. Thomas Manly constitutes a more substantial advance, though whether it will be so widely appreciated as the silver papers slow enough for development in gas-light remains to be seen. He calls his process "Ozotype." So far as concerns important and serious work, a small improvement in either carbon or platinum printing is likely to be of more real value than any possible change in silver printing. But Mr. Manly's is not a mere modification of detail. Putting it simply, he exposes the transfer paper instead of the pigmented tissue under the negative, and thus by one transfer he gets a print that is not laterally inverted, a result which requires a double transfer by the ordinary method, or else the making of a special inverted negative for single transfer. As the paper exposed is not pigmented, the progress of printing can be judged of by inspection, and there are other advantages of a less important character, such as the absence of any need for "safe edges" to the negatives. The paper that is exposed under the negative is made sensitive by means of a mixture of potassium dichromate and a manganous salt. On exposure, the chromate is reduced and the manganese is thereby oxidised, and both products of the change are insoluble in water. By washing, an image that has oxidising powers is obtained, and this may be utilised in many ways. It does not seem to deteriorate by keeping. To pigment the image, a piece of carbon tissue is soaked in a weak solution containing acetic acid, hydroquinone, and ferrous sulphate, squeegeed on to the print and allowed to dry. Development is effected as usual in carbon printing. Mr. Manly supposes that the acetic acid causes the manganic compound to reoxidise the chromic compound to a soluble salt (chromate?) which is absorbed by the gelatine of the tissue. In the gelatine the hydroquinone reduces the chromium compound to the chromic condition, which, as usual, renders the gelatine insoluble. This appears to be the inventor's working theory. Final practical details are not yet published, but it is certain that the process is capable of yielding good and useful results.

The toning of prints in which the image consists of metallic silver by causing it to act on the solution of the ferricyanide of a metal, reducing it, and thereby causing the deposition of the corresponding ferrocyanide on the image, is a method that has long been known. The ferrocyanide of copper, being of a reddish-brown colour, is a desirable toning material, but copper ferricyanide is not soluble in water, and the various solvents hitherto employed have not given satisfaction. Mr. W. B. Ferguson has just shown that a solution of potassium citrate is a solvent for the ferricyanide that serves perfectly, and has thus converted an almost useless process into one that is easy and certain. The colour appears to be rather browner than that yielded by the corresponding uranium process, and it is hoped that the colouring matter will prove more permanent.

There have recently been quite a number of new introductions that affect the production of negatives. Foremost among these stand the rapid "spectrum plates" of Cadett and Neall, and the colour screens adjusted thereto by Mr. Sanger Shepherd. Red sensitive plates have been made before, but the even sensitiveness throughout the spectrum that these plates show, has never, in our experience, been equalled. But no plate will of itself render the various colours according to their proportional visual brightness. The sensitiveness to blue and violet vastly preponderates in all cases, and in order to reduce this light and so compensate for the excessive sensitiveness thereto, various coloured screens have been in use. For general purposes, this screening has been done by the roughest of methods, whether yellow glass or dyed films have been used. But Mr. Sanger Shepherd has prepared screens that are adjusted to the plates within a small margin of error, using for the testing the method of colour sensitometry introduced by Sir William Abney. With such an adjusted colour screen and plate a coloured object can be photographed in almost any light so that the print will give the correct comparative luminosities of all the colours as they appear under the conditions when photographed. The chief exception is that light of less refrangibility than the solar line C, or about that, is not represented, this small portion of the less refrangible red being reserved as a light useful when making the plates and working with them. Colour screens are provided for dark-room lights, that transmit only the least refrangible red, far enough from where the practical sensitiveness of the plates begin to furnish a light that is quite unable to harm the plates under the usual conditions of development, &c. Mr. Sanger Shepherd also prepares colour screens for spectrum plates adapted for the three-colour process of reproduction, and as they are adjusted by measurement and to the same plate, this is a considerable step towards the simplification of work and the ensuring of correct results.

Some new intensifiers for negatives have recently been suggested, but as their effects have not been thoroughly investigated, they should not replace the use of mercuric chloride followed by ferrous oxalate, which is the only method that has yet been shown to give a definite result equally proportioned over the whole negative. Ammonium persulphate, as a reducer, has been shown to thin the image to a nearly equally proportioned degree all over, instead of removing a larger proportion of the thinner parts of the image, which, of course, lie near the surface of the film. This is an exceedingly useful effect; but here again the chemical changes have not been investigated, and the theories that have been suggested to account for the exceptional effect are far from satisfactory. It is not certain, indeed, that the remaining image is of pure silver.

The makers of apparatus are always seeking to improve their goods, and they are, as a rule, so successful that it is impossible to refer here to other than the most important advances. Photographers used to be satisfied with lenses that either covered a large field in proportion to their focal length, or that had a large aperture; but these properties that used to be considered incompatible now have to be combined; a large angle of view is maintained while the aperture is increased. Instead of *f*/8, which used to be regarded as the maximum aperture for outdoor work, we now have *f*/6, and even larger apertures, without the introduction of the peculiar faults usually associated with portrait lenses. The firm of Goerz, of Berlin, has quite lately put upon the market a doublet, each combination of which consists of five elements, the complete objective having an aperture of *f*/5·5. These—the stigmatics of Dallmeyer at *f*/4 and *f*/6, the planars of Zeiss with apertures of about *f*/4, and other lenses of similar properties—are instruments of precision for giving an image over an extended field, as telescope objectives are instruments of precision for giving definition over a very small field. In conjunction with the rapid gelatine plates of to-day, they place a power in the hands of scientific workers that was not conceived possible a few years ago.

The firm of Dallmeyer have recently improved their stigmatics, series *f*/6, by putting the combination of greater focal length in the front instead of behind. To use either combination alone, it is now only necessary to remove the other, and the extension of camera necessary is nearly the same for both the combinations, although their equivalent focal lengths are approximately as 1·5 to 2, taking the focal length of the whole combination as the unit. Dr. Rudolph, of Zeiss', has investigated the question of the use of cylindrical surfaces in objectives for the purpose of getting a different ratio of enlargement (or reduction) in two directions at right angles to each other. One result of this work is the "anamorphot" issued by Messrs. Zeiss, and its use is chiefly, if not exclusively, in the readjustment of the proportion of length to breadth of designs for their application in the decorative arts.

There does not appear to have been any radical improvement in cameras of late; but the system of cinematography, made possible by the perfection to which film-supported sensitive surfaces have been brought, continues to engage the attention of a large number of inventors. The most recent, and doubtless most interesting, application of this principle is in an apparatus that the Kodak Company are making for Sir Norman Lockyer, for use during eclipses of the sun. The apparatus will accommodate a film five inches wide and of length suitable for the required series of exposures. The opening behind which the film is exposed is twelve inches long and three inches wide. The apparatus is designed to photograph a series of spectra, as of the chromosphere, so that the exposures may follow each other with greater rapidity and certainty than is possible when plate-changing has to be done by hand. The operator has only to turn a handle continuously, and at each complete revolution an exposure is made, the exposed film is wound up, and a new portion brought into position. Three-quarters of the revolution effects the change of film; at the beginning of the remaining fourth the shutter is opened; it continues open until the revolution is completed, or nearly completed, when it is closed; then the film-changing takes place again, and so on. By stopping the crank during the last quarter of the revolution, a time-exposure of any duration may be given. It is expected that the apparatus will be used in conjunction with a twenty-foot objective of six inches aperture with a prism in front of the objective; and as this lens gives practically no curvature on a field twelve inches in length, the film will be used flat.

Scientific photographers on the Continent have lately been paying more attention to the measurement of the opacities of photographic plates. Dr. J. Hartmann, of Potsdam, has recently described an apparatus constructed for him for comparing opacities. It consists of a horizontal microscope with its ocular and objective, with a tube branching from it at right angles, downwards, that carries a second objective. At the junction of the two tubes is the well-known arrangement of two right-angled prisms, with their hypothenuse surfaces cemented together except at a small disc in the centre of the adjacent sides; so that one sees a small portion of the plate being tested surrounded by the comparison tint. The apparatus appears to be unnecessarily costly and complicated when compared with apparatuses that have been used in this country for a similar purpose.

There are many other matters that would claim attention in a complete *résumé* of recent progress in photography, some of which have already been referred to in these columns. C. J.

THE POSITION THAT UNIVERSITIES SHOULD TAKE IN REGARD TO INVESTIGATION.

THE American Society of Naturalists arranged for a discussion on the duties of universities with regard to investigation, and the American journal, *Science*, has recently published the contributions to the discussion made in the end of last year at the New Haven meeting. Profs. Dwight of Harvard, Chittenden of Yale, Jastrow of Wisconsin, Patten of Dartmouth, and Dr. Macdougal of the New York Botanic Gardens—five distinguished representatives of the natural sciences in America—made a formal and deliberate expression of their opinions, and an examination of these convictions cannot fail to be valuable to English readers. On all salient points these experts are in complete agreement. They have no doubt that the connection between universities and research is fundamental. Dr. Macdougal dismisses it as "axiomatic." Prof. Jastrow declares that a university should be the "natural habitat" of investigation. Prof. Dwight is "sure of a sympathetic hearing from public and universities for discussion of the modes and conditions of university research." The others differ only in the precise phraseology they employ. Nor is there any doubt but that university teachers should be investigators by temperament and habit. As Prof. Chittenden insists, the primary function of a university is a diffusion of the knowledge already gained, rather than the provision of new knowledge; but, although teachers who were not investigators have existed, the ideal teacher must be more than a diffuser. All universities of standing make success in investigation a necessary qualification for their teachers, and, in effect, our witnesses all agree that, having chosen rightly such men, it is the duty of the universities to see that time and opportunity for investigation should be found for them during their tenure of office.

There is a certain divergence of opinion as to the extent to which original investigation should be made an actual part of the training of students. Prof. Dwight and Prof. Patten are not inclined to encourage it, the former thinking chiefly of medical students and agreeing with Huxley, that whoever adds one tittle of what is unnecessary to medical education is guilty of a very grave offence, the latter disapproving of it entirely as a normal part of the curriculum. Others, again, incline to the view that actual new investigation, as opposed to ordinary laboratory work, is an extremely important and useful incident in training. On the other hand, there is no trace of difference of opinion as to whether or no it is not at once an imperative duty and an immense practical advantage for a university to provide every encouragement in the shape of equipment and scholarship or fellowship endowment for what may be called post-graduate research. In this respect the duties of a university are to be limited only by her resources.

The general result of this interesting discussion by experts is that an atmosphere of original investigation should pervade a university. Its professors must be investigators if only because otherwise they cannot be competent teachers. Its schools must be provided with the appliances and material facilities for research, and it must attach to itself by scholarships and fellowships numbers of young men devoting themselves, in the first place, to research; while the conduct of original investigation may be made an incident in the normal training of advanced students.

It is to be noticed that this emphatic pronouncement is based directly on experience, and on experience of a strictly pedagogic or university type. These experts in conference had no need to raise the underlying principles on which useful continuance of the existence of universities depends. Universities are organs of the community, and the pabulum that they absorb, whether it be derived from hoards of the past or from the circulating wealth of the present, obviously is diverted from other uses. Their utility depends upon the returns they make to the community. Such products consist of an output of trained men and of knowledge; these, to resume the metaphor, corresponding to the direct secretion of an organ, and the general diffusion of a subtle but pervading influence comparable with the internal secretions discovered by modern physiology. A university that starves and discourages research turns out into the world smooth and conventional graduates, blind to the surprising novelties of life, more ready to meet crises, small or great, with historical parallels than novel efforts; fitter to adorn success than to achieve it; it prefers criticism to knowledge, style to matter, glosses and reconciliations to the disconcerting energy of new ideas; it instils into the body politic a bland and slothful miasma of self-content. A university pervaded by the spirit of investigation sends out graduates ready to change with changing conditions, to whom difficulties are opportunities, and who, above all, are trained to watch for the inevitable changes in the most familiar ideas as new facts creep into light; it sends out the new knowledge, which becomes transmuted into new practical advantages for humanity, and it sends out the old knowledge not wrought into artificial harmonies, but with a bold presentation of the gaps and roughnesses which are the chief stimulus to new discovery; it radiates through the community the alert and adaptive spirit of progress.

It is needless to say that, like the American universities, the universities of the continent, and in especial those of Germany, are conspicuous for the extent to which they encourage research by their funds and by their arrangements. The historian of the future, who is to trace the vast progress made in recent years by Germany in power, wealth, commerce, the arts and industries, without doubt will notice the part played by her many universities in this momentous change. A single article in the pages of a scientific journal is not a suitable vehicle for any exact examination of the relative advances made by England and other countries in recent times. But, until matters have been put right, every opportunity is convenient to insist that the universities of Britain do not encourage research sufficiently, and that, in particular, her richest university habitually and systematically despises research in its general arrangements, in the allocation of its endowments, and in the distribution of its revenues. Moreover, it is especially unfortunate that not only is the amount of consideration given to research minute, but is diminishing.

A single example is more convincing than a multitude of general statements, and an appropriate instance lies unfortunately ready to hand in the preface to the last volume of "Linacre Reports," recently issued by Prof. Ray Lankester. The late Linacre Professor and present Keeper of the British Museum of Natural History, in a preface addressed to the Vice-Chancellor of the University of Oxford, deplores the attitude of the Oxford colleges to the natural sciences. "The College endowments," he states, and every one with knowledge of the matter is able to corroborate, "are now more largely than ever employed in maintaining a tutorial system, which is in itself of small value—if not positively injurious—and necessarily in complete antagonism to the development of the method of study, and to the wide range of subjects studied, which distinguish everywhere but in Oxford the University from the Preparatory School." Prof. Lankester believes that the natural sciences, the subjects particularly associated with research as a means of training and as a source of directive knowledge, should be supported by not less than two-thirds of the endowments at the disposal of these colleges. Oxford, no doubt, is an extreme example of the general failure of British universities to respond adequately to what everywhere but in England is regarded as the first duty of a university; but there is urgent need for inquiry into and redress of the conditions which have brought about the present state of affairs, and those institutions which have taken a larger view of their duties will be the first to approve a strong statement of the existing failure.

BRITISH DRAGONFLIES.[1]

Mr. LUCAS is favourably known to entomologists by previous works on British Butterflies and British Hawk-moths; but in the present work he has broken new ground, and gives us a complete and trustworthy account of our British Dragonflies, the study of which has previously been much neglected in England.

Dragonflies resemble butterflies in being among the largest and most conspicuous of day-flying insects; but they are far less numerous in species, for while there are 300 butterflies in Europe in round numbers, out of which from 60 to 70 inhabit the British Islands, the Dragonflies of Europe barely exceed 100, of which, however, 40 are admitted by Mr. Lucas as British, a considerably larger proportion than in the Butterflies. It is curious, however, that among seven additional species, properly excluded by Mr. Lucas as not truly indigenous, is *Pantala flavescens*, Fabricius, said to have been taken years ago by Sparshall in the Fens. This is an abundant species in nearly all parts of the world (Asia, Africa, Oceania and America), but with the single exception above-mentioned, it has never been noticed as occurring in any part of Europe.

One advantage of dealing with a limited subject is that it permits of its being treated with sufficient fulness for most practical purposes, in a sufficiently portable form.

While not neglecting the literature of his subject, a large portion of the present volume is based on Mr. Lucas's own personal observations, which imparts much greater value to the whole of his work; for although every author must be more or less dependent on the observations of others as well as on his own, yet he is not

[1] "British Dragonflies" (Odonata). By W. J. Lucas, B.A., F.E.S. Illustrated with 27 Coloured Plates and 57 Black and White Engravings. Pp. xiv + 356. (London: L. Upcott Gill, 1900.)

competent to judge of them, or to estimate their relative value and importance, unless he himself has a practical as well as a theoretical acquaintance with the subject.

One disadvantage in collecting Dragonflies is the difficulty of preserving the colours of most of the species. Hence the importance of carefully coloured illustrations taken from fresh specimens; and although Mr. Lucas's illustrations, which appear to be colour-printed, are not equal to Charpentier's beautiful plates of the same insects, they represent the insects very well, and the neuration of the wings is also accurately reproduced. Photography would, however, be the only way in which the neuration of many of these insects could be produced with absolute accuracy, especially in the case of *Neurothemis* and one or two other East Indian genera, in which the network is excessively fine, and must include thousands of divisions in each wing.

Mr. Lucas has divided his work into nine chapters—introduction, life-history, classification, the nymph, the imago, genera and species, reputed species, breeding the nymph, and preparing for the cabinet. The book concludes with addenda and corrigenda, list of works referred to, and a good general index. There are also detailed tables of genera and species, and even of the nymphs. The plain figures represent oviposition, eggs, nymphs, parasites, and various details of the insects.

In order to show the full manner in which Mr. Lucas has dealt with his subject, we will take one of the best known, though not one of the very commonest species, *Libellula quadrimaculata*, Linn., to which nearly twelve pages are devoted. First we have synonymy, then the original description (which we would gladly see inserted, as a matter of course, in all descriptive works, whenever possible, as it would save much misunderstanding and inaccuracy), size, description of the male imago, the female, immature colouring, variation, oviposition, egg, nymph, emergence of imago, date, habits, migration and distribution within the British Isles. It might be suggested that notes on extra-British distribution, and when desirable, notes on allied non-British species, would have made the account of each species more complete.

L. quadrimaculata is the most remarkable of the European Dragonflies for its migratory habits, and if memory serves us, it has sometimes been observed migrating in company with butterflies, though whether pursuing them as prey, or whether both species were urged by some common impulse, may be a matter for investigation. Most Dragonflies, except the slender-bodied and delicately-formed Agrionidæ, are very strong on the wing, and many even of those which are not migratory in their habits are often met with a long way from water. But there is no doubt that many Dragonflies are habitually migratory, which may partly account for the wide distribution of other species besides *L. quadrimaculata*, which latter, it may be noted, is found throughout temperate Asia and North America, as well as in Europe. In Christmas Island, near Java, where three wide-ranging species of Dragonflies are found (one of them being the almost cosmopolitan *Pantala flavescens*, already referred to), they are never seen except when the wind is blowing from a certain direction, when they appear suddenly in swarms.

A century ago we had no systematic works on British insects at all, except Lewin's admirable book on British Butterflies, published in 1795; for even Marsham's pioneer book on Coleoptera, and Haworth's on Lepidoptera, did not begin to appear till the beginning of the present century. At present we have more or less complete works on several orders and families of insects; but there are still many large groups, including the great order Diptera, and a large portion of the orders Hymenoptera, Neuroptera, and some families of Homoptera, of which we have no adequate up-to-date monographs at all, at least in a separate form.

We congratulate Mr. Lucas on his having so successfully filled up one of these remaining gaps in our British entomological literature.

As a specimen of Mr. Lucas's style, we may quote his account of the habits of one of the commonest of the larger British Dragonflies, *Æschna cyanea*, Müller:

"Though sometimes seen flying over the water, where it is difficult to catch, this insect is oftener met with along hedgerows and lanes, where it sometimes for a long time flies backwards and forwards over a very restricted range. On such occasions, notwithstanding its rapid, powerful flight, it is usually possible, with careful watching, to make a capture. When once startled, however, it usually soars away out of sight, to return very possibly, however, to the same spot a little later. On one occasion, in Berkshire, I noticed an *Æ. cyanea* hawking along a hedge in this way, and presently saw it capture a butterfly (probably the Small Copper). After circling round it several times the Dragonfly secured its prey, and began wildly careering round as if rejoiced at its success. While thus engaged, a wing of the butterfly—or part of one—was let fall, and *cyanea* settled in the

FIG. 1.—*Æschna grandis* ovipositing.

hedge, where it appeared to be further stripping its captive. Shortly after, the Dragonfly was captured in its turn, when the body of the butterfly was found still between its jaws. But it is, of course, not at all an uncommon thing for one of the larger Dragonflies to capture a butterfly, whose wings it removes in a very workmanlike manner."

Apropos of the above passage, we may remark that a large North American Dragonfly (*Anax longies*, Hagen), belonging to the same family as *Æschna cyanea*, is described as habitually *decapitating* its prey, which generally consists of some of the larger butterflies. W. F. K.

NOTES.

THE desire has been widely expressed in University circles in Edinburgh that the Curators of Patronage, with whom the appointment to the chair of medicine rests, should offer the post to Prof. Osler, of the Johns Hopkins University, who is well known as a teacher and clinicist of the highest scientific eminence, and whose acceptance of it would greatly strengthen both the systematic and clinical teaching in the University. It would appear, however, that the Curators have no choice in the matter, but are bound to advertise every vacancy, so that the far more satisfactory and dignified method of appointment by invitation is necessarily excluded. Nevertheless, it is confidently hoped that Prof. Osler may be induced to send in a formal application for the chair, since it is certain that his claims would receive every consideration from the present Board of Curators, who have more than once, on recent occasions, shown that they are superior to merely local considerations, and that they have regard in making these appointments solely to the best interests of the University. Prof. Osler is a Canadian by birth, and although he has for many years successively occupied the important chairs of medicine in Philadelphia and Baltimore, he has, we believe, never renounced his British nationality. His appointment to Edinburgh, although it would be felt as a serious loss by our kinsfolk on the other side of the Atlantic, would doubtless be considered by them, and especially by our Canadian fellow-subjects, as a graceful recognition that we are one people bound together in science, as in politics, by common interests, and that we are prepared to welcome the best man from whichever side of the water he may hail. Applications for the post, with testimonials, must be lodged with Mr. R. Herbert Johnston, Secretary to the Curators, at 66 Frederick Street, Edinburgh, on or before April 14.

THE Bakerian Lecture of the Royal Society will be delivered, on March 8, by Prof. Tilden, F.R.S., on "The Specific Heat of Metals, and the Relation of Specific Heat to Atomic Weight." The Croonian Lecture will be delivered, on March 22, by Prof. Paul Ehrlich, of Frankfurt-on-Main; the subject will be "Immunity, with especial reference to Cell Life."

PROF. ZITTEL, professor of palæontology and geology in the University of Munich, has been elected a correspondant of the Paris Academy of Sciences in the section of mineralogy. Prof. Pfeffer, professor of botany at Leipzig, has been elected a correspondant in the section of botany.

THE *Electrician* states that the late Prof. D. E. Hughes has bequeathed to the Paris Academy of Sciences a sum of 4000*l.*, the income of which is to be used as a prize for the most important discovery in physical science, preference being given to a discovery in electricity or magnetism.

PROF. C. PIAZZI SMYTH, for forty-two years Astronomer Royal for Scotland, and professor of practical astronomy in the University of Edinburgh, died on February 21, at the age of eighty-one.

THE committee of the Liverpool School of Tropical Diseases has decided to send out almost immediately another expedition to West Africa. The expedition will make its headquarters in Old Calabar, and carry on researches in Southern Nigeria.

THE *Times* states that Mr. Charles Whitehead, who has acted as technical adviser to the Agricultural Department of the Privy Council, and subsequently to the Board of Agriculture, during the past fifteen years, has been compelled to resign that appointment owing to ill health.

DR. C. L. GRIESBACH, the Director of the Geological Survey in India, has gone for a tour in the famine districts of the Central Provinces, Bombay and Rajputana, with a view to examining into the practicability of sinking artesian wells.

A BACTERIOLOGICAL Institute for Ceylon, erected from funds provided by Mr. J. W. Charles de Soysa, after the best European models, was officially opened at the end of January. The Director of the Institute will be Dr. Marcus Fernando, who has personally superintended its construction.

THE Government of India have added to Mr. John Eliot's designation of "Meteorological Reporter to the Government of India" the words "and Director-General of Indian Observatories." The meteorological office has been removed to a house specially built for it. The address of the office will henceforth be—Alipore (Calcutta), Bengal, India.

THE Sugar Beet Committee of the Central Chamber of Agriculture have decided to make arrangements for a series of not less than twenty experiments in the growth of sugar beet in different parts of Great Britain and Ireland during the forthcoming season, each experimental plot to be at least one acre in extent. As, in certain cases, previous experiments have demonstrated the value of sugar beet for the feeding of stock, independently of the value of the root for the manufacture of sugar, this point will be specially kept in view in connection with the proposed experiments of the present year.

MR. A. A. CAMPBELL SWINTON will give a lecture upon "Steam Turbines, Land and Marine," at the Camera Club, on Thursday, March 8.

As the Royal Meteorological Society will attain its jubilee on Tuesday, April 3, having been founded on April 3, 1850, it is proposed to observe this fiftieth anniversary in a special manner. The Council have arranged for a commemoration meeting on that day, at which the President will deliver an address, and delegates from other societies will be received. In the evening a conversazione will be held at the Royal Institute of Painters in Water-Colours. On the following day, April 4, the Fellows will visit the Royal Observatory, Greenwich, and in the evening will dine together at the Westminster Palace Hotel. In view of this Jubilee Celebration, Mr. G. J. Symons, F.R.S., was elected President at the annual meeting of the Society on January 17, but owing to illness he has since been obliged to resign this office. In these circumstances the Council at their last meeting appointed Dr. C. Theodore Williams as the President of the Society.

THE awards of prizes by the Reale Istituto Lombardo for the past year seem to indicate rather a lack of essays of real merit. The "ordinary" prize offered by the Institution for the best catalogue of remarkable meteorological phenomena prior to 1800 was unawarded, but premiums of 400 lire have been awarded to three of the competitors, and the judges consider that the publication of the results arrived at conjointly by the three would be of great value. Under the Cagnola foundation five prizes were offered, and none awarded, the only award being a premium of 1000 lire to the sole competitor who sent in an essay on illustrations of Hertz's phenomena. On two of the other subjects no essays were sent in, and on the other two the essays were not of sufficient merit to justify an award. The Pizzamiglio prize and the Ciani prize, for essays in political science, and the Zanetti prize, for discoveries in pharmaceutical chemistry, are all unawarded. The Fossati prize, for an essay illustrative of the macro- and micro-scopic anatomy of the central nervous system, has been conferred on Dr. Emilio Veratti. In striking contrast to the paucity of competitors in subjects of a more or less academical character is the keen competition for the Brambilla prize, given "to one who has invented or introduced into Lombardy some machine or some industrial process from which the population may derive a real and proved benefit." Seventeen competitors entered for this prize, the awards including a gold medal and 500 lire each to Bianchi and Dubini, for desiccators of silk-cocoons; to Aurelio Masera, for new processes connected with the textile industry; and to M. Rusconi, for developing the "Mercer" process in the cotton industry. In addition, gold medals and 400 lire are awarded to Carlo Carloni, for his invention of a mastic called magnesite, as a substitute for red lead for junctions of pipes, also for a bicycle brake; to Demetrio Prada and Co., for extracts used in tanning and for the manufacture of oxygenated water; and to J. Löffler, for introducing into Milan the manufacture of artificial flowers in porcelain. A gold medal and 300 lire is awarded to the Italian Colour Manufactory under Max Meyer and Co., and a bonus of 300 lire to E. Tuffanelli, of Milan, for an invention connected with water and gas pipes.

THE present position of chemical industry in Japan is referred to in the *Board of Trade Journal*. Near Osaka, the Yuso Kwaisha alkali works and the Nippon Yuso Kwaisha sulphuric acid plant are both in steady operation. It is stated that the Yuso Kwaisha plant was started in 1893 by English engineers, who fitted it up on the most approved principles, but is now entirely under Japanese management. At the works of the Nippon Yuso Kwaisha sulphuric acid is concentrated in Kioto porcelain vessels in terraced succession. Wakayama and Okayama pyrites, containing from 47 to 50 per cent. of sulphur, are used. The sulphuric acid, packed in earthenware carboys, has been exported in small quantities as far as Bombay. Iodine is also manufactured from seaweed, but in a very small way.

AMONG the new instruments brought out by Messrs. Isenthal, Potzler and Co., for use in connection with radiography and wireless telegraphy, is a mercury jet interrupter, which is one of the most perfect forms of break yet designed, and is more serviceable than Wehnelt's electrolytic interrupter. It consists essentially of a fine jet of mercury forming one contact piece, and a series of teeth cut in a cylindrical surface forming the other contact piece. The cylindrical surface surrounds the jet. Its axis is vertical, and the teeth taper downwards. Hence, when the cylinder is made to revolve, by means of a small motor to which it is connected, contact is made when the jet impinges upon a tooth, and broken when it comes upon an interspace. By raising or lowering the jet the ratio of contact to interruption may be varied from zero to infinity, and thus the mean current strength may be adjusted to any required value without interposing resistances. The number of interruptions may be varied through a wide range, and with twenty-four contacts and the motor geared up to three thousand revolutions, it reaches 72,000 per second, which suffices for practically every purpose.

THE magnetic qualities of building brick, to which so much attention has been directed of late by the work of Folgheraiter and others, have been tested quantitatively by Messrs. G. A. Gage and H. E. Lawrence, who, writing in the *Physical Review*, describe experiments, the original object of which appears to have been connected with the choice of bricks used in building physical laboratories so as to cause the least possible magnetic disturbance to the instruments. From the diagrams and tables it appears that certain bricks, described as "brown" and "pressed red," exhibited the most marked magnetic properties, and some of those described as white were among the least magnetic; and the authors infer that the effects are due to the presence of magnetic iron oxide either a constituent of the clay or formed by heat.

REFERENCE was recently made in NATURE to Signor G. Guglielmo's observations on certain modifications of hydrometers. In a still more recent number of the *Atti dei Lincei* (ix. 2), the same writer describes certain still different forms of total immersion hydrometers, in which the inclination of the instrument to the horizon determines the density of the liquid. The principle is, to all intents and purposes, the same as that of the bent lever balance commonly used for weighing letters. The hydrometer is an unsymmetrical body capable of turning about a horizontal axis at one extremity, and having its centres of gravity and buoyancy *not* in a straight line through this axis. On pouring any fluid into the vessel containing the hydrometer, the latter will rotate into a position in which the moments about the axis of support of the weight of the hydrometer and the upward reaction of the liquid balance each other, and as the position of equilibrium depends on the density of the liquid, the latter is determined by reading off the inclination of the instrument to the horizon. The object of this device is to obviate the disturbances due to capillarity which are inseparable from all forms of total-immersion hydrometers. Finally, by the use of a mirror method for reading the inclination (the effects of refraction being practically avoided by attaching the scale to the face of the containing vessel), great sensitiveness is obtained. It is easy to obtain hydrometers in which two or three degrees variation in temperature changes the deflection by 40°, but these are necessarily available only for a very limited range of density.

THE quarterly formerly entitled *Terrestrial Magnetism*, but which has now adopted the more comprehensive title of *Terrestrial Magnetism and Atmospheric Electricity*, bids fair to become a cosmopolitan medium of publication for papers bearing on this department of geophysics. In the last number (iv. 4) Profs. Elster and Geitel discuss, in a paper in German, the question of the existence of free electrical ions in the atmosphere, and the possibility of explaining the phenomena of atmospheric electricity by the properties of ionised air (see p. 422). This theory, while still open to objection, would appear to overcome some of the difficulties attaching to Exner's and Arrhenius's theories. In the same language, Dr. Lüdeling describes certain researches on the diurnal variation and on magnetic disturbances in polar regions. Dr. Lüdeling investigates graphically the phenomenon of the diurnal variation of the earth's magnetism for eleven stations with the aid of Von Bezold's vector diagrams. It would appear that when the magnetic disturbances are excluded, the direction of the curve is clockwise, but that the direction of the disturbance vector diagram is anti-clockwise; and Schuster's assumption, that the part of the diurnal variation freed from disturbance can be referred to an invariable revolving system, is not far from the truth. An article by the late General de Tillo deals with the relation between the magnetic elements and the distribution of land and sea, and the mean temperature of the earth's surface. The other papers include notes on the magnetic anomaly near Kursk, Russia, by G. W. Littlehales; on new magnetic intensity variometers, by A. Heydweiller; and a biographical sketch of Prof. Wild, illustrated by a portrait and view of the Constantine Observatory at Paulowsk.

A REPORT on the commercial value of the metric system, with special reference to the classification of German iron manufactures, was recently forwarded to the Wolverhampton Chamber of Commerce by the British Consul at Amsterdam, and is referred to in the *Board of Trade Journal*. The Consul states that the iron and steel manufacturers' unions of Germany have adopted a uniform system of dimensions for articles of universal consumption at home and abroad. Angle iron of all descriptions, flanged boiler ends or fronts for Cornish or Lancashire boilers, the boilers themselves, and iron and steel tubes and all fittings connected with them, such as valves, cocks, T pieces, are made, so far as flange, diameter, and working lengths are concerned, in normal standard sizes, in order that every part of one work may be procured at once to fit every corresponding part of another construction. These normal standards are all fixed by the free co-operation of the combined German engineers' associations, and are unanimously adopted by the various manufacturers all over Germany. At present a committee of the engineers' associations is occupied in endeavouring to fix a metric thread for bolts and screws, nuts, bolt-heads, &c., as the present universal normal standard (the Whitworth) is so differently constructed by different works that the parts are not as interchangeable as should be the case. These classifications are naturally making more and more progress in Germany, not in the iron trade alone, but in other manufactures. In view of these facts, the Consul points out that Germany and the Continent generally will have a constantly increasing advantage over British manufactures in the future in foreign countries, unless the metric system be fully and entirely adopted by Great Britain.

THE Danish Meteorological Institute has for the last few years been carrying on the useful work of collecting from all available sources particulars of the state of the polar ice. In the first place, observations were collected around Greenland only, but more recently it has been able to extend its observations so as to comprise the seas from Novaya Zemlya and Spitsbergen to Davis Strait and Baffin Bay. The results for 1899, accompanied by charts, have been published in the "Nautical Meteorological Yearbook" of the Institute for that year, and exhibit the following peculiarities:—(1) In the Kara Sea, the western part of Barents Sea, the South-east and part of North Spitsbergen, and also in Smith Sound and the immediately adjacent waters, there appears to have been more ice present than is usually the case. (2) South of Franz Joseph Land and on the east coast of Greenland, there has been considerably less ice present than usual. This latter condition gives promise of a good spring season off the south-west coast of Greenland. The great scientific and practical value of knowing, as far as possible, the annual distribution, character and quantity of drift ice of polar origin was unanimously recognised by the International Geographical Congress in Berlin last year, and the Danish Institute will gladly receive any observations upon the subject, to assist in compiling similar information for future years.

IN advance of the complete report of the Indian Plague Commission, a chapter has just been published devoted to Mr. Haffkine's method of anti-plague inoculations. Among the results of the Commissioners' critical study of the nature and effect of the anti-plague vaccine are the following:—(1) Inoculation sensibly diminishes the incidence of plague attacks on the inoculated population, but the protection which is afforded against attacks is not absolute. (2) Inoculation diminishes the death-rate among the inoculated population. This is due, not to the fact that the rate of attack is diminished, but also to the fact that the fatality of attacks is diminished. (3) Inoculation does not appear to confer any degree of protection within the first few days after the inoculation has been performed. (4) Inoculation confers a protection which certainly lasts for some considerable number of weeks. It is possible that the protection lasts for a number of months. (5) The varying strength of the vaccine employed has apparently had a great effect upon the results which have been obtained from inoculation. There appears to be a definite quantum of vaccinating material which gives the maximum amount of protection; and provided that this quantum can be injected in one dose, and provided also that the protection turns out to be a lasting one, reinoculation might with advantage be dispensed with. The best results of inoculation will only be obtained after an accurate method of standardisation has been devised. (6) The Commissioners finally recommend that, under the safeguards and conditions of accurate standardisation and complete sterilisation of the vaccine and the thorough sterilisation of the syringe in every case, inoculations should be encouraged wherever possible, and in particular among disinfecting staffs and the attendants of plague hospitals.

WE have received from Mr. H. Geitel an interesting paper read before the Brunswick Society of Science, entitled "Contributions to the Knowledge of Atmospheric Electricity," by Mr. J. Elster and himself. The paper deals principally with a summary of the results of experiments on the ionic conduction of gases, first investigated by W. Giese, in 1882, and subsequently by Prof. A. Schuster, J. J. Thomson, and others, and explains the recent advances made in the problem of atmospheric electricity by treating it from a similar standpoint. The results attained agree well with those arrived at by Mr. C. T. R. Wilson, of the Cavendish Laboratory, at Cambridge, in recent experiments, made at the instance of the Meteorological Council, on the relation between rain and atmospheric electricity (*Phil. Trans.* Ser. A, 193, 1899). He found that positive and negative ions (at least those produced in air by Röntgen rays) differed in their efficiency as condensation nuclei, that the negative ions are more efficient as nuclei for the condensation of water vapour, and that a preponderance of negative electricity will consequently be carried down by precipitation to the earth's surface. Elster and Geitel found that normal atmospheric air contains positive and negative ions in nearly equal quantity, and that when the air is pure the ions meet with little obstruction to their movement, the negative (as shown by Zeleny) moving faster, but that if the air is misty their mass is greatly increased, and their mobility almost entirely prevented.

A MEMOIR on the geology of Newport, Monmouthshire, by Mr. Aubrey Strahan, has just been issued by the Geological Survey. It is notified as the first part of a general memoir on the geology of the South Wales coal-field. The original geological survey of that large area was commenced more than sixty years ago by De la Beche, and it is but natural that the old one-inch maps have long been out-of-date. The re-survey was commenced by Mr. Strahan in 1891, and now, with the aid of several colleagues, a large part of the coal-field has been mapped in detail on the six-inch scale. These larger maps are deposited for reference in the Geological Survey Office in Jermyn Street, while the one-inch maps, which are published, afford a good general idea of the structure of the country. Of these sheet No. 249 is now described. The main advances made are in the sub-division of the Old Red Sandstone and of the Coal-measures, and in the tracing out of the faults and disturbances which have affected the position of the productive coal-strata. The memoir contains the results of a systematic survey, whereby the variations in the character and thickness of the strata have been followed, and the numerous coal-seams have been tabulated and correlated. The practical importance of the work in the colliery districts will be appreciated by those interested in the further development of the great coal-field. On scientific grounds geologists will find matter of interest relating to the Silurian rocks and fossils of the Usk district, as well as in regard to the Old Red Sandstone, Carboniferous Rocks, Keuper Marls, Rhætic Beds and Lower Lias. It is noteworthy that there appears to be a sharp plane of demarcation between the Silurian and Old Red Sandstone; and that no break has locally been found in the series of strata which constitute the Old Red Sandstone. The mapping of the Drift deposits has thrown much new light on the extent of the glaciation of South Wales.

PROF. TACCHINI, in a recent contribution to the *R. Accademia dei Lincei*, describes the Roman earthquake of July 19, 1899. The earthquake belongs to the series which have their origins beneath the Alban Hills, the epicentre being situated near Frascati. At this place, and in some of the neighbouring villages, buildings were damaged. The shock was felt to a distance of 130 km. from the epicentre, and was recorded by the seismometrograph at Catania (520 km.), having travelled there with a velocity of about 4 km. per second. Diagrams of great interest were obtained by means of the seismographs erected in the cellar of the Collegio Romano at Rome.

MUCH interest attaches to a short note, accompanied by a plate, by Mr. D. le Souëf, in the February number of the *Zoologist*, on the mode in which the newly-born Kangaroo is transferred to the maternal pouch and affixed to the nipple. "When the young one is ready to be born," writes the author, "the mother sits down on the ground, resting on the upper portion of the base of her tail, and with that appendage resting level on the ground in front of her; she then holds her pouch open with her two fore-paws, and, as the helpless mite is born, it rests on the soft fur of the under side of the tail. The mother immediately transfers it to her pouch with her lips only, and evidently with great care attaches it to the nipple. The mouth of the young one is apparently only a round hole, and it as yet has no power of suction; but the nipple is of a peculiar shape, with the point hard, and the mother is thereby enabled to insert it into the mouth of the young one. She then holds it in position while she pours the milk into the nipple, which thereby swells out and holds the young one on; but if, after being once firmly attached, it is pulled off, it cannot be replaced, even by the mother, for the end of the nipple now being flaccid instead of hard cannot well be inserted into the mouth of the little one."

WE have received from Messrs. G. H. Carpenter and W. Evans a reprint of their memoir published in the *Proceedings* of the Royal Physical Society of Edinburgh, on the spring-tails (Collembola) and bristle-tails (Thysanura) of the Edinburgh district; a group of insects the study of which has hitherto received somewhat scant attention.

A PAPER by Prof. H. A. Kelly in the December number of the *Bulletin* of the Johns Hopkins Hospital, entitled "The Recognition of the Poisonous Serpents of North America," merits notice, if only for the sake of the beautiful photographs of snakes' heads with which it is illustrated. In addition to these life-like portraits, the author gives brief descriptions of some of the leading features of the various species.

To the January number of the *American Naturalist* Prof. H. F. Osborn contributes an instructive paper on the intercentra and hypapophyses in the cervical region of the backbone of various groups of reptiles. In the same issue Mr. Alës Hrdlicka publishes a plan for the best arrangement of large series of human bones intended for comparative study; this may be commended to the careful attention of museum curators.

LAST year, in an aviary in one of the wards at Caterham Asylum, a wild rabbit turned a dove off its nest and sat on two doves' eggs till they were hatched. A correspondent of *The Christian Globe* (March 1) states that this year the nurses are trying another hatching operation. They have placed two bantam's eggs in the same nest. The same rabbit has taken to these eggs, and only leaves the eggs to take its food, returning at once to the nest. The nest is six feet from the ground; the rabbit, in the presence of the correspondent, was taken out of the nest and placed on the floor by the nurse, but it very quickly climbed up again to the nest.

THE *Transactions* of the English Arboricultural Society, vol. iv. part 2, contains several valuable papers on the pruning and culture of trees, as also some interesting photographs.

WE have received a copy of the second edition of "Die Moor- und Alpenpflanzen (vorzugsweise Eiszeitflora) des Alpengartens Zöschen bei Merseburg, und ihre Cultur," compiled by Dr. G. Dieck. The list occupies over 70 pages, and gives a large amount of information respecting the habit and mode of culture of a very great number of Alpine plants. They are offered for sale either singly or in assortments.

MESSRS. JAMES BACKHOUSE AND SON, LTD., of York, have inaugurated a new department in their Nurseries, which may be of great service to botanical lecturers and demonstrators, in providing a supply of material especially for microscopic work. They have issued an extensive priced cata ogue, comprising objects in the Myxomycetes, Algæ (including diatoms), Characeæ, Fungi, Hepaticæ, Musci, Pteridophyta (prothallia and vegetative organs), Gymnosperms, and all the more important orders of Angiosperms. The department is under the management of an experienced practical botanist, Dr. Arthur H. Burtt, and seems likely to supply a long-felt want.

DR. PAUL TOPINARD's volume on "Science and Faith" was recently noticed in these columns (p. 270). We have now received the French edition of the work, having for its title "L'Anthropologie et La Science Sociale," and published by MM. Masson and Co. Several sections are considerably larger in the French than in the English edition, and the section on social science is entirely different. The French title better expresses the scope of the work than the English one.

PROF. W. JOHANNSEN, of Copenhagen, has issued, in German, (Fischer, Jena) a pamphlet on the etherisation of plants, for the information of practical nurserymen. He has devised an apparatus for the exposure of growing plants to the action of the vapour of ether, and states that, while killing the leaves already on the plant, it promotes the rapid and luxuriant development of the buds after removal from the ether-box. The experiments were made chiefly on the lilac.

THE following lectures will be given at the Royal Victoria Hall, Waterloo Road, S.E., on Tuesday evenings during March:—March 6, Mr. A. Stanfield, "Money"; March 13, Mr. S. A. F. White, "The Polarisation of Light"; March 20, Prof. Frank Clowes, "Nature's Scavengers"; March 27, Mr. Bennett H. Brough, "The World's Copper Mines."

THE fourth part of the sixth edition of Sir Michael Foster's standard "Text-Book of Physiology" will be published immediately by Messrs. Macmillan and Co., Ltd. In previous editions this part has included Book III., on the senses and some special muscular mechanisms, and Book IV., on the tissues and mechanisms of reproduction. In the volume about to be issued, only the senses are deal with; and in the revision of this part Sir Michael Foster has had the valuable assistance of Dr. W. H. R. Rivers, whose name appears upon the title-page. Part v. of this work will consist of the subjects of Book IV. formerly included in Part iv.

THE additions to the Zoological Society's Gardens during the past week include a Pinche Monkey (*Midas oedipus*) from Colombia, presented by Mrs. H. V. Holden; a Marica Gazelle (*Gazella marica*, ♀) from the Persian Gulf, presented by Mr. B. T. Ffinch; a Red-crested Cardinal (*Paroaria cucullata*) from South America, presented by Miss Power; a Jackal Buzzard (*Buteo jacal*) from Africa, presented by Mr. Douglas Mann; a Nilotic Crocodile (*Crocodilus niloticus*) from Africa, presented by Mr. Rupert D'Oyly Carte; an Indian Darter (*Plotus melanogaster*), an Indian Hornbill (*Anthracoceros malabaricus*) from India, two Common Wolves (*Canis lupus*, ♂ ♀, white var.), a Four-lined Snake (*Coluber quatuorlineatus*), European; a Serrated Terrapin (*Chrysemys scripta*), two Speckled Terrapins (*Clemmys guttata*), fifteen Mississippi Terrapins (*Malacoclemmys geographica*) from North America, four Black-headed Terrapins (*Damonia reevesi unicolor*) from China, deposited; an Undulated Grass Parrakeet (*Melopsittacus undulatus*) from Australia, received in exchange.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN MARCH.

March 2.	6h.	Mercury in conjunction with moon. Mercury 4° 37′ S.
7.	23h.	Mercury at greatest elongation east (18° 16′).
8.	6h. 13m. to 7h. 3m.	Neptune occulted by the moon.
8.	9h. 31m.	Minimum of Algol (β Persei).
10.	13h. 43m. to 14h. 40m.	Occultation of f Geminorum (mag. 5·2) by the moon.
10.	14h. 18m. to 15h. 57m.	Transit of Jupiter's Sat. III.
11.	14h. 13m. to 15h. 6m.	Occultation of 29 Cancri (mag. 5·9) by the moon.
15.	Venus.	Illuminated portion of disc, 0·708. Mars, 0·993.
15.	15h. 20m. to 16h. 25m.	Occultation of e Leonis (mag. 5·1) by the moon.
17.	18h. 7m.	Transit (egress) of Jupiter's Sat. III.
21.	17h. 19m. to 17h. 33m.	Occultation of ρ Ophiuchi (mag. 5·3) by the moon.
23.	20h.	Saturn in conjunction with the moon.
23.	20h. 35m. to 21h. 46m.	Occultation of Saturn by the moon.
28.	11h. 12m.	Minimum of Algol (β Persei).
31.	8h. 1m.	Minimum of Algol (β Persei).

COMET GIACOBINI (1900*a*).—The *Astronomische Nachrichten* (Bd. 151, No. 3624) contains an ephemeris and the elements of this comet computed from the observations made on January 31, February 3 and 6, at the Nice Observatory, by M. Giacobini.

Elements.

T = 1900 April 28·2085 Paris Mean Time.

$$\left.\begin{array}{rl} \omega = & 23^\circ\ 8'\ 42'' \\ \Omega = & 40\ \ 7\ 29 \\ i = & 146\ 37\ 21 \end{array}\right\} 1900{\cdot}0$$

$\log q = 0{\cdot}12902$

Ephemeris for 12h. Paris Mean Time.

1900.	R.A. h. m. s.	Decl. ° ′	log Δ
Feb. 28	2 7 50	+2 19·1	0·304
Mar. 2	5 49	2 55·4	0·310
4	3 54	3 30·9	0·316
6	2 6	4 5·6	0·321
8	2 0 24	+4 39·8	0·327

METEOR PHOTOGRAPHY.—In the *Astronomische Nachrichten* (Bd. 151, No. 3623) Dr. Karl Kostersitz describes the photographic equipment which he employed at the Vienna Observatory for the detection of the Leonid and Bielid meteors in November 1899. A plate accompanies the article, showing the method of mounting the cameras, four of which were used without driving apparatus. The cameras were all fitted with rapid portrait lenses, and great care was taken to accurately orient the plates for subsequent reduction.

MOTIVE POWER. STEAM TURBINES. HIGH SPEED NAVIGATION.[1]

TWENTY centuries ago the political power of Greece was broken, although Grecian civilisation had risen to its zenith. Rome was growing continually stronger, and was rapidly gaining territory by absorbing weaker States. Egypt, older in civilisation than either Greece or Rome, fell, but two centuries later, before the assault of the younger States, and became a Roman province. Her principal city at this time was Alexandria, a great and prosperous city, the centre of the commerce of the world, the home of students and of learned men, its population the wealthiest and most civilised of the then known world.

It is among the relics of that ancient Egyptian civilisation that we find the first records of the early history of the steam-engine. In Alexandria, the home of Euclid, and possibly contemporary with Archimedes, Hero wrote his "Spiritalia seu Pneumatica." It is doubtful if Hero was the inventor of the contrivances and apparatus described in his work; it is more probable that they were devices generally known at the time. Nothing in the text, however, indicates to whom the several machines are to be ascribed. Two of these machines are of special interest. The first utilised the expansive force of air in a closed vessel heated externally, the pneumatic force being applied to the surface of water in other vessels, and the hydraulic force utilised for opening the doors of a Grecian temple, and working other pseudo-magic contrivances.

Then after describing several forms of cylindrical boilers, and the use of the steam jet for accelerating combustion, he comes to the first of a type of steam engine, the steam turbine, which is the subject of our discourse this evening.

This is a veritable steam engine. The cauldron contains water, and is covered by a steam-tight cover, a globe is supported above the cauldron by a pair of tubes, one terminating in a pivot, and the other opening directly through the trunnion joint into the sphere; short bent pipes are attached to diametrically opposite points on the equator. The steam generated in the cauldron passes up into the sphere and issues tangentically from the bent pipes, and by the reaction causes the sphere to rotate.

It seems uncertain whether this machine was ever more than a toy, or whether it was used by the Greek priests for producing motion of apparatus in their temples; but from our experience within the last twenty years it appears that, with some improvements in design and construction, it could have been applied to perform useful work at the date of Hero, and further that, when so improved, it might have claimed a place among economical steam engines, even up to the middle of the present century.

A few years ago I had an engine constructed to test the capabilities of this class of reaction steam turbine, the only difference between this engine and Hero's being that the sphere was abolished, as a useless incumbrance, the arms were made of thin steel tube of oval form, so as to offer the least resistance to their motion, and the whole was enclosed in a cast iron case which was connected to a condenser. When supplied with steam at a pressure of 100 lbs. per square inch, and a vacuum in the case of 27″ of mercury, a speed of 5000 revolutions per minute was attained, and an effective power was realised of 20 horse, and the consumption of steam was only 40 lbs. per brake horse-power. By this very creditable performance, I was encouraged to further test the system, and constructed a compound reaction engine, in which the steam was caused to pass successfully through three pairs of arms on one hollow shaft, each pair being contained in a separate compartment through which the shaft passed, suitable metallic packing preventing the passage of steam from one compartment to the next. The performance of this engine was, however, not superior to that of the single two-arm Hero's engine, for the simple reason that the excessive resistance to motion of the arms in the denser steam of the compartments more than neutralised the gain from the compound form. The performance of this engine was, however, sufficiently good to have it placed on a par with many ordinary steam engines in the middle of the present century.

The great barrier to the introduction of Hero's engine was undoubtedly the excessive speed of revolution necessary to obtain economical results, and with the crude state of mechanical engineering at that time, it would have been a matter of some difficulty to construct the turbine engine with sufficient accuracy of workmanship for satisfactory results, to say nothing of the necessary gearing for applying the power to ordinary useful purposes.

The next steam engine mentioned in history, which is capable of practical and useful development, is Bianca's in 1629. It is of the simplest form, a jet of steam from a steam boiler impinges on a paddle-wheel and blows it round. This form of engine has since 1889 been developed by Dr. De Laval, of Stockholm, with great ingenuity, and is extensively used for moderate powers on the Continent. The speed is, however, necessarily very high in order to obtain economy in steam, and spiral reduction gearing is used in order that the speed of revolution may be reduced for the application of the power. The improvements that have been made in Bianca's steam turbine by De Laval are firstly, the ordinary steam jet is replaced by a diverging conical jet, which permits of the expansion of the steam before it emerges from the jet, and so transforming the

[1] A Discourse delivered at the Royal Institution on January 26, by the Hon. C. A. Parsons, F.R.S.

potential energy of the high pressure steam into kinetic energy of velocity in the direction of flow.

Secondly, the crude paddle-wheel of Bianca is replaced by a wheel of the strongest steel, fringed round the periphery with little cupped blades of steel, somewhat analogous to the buckets of a Pelton water-wheel.

Lastly, the steel wheel is mounted on a long and somewhat elastic shaft, to allow of its easy and free motion, and on one extremity of this shaft is mounted the pinion of the spiral reduction gear.

The speeds of revolution of the steam wheels of De Laval's turbine are from 10,000 to 30,000 revolutions per minute, according to the size, involving peripheral speeds up to 1200 feet per second, or about one-half the speed of the projectile from a modern cannon. Such speeds are necessary to obtain power economically from the high-pressure steam jet, issuing at from 3000 to 5000 feet per second, as calculated by Rankine.

It is somewhat remarkable that not till a century after Bianca, the piston or ordinary reciprocating engine made its first appearance, in about the year 1705, and has since become one of the chief factors in the great mechanical and engineering growths of the last century. During this period the steam turbine seems to have been, practically speaking, neglected, which is somewhat remarkable in view of the numerous attempts of inventors to construct a rotary engine, attempts which had no practical results.

In the year 1884, the advent of the dynamo-electric machine, and development of mechanical and electrical engineering, created an increased demand for a good high-speed engine. Engineers were becoming more accustomed to high speeds of revolution, for the speed of dynamos was at this time from 1000 to 2000 revolutions per minute, of centrifugal pumps from 300 to 1500, and wood-working machinery from 3000 to 5000; and Sir Charles Wheatstone had made a tiny mirror revolve at a speed of 50,000 revolutions per minute for apparatus for measuring the velocity of light. The problem then presented itself of constructing a steam turbine, or ideal rotary engine, capable of working with good economy of steam at a moderate speed of revolution, and suitable for driving dynamos without the intervention of reduction gearing. To facilitate the problem, the dynamo was also considered with the view of raising its speed of revolution to the level of the lowest permissible speed of the turbine engine. In other words, to secure a successful combination, the turbine had to be made to run as slowly as possible, and the dynamo speed had to be raised as much as possible, and up to the same speed as the turbine, to permit of direct coupling.

In 1884 preliminary experiments were commenced at Gateshead-on-Tyne, with the view of ascertaining by actual trial, the conditions of working equilibrium and steady motion of shafts and bearings at the very high speeds of rotation that appeared to be essential to the construction of an economical steam turbine of moderate size. Trial shafts were run in bearings of different descriptions up to speeds of 40,000 revolutions per minute; these shafts were about $1\frac{1}{2}$ inches in diameter and 2 feet long, the bearings being about $\frac{5}{8}$ inch in diameter. No difficulty was experienced in attaining this immense speed, provided that the bearings were designed to have a certain small amount of "give" or elasticity; and after the trial of many devices to secure these conditions, it was found that elasticity, combined with frictional resistance to transverse motion of the bearing bush, gave the best results, and tended to damp out vibrations in the revolving spindle. This result was achieved by a simple arrangement; the bearing in which the shaft revolved was a plain gun-metal bush with a collar at one end and a nut at the other; on this bush were threaded thin washers, each being alternately larger and smaller than its neighbour, the small series fitting the bush and the larger series fitting the hole in the bearing block, these washers occupying the greater part of the length of the bush. Lastly, a wide washer fitted both the bush and block, forming a fulcrum on which the bush rested; while a spiral spring between the washers and the nut on the bush pressed all the washers tightly against their neighbours. It will be seen now that, should the rotating shaft be slightly out of truth (which it is impossible to avoid in practice), the effect is to cause a slight lateral displacement of the bearing bush, which is resisted by the mutual sliding friction of each washer against its neighbour. The shaft itself being slightly elastic, tends to centre itself upon the fulcrum washer before mentioned, under the gyrostatic forces brought into play by the rapid revolutions of the shaft and influenced by the frictional resistance of the washers, and so the shaft tends to assume a steady state of revolution about its principal axis, or the axis of the mass, without wobbling or vibration. This form of bearing was exclusively used for some years in turbine engines aggregating some thousands of horse power, but it has since been replaced by a simpler form fulfilling the same functions. In this later form the gun-metal bush is surrounded by several concentric tubes fitting easily within each other with a very slight lateral play; in the interstices between the tubes the oil enters, and its great viscosity when spread into thin films has the result of producing great frictional resistance to a rapid lateral displacement of the bearing bush; the oil film has also a centring action, and tends under vibration to assume a uniformity of thickness around the axis, thus centring the shaft, and like a cushion damping out vibrations arising from errors of balance. This form of bearing has been found to be very durable and quite satisfactory under all conditions.

Having tested the bearings up to speeds above those contemplated in the steam turbine, the next problem was the turbine itself. The laws regulating the flow of steam being well known (which was not the case in Hero's time), various forms of steam turbine were considered, and it appeared desirable to adopt in principle some type that had been both successful in the water turbine, and also easily adapted to a multiple or compound formation, a construction in which the steam should pass successively through a series of turbines one after the other.

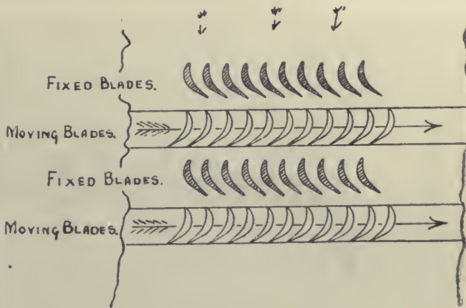


Fig. 1.—Fixed and moving blades of turbine.

The three best known of water turbines are the outward flow, the inward flow, and the parallel flow, and of these the latter appeared to be the best adapted for the multiple of compound steam turbine, for reasons which will afterwards appear.

The object in view being to obtain a good coefficient of efficiency from the steam with a moderate speed of revolution and diameter of turbine wheel, it becomes essential that the steam shall be caused to pass through a large number of successive turbines, with a small difference of pressure urging it through each individual turbine of the set, so that the velocity of flow of the steam may have the proper relation to the peripheral velocity of the turbine blades to secure the highest degree of efficiency from the steam, conditions analogous to those necessary for high efficiency in water turbines. A large diameter of turbine wheel, it is true, would secure a moderate speed of revolution, but this may be dismissed at once for the simple reason that the frictional resistance of such a disc revolving at the immense peripheral velocity, in the exhaust steam, would make it a most inefficient engine.

In the year 1884, a compound steam turbine engine of 10 horsepower and a modified high speed dynamo were designed and built for a working speed of 18,000 revolutions per minute. This machine proved to be practically successful, and subsequently ran for some years doing useful work, and is now in the South Kensington Museum.

This turbine engine consisted of two groups of fifteen successive turbine wheels, or rows of blades, on one drum or shaft within a concentric case on the right and left of the steam inlet, the moving blades or vanes being in circumferential rows projecting outwardly from the shaft, and nearly touching the case, and the fixed or guide blades being similarly formed and projecting inwardly from the case and nearly touching the shaft. A series of turbine wheels on one shaft were thus constituted, each one complete in itself, like a parallel flow water turbine, but unlike a water turbine, the steam after performing its work in each turbine passed on to the next, preserving its longitudinal velocity without shock, gradually falling in pressure on passing through each row of blades and gradually expanding. Each successive row of blades was slightly larger in passage-way than the preceding, to allow for the increasing bulk of the elastic steam, and thus its velocity of flow was regulated so as to operate with the greatest degree of efficiency on each turbine of the series (Fig. 1).

All end pressure from the steam was balanced by the two equal series on each side of the inlet, and the revolving shaft lay on its bearings revolving freely without any impressed force except a steady torque urging rotation, the aggregate of the multitude of minute forces of the steam on each blade. It constituted an ideal rotary engine; but it had faults. The comparatively high speed of rotation that was necessary for so small a size of engine as this first example, made it difficult to prevent, even with the special bearings described, a certain spring or whipping of the massive steel shaft, so that considerable clearances were found necessary, and leakage and loss of efficiency resulted. It was, however, perceived that all these defects would decrease as the size of the engine increased, with a corresponding reduction of rotational velocity, and consequently efforts were made towards the construction of engines of larger size, which resulted, in 1888, in several turbo-alternators of 120 horse-power being supplied for the generation of current in electric lighting stations, and at this period the total horse-power of turbines at work reached in the aggregate about 4000, all of which were of the parallel flow type and non-condensing.

In 1889, in consequence of partnership difficulties and the temporary loss of patents, the radial flow type of turbines was reluctantly adopted. This type of turbine consists of a series of fixed discs with interlocking flanges at the periphery, forming, when placed together, a cylindrical case with inwardly projecting annular discs. On the shaft are keyed a similar set of discs, the faces of the fixed and moving discs lie a short distance apart. From the faces of the fixed discs project the rows of guide-blades which nearly touch the moving disc, and from the moving disc project the rows of moving blades which nearly touch the fixed disc.

The steam is admitted into the case between the balance piston on the left and the first fixed disc, and passes outwards through the rows of fixed and moving blades between the first fixed and moving discs; then inwards towards the shaft at the back of the first moving disc, then again outwards between the second fixed and moving discs, and so on to the exhaust; the action being the same as in the parallel flow type.

In 1892, this type was the first to be adapted to work in conjunction with a condenser. The first condensing turbine of the radial flow type was of 200 horse-power, and at a speed of 4800 revolutions per minute, drove an alternator of 150 kilowatts output. It was tested by Prof. Ewing, and the general result of the trials was to demonstrate that the condensing steam turbine was an exceptionally economical heat engine. With a steam pressure of 100 lbs., the steam being moderately superheated, and a vacuum of 28 inches of mercury, the consumption was 27 lbs. per kilowatt hour, which is equivalent to about 16 lbs. of steam per indicated horse-power. This result marked an era in the development of the steam turbine, and opened for it a wide field, including some of the chief applications of motive power from steam. At this period turbine alternators of the condensing type were placed in the Newcastle, Cambridge and Scarborough Electric Supply Company's Stations, and soon afterwards several of 600 horse-power of the non-condensing parallel flow type were set to work in the Metropolitan Companies' Stations, where the comparative absence of vibration was an important factor. Turbine alternators and turbine dynamos of 2500 horse-power are now in course of construction in England and the United States, and larger sizes are in prospect.

A turbo-alternator manufactured at Heaton Works, Newcastle-on-Tyne, for the Corporation of Elberfeld in Germany, was tested a few days ago by a committee of experts from Germany, Prof. Ewing being also present, with the following remarkable results. At the full load of 1200 kilowatts, and with a steam pressure of 130 lbs. at the engine, and 10° C. of superheat, the engine driving its own air pumps, the consumption of steam was found to be at the rate of 18·8 lbs. per kilowatt hour. To compare this figure with those obtained with ordinary piston engines of the highest recorded efficiencies, and assuming the highest record with which I am acquainted of the ratio of electrical output to the power indicated in the steam engine, namely 85 per cent., the figure of 18·8 lbs. per kilowatt in the turbine plant is equivalent to a consumption of 11·9 lbs. per indicated horse-power, a result surpassing the records of the best steam engines in the production of electricity from steam.

FIG. 2.—The *Viper*.

Turbine engines are also used for generating electrical current for the transmission of power, the working of electrical tramways, electrical pumping and coaling, and similar purposes. They are also used for coupling directly to and driving fans for producing forced and induced draught for general ventilating purposes, also for driving centrifugal pumps for lifts up to 200 feet, and screw pumps for low lifts.

The most important field, however, for the steam turbine is undoubtedly in the propulsion of ships. The large and increasing amount of horse-power and the greater size and speed of the modern engines tend towards some form which shall be light, capable of perfect balancing and economical in steam. The marine engine of the piston type does not entirely fulfil all these requirements, but the compound turbine engine, as made in 1892, appeared to be capable of doing so, and of becoming an ideal marine engine. On the other hand, an element of uncertainty lay in the high speed of the turbine engine, and to couple it directly to a propeller of ordinary proportions would have led to failure.

In January 1894, a pioneer syndicate was formed to explore the problem, those chiefly associated in the undertaking being the Earl of Rosse, Christopher Leyland, John Simpson, Campbell Swinton, Norman Cookson, the late George Clayton, H. C. Harvey, and Gerald Stoney. It was deemed expedient, for reasons of economy and also of time (as many alterations were anticipated), to build as small a vessel as possible, but not so small as to preclude the attainment of an unprecedented high speed in the event of success. The *Turbinia* was constructed, her dimensions being 100 feet in length, 9 feet beam, 3 feet draught of hull, and 44 tons displacement. She was fitted with a turbine engine of 2000 actual horse-power, with an expansive ratio of a hundred-and-fifty-fold, also with a water-tube boiler of great power, of the express type, with small tubes. The turbine engine was designed to drive one screw shaft at a speed of from 2000 to 3000 revolutions per minute.

Many trials were made with screw propellers of various sizes and proportions, but the best speeds were quite disappointing, and it was clear that some radical defect lay in the propellers. This was corroborated by dynamometric measurements. The excessive slip of the propellers beyond the calculated amount, and their inefficiency, indicated a want of sufficient blade area upon which the thrust necessary to drive the ship was distributed, in other words, the water was torn into cavities behind the blades. These cavities contained no air, but only vapour of water, and the greater portion of the power of the engine was consumed in the formation and maintenance of these cavities instead of the propulsion of the vessel. This phenomenon was first noticed in the trials of the torpedo boat *Daring*, by Messrs. Thornycroft and Mr. Barnaby, shortly before the commencement of the trials of the *Turbinia*, and was named "cavitation" by R. E. Froude.

To return to the *Turbinia*, a radical alteration was deemed necessary. A new turbine engine was made, consisting of three separate engines, high pressure, intermediate pressure, and low pressure, each of which drove one screw shaft, the power of the engine was distributed over three shafts instead of being concentrated on one, and three propellers were placed on each shaft. The result of these changes was marvellous. The vessel now nearly doubled her speed, 30 knots was soon reached, and finally $32\frac{3}{4}$ knots mean speed on the measured mile authenticated, or the fastest speed then attained by any vessel afloat. The economy of her engines was investigated by Prof. Ewing, assisted by Prof. Dunkerly, the consumption of steam per indicated horse-power for all purposes at 31 knots speed was found to be $14\frac{1}{2}$ lbs., or in other words, with a good marine boiler the coal consumption would be considerably under 2 lbs. per indicated horse-power, a result better than is obtained in torpedo boats or torpedo-boat destroyers with ordinary triple expansion engines.

The vessel's reversing turbine gave her an astern speed of $6\frac{1}{2}$ knots, and she could be brought to rest in 36 seconds when running at 30 knots speed, and from rest she could be brought up to 30 knots in 40 seconds.

The *Turbinia* cruised from the Tyne to the Naval Review at Spithead, where she steamed on the day of the Review at an estimated speed of $34\frac{1}{2}$ knots. These results represent about 2300 indicated horse-power, and may be said to have been obtained without a very abnormal performance as regards the boiler; its total heating surface being 1100 square feet, and an evaporation of about 28 lbs. per square foot at the speed of $34\frac{1}{2}$ knots.

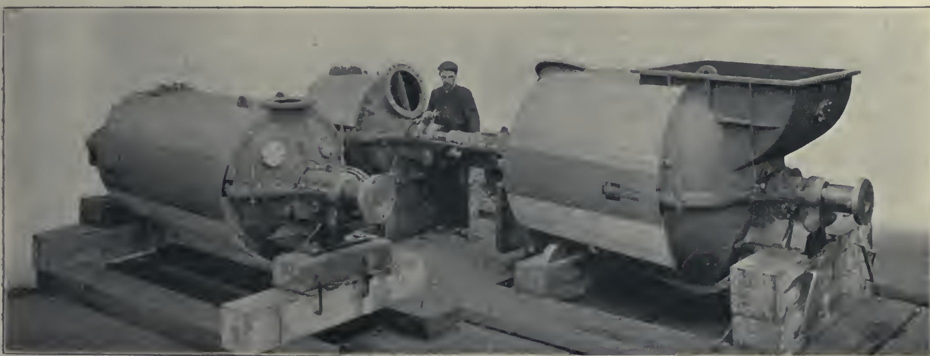


FIG. 3.—Turbine engines of the *Viper*

This phenomenon has been investigated experimentally with propellers of small size working inside an oval tank, so as to represent approximately the conditions of slip ratio customary in fast ships. To enable the propeller to cause cavitation more easily the tank is closed, and the atmospheric pressure removed from the surface of the water above the propeller by an air-pump, glass windows are fitted for observation and illumination. Under these conditions the only forces tending to hold the water together and resist cavitation are the small head of water above the propeller, and capillarity. The propeller is 2 inches diameter and 3 inches pitch; cavitation commences at about 1200 revolutions and becomes very pronounced at 1500 revolutions. Had the atmospheric pressure not been removed, speeds of 12,000 and 15,000 revolutions per minute would have been necessary, rendering observations more difficult.

The arrangement we have now was kindly suggested by Mr. Heath, and is a decided improvement, the revolving disc with narrow slots synchronising approximately with the revolutions of the propeller. The propeller is now seen to rotate very slowly, it also permits of the projection of the phenomenon on the screen, which was not possible with my previous arrangement. The permanence of the vortices behind the blades is very striking. The inference to be drawn from these experiments seems to be that for fast speeds of vessels, wide thin blades, a coarse pitch ratio, and moderate slip, are desirable for the prevention of cavitation, and in order to obtain the best efficiency in propulsion of the vessel.

These speeds were not obtained by bottling up the steam and opening the regulating valve on coming to the measured mile, but were maintained for many miles together with constant steam pressure, and as long as the fires were clean. On the other hand, the endurance of the engines themselves seems to be unlimited, all heavy pressures, including the thrust of the propellers, that would in ordinary engines came on the bearings, being counterbalanced by the steam pressure acting on the turbines.

It seems clear that the results obtained in the case of the *Turbinia* were almost entirely due to the economy in steam of the turbine engines, and the unusually small weight of the engines, shafting and propellers, in proportion to the power developed.

It may also be said that generally speaking every part of the machinery was as substantial as in naval vessels of the torpedo-boat class, yet she developed 100 horse-power per ton of machinery, and 50 horse-power per ton of total weight of vessel in working order.

The results of the *Turbinia* having been found satisfactory, the original company which built her was merged into a large company under the same directorate for carrying on the work on a commercial scale. At Wallsend-on-Tyne, the Parsons Marine Steam Turbine Company erected works, and in 1898 contracted with the Admiralty for a 31-knot torpedo-boat destroyer, the *Viper* (Fig. 2), which is of the same dimensions as the usual 30-knot vessels of this class, viz. 210 feet length, 21 feet beam, and about 350 tons displacement, but with machinery of much greater power than usual in vessels of this size; they also contracted with Sir W. G. Armstrong, Whitworth and Co. for machinery for one of their torpedo-boat destroyers.

The turbine engines of these vessels are similar to those of the *Turbina*, but are in duplicate, and consist of two distinct sets of engines on each side of the vessel. There are four screw shafts in all, entirely independent of each other, the two on each side being driven by one high and one low-pressure turbine respectively of about equal power; the two low-pressure turbines drive the two inner shafts, and to each a small reversing turbine is also permanently coupled, and revolves idly with them when going ahead. The screw shafts are carried by brackets as usual, and two propellers are placed on each shaft, the foremost in each case having a slightly lesser pitch than the after one. The thrust from the screw shafts is entirely balanced by the steam acting on the turbines, so that there is extremely little friction.

The boilers, auxiliary machinery and condensers are of the usual type in such vessels, but their size is somewhat increased to meet the much larger horse-power to be developed, and to compensate for the lesser weight of the main engines, shafting, propellers, as well as the lighter structure of the engine beds. The boilers are of the Yarrow type, with a total heating surface of 15,000 square feet, and grate surface of 272 square feet, and the condensers have a cooling surface of 8000 square feet. The hull and all fittings are of the usual design.

Let us consider the machinery on one side of the vessel only: the steam from the boilers is admitted directly through a regulating valve to the high-pressure turbine driving one shaft, it then passes to the adjacent low-pressure turbine, driving its shaft independently, thence it flows to the condenser, and both the shafts then drive the vessel ahead; the reversing turbine revolves with the low-pressure shaft, and being permanently connected with the vacuum of the condenser no appreciable resistance is offered to its motion under these conditions. To go astern the ahead steam valve is closed and the astern steam valve opened, admitting the steam from the boilers to the reversing turbine, and reversing the direction of rotation of the inner screw shaft.

On the other side of the vessel the arrangement is the same, and it will be seen that she can be manœuvred as an ordinary twin-screw vessel, and with great facility and quickness.

On her second preliminary trial about three weeks ago, the mean speed of four consecutive runs on the measured mile reached 34·8 knots, and the fastest run was at the speed of 35·503 knots, which is believed to be considerably beyond the recorded speed of any vessel hitherto built. The vessel was scarcely completed at the time of this trial, and it is anticipated that still higher speeds will be realised on subsequent and official trials. The speed of 35·5 knots, or nearly 41 statute miles, represents about 11,000 indicated horse-power in a vessel of 350 tons displacement, as compared with 6000 to 6500 developed in the 30-knot destroyers of similar dimensions and 310 tons displacement.

At all speeds there was very little vibration. Her speed astern is guaranteed to be 15½ knots.

The *Viper* has surpassed the *Turbinia* in speed, and is at the present time the fastest vessel afloat.

In regard to the general application of turbine machinery to large ships, the conditions appear to be more favourable in the faster class of vessels, such as cross-Channel boats, fast passenger vessels, liners, cruisers and battleships; in all such vessels the reduction in weight of machinery, and economy in the consumption of coal per horse-power, are important factors; in some the absence of vibration is a question of first importance, as affecting the comfort of passengers, and, in the case of ships of war, permitting of greater accuracy in sighting of the guns.

The model exhibited represents a proposed cross-Channel boat for the Dover and Calais or Newhaven and Dieppe routes. She is 270 feet length, 33 feet beam, 1000 tons displacement, and 8 feet 6 inches draught of water. She has spacious accommodation for 600 passengers, and with machinery developing 18,000 horse-power would have a sea speed of about 30 knots as compared with the speed of 19 to 22 knots of the present vessels of similar size and accommodation.

It is perhaps interesting to examine the possibilities of speed that might be attained in a special unarmoured cruiser, a magnified torpedo-boat destroyer of light build, with scanty accommodation for her large crew, but equipped with an armament of light guns and torpedoes. Let us assume that her dimensions are about double those of the 30-knot destroyers, or of the *Viper*, with plates of double the thickness, and specially strengthened to correspond with the increased size and speed, length 420 feet, beam 42 feet, maximum draught 14 feet, displacement 2800 tons, indicated horse-power 80,000, there would be two tiers of water-tube express boilers, these, the engines and coal bunkers, would occupy the whole of the lower portion of the vessel, the crew's quarters and armaments would be on the upper decks. There would be eight propellers of 9 feet in diameter, revolving at about 400 revolutions per minute, and her speed would be 44 knots. She could carry coal at this speed for about eight hours, and she would be able to steam at from 10 to 14 knots, with a small section of the boilers and supplemental machinery, more economically than other vessels of similar size, and of ordinary type and power, and when required all the boilers could be used, and full power exerted in about half an hour.

In the case of an Atlantic liner or a cruiser of large size, turbine engines would effect a reduction in weight of machinery, and also increased economy in fuel, tending either to a saving in coal on the one hand, or, if preferred, to some increase in speed on the same coal consumption per voyage.

In conclusion, it may be remarked that in the history of engineering progress, the laws of natural selection generally operate in favour of those methods which are characterised by the greater simplicity and greater economy, whether these advantages be great or small.

The work in this undertaking has perhaps been slow, but many difficulties were met with besides those of a mechanical nature, and, as is generally the case, the success so far attained has been largely due to devoted colleagues and staff, and in the marine developments to the enterprising and generous financial assistance.

My thanks are due to the officials of this Institution for the kind assistance they have afforded me in the arrangement of the apparatus.

ADVANCEMENT OF ELECTRICAL CHEMISTRY.

ON reviewing the science of electro-chemistry and its application to modern manufacturing processes, one is struck with amazement at the enormous strides which have been made within the last ten or twenty years. On studying works on chemistry little more than ten years old, hardly a reference is found to the use of electricity in metallurgy, still less in regard to the manufacture of metallic salts, or of the non-metals, and absolutely none in reference to the preparation of organic chemical bodies, at any rate on a large scale.

We are told that in 1808 Sir Humphrey Davy discovered the metals—sodium and potassium—by the electrolysis of their moist hydroxides; we are then informed that they are now manufactured by the much cheaper method of heating the carbonates with charcoal and chalk, or the hydroxides with carbide of iron. To-day we find a retrograde step has been taken, and that they are manufactured by the vastly cheaper method of electrolysing their chlorides or hydroxides.

Notwithstanding that Faraday and others early in the nineteenth century had shown that metals could be deposited, from the solutions of their salts, upon other metals by means of an electric current, and Faraday had, in 1833, formulated his law that "The amount of any substance liberated is proportional to the total quantity of electricity passed through the solution," and that "the amount of different substances liberated by the same quantity of electricity are in the ratio of their chemical equivalents"; electricity until quite recently was not used as an adjunct to chemical analysis. Within the last few years electro-chemical analysis has been very much studied, and now most laboratories *abroad* are fitted with special apparatus for this class of analysis. It is to be feared that in this country we are hardly so advanced.

Within the last thirty years the process for depositing metals from their solutions, and so obtaining moulds for casting, &c., has not undergone any very radical changes, but the means at our disposal for carrying out the work have enormously improved.

Until the advent of the dynamo and the storage battery, methods of electrical analysis or of galvanic deposition could not profitably be employed, at any rate on a very large scale; now, however, with the cheapening of production, very much has been made possible, which but a few years ago would have been scouted as Utopian. Is it realised by those who admire the splendid photographic reproductions which are met with on every hand, even in penny illustrated journals, that the majority of these are reproduced by means of electrical processes? A scene, *e.g.* the leaving of volunteers for the seat of war, is photographed, and in a few hours by means of electrical stereotype is transferred to a metal plate and is ready for the printer.

Those interested in metallurgy knows how difficult it is to obtain absolutely pure copper by furnace methods, even after many processes of refining, the copper still contains small quantities of impurities from which it is only with great difficulty freed. When copper is required for electrical purposes, very small quantities of impurities considerably reduce its conducting power. For this reason then it is important to obtain perfectly pure copper; and as the impurities often consist of gold and silver, endeavours have been made to obtain a process which would produce absolutely pure copper, and at the same time leave the gold and silver in a workable condition. Thanks to electro-chemistry, such a process has been devised and is now very largely used. The copper which has either been cast into plates or bars, or granulated, is placed in a bath of copper sulphate and connected with an electrical machine as the anode, a plate of pure copper forming the kathode. On the current being passed, the copper at the anode dissolves and is deposited on the kathode in the pure condition; the impurities—gold, silver, antimony, arsenic, etc., dissolving in the bath or remaining on the anode as a sponge, finally falling to the bottom of the bath forming a muddy sediment ("anode sludge").

The electrolytic deposition of copper is also made use of in the manufacture of weldless copper tubing. In a bath of copper sulphate, granulated copper is made the anode, the kathode consisting of metallic spindles, the thickness of which is determined by the size of the tube it is desired to produce. The spindle is made to revolve at a very high rate of speed; by this means the copper, which ordinarily is deposited in a more or less crystalline condition, forms a dense and even deposit, which, when used for boiler tubes, &c., is capable of sustaining very high pressures without bursting.

Although it has not up to the present been found practicable to obtain zinc commercially from its ores by electrolytic methods, notwithstanding the many attempts which have been made, it is interesting to note that zinc galvanising by electrolysis is now being used to a very considerable extent, in place of the old method of hot dipping, the zinc, as in the case of the copper deposition just described, being made the anode in a weak acid bath, the material to be galvanised the kathode. The galvanising of the inner surfaces of tubes has always been very difficult; in the electrolytic method the difficulties are overcome. The bottoms of ships, torpedo-boats and other large surfaces are now frequently galvanised by means of the electrical galvanic process.

The advantages which this method has over the hot dipping process are obvious. In the latter, many tons of zinc have to be kept in a state of fusion over long periods, the expense of fuel being very great, and the loss of zinc through alloying and oxidation very considerable. In the old process the tensile strength of the iron and steel is said to be diminished. In the new process it is claimed that the quality is in no way depreciated.

Probably "the man in the street" would point to the manufacture of aluminium as being the triumph of electrical chemistry. Certainly, here is a triumph, and it will perhaps be interesting to briefly trace the development of the industry since the discovery of the metal by Wöhler in 1827. He obtained it as a grey powder by heating aluminium chloride with potassium. In 1856, Bunsen prepared it by electrolysis of the double chloride of sodium and aluminium. Deville, in 1854, obtained it by the action of sodium on this same double chloride, but owing to the high price of sodium, aluminium cost, in 1857, 5*l.* the pound; even in 1888 the price was over 2*l.* per pound. In this year the Netto-Castner process for the manufacture of sodium was perfected, and as a consequence the price of aluminium at once fell to 15*s.* the pound. Shortly after this the electrical methods were employed, and now aluminium may be obtained at less than 2*s.* the pound; the cost would probably be still further reduced if the metal itself were of more general use.

Calcium carbide, which is now being largely manufactured by heating a mixture of limestone and coke in an electrical furnace, has made it possible to obtain, at a small cost, acetylene gas, which, were it not for the restrictions that are placed upon the storage of the carbide, would probably be used to a very much greater extent. The extraordinary brilliancy of the light which this gas gives causes one to wonder that attempts have not been made to employ it for street lighting.

In gold, silver, and nickel-plating, electrolysis on a small scale has been employed for a number of years, and within the last few years it has been successfully used on a large scale for gold extraction. In the McArthur-Forrest cyanide process for obtaining gold from the "tailings," a double cyanide of gold and potassium is obtained; from this double cyanide the gold is precipitated by means of metallic zinc, the gold so obtained having to be refined and purified. By the Siemens-Halske process the cyanide solution is electrolysed by means of weak currents, the gold being deposited in a purer form than when precipitated by means of zinc. In this process the anodes are of iron, and the kathodes on which the gold is deposited of lead; an amalgam of lead and gold being obtained, from which the latter is recovered by cupellation. By this method the gold is obtained purer, and the quantity of cyanide employed is much less than is the case in the original cyanide process. There is little doubt that in a short time a very large percentage of the "tailings," both in Australia and Africa, will be worked by means of electrical processes, and it is not impossible that a process will be devised for the treatment of the auriferous quartz, though, up to date, attempts in this direction have not been commercially successful.

Either with the electric furnace or by electrolysis, it is now possible to obtain practically all the metals from their oxides or salts, *e.g.* chromium, by heating the sesquioxide with aluminium in an electric furnace; magnesium, by electrolysis of fused carnallite; the rare metals yttrium, lanthanum, and cerium have also been isolated by electrolysis of their fused chlorides. An interesting process for purifying tin might be mentioned here. The metal obtained from American sources often contains appreciable quantities of gold. A very neat method for separating the tin from the gold has lately been patented. The gold-containing tin forms the anode in a bath of sodium sulphide, the kathode being a strip of pure tin; on the current being passed, the tin at the anode dissolves, forming a thio salt, from which it is deposited, pure, on the kathode. The gold with other impurities hangs on the anode in a spongy form, or falls to the bottom of the bath, as "anode sludge," from which it is readily extracted.

As showing the many-sided character of electro-chemistry, an interesting process for obtaining accurately reflecting mirrors might be mentioned. Many attempts have been made to prepare perfect metallic mirrors, in which the use of glass could be done away with, and on a small scale for lamps the attempts have been fairly successful; but where a moderately large and true reflecting mirror is required, attempts to substitute cast, spun or stamped metal for glass have always been unsatisfactory. The difficulty seems to have been overcome in a process brought out by Mr. Cowper-Coles. A glass mould is obtained, the convex side of which is accurately shaped and polished to form a true parabolic or other reflecting surface. On the prepared surface a metallic coating of silver is deposited by chemical means; it is then polished, and a backing of copper is deposited to any desired thickness, by making the silver the kathode in a bath of copper sulphate, the mould being at the same time rotated in a horizontal position. The copper adheres firmly to the silver, and as soon as sufficient has been deposited the glass mould is placed in cold water, which is gradually warmed. The unequal expansion of the metal and the glass causes the two to separate, yielding a concave surface of silver on copper, exactly corresponding to the mould, which requires no further polishing. As, however, silver when exposed to atmospheric conditions rapidly tarnishes, metallic palladium is electrolytically deposited on its surface. Palladium is not affected by atmospheric changes, being practically unoxidised even at high temperatures. Its reflecting power, moreover, is but little inferior to that of silver.

A metallic reflector prepared after this method was recently tested at Portsmouth, a number of rifle bullets being fired through it; it was even then found that the beam was but slightly affected. Whereas one shot fired at a glass reflector smashed it to pieces. It is obvious then that such mirrors should be of great value in the Army and Navy, as reflectors for search-lights, where the breaking of the mirror in time of action might have very serious results.

In this article it has only been possible to touch the margin of the electro-chemical industry, and only, with the exception of calcium carbide, such processes as deal with electro-metallurgy and electrolytical deposition have been dwelt upon. It is hoped in another article to draw attention to the production of non-metallic elements, and to the manufacture of chemical products both inorganic and organic. F. MOLLWO PERKIN.

THE PROBLEM OF COALING AT SEA.

WAR, at the present time, brings home to us the necessity of considering "Energy," its different forms, and their practical application. In these days, when the machinery of a battleship not only propels the vessel, but lights, ventilates, and controls the working of the heavy guns, it may be said that the ship is primarily dependent on one source of energy—Coal. A vessel short of this requisite has hitherto been compelled to fall out of line and be thus useless until she has "coaled ship," which in many cases entails several miles steaming, delay, and perhaps lost opportunities.

On this account any efficient mechanical contrivance for overcoming the difficulty of obviating the ship putting into port and enabling a full recharge of energy while cruising to be possible must be looked upon by all with interest.

In the *Engineering Magazine* for February is an illustrated account of a series of trials made in the United States Navy with the "Miller Conveyor" for coaling at sea, and the method may be briefly described as follows:—

The battleship to be coaled tows the collier, from which it takes the coal in loads of 840 lbs. by means of an overhead cable and suspended carriage. During the experiments two points of interest presented themselves: (1) The proper distance between the ships; (2) The way of overcoming the variation required in the length of ropes caused by the rolling and pitching. With regard to the first point it was found that with 300 feet between the ships, the collier would not follow properly, but during the rough weather trial with about 400 feet between the ships, the collier followed perfectly.

The second point caused the chief difficulty, and in Mr. Miller's design we find the length of overhead cables made variable, as required partly by the movement of the ships themselves, and partly by the power engine on deck. In the following table will be found information and data of the five trials made:—

Trial Number	Speed	Number of loads (840 lbs.) or tons transshipped	Remarks
First	5 to 6 knots	9 loads only	Adjustments made
Second		14 tons 5 cwt. in 38m. 40s.	Work stopped through lack of skill on part of operator
Third		22 tons in one hour	Work could have continued but for lack of sufficient crew to fill the bags
		Between the third and	fourth slight alterations made
Fourth		75 tons in 3h. 43m.	Trial lasted four hours; water smooth, ground swell
Fifth		80 trips made in 80m., or 30 tons in 1h. 20m.	Could have continued indefinitely. Board of Judges satisfied. Water rough.

As we are informed that the battleship consumed about $3\frac{1}{2}$ tons of coal per hour, the actual (or rather "paying") rate of coaling obtained was sixteen or seventeen tons.

The behaviour of the apparatus in rough weather was satisfactory, and the author writes, "The boats steered at first head on to the sea, the forecastle of the battleship *Massachusetts* was washed at every plunge, and no coal could have been delivered there, even if desired. The course was then changed quartering on the sea; the results were the same. Then the boats steered in the trough of the sea, and the rolling did not affect the working."

The article, which is illustrated with ten good photographs and a diagram, is certainly worthy of note, and deals with a subject which it is possible will revolutionise naval warfare in the near future.

MERCURY AS A NAKED EYE OBJECT.

RARELY visible, and always difficult to observe satisfactorily in a telescope, this planet is yet a most attractive object to the unaided eye. Not receding to a greater distance than 28° from the sun, he is, however, never above the horizon in England for a longer period than two and a quarter hours before sunrise, or for a similar interval after sunset. When an evening star in the spring months or a morning star in the autumn season, he may often be caught and watched for an hour or so, shining with a sparkling, rosy lustre, and presenting much the same aspect as a fixed star.

To secure a view of Mercury forms one of the earliest and greatest ambitions of the amateur astronomer. Among his first books there will sure to be a copy of Mitchell's "Orbs of Heaven," or Dicks's "Celestial Scenery," and on reading the statement that Copernicus never succeeded in seeing Mercury, he resolves that he will do his best to catch a glimpse of this elusive little "Messenger of the Gods." After some vain attempts he finally succeeds, and it is not too much to say that the spectacle sometimes excites and gratifies the observer more than any other subsequent event in his astronomical career. Who is there among us who does not remember the thrill of pleasure incited by the first detection of this fugitive orb, and the conscious pride with which we realised that we had commenced our celestial work by achieving a feat which had been denied to the greatest astronomer of the sixteenth century?

But, as a matter of fact, there seems to be considerable doubt whether Copernicus ever really complained of failure to see Mercury. There is evidence to show that he never expressed himself in the manner quoted in many of our popular text-books. There may, it is true, have been some ground for the statement, but it is well known that a biographer has only to introduce a special incident of the kind alluded to, or to unduly colour some expression, and whether on doubtful evidence or not, it is liable to be copied and recopied by subsequent writers without any investigation until it becomes generally accepted as a fact. But admitting for the moment that Copernicus really failed to discern Mercury, he seems to have had very good reason for it. His residence was at Thorn, in Prussia, and through the valley near ran the River Vistula, over which were frequent fogs which obliterated objects near the horizon.

This tradition about Copernicus and Mercury has certainly, however, enhanced the interest with which the planet is regarded as a naked eye object. The beautiful white lustre of Venus—incomparably brighter than the aspect of Mercury—the stronger and steadier, yellowish light of Jupiter, or the conspicuous ruddy hue of Mars may present a more striking appearance in the sky than the twilight-veiled splendour of Mercury, but there is something about the sparkling lustre of the latter orb, hovering fugitively on the brow of the horizon, which forms an attraction peculiarly its own.

The best time to observe the planet in 1900 will be during the first eleven days of March, when his times of setting will be as follows:—

		h. m.			h. m.
March	1	7 10	March	7	7 36
	2	7 16		8	7 39
	3	7 21		9	7 41
	4	7 25		10	7 41
	5	7 29		11	7 41
	6	7 33			

During this period Venus will be a very brilliant object, situated about 21 degrees E.N.E. of Mercury. The greatest elongation of the latter (18° 16′ E.) will occur at 11 a.m. on March 8, on which day he sets about 1h. 50m. after the sun. If the western sky is clear on March 2 at about 6 p.m. an exceptionally good opportunity will occur for detecting the planet, for he will be in conjunction with the crescent of the new moon at that time, and about 4½ degrees south.

On reference to my note-book I find that I obtained naked eye views of Mercury on 102 occasions between February 1868 and December 1899. But the planet was very rarely looked for here at the morning apparitions, and not always at really favourable spring elongations. If an observer with good sight made it a point to secure as many unassisted eye observations of this object as possible, he might be successful on about twelve occasions in a year. In a finer climate than ours, the planet may, of course, be more frequently seen. I think that some disappointments in regard to finding Mercury are due to the fact that observers scan the heavens at or after the time of maximum eastern elongations, instead of during a week or more preceding them. The phase and apparent brilliancy decrease rapidly at these periods. I have occasionally noticed Mercury as a very brilliant object about ten or twelve evenings before his greatest elongation, while at the date of his elongation he has appeared quite faint, and a few evenings later, become practically invisible, though above the horizon for about two hours after sunset.

My observations in various years have led me to the following conclusions regarding the visibility of the planet at the evening apparitions :—

(1) The greatest brightness of the planet is attained ten or twelve days prior to his greatest elongation.

(2) In February and March the planet may sometimes be caught twenty minutes after sunset, in April thirty minutes after sunset, and in May forty minutes after sunset. The stronger twilight towards midsummer occasions the difference.

(3) The duration of his visibility to the naked eye is about 1h. 40m. in March, 1h. 30m. in April, and 1h. 20m. in May. On a very exceptional occasion it is possible these limits may be exceeded.

(4) The planet is a conspicuous object, and certainly much brighter than a 1st mag. star. In February 1868 I considered that his lustre vied with that of Jupiter, then only 2° or 3° distant. In November 1882 he appeared brighter than Sirius. In 1876 he looked more striking than Mars, then 13° distant, but the latter planet was faint and at a considerable distance from the earth.

The greatest number of naked eye observations of Mercury at the same elongation was obtained at Bristol in the spring of 1876, when the planet was seen on thirteen different evenings. When Venus is near Mercury at a favourable time, she affords an excellent guide to the identification of the latter. But errors have often been induced, and either Venus or Jupiter has been mistaken for Mercury on many occasions. In April 1898 Venus was near Mercury, and some people, including a few regular astronomical observers, readily saw Venus and believed (and still ardently believe) that they were looking at Mercury.

The albedo, or reflecting capacity of the planet, is rated exceedingly low, being only 0·11, whereas Mars is 0·27, Saturn 0·50, and Venus and Jupiter 0·62. This is remarkable when we consider the occasional striking brightness of the small planet in a region of the sky full of strong twilight. By telescopic comparisons of the disc of Mercury with other planets, it is, however, easily seen that the former is relatively feeble in brilliancy. On May 12, 1890, I viewed Mercury and Venus in the same field of view of a 10-inch reflector, and remarked that the brilliant silvery light of Venus contrasted strongly with the much duller hue of Mercury. The probability is that the latter object is provided with a much thinner atmosphere than that which envelops his sister planet. There are undoubted markings visible on Mercury, but they are nothing like the peculiar representations of them which have been published in the last few years. The extreme difficulty of obtaining satisfactory views of the planet furnishes the principal reason why his rotation period still awaits accurate determination.

W. F. DENNING.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—Junior Scientific Club, February 21.—Mr. H. B. Hartley (Balliol College) read a paper on liquid crystals, and showed, by microscopic demonstration upon the screen, experiments with para-azoxyanisol and para-azoxyphenetol which melt to doubly refracting liquids at 116° and 135° respectively. These remarkable bodies have not previously been shown in England; the curious transformations which they undergo were made clearly visible to a large audience.

CAMBRIDGE.—A very valuable and interesting collection of Irish antiquities, formed during the last seventy years by Mr. T. R. Murray, of Edenderry, has been acquired for the University by Prof. Ridgeway. It includes unique bronze weapons and ornaments, stone axes and arrowheads, medieval pottery, &c. The collection will be exhibited in the Fitzwilliam Museum on March 5.

A University Prize for the best M.D. Thesis has been founded in memory of Raymond Horton-Smith, M.A., M.B., late scholar of St. John's College, who, after a distinguished career in the University and at St. Thomas's Hospital, London, died last year at the untimely age of twenty-seven. Candidates must have taken honours in one of the Tripos examinations, and the Prize Thesis is to be printed and circulated.

The arrangement with Addenbrooke's Hospital, by which the Professors of Physic and Surgery are to have places on the staff, in consideration of an annual subsidy of 300*l*. from the University, is now submitted for adoption by the Senate. It has already been approved by the Hospital Court, and will probably come into effect forthwith. It puts an end to an old difficulty between the medical school and the hospital.

The thanks of the University are ordered for certain valuable gifts to the Engineering Laboratory. Lord Kelvin has presented a set of apparatus for electrical measurements, Messrs. Siemens Brothers a pair of coupled dynamos, and the Forward Engineering Company a gas engine.

The University Lecturer in Chemical Physiology, Mr. F. G. Hopkins, M.B., London, is to receive the honorary degree of Master of Arts.

THE Senators of Edinburgh University have decided to confer the degree of LL.D. upon Miss Eleanor A. Ormerod, in recognition of her services to entomology.

THE Senators of St. Andrews University have resolved to confer the honorary degree of Doctor of Laws upon Prof. McIntosh, Edinburgh, and Dr. Hugh Robert Mill.

THE Norwich Union Fire Insurance Company have just settled the claim of the West Ham County Borough Council, on account of the damage done in the disastrous fire at the Municipal Technical Institute last October, for the sum of 25,100*l*., the Council retaining the salvage. This sum is expected to cover completely the cost of the reinstatement. The opportunity will be taken to enlarge the Institute, accommodation having already proved too small for the classes. A new block is to be built to contain the whole of the chemical department. This block will contain two lecture rooms, an advanced and an elementary chemical laboratory, furnace room, combustion room, gas analysis room, balance room, and private laboratory, together with the usual private rooms and store rooms. A small forge and a foundry are to be added to the engineering department. The engine and dynamo laboratory, and the engineering laboratory are both to be enlarged, and extra accommodation will be provided for building-trade classes and for the Women's Department and Art Department, together with several extra class-rooms. The cost of these extensions is estimated at 8000*l*. The builders are busily engaged on the work of reinstatement, and it is fully expected that both new and old portions will be ready for use at the beginning of the new session in October next.

A COPY of an address recently delivered by Sir William White, K.C.B., F.R.S., at the Merchant Venturers' Technical College, Bristol, has been received. In the course of his remarks, Sir William White pointed out that what is wanted from the national point of view is increased individuality and intelligence among the workers engaged in manufactures and industries. A good technical institution provides the means for developing these qualities, and in such a college a student can find help and assistance in trying to obtain a fuller grasp of principles, and a better knowledge of fundamental principles upon which to base his own further efforts. An engineer, whatever his line may be, cannot be completely furnished with the means of carrying on his profession by studying it in the most completely equipped college that could be established; that is only one portion of his education. Until Technical Colleges came into existence, the system of training that was favoured, with those whose means and leisure permitted, was that of pupilage. Now it is quite recognised that an alternative method of commencing training is afforded by well-equipped Technical Colleges. In conclusion, Sir William White referred to the steps which have been taken in the organisation of educational work in Bristol, and to prevent over-lapping of the various institutions and authorities concerned with education. Prof. Wertheimer, the headmaster, reports that, acting on the suggestions of the Technical Instruction Committtee of the Bristol Town Council, the Governors of the Technical College have completed an agreement with the Bristol School Board, in virtue of which the evening class work of the Board and of this College, in science and technology, are so arranged as to avoid overlapping. In virtue of an agreement with the Bristol School of Art, the Art School of the College will be closed at the end of this session, and art students will be advised to attend the other school; the School of Art on its side will close its science classes and advise its students of science to attend the College. The relation of the Technical College to the University College does not appear to be mentioned in the report.

SCIENTIFIC SERIALS.

American Journal of Science, February.—Sedimentary rocks of Southern Patagonia, by J. B. Hatcher. Two years of further study have greatly augmented the results obtained since the first report. Chief among the additional observations and resultant modifications of the author's former views are:—(1) The discovery near Sandy Point, in the Strait of Magellan, of an entirely new series of Tertiary deposits several hundred feet thick, and underlying the Patagonian Beds. These new Tertiary deposits have already been noticed by Dr. A. E. Ortmann, and have been named by him the Magellanian Beds. (2) The discovery near Lake Pueyrredon of several distinct fossil-bearing horizons in the Cretaceous.—Explorations of the *Albatross* in the Pacific (II.), by Alexander Agassiz. The choice of Dolphin Bank, Tahiti, as a standard to determine the growth of coral turns out to have been unfortunate, as it is in the midst of an area comparatively free from corals. Only a few growing corals were found by the author, the top of the bank being entirely covered by Nullipores. After coaling at Tahiti, the *Albatross* left for a cruise in the Paumotus. The western islands are probably all on a great plateau connected perhaps by the 800-fathom line. The soundings, like those off the Fijis, show that atolls do not necessarily rise from great depths, and that in this characteristic atoll district atolls are found, it is true, with steep slopes, but rising from moderate depths.—Action of ammonium chloride upon analcite and leucite, by F. W. Clarke and G. Steiger. When analcite is heated with four times its weight of ammonium chloride, about one-half of the soda in the analcite is converted into chloride, while variable ammonia is retained. Other zeolites, like leucite, natrolite, laumontite, stilbite, chabazite, apophyllite, show a similar reaction, varying, however, to an extent which probably depends upon their molecular structure. A new means of studying the latter is thus provided.—Devonian strata in Colorado, by A. C. Spencer. Devonian and associated strata were deposited originally over an extensive area in the southern Rocky Mountain region, the boundaries of which are as yet entirely unknown.—Estimation of thallium as the acid and neutral sulphate, by P. E. Browning. The salt obtained by heating thallous chloride with sulphuric acid until the excess of the latter is expelled, and then raising the heat to redness, has the constitution of a neutral sulphate. The author tested whether this neutral sulphate, or the acid sulphate described by thallium, can be used for the estimation of thallium, and finds that it can be done, provided the conditions of temperature are carefully attended to.—Motion of a submerged index-thread of mercury in the lapse of time, by C. Barus. The author endeavoured to frame a theory to account for the observed gradual sinking of an index-thread of mercury in a vertical tube containing water. He proceeded on the supposition that water penetrates past the index-thread in a very thin sheet, but found that the thickness of the sheet would have to be far below that of a molecule of water. He eventually found that the sinking was due to the volume viscosity of glass. A four years' experiment showed that the sinking proceeds at a regularly retarded rate through infinite time.

Annalen der Physik (formerly *Wiedemann's Annalen*), No. 1.—A study on soap-bubbles, by O. Dörge. The author performs on a soap-bubble a cyclical electric process analogous to a Carnot cycle, the expansion and contraction being either at constant charge or at constant potential. He arrives at a law which states that no process is possible in which electric energy is transferred without loss or gain from one potential to another. This law corresponds to the second law of thermodynamics.—Diffuse reflection of light, by H. Wright. If the angle of incidence is constant, the intensity of reflected light varies as the cosine of the angle of reflection in the case of perfectly dull surfaces. The converse does not hold good, so that Lambert's law is only partially correct.—Electric conductivity of dilute amalgams, by A. Larsen. Experiments upon amalgams of lead, zinc, cadmium, tin and bismuth show that the metal contained in dilute liquid amalgams is dissociated, and that the degree of dissociation increases with the dilution and the temperature.—Stationary temperature of an electrically heated conductor, by F. Kohlrausch. The author supposes a conductor whose surface is protected from loss of heat, except two terminals, each of which is kept at a constant temperature and a constant potential. When the stationary state has been attained, all points at the same potential will also have the same temperature. The greatest quantity of heat will be developed in those metals in which the ratio of the thermal to the electrical conductivity is smallest.—Spark potential in gases, by A. Orgler. The author proposes a new definition of the "specific electric strength" of a gas, which gives a real constant for any given gas. If δ is the width of the gap, and A and B the spark potentials in the gas and in air respectively, the specific electric strength is the ratio $\frac{dA}{d\delta} : \frac{dB}{d\delta}$. It is units for air, 0·888 for carbonic acid, and 0·563 for hydrogen, whatever the width of the gap.—Molecular susceptibility of paramagnetic salts of the iron group, by O. Liebknecht and A. P. Wills. Jäger and Meyer's series of atomic susceptibilities of Mn, Fe″, Co, and Ni, in the ratio of 6 : 5 : 4 : 2, is not confirmed, the numbers obtained being 6·98 : 5·86 : 4·70 : 2. Wiedemann's series a, $a+b$, $a+\frac{3}{2}b$, $a+2b$ agrees rather better with facts, but a still closer approximation is obtained by putting $b = 1{\cdot}25a$ instead of $1{\cdot}15a$. There is a sudden rise from chromium to manganese and ferric iron, and a gradual fall from the latter to cobalt, nickel and copper.—Molecular susceptibilities of salts of the rare earths, by H. du Bois and O. Liebknecht. There is a gradual rise from cerium to praseodymium and neodymium; a decided rise in samarium, gadolinium and erbium, and a sudden fall to ytterbium.—Magnetic viscosity, by Lizzie R. Laird. To preserve the initial or instantaneous magnetisation of a disc for measurement, it is kept in rotation, and the rise of intensity of magnetisation on stoppage is recorded by a photographic device.

THE number of the *Journal of the Royal Microscopical Society* for February 1900 contains a further instalment of Mr. F. W. Millett's Report on the recent Foraminifera of the Malay Archipelago, collected by Mr A. Durrand; and a paper by Dr. H. C. Sorby, F.R.S., on the Preparation of Marine Worms as Microscopical Objects, the fluid used for removing the salt being a strong solution of glycerin. The character and arrangement of the blood-vessels are especially well brought out by this mode of treatment. Among the paragraphs relating to Microscopy may be especially mentioned an abstract of van Heurck's paper, from the *Annales de la Société Belge de Microscopie*, on Modern Apochromatic Objectives.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, January 18.—"An Experimental Investigation of the Thermodynamical Properties of Superheated Steam." By John H. Grindley, B.Sc., Wh.Sc. Communicated by Prof. Osborne Reynolds, F.R.S.

In Regnault's experiments on the relations between the pressure, temperature, and latent heats of saturated steam, the steam to be experimented upon was obtained by withdrawing it upwards from a boiler, allowing any entrained moisture to be separated by gravity. Saturated steam obtained in any other manner would not necessarily have the same total heat of evaporation as that obtained by Regnault.

Whether the steam could always be brought into the same condition, as regards its freedom from moisture, by such a process of drainage was open to question, and it remained to be determined by further researches whether this condition was unique at any particular pressure and temperature in the saturated steam.

When saturated steam is wiredrawn by free expansion through a small orifice, if the pressure in the wiredrawn steam be sufficiently reduced, the steam will become superheated, and, if the flow through the orifice is truly adiabatic, the total energy per lb. of steam is the same on both sides of the orifice. Now, if the energies of motion be made sufficiently small, this energy will exist as heat, and, assuming the steam before passing the orifice to be in the same condition as that experimented on by Regnault, its total heat energy above that of water at 32° F. is known, and hence the total heat of gasification of the superheated wiredrawn steam from water at 32° F. is known. If, therefore, we observe the pressures and temperatures in superheated steam wiredrawn from definite initial saturated conditions, simple calculations will suffice to give various values of the specific heat at constant pressure in superheated steam.

In the experiments, the author obtained adiabatic flow by using orifices drilled in pieces of plate glass. The temperature and pressure of saturated steam in a steam chest, in which a constant supply of steam is kept, are taken, the steam is then drawn upwards to the orifice, and, after wiredrawing, its pressure and temperature are again taken, using for the determination of the latter a thermoelectric junction immersed in the steam.

The results of the experiments show that saturated steam at any particular pressure, obtained by relieving it of suspended moisture by gravitation, has only one condition as to its dryness, and the total heat of evaporation of steam so obtained is that given by Regnault's experimental results. It is further shown that steam obtained in this manner has not the maximum density at that particular pressure and temperature of saturation, there being still an effect as if a small quantity of moisture remained in the steam, which would require removal by further application of heat at the same temperature before the steam would become superheated, thus showing that the latent heat of such steam as given by Regnault's results, has not its maximum value.

It was also found that by an application of Prof. Reynold's method of determining the perfectly gaseous condition of steam, under ordinary pressures and temperatures, no indications of that condition of steam known as a perfect gas were even approximately obtained, and that Rankine's formula

$$H = H_0 + c(T - 32)$$

for the total heat of gasification H of superheated steam at a temperature T (H_0 being the latent heat of formation of steam at 32° F.), which was formed on the assumption that such a perfect gas condition did exist in steam, could not be applied to superheated steam.

The mean specific heat under constant pressure was obtained for various pressures and between various temperatures, showing a wide range of variation in its value with temperature. Thus, at atmospheric pressure the mean K_p between 230° F. and 246°·5 was 0·4317, and between temperatures of 295° and 311°·5, K_p was 0·6482.

The specific heat K_p was found to be independent of the pressure, but to vary very nearly as the fourth power of the absolute temperature.

If $c\left(=\frac{\partial\theta}{\partial p}\right)$ denote the cooling effect produced by free expansion, the following formula, which is thermodynamically correct, viz. :

$$\frac{\partial}{\partial p}\left(K_p\right) = -\frac{\partial}{\partial T}\left(cK_p\right) \quad \ldots\ldots (1)$$

enables a check to be made on the experimental results, for if K_p is independent of the pressure, the product cK_p must be independent of the temperature. In the experiments, the product cK_p was found to be independent of both pressure and temperature.

By integrating Thomson's formula

$$\frac{dT}{T} = \frac{dv}{v + cK_p} \quad \ldots\ldots\ldots (2)$$

for the cooling effect c, and using the experimental value of the product cK_p obtained, values of the specific volumes (v) of superheated steam at various pressures and temperatures were calculated, the lower limit of integration being taken from the known data in the saturated condition of steam.

It follows from equation (1) that, for any gas in which K_p is independent of the pressure, and this is so for many gases, formula (2) must be capable of direct integration in the form

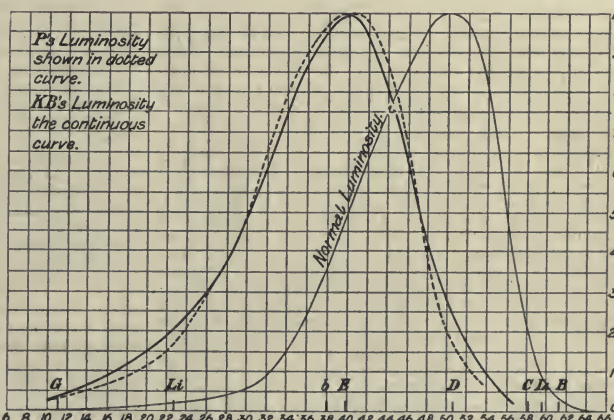
$$\frac{v + cK_p}{T} = f(p),$$

where $f(p)$ denotes any function of the pressure.

February 1.—"A Case of Monochromatic Vision." By Sir W. de W. Abney, K.C.B., F.R.S.

The patient, K. B., was aged twenty-five, and the notes of his case are as follows:—Vision always defective; has always been colour blind. Has quick horizontal nystagmus; probably an absolute central scotoma. He is always "day blind." His vision for right and left eyes is 6/60. He is not night blind. His fields are nearly, but not quite, full for white. He shows no definite changes in his eyes. As to his luminosity curve, he matched all colours with white, and with the same facility as if they were white.

In the accompanying diagram the curve shows the luminosity of the spectrum to the patient K. B. and also of a previous case, P., together with the curve of luminosity for the normal eye.



As regards the first two, it will be seen that the maximum of each curve is about scale number 40, or close to E. On the right-hand side of the maximum the curves do not absolutely agree. K. B.'s observations were first made in the red and green, and his readings at first were not very close, and a mean had to be taken. As the colours he had measured went towards the blue his measures were much more accordant, as he had become accustomed to the methods employed. The slight divergence on the left-hand side of the curve from that of P is probably due to his colouring matter in the yellow spot. Attention must be again called to the fact that these curves are practically identical with those obtained by the normal eye when it measures a spectrum of very feeble luminosity, and also agrees with the results obtained by measuring the diminution of each ray when it first becomes invisible, and making a curve of the reciprocals of the numbers, taking the highest point of it as 100.

Physical Society, February 23.—Prof. S. P. Thompson, F.R.S., Foreign Secretary, in the chair.—Prof. R. W. Wood, of the University of Wisconsin, U.S.A., exhibited and described: (1) Photographs of sound waves and the kinematographical demonstration of the evolutions of reflected wave-fronts. The sounds were produced by electric sparks, and photographed by means of the light emitted by carefully-timed subsequent sparks, according to the methods described in the *Phil. Mag.* for last year. The photographs included: (*a*) The reflection of a spherical wave, as a spherical wave from a plane surface; (*b*) the reflection, by an ellipse, of circular waves from one focus, and the concentration of the waves, as circular waves, at the other focus; (*c*) the plane wave-front formed by the reflection of a spherical wave at a parabolic surface; (*d*) the wave-front formed by a spherical wave incident on a spherical surface; (*e*) the wave-front formed by a plane wave incident on a spherical surface. In cases (*d*) and (*e*) the wave-fronts are complicated, and contain cusps. Prof. Wood pointed out that the paths of the cusps on the wave-fronts traced out the caustic curves. In the following cases the wave-fronts were drawn for one hundred successive positions, and the evolution of the reflected wave was made clear by means of a kinematograph: (*a*) Plane wave on a hemispherical mirror; (*b*) spherical wave on a hemispherical mirror; and (*c*) circular wave inside a complete circular mirror. (2) A new seudoscope. In this instrument the real and inverted images formed by two convex lenses are viewed stereoscopically. The inversion of the object viewed causes the relief to be reversed. (3) Diffraction colour-photographs. Prof. Wood showed some coloured photographs taken by his diffraction process. The principle of the method is based upon the tri-colour theory. Different colours are produced by gratings so ruled and arranged as to throw upon the eye the particular constituents of the required colours. The arrangement of gratings necessary to produce a coloured picture is obtained by photographing properly spaced gratings through red, green and blue chromograms of the object. The superposition of one grating upon another which occurs in this process gives rise to an in-and-out-of-step arrangement, which produces secondary spectra. These, however, seldom affect the picture to any serious extent. (4) Artificial parhelia. When printing fine gratings upon gelatine, if the film is too thick, no print is formed, but the gelatine warps. If such a film is placed in a converging beam, the central image is accompanied by four marked concentrations of light situated at the extremities of two diameters at right angles. An examination of one of these plates with a microscope shows that there is a ridge for every third line of the grating, and that the plate is crossed at right angles to these lines by irregularly spaced cross ridges. Prof. Wood also exhibited some photographs taken by zone plates, a silvered copy of a Rowland grating, a photograph of a dynamite explosion, the motion of a ball in its flight, and the anomalous dispersion produced by a cyanine prism.—Mr. Boys gave some details concerning the photograph of the explosion shown.—Prof. Everett expressed his interest in the demonstrations.—Prof. Herschel asked if the photographs of sound waves after reflection had been verified by comparison with waves on mercury.—Mr. Watson pointed out that this could not be done, as it is impossible to get a solitary wave on the surface of mercury. Owing to the dependence of velocity on wave-length, any such solitary wave draws out into a train of waves.—The chairman proposed a vote of thanks to Prof. Wood, and announced that, by invitation of Prof. Callendar, a special meeting will be held at University College on March 2.—The meeting then adjourned.

Chemical Society, February 8.—Sir Henry Roscoe, Vice-President, in the chair.—Prof. T. E. Thorpe, President, delivered the Victor Meyer Memorial Lecture.—February 15, Prof. Thorpe, President, in the chair.—The following papers were read.—Ammonium amidosulphite, by E. Divers and Masataka Ogawa. Dry ammonia and sulphur dioxide do not combine at a low temperature, but on passing sulphur dioxide into a dry ethereal ammonia solution, a colourless, deliquescent unstable salt, ammonium amidosulphite, $NH_4.SO_2.NH_2$, is deposited; it is decomposed by water and dissolves in alcohol, with formation of ethyl ammonium sulphite.—On the products obtained by heating ammonium sulphites, thiosulphate and trithionate, by E. Divers and Masataka Ogawa. Anhydrous ammonium sulphite and pyrosulphite sublime unchanged on heating in dry nitrogen.—The colour of alkali nitrites, by E. Divers. The author confirms his previous statement that the alkali nitrites have a slight yellow colour which is specially marked in solution.—Solubility of mixed potassium nitrite and nitrate, by E. Divers.—The combination of sulphur dioxide with oxygen, by E. J. Russell and N. Smith. When a mixture of sulphur dioxide and oxygen acts on certain oxides, in addition to the absorption of sulphur dioxide, sulphur trioxide is formed, owing apparently to the "surface action" of the oxide; no sulphur trioxide is formed unless a simultaneous absorption of sulphur dioxide occurs.—Notes on the estimation of gaseous compounds of sulphur, by E. J. Russell. Volumetric methods of analysis are given which work satisfactorily in the estimation of sulphur dioxide, hydrogen sulphide, carbonyl sulphide and carbon disulphide in gaseous mixtures.—The influence of the "nascent state" on the combination of dry carbon monoxide and oxygen, by E. J. Russell. The nascent condition has no great effect in promoting combination between carbon monoxide and oxygen, the unburnt residue of carbon monoxide being similar in amount to that found in Dixon's experiments; the sources of nascent carbon monoxide used were carbonyl sulphide and nickel carbonyl, whilst nascent oxygen was supplied by the monoxide and peroxide of chlorine.—Asymmetric optically active tin compounds. Dextromethylethyl-n-propyl tin iodide. Preliminary note, by W. J. Pope and S. J. Peachey. The previously unknown mixed alkyl tin compounds of the type $SnX^{I}X^{II}X^{III}X^{IV}$ can be readily prepared from trimethyl tin iodide by the following series of reactions:

$$
\begin{aligned}
&(1)\ 2SnMe_3I + ZnEt_2 = 2SnMe_3Et + ZnI_2.\\
&(2)\ SnMe_3Et + I_2 = SnMe_2EtI + MeI.\\
&(3)\ 2SnMe_2EtI + ZnPr_2 = 2SnMe_2EtPr + ZnI_2.\\
&(4)\ SnMe_2EtPr + I_2 = SnMeEtPrI + MeI.
\end{aligned}
$$

On treating methylethylpropyl tin iodide with silver dextrocamphorsulphonate, it yields dextromethylethylpropyl tin dextrocamphorsulphonate, $SnMeEtPr(C_{10}H_{15}OSO_3)$, from the aqueous solution of which dextromethylethyl-n-propyl tin iodide may be precipitated by potassium iodide.—Note on the refraction and magnetic rotation of hexamethylene, by S. Young and E. C. Fortey.—Apiin and apigenin. Part II. Note on vitexin, by A. G. Perkin.—The yellow colouring principles of various tannin matters, VII., by A. G. Perkin.—Note on the bromo-derivatives of camphopyric acid, by J. A. Gardner. Camphopyric acid yields two derivatives, α- and β-bromocamphopyric acid, with bromine; the former gives an α-hydroxycamphopyric acid, $C_9H_{13}(OH)O_4$, on hydrolysis with potash.

Mathematical Society, February 8.—Prof. Elliott, V.P., F.R.S., and subsequently Lieut.-Colonel Cunningham, V.P., in the chair.—Prof. Elliott announced that the Council had passed the following resolution, and registered the same at Somerset House, viz. that the objects of the Society requiring that it shall consist of more than 250 members, it is resolved that the number of its members may be increased by further elections to 350.—Prof. Love, F.R.S., communicated a paper, by Mr. J. H. Mitchell, on some elementary distributions of stress in three dimensions, and Major MacMahon, F.R.S., gave a sketch of further results arrived at by him in combinatorial analysis, the foundation of a new theory.—The following papers were taken as read, viz.: A formula in the theory of the theta functions, by Prof. A. C. Dixon; The canonical reduction of a pair of bilinear forms, and Reduction of a generalised linear substitution to a canonical form, with a dynamical application, by Mr. Bromwich.

Anthropological Institute, February 13.—Mr. C. H. Read, President, in the chair.—Mr. W. L. H. Duckworth presented a note on the Congress of German and Viennese anthropological societies held at Lindau in September 1899, and on the anthropological faculty lately established in the University of Munich.—Dr. R. Koettlity gave a detailed description of the ethnography and civilisation of the Somali, Galla, Abyssinian, and Shangalla tribes, which he had the opportunity of studyiug during a recent journey from the Gulf of Aden to Khartoum. The paper was illustrated by many lantern slides from sketches and photographs, and by a large number of specimens collected in the course of the expedition.—In the discussion which followed, Mr. E. G. Ravenstein laid great stress upon the importance of a careful and detailed study of the natives of the region in question, and especially of the southern Galla tribes, who remain practically uninfluenced either by the Mohammedanism of the coast or by the debased Christianity of the Abyssinians in the interior.

Royal Meteorological Society, February 21.—Mr. E. Mawley read his report on the phenological observations for last year, in which he showed that the weather for the year ending November 1899 was chiefly remarkable for its high temperatures, scanty rainfall, and splendid record of sunshine. The winter and summer were singularly warm seasons, while the autumn was also warm, but during the three spring months rather low temperatures prevailed. In the early part of the flowering season, wild plants came into blossom in advance of their mean dates, but after March they were mostly late in coming into bloom. Taking the country as a whole, the best farm crop of the year was wheat; the yield of barley proved also good, while oats were slightly under average. The crops mostly affected by the dry weather were those of hay and turnips, the latter being in most districts exceptionally poor. The only part of the British Isles where the summer drought was not severely felt was in Ireland, throughout a great part of which there was abundant keep in the pastures during the whole summer. This year was a very bad one for fruit. The yield of apples, pears, plums and strawberries varied greatly in different localities, but was in most of them much under average.—Dr. R. H. Scott, F.R.S., read a paper giving the results of the percolation experiments which have been carried on at Rothamsted by Sir J. B. Lawes and Sir J. H. Gilbert, from September 1870 to August 1899. Three gauges were used, with 20 inches, 40 inches and 60 inches depth of soil respectively; the area of each gauge being one-thousandth of an acre. The amount of water collected at the depth of 40 inches is always in excess of that collected at 20 inches, and also of that collected at 60 inches. In the winter months more than half the amount of rain penetrates into the soil and is available for springs, while in summer this amount only reaches a quarter that of the rain.

MANCHESTER.

Literary and Philosophical Society, February 20.—Prof. Horace Lamb, F.R.S., President, in the chair.—Some criticisms on the modern theory of solutions, by Edgar F. Morris. By applying the ordinary assumptions of the kinetic theory of solutions to the case of a semipermeable cell depressed below the surface of the solvent, the result is deduced that the percentage composition of any solution is a linear function of its density. The form of the reaction equation for the catalysis of esters shows that the action cannot be attributed to independently moving ions. Other facts disproving this theory are the occurrence of electrolytic solutions with normal molecular weights, and of cases where the molecules would have to be regarded as split into most curious fragments to provide a sufficient number of ions—in the case of certain metals in mercury solution into more ions than atoms. Prof. Fitzgerald has previously shown the physical basis of this theory to be unsound, and, as the chemical applications give untrue results, it was held that the theory should be abandoned.

EDINBURGH.

Mathematical Society, February 9.—Mr. R. F. Muirhead, President, in the chair.—Remark on Dr. Peddie's proof of a theorem in potential, by Mr. R. F. Muirhead.—A general mechanical description of the conic sections, by Mr. Alex. Morrison.—On Bessel functions and spherical harmonics, by Mr. John Dougall.

DUBLIN.

Royal Dublin Society, January 17.—Sir Howard Grubb, F.R.S., in the chair.—Mr. W. E. Thrift read a paper on the possible rapidity of movements in cells produced by diffusion, the paper being communicated through Prof. G. F. FitzGerald, F.R.S.—Prof. J. Joly, F.R.S., read a paper on a fractionating rain-gauge. The apparatus was exhibited and described.

PARIS.

Academy of Sciences, February 19.—M. Maurice Lévy in the chair.—Researches on the isomerism of the sulphocyanide derivatives, by M. Berthelot. Determinations of the heats of combustion and formation of the sulphocyanides and isosulphocyanides of methyl, ethyl and phenyl.—On the determination of the integrals of certain partial differential equations by their values on a closed contour, by M. Émile Picard.—The tetrahedric deformation of the earth and the displacement of the pole, by M. Marcel Bertrand. A discussion of Lowthian Green's theory, in which it is shown that no results inconsistent with facts are obtained by the logical development of this view. Six diagrams are given showing the tetrahedron of volcanic fractures and various sections of the earth on the assumption of the existence of the tetrahedron.—On the culture of blue lupins (*Lupinus angustifolius*), by MM. P. P. Dehérain and E. Demoussy. The experiments described show that the blue lupin is incapable of utilising by itself atmospheric nitrogen, although it may attain full development in the absence of nodules upon the roots. In the latter case the plant appears to profit by work carried out by bacteria living upon certain algæ. It was found that the roots of the blue lupin may bear nodules containing bacteria that are of no use to the plant.—On the new Giacobini comet, by M. Perrotin.—M. Stokes was elected a Foreign Associate in the place of the late M. Weierstrass, M. Zittel a Correspondant for the Section of Mineralogy, and M. Pfeffer a Correspondant for the Section of Botany.—On calculating machines, by M. L. Torres.—Remarks on a meteor which fell at Bjurböle (Finland) on March 12, 1899, by the French Consul in Finland.—Determination of surfaces having a system of lines of equal curvature, by M. R. Bricard.—On a transformation of isothermal surfaces, by M. C. Guichard.—On the problems of Neumann and Gauss, by M. W. Stekloff.—On functions with four pairs of periods, by M. G. Humbert.—Theory of helices of propulsion, by M. Rateau.—On the determination of standard lines in the spectrum, by M. Maurice Hamy. Four rays from a cadmium tube are selected, having approximate wave-lengths 644, 515, 508 and 466, and the exact ratios of the first to each of the last three determined with a high degree of precision.—Determination of new points of reference in the spectrum, by MM. A. Perot and Ch. Fabry. An application of the interference method previously described by the authors to the measurements of eighteen wave-lengths between $\lambda = 435{\cdot}8\,\mu\mu$ and $\lambda = 670{\cdot}8\,\mu\mu$, the error of the determination being less than one-millionth.—On a method of focussing a photographic telescope, by M. Georges Meslin.—A new interpretation of the results of M. Michelson for the analysis of homogeneous light by Newton's rings, by M. E. Carvallo.—The instantaneous disappearance of magnetic rotatory polarisation, by MM. H. Abraham and J. Lemoine. The authors apply the method previously used by them in the measurement of the duration of the Kerr phenomenon to the study of the extinction of magnetic rotation, and find that the polarisation is less than a hundred-millionth of a second (·000,000,01 sec.) behind the current producing it. Hence the magnetic rotation follows without any lag the variations in the fields which produce it.—On a method of preparation of alkaline arsenides, antimonides, and some alloys of the alkali metals, by M. P. Lebeau. The ordinary method of preparing arsenides by heating together the elements composing it, never gives a pure product, but if the crude arsenide thus obtained is extracted with liquid ammonia at $-80°$, the excess of sodium is removed, and the Na_3As is left in a pure state. Na_3Sb, Na_3Bi, and Na_4Sn can be prepared in a similar manner.—On iodide of nitrogen, by M. C. Hugot. A study of the action of liquid ammonia upon iodine. The results obtained are expressed by the author in the equation

$$16NH_3 + 3I_2 = 3(NH_4I.3NH_3) + NI_3.3NH_3.$$

—Meconine, opianic acid, and hemipinic acid, by M. Émile Leroy. A thermochemical paper containing determinations of the heats of combustion and formation of meconine, opianic acid, its potassium salt, and methyl ether.—Resolution of racemic benzylidene-camphor. Isomorphism of the two active components, by M. J. Minguin. The splitting up was effected by adding a dextrorotatory crystal to the toluene solution of the racemic compound.—Rapid method for determining the carbonic acid in various gaseous mixtures, by MM. Léo Vignon and Louis Meunier. The method is only applicable to gases such as air or coal gas, which can be obtained in unlimited quantities, and consists of a titration with lime-water tinted with phenolphthalein.—On the volumetric estimation of boric acid, by M. Alfred Stock. The solution containing the boric acid is treated with a mixture of potassium iodide and iodate to remove free mineral acids, and the boric acid, which is without action upon this mixture, then titrated with soda in presence of mannite. It is absolutely essential that all the solutions should be boiled till free from carbon dioxide, quite erroneous results being obtained in presence of dissolved carbonic acid.—Researches on the genesis of compounds of the menthol series in plants, by M. Eugène Charabot.—On a new Epicarid, *Crinoniscus equitans*, by M. Ch. Pérez.—Development of the azygospores in *Entomophthora*, by M. Paul Vuillemin.—Relation between the variation of excitement of nerves and the variation of the exciting currents of different potentials, by M. Stéphane Leduc.—The quotient of fatigue, $\frac{H}{N}$, by Mdlle. J. Joteyko.—New method for measuring the acuteness of hearing for the intensity of sound, by MM. Ed. Toulouse and N. Vaschide. The sounds are produced by drops of water falling upon a metallic plate, the variations in intensity being obtained by varying the height through which the drops fall.—On the normal asymmetry of the binary organs in man, by M. P. Godin.—On the composition and feeding value of the mammalia, birds and reptiles, by M. Balland.—The barometric oscillations of February 13–19, 1900, by M. Joseph Jaubert. The oscillations were remarkable on account of their amplitude and short period, four maxima and minima being noted in six days, with an average amplitude of over 10 mm.

Cape Town.

South African Philosophical Society, January 31.—Mr. L. Péringuey, President, in the Chair.—Mr. Chas. F. Juritz read a paper, entitled "The Soils of the South-Western Districts of the Cape Colony." The low percentage of phosphates in some samples of oat-hay analysed by the author ten years ago, led him to urge the Government to allow investigations into the chemical nature of the colonial soils to be carried out. The work has progressed to a very considerable extent, but the area from St. Helena Bay to Mossel Bay having been also geologically surveyed, Mr. Juritz confined his present paper to it. Most of the soils analysed were from the Malmesbury and Bokkeveld Beds. In portions of the Malmesbury district the underlying limestone greatly aids the fertility of the soil and renders its wheat "rust-resistent." The lime dimishes in amount from D'Urbanville to Hopefield. The Caledon soils are poor, but those of Bredasdorp are much better. The soils on the Enon Beds of Swellendam and Mossel Bay are good all-round soils. Of the two hundred and twelve soils examined, only fifteen contain a satisfactory amount of phosphates, forty-five a normal amount of lime, and fifty-seven of potash.

DIARY OF SOCIETIES.

THURSDAY, March 1.

Royal Society, at 4.30.—An Experimental Inquiry into Scurvy: F. G. Jackson and Prof. Vaughan Harley.—The Velocity of the Ions produced in Gases by Röntgen Rays: Prof. J. Zeleny.—Mathematical Contributions to the Theory of Evolution. VIII. On the Correlation of Characters not Quantitatively Measurable: Prof. K. Pearson, F.R.S.

Linnean Society, at 8.—On Botanic Nomenclature: C. B. Clarke, F.R.S.—On some Foraminifera of Tithonian Age from the Limestone of Nesseldorf: F. Chapman.

Chemical Society, at 8.—Pilocarpine and the Alkaloids of Jaborandi Leaves: Dr. H. A. D. Jowett.—Isomeric Partially Racemic Salts containing Pentavalent Nitrogen, Parts I.–VII.: Prof. F. S. Kipping, F.R.S.—New Synthesis of Indene: Prof. F. S. Kipping, F.R.S., and Harold Hall.—(1) Potassium Nitrito-hydroximidosulphates and the Non-existence of Dihydroxylamine Derivatives: (2) Identification and Constitution of Fremy's "Sulphazotised Salts of Potassium": Dr. E. Divers, F.R.S., and Dr. T. Haga.—Some Acids obtained from α-Dibromocamphor: A. Lapworth and E. M. Chapman.

Röntgen Society, at 8.—Measurements of the Absorbability of Röntgen Rays: J. H. Gardiner.—Skiagrams of Two Cases of Renal Calculus before and after Removal: Dr. Hugh Walsham.

FRIDAY, March 2.

Royal Institution, at 9.—Malaria and Mosquitoes: Major Ronald Ross.

Physical Society (University College), at 4.30.—The Relative Rates of Effusion of Argon, Helium, and some other Gases: Dr. F. G. Donnan.—On the Distillation of Liquid Air and the Composition of the Gaseous and Liquid Phases: E. C. C. Baly.—The Reversibility of Galvanic Cells: T. S. Moore.—On the Damping of Galvanometer Needles: M. Solomon.

Geologists' Association, at 8.—Wind-worn Pebbles in the British Isles: F. A. Bather.

SATURDAY, March 3.

Royal Institution, at 3.—Polarised Light: Lord Rayleigh.

MONDAY, March 5.

Royal Geographical Society, at 8.30.—In the Heart of Borneo: Charles Hose.

Society of Arts, at 8.—The Photography of Colour: E. Sanger Shepherd.

Society of Chemical Industry, at 8.—The Presence of Naphthalene in Coal Gas: R. W. Allen.—Notes on the Determination of the Iodine Value of Oils: Arthur Marshall.

Victoria Institute, at 4.30.—Coins of the Ancients: Dr. Zimmerman.

TUESDAY, March 6.

Royal Institution, at 3.—Structure and Classification of Fishes: Prof. E. Ray Lankester, F.R.S.

Zoological Society, at 8.30.—Descriptions of New Reptiles and Batrachians from Borneo: G. A. Boulenger, F.R.S.—On the Brain of the Siamang (*Hylobates syndactylus*): F. E. Beddard, F.R.S.—On a Collection of Mammals from Siam: J. Lewis Bonhote.

Institution of Civil Engineers, at 8.—*Paper to be further discussed*: Corrosion of Marine Boilers: John Dewrance.—*And, time permitting, Papers to be read with a view to discussion*: A Short History of the Engineering Works of the Suez Canal: Sir Charles Hartley, K.C.M.G.

Royal Photographic Society, at 8.—Some Beauty Spots of English Scenery: John A. Hodges.

WEDNESDAY, March 7.

Society of Arts, at 8.—Macombe's Country (South of the Zambesi): its Ancient Gold Fields and Industrial Resources: Dr. Carl Peters.

Geological Society, at 8.—Notes on the Geology of Gilgit: Lieut.-Gen. C. A. McMahon, F.R.S.—(1) The Rocks of La Saline (Northern Jersey): (2) The Rocks of the South-eastern Coast of Jersey: John Parkinson.

Entomological Society, at 8.

Society of Public Analysts, at 8.—The Determination of Carbon and Sulphur in Steel: Bertram Blount.—Maize Oil: Rowland Williams.—Note on the Assay of Creosote: A. D. Hall.—Note on the Influence of Temperature and Concentration on the Saline Constituents of Boiler Waters: Cecil H. Cribb.

THURSDAY, March 8.

Royal Society, at 4.30.—Bakerian Lecture: The Specific Heat of Metals and the Relation of Specific Heat to Atomic Weight: Prof. Tilden, F.R.S.

Royal Institution, at 3.

Mathematical Society, at 8.—On the Use of the Curve of Error as an Auxiliary Curve in Statistics with Tables: W. F. Sheppard.

Institution of Electrical Engineers, at 8.—On the Applications of Electricity in Medical and Surgical Practice: Dr. H. Lewis Jones.

Camera Club, at 8.—Steam Turbines, Land and Marine: A. A. Campbell Swinton.

FRIDAY, March 9.

Royal Institution, at 9.—Bacteria and Sewage: Prof. Frank Clowes.

Royal Astronomical Society, at 8.

Institution of Civil Engineers, at 8.—The Distribution of Stress in the Walls of a Thick Cylinder: John Duncan, W. A. Wales, and G. J. Day.

SATURDAY, March 10.

Royal Institution, at 3.—Polarised Light: Lord Rayleigh.

CONTENTS.

THURSDAY, MARCH 8, 1900.

EGYPTIAN AND BABYLONIAN RELIGION AND MYTHOLOGY.

Books on Egypt and Chaldaea. Egyptian Ideas of the Future Life; Egyptian Magic. By E. A. Wallis Budge, M.A., Litt.D., D.Lit. 2 vols.

Babylonian Religion and Mythology. By L. W. King, M.A., F.S.A. 1 vol. (London: Kegan Paul, Trench, Trübner and Co., Ltd., 1899.)

THE delightful certainty which characterises the youth of an individual not infrequently finds its analogue in the initial phases of a science. At the outset assertion is dogmatic inversely to the evidence, and the flimsiest figments are made to serve as the basis of the widest generalisations. Maturity brings with it a curious restriction of certitude, but for this there is a compensation in the knowledge that for the faith which we do hold there is an adequate reason. Thus it has long been the custom to regard the religion of ancient Egypt as a tissue of the grossest idolatry, and this amongst persons who were not, in general, ill-informed. To such a view the education of the public school and the university has largely contributed, and those who were contented to mould their opinions upon classic authorities would be apt to remember nothing more than Juvenal's telling gibes, which practically epitomise the creed as that of the ape and onion. Whatever the poet's personal views may have been, those which the exigencies of his satire led him to express are far removed from the truth or, at least, they state it so partially as to be wholly misleading; and it may come as a surprise to many to learn the magnitude of the libel. As a matter of fact, the ideas and beliefs of the Egyptians concerning God closely approximated to those of the Hebrews, and of the Muhammadans at a later period; and they arrived at conceptions of man's immortality for which we look in vain in the Jewish record, and which we only re-encounter in the teaching of the Christian churches.

Dr. Budge emphasises the fact that an exalted monotheism was the basis of the theology and religion of ancient Egypt, and that it persisted throughout its historic periods with a tendency ever increasingly assertive. God was one, self-existent, immortal, invisible, eternal, omniscient, almighty and inscrutable; the creator of the heavens, the earth, and of all things visible and invisible. But long as the period was during which this noble creed was held, there was unquestionably a time prior to its evolution when a more primitive conception prevailed, and when the beliefs of the people were probably similar to those of existing savages: when family and tribal gods were worshipped whose characteristics were those of their adorers, and whom a victory or a defeat raised to supremacy or relegated to oblivion. It has been observed that three main elements may be recognised in the Egyptian religion. A solar monotheism, or a god specially manifested in the sun; the worship of the regenerating powers of nature or the adoration of ithyphallic deities; and an anthropomorphic divinity; but the sequence in time of these phases of faith is doubtful, and they ultimately became intermingled in a most bewildering manner. Where such uncertainty exists we must rest satisfied with a suspension of judgment; but it may be reasonable to assume that the less exalted views were formulated before those of a higher type; that the earlier notions acquired from their antiquity a sanctity which led to their retention; and that ecclesiastical conservatism was responsible for that grotesque admixture of puerile superstitions, both in faith and practice, which disfigured the higher faith to such an extent as to cause strangers to regard it as the essential element of that purer religion by which it had been supplanted. This curious grafting of views has an apt illustration in the picture symbol for the supreme being, who is figured by a stone axe-head in a wooden handle, a reminiscence of the time when their god was but a magnified chief, and when the wielder of the biggest war-axe being the person of prime consideration, an image of the weapon was a recognised emblem of power and sovereignty Apart from these survivals, the very piety of the worshippers served to enhance the number of the gods, for the sun-god, himself the type and symbol of the supreme deity, found his every form, phase and attribute deified, until so strangely complex a pantheon was set up that the protogod was almost whelmed by the sanctifications of himself.

In spite of this seeming multiplication of entities, the unity of God is constantly reiterated; and if, as may well have been, this truth was hidden from the perception of the vulgar crowd, we may believe that to the educated layman, as well as to the priest, it was an ever-present fact. The pure and unthinkable spirit which formed the subject of their devout adoration dwelt originally in the darkly-shrouded water of the primeval abyss. Thence, by uttering his own name, he evolved himself; whilst from the void, the world sprang into existence, after the type which was pre-existent in the divine mind. Following this creative act was the production of the germ from which emerged that embodiment of the power of God, the holy Ra, whose attributes were subsequently annexed by that great Osiris, who for ages was the ensample and comfort of aspirants to immortality. It is curious that no comprehensive account of the career of Osiris has been found in the Egyptian records, and that we depend upon Plutarch for a connected history. This, as it is confirmed by various Egyptian inscriptions, may be outlined as follows:—Osiris was the offspring of Nut by Seb, and was the husband of his sister Isis. As King of Egypt, he advanced civilisation; taught the art of agriculture; and exhorted men to worship the gods, both in his own and other lands. On his return from foreign proselytising, he was slain by the machinations of Set, who repossessed himself of the body, after it had been obtained by Isis, and tore it to pieces. The fragments, with a single exception, were recovered and buried by Isis, who instituted a special festival in honour of the missing portion. By divine assistance Isis obtained such a revivification of Osiris that, by him, she became the mother of Horus, who was, later, his father's avenger. Of the exact position which in prehistoric days was occupied by Osiris we are ignorant; but, in all later times, he was regarded as a being of divine origin, who was killed and mutilated by the powers of evil, and who rose again to become King of the Underworld and judge of the dead. He represented the idea of one who, though a god, had been a man who had suffered and died, and who was, therefore, in full sympathy with human beings in their own time of trial and death. As his flesh had not seen corruption, so was he the cause of mortals being born again, and the righteous who followed his ensample might, with the help of the gods, secure a resurrection to everlasting life, and dwell with him in his kingdom.

In this way Osiris, from being the example of a man raised from the dead, became himself the cause of the resurrection and the bestower of eternal life, and it is needless to say that his ever-increasing popularity finally raised him to the position of the quasi-national God. He gradually assumed the attributes of the cosmic deities and even of the creator; and thus making himself his father's equal, he reigned beside him in Heaven as the divine source of all things. It is sufficiently evident that the growth of such conceptions must have been gradual, and that prior to their formulation the condition of the disembodied spirit must have been largely problematic. It was then, no doubt, regarded as a spook which it was as well to banish from the precincts of the living; and those mutilations and cremations of corpses which were originally practised may have been intended to coerce the spirit into an abandonment of his old habitation. With the belief in a resurrection a new order of ideas arose, and, far from a desire to destroy the body, every means was sought for its preservation. The outcome of the new dogma was that wonderful system of mummification with which we are familiar, but the adoption of which, in view of the strongly expressed declaration that immortality was confined to the spiritual body, is somewhat inexplicable. It may be that the primary conception of the resurrection was that of the physical body, and that the spiritualisation of the tenet was a subsequent modification; in which case the later retention of the practice would be due to the ever observable reluctance of man to change the procedures associated with the crises of his existence. Another explanation may be found in the fact that the spiritual body derived its existence from the physical body through the prayers and ceremonies of the funeral rites. There are various pictures representing the departed soul as hovering in proximity to the mummied corpse, of which, possibly, it could but gradually acquire the characteristics. Were that the case, the necessity for a prolonged retention intact of the senseless clay is intelligible in order to afford ample time for the intended assimilation whereby the mortal put on immortality. Be this as it may, by whatever process the spiritual body acquired its existence, it was called upon to answer for the deeds done in the flesh: the heart, as the seat of being, was literally weighed in the balance, and woe to its possessor were it found wanting. Then the deceased had to declare himself innocent of forty-two specific transgressions contained in a catalogue which is so skilfully compiled to include every possible wickedness, that it must have been very difficult to sin outside it. Either, then, the gods failed to verify their facts, or, unless they differed considerably from the men and women of to-day, the number of the Egyptian elect must have been infinitesimal. The final admittance to Elysium was further hindered by a series of perplexing interrogatories—floor and threshold—hasp and socket each in turn propounded its riddle to the aspiring soul; an ordeal apparently purposeless until it is understood that it was the business of the priesthood to furnish the replies which were needed to pass the purified spirit to the presence of that Osiris with whom he had at last become identified.

When we find the ecclesiastical body purveying such wares for the spiritual well-being of their flock, it is evident that the line of demarcation between religion and magic is faint. Indeed, as one reads the documents cited by Dr. Budge, it is by no means easy to determine the category to which certain practices and invocations should be relegated. In a sense the whole religion was so theurgic that it might pass for a sublimated magic; whilst much of what is classed as magic consisted in such invocations of divine beings, and aspirations for assimilation to them, as to contain the essence of genuine religion. It may be taken that the fundamental doctrine of magic is contained in the formula, "whatever is above is below, and whatever is below is above." The idea being that all existing things are created after divine prototypes, and that by an accurate perception of the one a knowledge of the other is obtainable. The germ of such an idea evidently existed in Egypt, the Supreme God having produced the universe in accordance with his previous mental conception. The premises being admitted they might serve either as the means by which a partial comprehension of the creator was obtainable, and as inciting the student to thankfulness and adoration; or they might place in his hands a means not only of invoking the gods, but of compelling them to his will. It must always be borne in mind that ideas, whether religious or not, are not the outcome of unreasoning invention, but are the result of a certain sequence of thought, however wanting it may be in logical acumen. The association of a certain evil with a certain precursory series of facts may have been arrived at on the post-hoc propter-hoc principle; but that this is so only proves the insufficiency and inadequacy of the observations upon which the association was reached, and not that it was arbitrarily devised. In many cases the mental position from which a belief or a custom was reached is so alien to our own that we are unable to reconstruct the train of thought by which it was arrived at; but in some cases we have been provided with a key to the mystery, and that is especially the case where names are in question. A spirit appearing before the gods had to be known and named by them. Nameless, he was non-existent, and consequently we find that, to the Egyptian, the name was as much a part of a man's being as his soul. Just as possession of the soul would place the entire individual in the possessor's power, so the name of god or devil gave a control which made the spirit your humble servant. The names of beings or things were words of power to conjure with, and, as has been stated, it was by the utterance of his own name that God brought all things into existence. It was but doing on a supreme scale what man on a lesser might perform; and when the potency of the uttered word was admitted, the transition to the efficacy of the written charm and the engraved talisman was a mere question of time and of a certain subtlety of reasoning. From an existent sympathy between words and things a belief in an equivalent interrelation betwixt objects might arise, either from a fancied resemblance of nomenclature or by an analogous train of thought which classed together things which had some real or fancied resemblance, a process of which the mandragora of later legends is an instance. From this system of affinities, bounded only by the imaginative powers of the sorcerer, the weaving of the most complex web of enchantment was inevitable. In Egypt the system was prolific, and bore as its fruit that crop of magical figures, pictures, spells, and ceremonies, with the attendant beliefs in lucky and unlucky days, dreams, demoniacal possessions, and astrological lore, with which the learned doctor has filled his pages to the delight of the occultist.

In the study of the Babylonian religion and mythology which is presented to us by Mr. King, we find a less exalted view of divine beings than that reached in Egypt, the beliefs of the Babylonians, in such matters, having received a tincture from their predecessors, the Sumerians, which was never wholly eradicated. Of the creed thus evolved, documentary evidence older than the seventh century B.C. is wanting, but this source of information is supplemented by the recorded beliefs of the Assyrians who were themselves colonists from Babylonia. Here the gods were many, a catalogue of 1800 names failing to furnish a complete enumeration, a heterogeneous company essentially human in their attributes, who were born, caroused, loved, fought, and even died. In later historical periods the chief deities acquired definite characteristic personalities, but they were only in degree superior to their worshippers, who never reached the conception of a Supreme Being essentially different to themselves. The gods, who were personifications of the forces of nature, had their cults curiously relegated to special centres, being localised in different cities, the fortunes of which they followed. The great triad of Anu, Bel and Ea, the respective deities of heaven, earth and the abyss of waters, headed the company of the gods; with the subsidiary trinity of Sin, the moon-god, his son Shamash the sun-god, and Rammān, god of the atmosphere; but the most prominent deity was Marduk, the tutelary god of Babylon, who, as that city rose into importance, became identified with Bel, and was established as the intercessor for mankind. Scant justice was accorded the ladies, the goddesses being but faint reflexes of their husbands, with the exception of Ishtar, who occupied a position of commanding importance in her dual aspects of the patroness of love and war. No doubt the heavenly host was influenced by the peculiar cosmogony which obtained. It was thought that from out the waters which, in the darkness of chaos, alone at first existed, abnormal creatures sprang. Over this monstrous brood the woman-dragon Tiāmat was supreme, until, after creating the gods, she rose in revolt against them. She was vanquished and slain by the divine champion Marduk, who employed the fragments of her body to fashion the earth and heaven. The portion used to make the earth he shaped as an inverted bowl surmounted by the remainder of the corpse bent into the hollow hemispherical vault of heaven, and both resting on the waters of that great deep, from which all things had their origin. Above the firmament was a celestial ocean, and beyond that the innermost heaven to which the gods retired when weary of their earthly abodes and the immediate conduct of human affairs.

Beneath the earth was the seven-walled house of the dead in the "Land of no Return." Here no distinction was made between the good and the bad, all being alike condemned to the same joyless existence. The gloom which pervaded the tomb may have originated in the rapidity of decomposition and decay in the moist alluvial soil of Mesopotamia, and the elaborate burial rites which were observed had no further object than to prevent the wanderings of the earth-bound shade, who would haunt those who neglected to secure him a safe passage to Hades.

Whilst this and other passages scattered through the text will give the student of folk-lore and demonology much food for thought, the chief interest of the work naturally centres in the exposition of the resemblances which exist between the Babylonian myths and the Jewish traditions recorded in the Bible. Mr. King has directed attention to the legends of the Great Dragon, the Creation, and the Deluge, and shows that both nations derived their narratives from a common source, or that, at any rate, the Hebrews' indebtedness to the Babylonians was long antecedent to the period of the captivity. It is a matter for regret that the limits of this notice forbid more than an allusion to this section of the volume, which is likely to be that most generally attractive. In the succeeding portion is recited the poem of Gilgamesh, in which are recounted his exploits and those of his semi-divine friend Ea-bani. This story has no Biblical equivalent, unless we see in Ea-bani, who "was clothed with long hair like a woman," was of stupendous strength, and became a victim to the wiles of the woman Ukhat, the analogue of Samson and Delilah. Such resemblances must necessarily arise, and to insist upon too close an identification may be unwise; but, in leaving such speculations, we pass to what is of more human interest, the personal relations which existed between the Babylonian and his gods. Here we find that to each man, from his birth, a god and goddess were allotted as guardians and monitors. They departed from him if he transgressed, and when they so withdrew, priestly intervention was necessary to secure a return of their favour. At first mere defects of ritual observance or the utterance of ill-omened words were the sole causes of divine estrangement; but as the mental conceptions of the people were elevated, injustice to their fellows and sins against their neighbours were regarded as constituting equally valid grounds for the wrath of the gods. And so in process of time it came to pass that upon a foundation of much apparent absurdity, the good sense of the Babylonians erected a working code of morality which an existing tablet cataloguing acts that were regarded as sins shows to have been little inferior to that of the Hebrews.

It is impossible within the necessary limits to do fitting justice to the contents of these most interesting volumes, and the care with which the great mass of facts which they contain has been condensed defies any attempt to reduce them to a précis. That they fill an existing blank in the text-books on comparative religions is obvious, and their careful documentation cannot fail to convince the reader that, in following the authors through the mazes of Egyptian and Babylonian belief and ceremonial observance, he has no uncertain guides. There will be few who will not learn from these volumes much detail of which they were previously ignorant, and many will derive from them their first clear conception of what was really believed in ancient Babylonia and of the sublime grandeur of that faith which during so many centuries was the spiritual stay and solace of the Egyptians.

Frank Rede Fowke.

HUXLEY'S SCIENTIFIC MEMOIRS.

The Scientific Memoirs of Thomas Henry Huxley. Edited by Prof. Sir Michael Foster, K.C.B., M.A., LL.D., F.R.S., and by Prof. E. Ray Lankester, M.A., LL.D., F.R.S. In Four Volumes. Vol. II. With Portrait. Pp. xi + 612. (London: Macmillan and Co., Ltd.)

The second volume of this valuable series will be welcomed by a large class of readers, and not alone by those who are professed biologists. The thirty-seven memoirs here collected together for the first time in one volume were published at dates ranging from 1857 to 1864, and, therefore, cover a period of strife and ferment which originated within the scientific world, but soon spread beyond it, that, namely, caused by the publication of Darwin's "Origin of Species" in 1859.

Naturally, we find amongst the writings, at this period, of one of the foremost champions of Darwinism, many memoirs devoted either to discussion of the problem of evolution as a whole, or to threshing out some special point in the evidence for or against the theory and its applications. Such papers will always possess an interest, even if only a historical one. Here we have, for instance, Huxley's famous controversy with Owen as to the alleged constancy of the "posterior horn of the lateral ventricle" and the "hippocampus minor" as characters distinguishing absolutely the brain of man from that of the ape, and of sufficient importance to rank man as a distinct sub class of the mammalia. It is difficult to imagine any naturalist of eminence at the present day advancing such conclusions, even granting the correctness of the premises, which, as a matter of fact, Huxley was able to impugn without difficulty. Here, again, we find the well-known controversy as to whether the human remains from the Neanderthal were those of an ape-like man or of a "rickety Mongolian Cossack." And before leaving the subject of Darwinism, we may draw attention to Huxley's eloquent and impassioned appeal, in a lecture, "On Species, Races and their Origin," delivered before the Royal Institution, for consideration of the facts of the case without prejudice. In his peroration the clerical and other opponents of the progress of physical science are likened to "little Canutes of the hour, enthroned in solemn state," who bid the great wave to stay, but who, when forced to fly, learn no lesson of humility, and pitching their tents at what seems a safe distance, repeat their folly; and, in conclusion, he calls upon the people of England to cherish and venerate science. "Listen to those who would silence and crush her, and I fear our children will see the glory of England vanishing like Arthur in the mist." At a time when colleges could be named in our great Universities whose authorities would prefer a "football blue" to a "research student," we may ask ourselves if we are not beginning to realise this prophecy.

It is not possible within the limits of a review to do more than indicate the many papers of interest collected in this volume, some of which laid the foundations of our knowledge, or marked an epoch in its advance, in not a few directions. Of great merit, but of interest to a more limited circle, are the numerous treatises upon fossil types, contributed to various geological periodicals; or anatomical memoirs, of which that upon the Nautilus may be taken as an example. Of more general interest are the two classical memoirs, "On the Agamic Reproduction and Morphology of Aphis," and "On the Anatomy and Development of Pyrosoma," in which Huxley made great additions to our knowledge, both of the theory and of the facts, of non-sexual processes of reproduction in both forms. From Pyrosoma he was led on to a discussion of the significance of the germinal vesicle of the ovum, which also forms the subject of a Royal Institution lecture deserving more than a passing notice.

At the present day it may be safely asserted that though much remains to be investigated and elucidated, yet a number of fundamental facts have been generally established with regard to the question of the nature of the sexual elements, and the process of fertilisation, in animals and plants. No instructed person now doubts that the ovum, whatever its size or peculiarities in a given species, represents a single cell set free from a many-celled organism, and that the germinal vesicle is the cell nucleus, which, after certain processes of maturation, unites in the process of fertilisation with the nucleus of the male cell or spermatozoon to form the so-called segmentation nucleus, the ancestor by repeated divisions of all the nuclei in the body of the future embryo. These are facts which now are taught to every student of biology in his first term, but in the early sixties it was not so. The details of fertilisation were unknown, except in so far that both ovum and spermatozoon were concerned in it, and the true nature of these two elements, in the light of the cell theory, was not understood. Many authorities believed that the germinal vesicle of the ovum and its contents disappeared, and had no direct connection with the cells of the blastoderm or future embryo. Huxley, on the contrary, was on the side of those who held the more correct view, that the cells and nuclei of the blastoderm stand in genetic relation to the germinal vesicle. His observations were, however, in so far erroneous, in that he believed he had seen in Pyrosoma the vitellus of the ovum disappear, and the cells of the blastoderm arising within the germinal vesicle.

In judging a mistake of this kind, the modern biologist will remember, in the first place, that the present state of our knowledge with regard to these matters has been attained by the gradual perfection of a technique more complicated than French cookery, and that to investigate or demonstrate these now well-known facts, a laboratory stocked with reagents and aniline dyes, with complicated machines for section cutting and other apparatus, is required. In the second place he will note, perhaps with astonishment, that Huxley's observations upon Pyrosoma were "conducted upon thin sections (that is to say, cut by hand with a razor, and not with a pair of scissors) of a spirit specimen, rendered clear by glycerine."

When all this is borne in mind, we can but admire the accuracy of the observations, taken as a whole, which Huxley was able to make upon the anatomy and development of this remarkable form of life; while any impulse we may feel to criticise an error with regard to finer points of cytological detail will be checked by the thought that if, in the short space of forty years, biology can make such progress in the investigation of the most mysterious of vital processes, what judgments may the future not have in store for much of our work at the present day, even within the lifetime of many of us!

We have said enough, we hope, to prove how much interesting reading of the most varied kind is furnished by the collected works of one of our greatest scientific men, and we feel sure that many will look forward with pleasurable anticipation to the continuance and completion of this series. E. A. M.

SCENERY AND GEOLOGY.

The Scientific Study of Scenery. By John E. Marr, M.A., F.R.S. Pp. xi + 368. (London: Methuen and Co., 1900.)

SO much has been done within the last thirty years in all parts of the world, and especially in America, to discover and interpret the varied forms of earth-sculpture, that the knowledge required to be summarised. Scientific surveys and explorations, the facilities for travel, and the use of the camera have largely contributed towards the accumulation of facts. One result, and by no means the most satisfactory one, is the increase of technical terms, for which our American brethren are largely responsible. To remember what is the Uinta type of mountain folding; what is meant by consequent, subsequent and obsequent streams, by inconsequent drainage and corrasion; and what is the difference between clouds of radiation, of inversion, of interfret, and of inclination, may tax the memory and patience of any one who is not constantly engaged in teaching. Here Mr. Marr comes to the rescue, describing and explaining in clear language all the leading types of scenery, and many of the minor and no less interesting features connected with it. He discusses the origin of hill and dale, of peneplain and nunatak, butte and zeuge; and, moreover, he gives in his work an index which will enable us to dispel our ignorance or refresh our memories when, as so often happens, we come across an unfamiliar or forgotten term. There was need for this concise handbook on the scientific study of scenery.

The author makes a praiseworthy attempt to please two classes of readers—the student and the "general reader." That his work will be appreciated by the student we are fully persuaded. That the general reader will steadily puruse the volume must depend upon whether he or she reads for the sake of solid instruction.

The author's brief introduction is fascinating, but we are plunged in the next chapter into "three envelopes," the lithosphere, hydrosphere and atmosphere, and into a consideration of anticlines, synclines and monoclines, and planes of foliation, cleavage and faulting: subjects necessary for the proper understanding of various types of scenery, but not readily dealt with in pleasing language. Here and there throughout his book the author enters into a little more detail than appears to be required to explain the relation between rock-structure and rock-texture and scenery; and the general reader may find it difficult to distinguish between the "Normal Fault" and the "Monoclinal Fault" figured on p. 66. When, however, the author speaks of his work as an "Introductory Treatise on Geomorphology," we feel not only that he intends it mainly for serious study, but that he has a very decided personal regard for technical terms. He shows how dependent the scenery is on the structure of the earth's crust, on the sculpturing agents, and on the character of the climate. The colours of the sky, the water and the rocks, the forms of cloud, and the influence of vegetation come in for appropriate notice in different parts of the volume.

Continents and ocean-basins, crust-waves and speculations on lines of uplift are duly considered, and so also are mountains and valleys, escarpments, volcanoes, deserts and plains, oceans and oceanic islands. The author writes with evident enthusiasm for his subject; and whenever he is free from detail, the labours of the conscientious reviewer become more pleasant. With Kingsley he can speak with eloquence of the beauties of the Fenland, and with Captain McMahon of the charms of the desert. He records his sorrow at "the mutilation of a district rich in natural beauty" by the operations of mining or quarrying, when such works are not, as was the case with the water-works of Thirlmere, "justifiable on the ground of necessity." We remember to have seen quarrying operations in the heart of the Cheddar Cliffs, perhaps the finest inland cliffs in England, and this is an instance where local rights should be compulsorily purchased at the public expense.

We are glad to find the author dealing, every now and again, with the sentimental aspects of the subject. Hugh Miller, jun., enlarged on such topics in his "Landscape Geology" (1891); while the more recreative aspects of scenery are charmingly portrayed in the Badminton volume on Mountaineering, by Mr. C. T. Dent.

The work before us is illustrated by an admirable series of plates, reproduced from photographs. The High Force of Teesdale and the Screes of Wastwater are fine examples; while others, equally good, exhibit mountain structure, glaciers and lakes. The origin of lakes is varied, but the subject has given rise to much controversy among geologists—a controversy mainly concentrated on the question whether rock-basins of any magnitude have been excavated by ice-action. On this subject Mr. Marr has his doubts, and he says

"that in order to prove that ice can excavate a basin, we must show, first, that the actual rock basin exists; and, secondly, that it cannot have been formed in any other way than by the erosive action of ice."

The question is one which is under investigation at the present time; but it may be observed that, in many a lake earth-movements, dams and erosion may all have contributed towards the production of the features.

The work of frost, snow and ice, and the accounts of glacial phenomena past and present, are, like every other portion of his subject, very fully and ably dealt with by the author. The work, indeed, embodies the results of the most recent researches on all the physical features of the earth's surface; it unites the labours of the geographer and geologist; and should prove a most helpful companion to every traveller. H. B. W.

OUR BOOK SHELF.

Plant Relations: a First Book of Botany. By John Coulter, A.M., Ph.D. Pp. vii + 264. (New York: D. Appleton and Co., 1899.)

A NOTABLE tendency to be observed in many modern text-books of botany is one indicating a departure in the direction of "natural history" as distinct from the more formal, and especially the histological, methods of teaching which have been in vogue (and somewhat too exclusively so) during the last few decades. It is perhaps chiefly in American works that this change has been most prominent, and Prof. Coulter's new book forms a weighty addition to the list.

It may perhaps be open to question whether ecology, as it is now the fashion to designate what used to be called natural history, is precisely the best aspect from which to treat botany regarded as an instrument of school education. For it is impossible to escape from a certain elusive vagueness in attempting even an elementary discussion as to the nature and interaction of the factors which determine so complex a matter as the forms or the mutual adaptation of living organisms.

But whatever may be thought in the abstract, of ecology as an introduction to botany from the scholastic point of view, there can hardly be two opinions with regard to the fascinating nature of the study itself; and as Prof. Coulter remarks in the preface to his book, it may perhaps not unfairly be argued after all that "the study of the most evident life-relations of plants gives a proper conception of the place of plants in nature. . . . The large problems of ecology are constantly presented in subsequent experience, when details of structure would be forgotten." The latter sentence, however, involves an admission of principles to which many educationalists would refuse assent. Prof. Coulter's book contains a great deal more, however, than geology in the more limited sense of the term; and it may perhaps not unfairly be described as dealing with the plant primarily as a living organism, a "going concern," and one which has, moreover, to maintain the order of its going.

In fact, the author may be congratulated on having produced one of the most interesting and refreshing little text-books that have appeared in recent years, and it will well repay a perusal on the part of those whose business it is to teach as well as to learn. The dominant note all through the book is physiology, using the term in its widest sense; and, although here and there perhaps an expression might prove to be open to misconstruction, the treatment is generally accurate and lucid. The differences between spores and seeds, for example, are (p. 111) forcibly and almost epigrammatically expressed, and this is but one out of many instances which might have been cited.

The numerous illustrations, which are nearly all excellent, add materially to the value of the book, and those which portray the vegetation characteristic of the different physical conditions of life call for especial praise. Not only are they admirably reproduced, but they really do emphasise clearly the *facies* of the various kinds of plant-societies. J. B. FARMER.

Elementary Chemistry for High Schools and Academies. By Albert L. Arey, C.E. Pp. xi + 271. (New York: The Macmillan Company, 1899.)

MR. AREY has followed the syllabus of the New York State Board of Regents in selecting portions of the science of chemistry for treatment, and in deciding the order in which such subjects shall be dealt with. A notable characteristic of his book is the admirable series of questions which the author has interspersed with the view of guiding the student's inferences, and of suggesting a definite line of thought in each experiment. But the exigencies of teaching in schools where the syllabus of instruction is laid down by an outside authority has made it impossible for Mr. Arey to consistently follow out this excellent plan; for the students are expected to become familiar with substances which do not lend themselves to experimental treatment, and with principles which cannot be practically proved, at the hands of young pupils. The consequence is that two methods of presentation exist side by side. In one the student is told the properties of certain chemical bodies; while in the other the properties of the compounds have to be determined by the pupil's own observation, and are not stated in the book at all. Notwithstanding this, the volume provides a good introduction to the study of inorganic chemistry.

A Manual of Chemistry, Inorganic and Organic. By Dr. Arthur P. Luff, B.Sc., and Frederic J. M. Page, B.Sc. Pp. xvi + 541. (London: Cassell and Company, 1900.)

DR. LUFF'S "Introduction to the Study of Chemistry," which has been well known to medical students for the past eight years, has been completely revised by Mr. Page, who has also incorporated such new facts and methods as the research work of these years has made necessary. The plan of the book is of a kind which was more familiar twenty years ago. No instructions for experiments to be performed by the student himself are included, except in the short concluding section of the volume, which provides tables for the examination of chemical substances containing one metal and one acid, and includes some half-dozen pages on the preparation of a few typical compounds. The book will probably continue to be useful in assisting medical students to pass their examinations; but it is unlikely to be adopted for any other purpose. So much ground is covered in the little volume that in parts it is little more than a dictionary.

Dictionary of the Lepcha Language. Compiled by the late General G. B. Mainwaring. Revised and completed by Albert Grünwedel. Pp. xvi + 552. (Printed and published by order of H.M. Secretary of State for India, 1898.)

THE preservation of the language of a dying race is a duty which ought never to be neglected. The late General Mainwaring had an intimate acquaintance with the language of the Lepchas of the Sikkim and Darjiling hills, and published a grammar of it in 1876. He also collected the materials for a dictionary, but death prevented him from completing it. To Dr. Grünwedel was entrusted the task of preparing this work for press, and he has found it a very difficult one. The whole of the manuscripts had to be rewritten and rearranged, and many new definitions had to be added. Errors and discrepancies are inseparable from a dictionary of an Indian language commenced by an Englishman, completed by a German, and printed by printers who understand neither Lepcha nor English; but they will be overlooked if the difficulties the editor has had to contend with, and the permanent value of the work, are considered.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Structure of the Inner Corona.

IT was my good fortune to observe the total eclipse of 1878 at the very exceptionally favoured station of Pike's Peak, at an elevation of 14,000 feet, and in the clearest air.

Having a few months earlier, on the occasion of the transit of Mercury, of May 6, been enabled to see the planet *before* it reached the sun's limb, owing to its projection on the background of the inner corona, I was greatly impressed by the brightness of the latter close to the sun, and though unable to give it more than a few seconds' visual observation during the eclipse, this was done with a five-inch achromatic, with a magnifying power of 72, which, so far as I know, gave the earliest intelligence of the extraordinary structure which obtains there.

I quote from my report addressed to the Superintendent of the United States Naval Observatory, and published in the *Annals* of the Observatory for 1876 (Appendix iii. p. 209):—

"What I saw thus momentarily was not in the least what I expected. If there were any structure in the very inner corona, it had escaped me when I had searched for it in a previous eclipse (at Jeres, in 1870). It is true that the sky was hazy on that occasion, and that on this it was exquisitely clear. Now what I saw in this brief view was a surprisingly definite filamentary structure, somewhat coarser and decidedly more sharply defined than I have ever seen filaments in the photosphere, not disposed radially, or only so in the rudest sense, sharpest and much the brightest close to the disc, fading rapidly away into invisibility at a distance of five minutes of arc or more (possibly in some cases of ten). The salient point to me was this very remarkable definiteness and precision of these forms, and this impression, made on my mind in that too brief moment, is reproduced in this sketch (*not here given*), taken from one made within ten minutes of the event. It is in no way a 'picture,' but a reproduction of the original memorandum of the first impression of the features of the (telescopic) inner corona, which were, to repeat: (1) Extraordinary sharpness of filamentary structure; (2) arrangement not radial, or only so in the rudest sense; (3) generally curved, not straight lines; (4) curved in different directions; (5) *very* bright close to the edge, and fading very rapidly,—fading out wholly at from five to ten minutes from it."

If I can trust to this memorandum of an observation which, however brief, was made under uniquely favourable circumstances, and to my own recollections, I should say that while most interesting photographs of the inner coronal structure have recently been made, yet that this feature has not yet been done justice to even in the best of them I have seen, and that it perhaps cannot be, with our present means. While trusting then that at the coming eclipse it will be a prominent subject for every party with an adequate photographic outfit, I beg to express the hope that wherever possible it may be made the subject of telescopic visual study. S. P. LANGLEY.

Smithsonian Institution, Washington, February 23.

Suggested Source of the Energy of the "Becquerel Rays."

IN view of the difficulties arising in supposing that the energy to produce the photographic, ionising and phosphorescent screen effects with the "Becquerel Rays," continuously emanates from the active substance, I would suggest that the possibility should be kept in view of the real source of the energy being found in the things themselves in which these effects are manifested.

From this point of view the emanating influence would be looked upon rather in the light of lines of force than as a wave propagation; and, indeed, up to the present we have no conclusive evidence that the effects are those of waves.

The ionising power is especially suggestive, and considered in connection with other known ionising effects through molecular distances, may well be only the case of similar action taking place over greater distances, corresponding to centres of greater molecular mass, such as the atomic weights of those up to the present observed active substances possess. The effect would then be viewed as due to what might be called a Becquerel field of force, arising it may be from some strained condition of the ether directly accompanying the existence of material molecules, or through the intermediary action of molecular chains. In this connection, as well as on account of the magnetic deflection, it would be important to know if the action takes place through a really high vacuum.

From this view the active substance need not lose in power with time, and so long as fresh unused-up material to be acted upon is brought up there need be no cessation in the effects observed.

An observation of M. and Mdme. Currie that a phosphorescent screen ceased to afford illumination after a time, although the active substance continued to effect fresh screens is in agreement with this, as well as their further observation that the exhausted screen after exposing to light is again capable of being effected. Thus some of the energy, at least if not all, is apparently to be attributed to the screen.

The effect, then, would be looked on as one of chance alignment or directive selection in a field of force; advantage, so to speak, being taken of suitable molecular movements according as they occur in the effected matter.

From this point of view there would be a close analogy with the action which takes place in a piece of soft iron in the field of a permanent magnet. The process of gradual orientation of the molecules in the iron, while it is occurring, corresponding to, say, the luminous stage in the phosphorescent screen. The final stage of magnetisation corresponds to the exhausted condition of the screen.

If these suggested views were correct we might expect from the analogy that forces should exist between the acted-on substance and the source of the "Becquerel Rays."

FRED. T. TROUTON.

Physical Laboratory, Trinity College, Dublin.

A Possible Cause of the Variability of Stars.

IN our study of nature it is sometimes advantageous to speculate as to possible causes of observed phenomena in cases where we are not yet in a position to institute an investigation which would entitle us to have no doubt as to the true cause. The cause suggested by the speculation may possibly prove to be the true cause; and if not, it is at all events likely to bear a valuable analogy as regards the laws of its operation, with the mode in which the real cause operates.

Prof. George Darwin's theory as to the origin of the moon is one of the most striking examples of such a speculation; and it was on reading it some years ago that an application of the same principles of action to account for variable stars occurred to the present writer. He now publishes the speculation because it seems to offer a satisfactory explanation of some remarkable facts recently brought to light which have attracted much attention, viz. that as many as forty stars of the Cluster Messier V., nearly one-twentieth of all the stars in the cluster, have been found to be variables possessing periodic times, light-curves, maxima of brightness, and minima of brightness, which, though not the same, do not differ much from one star to another.

As an introduction to the explanation which is about to be suggested, it will be convenient to refer to a very early experience of the writer. Potatoes used formerly to be boiled in open pots over a naked fire, and a phenomenon then presented itself, which he often watched when a boy with wonder, until at length, to his satisfaction, he perceived the very simple cause to which it is due. The water at almost equal intervals of time swelled up, and a little boiled over; it then subsided and boiled more tranquilly. These phases were repeated with surprising regularity, making the whole a definite quasi-periodic phenomenon; although upon a closer scrutiny it was found that the intervals, while nearly, were not exactly equal, neither were the recurring phases of the phenomenon accurately alike. Further experience showed that this example of quasi-periodicity is not exceptional, but one of a great body of quasi-periodic phenomena which occur in nature. With one of them we are here concerned, viz. with that which goes through its evolutions upon our sun, and manifests its approximately periodic character in the eleven-year period of sun-spot frequency.

It is obvious that the movements and other events to which sun-spots are due would only need to become a good deal more energetic to render our sun a perceptibly variable star with a period of eleven years. Now, a cause which may perhaps render them more effective is this. According as the sun or other star shrinks, its sun-spot or star-spot period will presumably undergo some change; but it is very unlikely that this change will follow the same law as that which governs the progressive shortening of the period of natural pulsation within the entire mass of the star. Accordingly, at a certain epoch in the history of the star, the two periods may approximate to one another. Thereupon the events producing star-spots are likely to acquire augmented intensity, which may render the star a variable star for a long cosmical period; in fact, until further shrinkage shall have slowly destroyed the adjustment.

Nor is it necessary that the two periods—that of star-spot frequency and that of natural pulsation within the star—shall become identical. The fluctuations in the number and size of star-spots will probably become exaggerated whenever the two periods in question become related in other simple numerical ratios. Accordingly, a star in the whole course of its life-history may at more than one stage become a variable star, although the most conspicuous fluctuation of its brightness, and that which is represented by the simplest form of light curve,[1] will only occur when the periods become equal.

In Messier V.—the great cluster in Virgo—the evidence which is published by Prof. Bailey in the *Astrophysial Journal* of last November establishes the fact that at least forty of its stars, or nearly one-twentieth part of all the stars of the cluster, differ but little from one another in brightness, and exhibit other resemblances which indicate that these stars are now very much alike in their physical condition. It is, therefore, in a considerable degree probable that at a remote epoch in the past they were so nearly in the same physical condition as to have then had pretty nearly the same brightness, the same star-spot period, and the same period of internal dynamical vibration. This amount of resemblance between so large a proportion of the stars of the cluster will not seem improbable to any one with experience of the appearances of star clusters, in many of which a conspicuous feature is the very notable proportion of the stars which are of one or of some few definite magnitudes.

If then these forty stars were originally nearly alike, they would continue so during their subsequent history. They would all shrink in the same way, they would continue at each subsequent epoch to have nearly the same star-spot period, and also to have all of them approximately the same period of natural internal pulsation; and would accordingly all arrive nearly simultaneously at that stage when these periods approximate. They would then all of them become variables, and under precisely the circumstances which have been observed, viz. with the simplest form of light curve, and with some approach towards having the same maximum of brightness, the same minimum, and the same period of fluctuation.

It has been observed above that in the successive adjustments that may arise while a star is shrinking, some may be of a kind to lead to variability with more than one minimum in each cycle, while the principal adjustment (where the two periods become the same and not merely simply related) will have only one minimum in each cycle. Instances of both are presented by known variable stars; though naturally the second case is that which has been most noticed because it is, when it occurs, that the brightness of the star exhibits the most conspicuous range of fluctuation. G. JOHNSTONE STONEY.

8 Upper Hornsey Rise, N., March 1.

[1] There is quite enough of correspondence between the light curve of those variable stars which have one minimum in each cycle, and the curve of sun-spot frequency, to create an appreciable presumption in favour of the speculation of the present paper.

A New Peripatus from New Zealand.

As the genus Peripatus is always regarded with exceptional interest by zoologists, I should like to make known through the medium of your columns the discovery of a new and very beautiful species in the dense beech forest at the head of Lake Te Anau, in the South Island of New Zealand. I found it a few days ago in the decaying trunks of trees (presumably beech), and have since collected between twenty and thirty specimens. The species resembles the well-known *P. novaezealandiae* in shape and size, but is at once distinguished both from it and from the other New Zealand species, *P. suteri*, by the possession of only fourteen pairs of walking legs, and by the presence on the dorsal surface of fifteen pairs of green spots arranged segmentally, one pair over each pair of legs, and one pair over the oral papillæ. The general coloration of the dorsal surface is dark grey mottled with orange, with a dark median band and a black or nearly black triangular patch between each two successive green spots on each side. There are also pale orange or whitish papillæ, very regularly arranged. The ventral surface is mottled grey or violet, with pale areas between the legs. The antennæ are grey, ringed with orange. One specimen is almost jet black on the dorsal surface except for the green spots. Adult females are at once distinguished by the presence of an elongated protuberance between the legs of the last pair. This organ is yellowish in colour and bears the genital aperture, closely resembling the ovipositor of the egg-laying Victorian species, *P. oviparus*. The males are rather smaller than the females, and have a white papilla at the base of each leg of the last nine pairs. I propose for this species the name *Peripatus viridimaculatus*.

Lake Te Anau, N.Z., January 14. ARTHUR DENDY.

Notes on the Occurrence of Amphioxus at Singapore.

THE following notes on the occurrence of *Branchiostoma belcheri*, Gray, at Singapore have been written at the suggestion of Dr. Arthur Willey, who has kindly examined and identified the specimens for me; they were collected by Mr. W. F. Lanchester and myself, and are, I believe, the first that have been obtained from the locality. The first indication we had of the presence of Amphioxus in the district occurred about the middle of November 1898, when a number of young examples were found amongst the material collected by tow-netting at the extreme surface of the water about one or two hours after sunset. At the time we were living on a small island about ten miles off Singapore, and we tow-netted every night just outside or over the edge of the reef surrounding the island. The tidal currents were generally very strong, and no doubt brought a considerable amount of the plankton from the deeper layers to the surface.

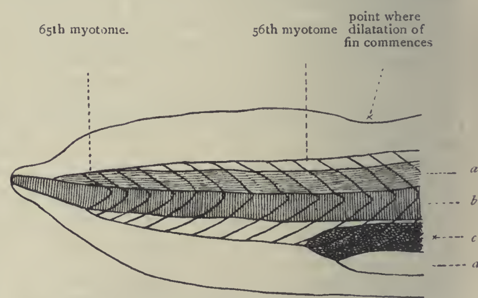


FIG 1.—*Branchiostoma belcheri*, caudal extremity, before metamorphosis; length of whole larva about 5 mm.

a, Nerve cord; *b*, notochord; *c*, rectum; *d*, ventral fin space.

Up till the end of November (when we left the island) young Amphioxus continued to be fairly plentiful; but they were never met with elsewhere, and in June last year I visited the island again and could find no trace of them.

All these specimens were in different later stages, some having completed their metamorphosis, the fin-rays and ventral fin-chambers being already formed, while in others the gill-slits were still unilateral and opened freely to the exterior.

After the capture of the above examples we repeatedly dredged in the hope of obtaining adult examples, but on only one occasion were we successful, and then only a single specimen was found. It occurred in about six fathoms of water on a bottom composed of somewhat coarse gravel-sand close to the west entrance to Singapore Harbour. I am inclined to attribute our failure in securing more adults to the nature of the ground in which they live. With an ordinary dredge they could easily wriggle through the meshes, and the only time I tried a canvas-bag dredge it filled so rapidly with sand as to be quite useless.

We frequently also used a small shrimp trawl, but it was quite ineffectual as far as Amphioxus was concerned.

Two species of Amphioxus, *Branchiostoma belcheri* and *B. cultellum*, occur in the Malay Seas; the latter is known from Moreton Bay, Torres Straits and Celebes, while *B. belcheri* has been hitherto recorded from Prince of Wales Islands, Torres Straits, Borneo and South Japan, so that either of these species might with equal probability have occurred at Singapore. There is little of interest to note with regard to the specimens themselves. Dr. Willey tells me that in the adult example the "oral cirri are remarkable for the great size of the sense-papillæ which form long projecting conical processes."

In the young, both before and after metamorphosis, the dilation of the dorsal fin at a point vertically above the anus is very marked (see woodcut). This feature has been noted by Mr. Andrews in Japanese examples, and seems to be a point of difference from the specimens examined by Dr. Günther (*v. Zool. Anz.* 18, 1895, p. 59). In the diagram (Fig. 1), which was drawn from a preserved specimen, the notochord is curved up dorsally at the posterior end. This seems to occur in all the preserved examples I have examined, but it is certainly not constant during life. F. P. BEDFORD.

Zoological Laboratory, University College, W.C.

Indian Corn.

I THINK I can satisfy your correspondent, Mr. Kumagusu Minakata (NATURE, February 22, p. 392) about the "maize." I have not Athanasius Nikitin's travels before me, but I have been over a good deal of his ground—and professionally in charge of it—with the book in my pocket.

We cannot now be sure what cereal he meant by "Indian Corn." Probably the term includes several species of Indian millets, great and small; species of Holcus and Eleusine, perhaps even rice. But *Zea Mays*, though well known along Nikitin's line of march, is not a staple grain there even now, though I understand it to be so used, to some extent, a few degrees northwards.

I do not think that any Anglo-Indian botanist will be found to treat it as other than a Portuguese or Musalman importation from the West. The natives certainly look upon it as an imported plant; like potatoes, tobacco, and several others. I suspect that the native trivial name, *Maká*, implies that some seeds may have been brought to India by pilgrims returning from Arabia.

As to Japan, that country is so much nearer to America, and has so ancient a civilisation and commerce, that I should think it very likely to have received American seeds of maize and of other plants long before the Indian peninsula, though that country is now full of Mexican and Peruvian plants—some thoroughly naturalised—which have come "with the sun."

At one time I thought that there were representations of maize-heads in the Ajantá caves, but I have had to give the idea up, after examination on the spot. W. F. SINCLAIR.

Chelsea, February 23.

Colour of Horses for Service in Hot Countries.

GENERAL DAUMAS, of the French Army, states in his book on the horses of the Sahara that dark-coloured horses bear great atmospheric heat much better than light-coloured horses. I have had many opportunities in India of proving the correctness of this observation; but I have not been able to find a correct explanation of this fact, and would therefore feel greatly obliged if you or any of your readers would give me it.

When the temperature of the surrounding air is much higher than that of the animal body, the fact of a horse's coat being dark would at first glance appear to be a disadvantage, because it would absorb heat faster than if it were light in colour. Its power of radiation is evidently greater than that of heat absorption. The colour of tropical animals, as we all know, is darker than that of animals in colder climates.

In speaking of light-coloured horses, I refer to the coat (hair) and not to the skin. Absence of pigment in the skin appears to decrease a horse's resistance to the effects of atmospheric heat. Respecting this point, I have not sufficient data to make any definite statement. M. H. HAYES.

Rugby, March 3.

An Interesting Case of Resonance.

A CURIOUS example of resonance is to be noticed in Llandingat Church, Llandovery, South Wales. In one of the windows there is a pane of glass which is not very tightly fixed, being free to oscillate with a definite frequency, which happens to correspond to the frequency of the low pedal "G" of the organ. The consequence is that when the service is taken in G, at the end of each of the Responses, Amens, &c., quite a loud buzzing noise is produced by the resonance of the window; and I have seen strangers sitting near the window seem quite perplexed, not knowing what causes the noise.

Llandovery College, March 4. KENNETH MCMURTRIE.

THE RELATION BETWEEN THE PERIODIC CHANGES OF SOLAR ACTIVITY AND THE EARTH'S MOTION.

ONE of the most interesting questions arising from the problem of the sun's activity is that of a possible connection between the varying display of forces on the solar surface and certain phenomena on our planet. The evidence which has been gradually accumulating can hardly fail to convince us of the existence of an intimate, though still mysterious, relation between some of the manifestations of the earth's magnetic forces and the state of dynamic action on the sun. Not only the extraordinary coincidences repeatedly recorded between solar eruptions and terrestrial magnetic storms, but still more the striking synchronism between the varying frequency of solar spots and the observed changes in the display of auroræ, and in the daily oscillations of the magnetic needle clearly point to that conclusion. Scarcely less certain seems to be the fact, confirmed by many recent investigations, that a greater or less disturbance of the sun's surface is attended by corresponding effects upon terrestrial temperature, rainfall, and other meteorological phenomena.

But there appears to me to be good reason for believing that the influence of the solar activity upon our planet is of an even more profound and far-reaching nature than has hitherto been imagined. I shall endeavour here to state as briefly as possible the results of investigations (more fully developed in *Astr. Nachr.* No. 3619) which have led me to conclude that the period of solar activity can be distinctly traced in the minute residuals which it has not hitherto been possible to eliminate from the observed values of the earth's elements. We are thereby led to infer that the same unknown force which apparently plays so important a part in the meteorology of the sun, acts upon the motion of the earth to such a degree as to produce perturbations which, though minute, are yet of considerable importance from a theoretical and even practical point of view.

As regards the variation of the spot-phenomenon, all the material here required could be taken from Wolf's *Astronomische Mittheilungen.* The chief results which we owe to the never-tiring zeal of this eminent astronomer, and to his intense devotion to this particular branch of astronomical science, are too well known to require, for our present purpose, more than the remark that there are two well-defined periods in the spot-development, the shorter embracing, on an average, about eleven years, and the longer covering, in Wolf's opinion, nearly six times that interval. These two periods are equally important for the following investigation, the curves of the residuals showing the influence of the greater cycle not less distinctly than that of the shorter one. To mention some of the principal features of the "great" spot period—this being probably less familiar to men of science than the eleven years cycle—it may be stated that this curve rises from a minimum near the middle of last century to a high maximum in 1783, then rapidly descends to a low minimum in 1816, attains subsequently another high maximum in 1838, descends again to a moderate minimum in 1861 rises to a small maximum about 1873, and eventually falls to a low minimum in 1888, from which it has since been steadily proceeding to higher values, so that another maximum may be expected in the near future.

Now, to prove our assertion as to a connection between the periodic changes of solar activity and the motion of our planet, we shall, in the first place, consider the changes in the mean obliquity as observed at Greenwich from Bradley's time up to 1896. If, besides the gravitational effects produced by sun, moon and planets, no other perturbing force were acting on the earth-spheroid, the observed values of the mean obliquity should be found to decrease uniformly with the time, this "secular variation" being due to the perturbations produced by the planets. The measured arcs of the obliquity would then be very nearly represented by Leverrier's formula

$$\epsilon = \epsilon_{1850} - 0''\cdot47594\ (t - 1850).$$

Owing to the uncertainty of the values of the masses adopted for some of the perturbing planets, the numerical factor in this equation may have a somewhat different value. But the differences between the observed arcs of the obliquity and the values derived from Leverrier's equation ought in any case to be found to increase or decrease uniformly with time. This, however, is far from being the case, as may be readily seen from the accompanying diagram, in which the abscissæ are represented by the epochs of observation, and the ordinates by the differences Observed Obliquity *minus* Leverrier. The data from 1757 up to 1812 are taken from Prof. Newcomb's treatise, "Elements of the Four Inner Planets, &c., Washington, 1895." Since 1812 the data are deduced directly from the annual Greenwich observations. In order to eliminate any possible influence of the shorter sun-spot cycle, which shall be investigated separately later on, these annual values are combined into groups comprising twelve years of observation. This method enables us to study the waves of long period by themselves, independently of the shorter cycle.

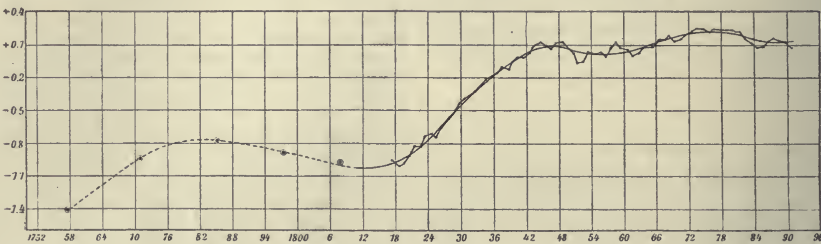


FIG. 1.—Curve of obliquity. (From the *Astron. Nachr.* 3619.)

Here, then, it will at once be seen that the observed changes in the mean obliquity cannot be represented by a linear function of the time, but that, besides the secular term, they show three distinct relative maxima and minima. Now the remarkable feature about these turning points is that their positions agree almost absolutely with those exhibited in the "great" sun-spot period. The two high maxima about 1780 and 1840, as well as the very low minimum in 1815, nay even the less pronounced oscillations indicated by the curve of solar spots, are also most clearly recognisable in the curve of the obliquity represented in Fig. 1. In view of so remarkable a coincidence, the observed changes in the obliquity may be closely represented by the introduction into Leverrier's formula of a term depending on the great sun-spot period. If this term, after being evaluated for all the epochs of observation, is subsequently subtracted from the single values of $\delta\epsilon$ in Fig. 1, the following curve is obtained:

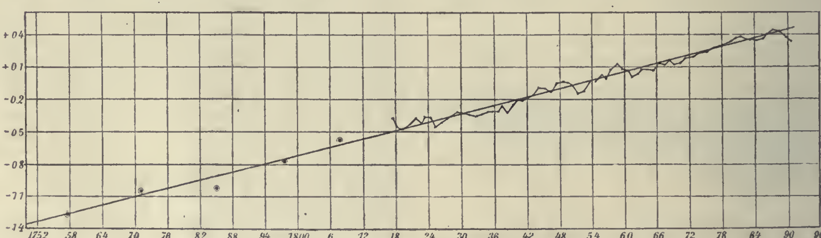


FIG. 2.—Corrected curve of obliquity. (From the *Astron. Nachr.* 3619.)

Now, uniform increase or decrease with time implies that the values of the obliquity should be grouped approximately along a straight line. While this was by no means the case in Fig. 1, it is perfectly true of Fig. 2; and thus it is clear that, taking into account the additional perturbing force due to solar activity, the observed values of the mean obliquity are brought into entire agreement with the deductions of planetary theory.

The significance of the result just obtained is considerably enhanced by the remarkable fact that exactly the same peculiarities appear in the variations of all the other elements of our planet as in those of the obliquity. Not one of the elements, as deduced from observation, can be rigorously represented by a secular term alone; they all show in addition well-marked periodic fluctuations closely agreeing with those of the "great" spot period.

The reality of a distinct, if minute, influence exerted by the changes of solar activity on the earth's motion cannot therefore be doubted, though we are as yet completely in the dark as to the physical causes of this peculiar perturbation.

Now the question arises as to whether traces cannot be discovered of a similar influence upon the motion of the earth-spheroid synchronous with the eleven-years cycle of solar activity. The result obtained on this point receives additional importance from the fact that it throws quite a new light on the theory of a peculiar phenomenon, which has now greatly attracted the attention of astronomers, viz. the *variation of latitude*. The conclusion to be drawn from our investigation points to a close relationship between the amplitude of the motion of the terrestrial pole and the period of solar activity. It may be taken to be clearly established that the radius of the circle described by the pole of instantaneous rotation is greatest at times of sunspot-minima, and smallest at times of maximum-displays of solar spots. This correspondence is found to hold true for the whole interval of about sixty years now covered by Dr. Chandler's investigations. The subjoined diagram may help to give a clear idea of this peculiar relation, the first curve showing the semi-amplitudes of the latitude-variation for every year from 1856 to 1898, as deduced from Chandler's curves in *Astron. Journ.* Nos. 277 and 446, and from Dr. Nyrén's values communicated in *Publications de l'Observatoire Central Nicolas*, Série ii. vol. ii.; while the second curve indicates the spot-frequency according to Wolf during the same space of time. As the latitude-phenomenon has been found to lag behind the spot-curve by an interval of about 1·5 years, the latter curve has been shifted one and a half years in the forward direction, in order to establish an agreement between the positions of the maxima and minima of the two curves.

Attention may here be drawn to Sir Norman Lockyer's discovery that a similar lag can be traced in the curves representing the changes in the lines widened in sun-spot spectra during a spot-cycle, the maxima and minima of the spectroscopic curves showing indeed, so far as observations go, a perfect synchronism with those of the curve of latitude-variation.

Judging from these curves the conclusion may be drawn that a very marked influence on the motion of the terrestrial pole of rotation is exerted by a force varying synchronously with the display of spots on the solar surface. Chandler's data previous to 1856 have not been included owing to their incompleteness. But it ought to be mentioned that the correspondence with regard to the positions of the maxima and minima is quite as certain as in the interval exhibited in the above curves. The sun-spot maximum in 1838 is followed by a minimum of the semi-amplitude in 1840, while the next sun-spot minimum in 1843 is succeeded by a very pronounced maximum of the semi-amplitude in 1845. Judging from the epochs of the maxima, the amplitude of the latitude variation completes three full periods in thirty-four years; while the epochs of the minima make this figure only slightly less, viz. thirty-two years. Hence the period of the amplitude is found to be eleven years.

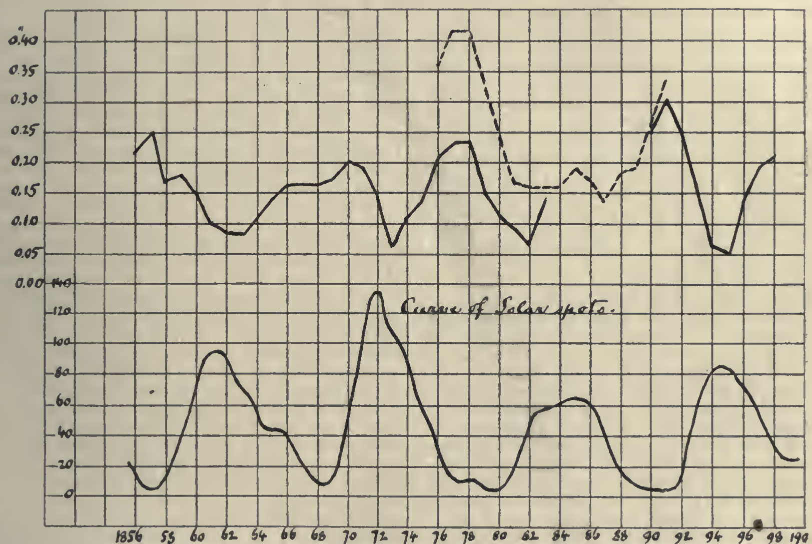


FIG. 3.—Curves of variation of terrestrial latitude, and of solar activity. The upper curves represent semi-amplitudes of latitude-variation. ——— Chandler. ···· Nyrén.

On the whole, then, we are confronted by the fact, so distinctly brought out by observation, that the motion of our planet reveals traces of the action of a force, the intensity of which can be measured by the state of activity on the solar surface. No doubt, the perturbations caused by this force are extremely minute as compared with the gravitational effects exerted on the earth-spheroid. But still, in the present state of our theoretical knowledge regarding planetary motion, and with the high degree of perfection now attained in the art of astronomical observation, such minute quantities are of considerable importance. This is, for instance, sufficiently illustrated by the derivation of the solar parallax from the secular variations of the obliquity and the node of Venus. The value for this constant, as found after eliminating the perturbing effect of the new solar force from the secular variation of the obliquity, is $\pi = 8''\cdot802$, a result which is in perfect accordance with Newcomb's value obtained from other sources. The great difficulty, by which this distinguished man of science found himself embarrassed in this part of his work (see pp. 158–159 of the treatise quoted above), so much so, indeed, that he well-nigh despaired of arriving at a final conclusion as to the value of π to be adopted, has now disappeared. The values for the masses of the earth, m(♁+☾) = 1 : 327923, as well as of Venus, m(♀) = 1 : 414991, as derived from the secular variations, may thus be accepted with confidence.[1] This is one example showing the theoretical importance of the phenomena here discussed; possibly the results arrived at may be eventually found to contribute towards removing other difficulties still connected with the theory of planetary motions.

We are, it seems to me, fairly warranted in assuming the force acting in such a peculiar way on the motion of the terrestrial pole to be identical with that which exerts its influence on the secular variations. As regards the nature and origin of this force, there is a wide field for speculation. A suggestion to which I was led by a discussion on this subject with my colleague, Mr. G. Clark, of this observatory, and which seems worthy perhaps of further investigation, is that the force may stand in some connection with the still very mysterious phenomena of the earth's magnetism. There is certainly one fact which lends some support to this hypothesis, viz. the eccentric position of the earth's magnetic poles. Joule's well-known experiments on magnetic strain in iron bars suggest the idea that something similar to the molecular displacement in the iron bar may take place in the body of the earth with regard to its magnetic axis. Such a strain along the axis of maximum magnetic moment would almost necessarily cause a displacement of the axis of figure with regard to the axis of rotation. Only so long as the total magnetic potential of the earth was not subject to alterations could this displacement remain constant. In that case the pole of rotation would describe a circle with a *constant* radius round the pole of figure. But there are facts which force us to assume that the potency of the earth's magnetic forces varies with the state of solar activity, and that consequently the molecular displacement in the direction of the magnetic axis varies accordingly. The most striking fact in this respect is the increase of auroræ with an increasing number of solar spots. Now, if we were to consider auroræ as discharges of electric force gradually accumulated in the earth's interior, the strain in the direction of the magnetic axis should have abated after such a discharge, and the pole of figure should therefore approach the pole of instantaneous rotation. This, then, would explain the fact that the semi-amplitude of latitude-variation is smallest after a maximum display of solar spots. How far this hypothesis is able to account for other phenomena brought out by observation must be left to future research.

J. HALM.

Note.—In a very interesting note in *Monthly Notices*, March 1898, Mr. Thackeray investigates the effect of the latitude-variation on the longitudes of the sun as well as on the arc of the obliquity. It appears from his result that the correction to the sun's longitude due to the motion of the pole has an amplitude two and a half times greater than that to the obliquity, cosec. ϵ being almost exactly 2·5. Now from Prof. Newcomb's and Mr. Thackeray's tables showing the corrections to the right ascensions of the sun relative to the stars, as derived from Greenwich observations, I have computed the numerical effect of an error produced in the sun's longitude by an increase from 0 to 10 in Wolf's relative spot-numbers. Assuming Prof. Newcomb's weights assigned to the observations, I obtained $\Delta\lambda = 0''\cdot4457 \pm 0''\cdot0523$, and consequently $\Delta\lambda \sin \epsilon = 0''\cdot1775 \pm 0''\cdot0209$. On the other hand, the value previously found for the obliquity in *Astr. Nach.* 3619, was $\Delta\epsilon = 0''\cdot1703 \pm 0''\cdot0145$. Hence the result that the effect of the force varying with the great spot-period is in point of amplitude exactly analogous to that found by Mr. Thackeray with regard to the phenomenon of latitude-variation. This must, I think, point to the conclusion that those anomalies in the sun's longitude and in the arc of the obliquity which correspond to the great sunspot-period are due to the same force which causes the deviations observed in the motion of the terrestrial pole, that in fact these anomalies are merely another proof of our assertion that the displacement of the pole stands in some connection with the variation of solar activity. The results are derived from two perfectly independent series of observations, the probable errors of $\Delta\lambda$ and $\Delta\epsilon$ being not more than one-tenth of the values obtained; hence the assumption as to the peculiarities elicited from the observations of the sun's right-ascensions and declinations being the result of chance appears to be absolutely untenable.

J. H.

[1] This value of the mass of Venus is in close accordance with that derived by Prof. Backlund from the perturbations of Venus on Encke's Comet.

APPLIED METEOROLOGY.[1]

THE name of Prof. Cleveland Abbe is indelibly associated with the onward progress of meteorology in the United States, whether in respect of its commercial and general utility, or on the severer but not less interesting side of dynamical investigation, to which we must look for any theoretical advancement. In the organisation of an immense service, the observations and returns of which cover a large field in the applied science, he has played a yeoman's part; and further, by his translations of many important mathematical papers, he has stimulated study, and given to his countrymen the opportunity of familiarising themselves with the difficult theory which Helmholtz, Hertz, Kirchhoff and others have developed, and on which the perfected science must eventually be based. It seems fitting, therefore, when one of the States—in this case, Maryland—proposes to advance beyond the mere accumulation of meteorological data, and is prepared to foster the study and discussion of special problems connected with climate and its effects, to devote funds for the prosecution of certain lines of research and investigation, that he should be selected to indicate the direction in which study can be most profitably turned with the view of benefiting every human interest. We at least may congratulate ourselves upon the selection, for the outcome has been to collect into an essay of moderate dimensions a list of the most prominent fields of usefulness to which a State weather service can devote itself. We have here a scheme, which though in the first place intended for a particular climate and district, yet is not limited in its scope, and but with few changes may be made to serve as a model for wider areas, and in its fullest application would meet the demands and the necessities of the best instructed meteorologists.

It would be wearisome to give a bare statement of the manifold duties and occupations in which a properly constituted weather service finds itself called upon to take part, and in these pages, fortunately, such a task is not necessary. There may be some who think that weather prediction for shorter or longer periods alone occupies the attention and satisfies the ambition of the meteorologist. To such we commend the list of twenty-nine distinct subjects of enquiry, bearing on every walk of life, assisting every one of the applied sciences, and touching every material interest, that Prof. Cleveland Abbe has put in the foreground of his essay, as additions to the daily storm and weather forecasts, admitted by the least attentive to be the main duty of a meteorological office. But it is needless to say that the author is not satisfied with the mere utilitarian aspect of the science, however valuable the results may be to the agriculturist, the engineer, the mariner, the physician and others throughout the entire circle of the professions. Just as

[1] "The Aims and Methods of Meteorological Work, especially as conducted by National and State Weather Services." By Cleveland Abbe. (Baltimore: Johns Hopkins Press, 1899.)
"The Monsoon Forecast." *The Pioneer*, August 10 and October 23, 1899.

little is he content with that view of popular government, which views favourably the application of scientific results derived from private means and individual enterprise, but does nothing to develop science by research and investigation, on its own initiative. To ask for bricks without providing straw is a complaint that is not limited to one time or one nationality. Prof. Abbe, writing as the adviser of a government prepared to spend its funds on the furtherance of scientific aims, fortunately has not to labour this point; but he nevertheless urges the duty on administrative authority, not only of developing the art of applying the sciences, but also that of constructing them.

The observational side of meteorology has been so long in evidence at the expense of the experimental, that it is very desirable that an eminent authority should insist upon the necessity of experiment and research in physical laboratories, as distinct from the ordinary meteorological observations with which so many observers content themselves. Foremost among the inquiries demanding increased attention, the author places the physical constants pertaining to the atmosphere itself, such as its chemical composition, its weight per unit volume, the law of the relation between pressure, density and temperature, the specific heat of the air, the viscosity, the radiating and absorbing powers, &c.

We need not follow the professor through all the problems that he enumerates calling for increased attention, since every physicist will readily admit that there is a large harvest of information to be gathered in all that concerns the behaviour of the atmosphere, whether at rest or in motion; and every one will find a still larger number of subsidiary problems, awaiting solution, in proportion to the thorough and exhausting character of the work that is bestowed on each main line of investigation. Neither is it necessary to pursue in detail the various topics of applied meteorology, which may at first sight appear somewhat local in their character, but which will be found to apply with very slight modifications to other districts, wherever sufficient enterprise and enlightenment invite the co operation of the physicist in fields of practical utility. It is of more importance, especially in consideration of the matter suggested by the second subject of this article, to see what he has to say concerning the hopefulness of the application of any theory to the problem of the general circulation of the atmosphere. In our wide dependency of India it is necessary at times to deal with imperfect information by imperfect methods; to treat a problem of economic importance with skill based on experience where it is impossible to introduce the certainty that follows mathematical deduction. This course appears to meet with approval, for it is urged that, "for the present at least, it may be wisest to seek for graphic methods and processes of quadrature, which may enable us to arrive at approximate solutions of the complicated systems of equations that represent the interaction of the nine elements that enter into the problem of the motions of the atmosphere." The attitude here suggested is scientific and prudent, and conveys a quiet censure on those who, knowing little of the difficulties that beset the solution, are impatient at the non-fulfilment of forecasts, which the better instructed know are tentative and provisional in their character. To those who exhibit their smartness by immature criticism, we recommend the study of the following paragraph with which Prof. Abbe concludes his review of the general problem. "Add to all these (difficulties) the further consideration that, when once set in motion, the atmosphere may, by some very delicate change in the conditions under which it is moving, assume some obscure form of discontinuous motion, and we at once see that the difficulties of the analytical mechanics of meteorology challenge the intellectual power of man to overcome them."

What, then, is to be said of those, who, occupying a prominent position in journalism, have the opportunity of guiding intelligent opinion, yet use that position with the deliberate intention of discrediting meteorological inquiry and of throwing additional obstacles in the way of those who struggle to solve a problem of enormous magnitude by means of very inadequate data? For this we understand to be the position of Mr. Eliot and his critics, or rather his assailants, for of criticism there is none. It is not contended that an erroneous theory has been pursued, or that some source of information has been overlooked; it is not suggested that any other forecast could have been made from the materials at hand; there is only that kind of cheap sneer, with which we are so painfully familiar, "that all the material which science has so painfully accumulated and laboured over for so many years, can give us no hint of a vital change in the weather, impending at three weeks distance." There is no recognition of the valuable work that the Indian Meteorological Office has inaugurated, and to some extent accomplished, or of the fact that for thirteen consecutive years the forecast of the monsoon has been fairly accurate, and that this is the first conspicuous failure. It seems positively childish to condemn a system which has such a uniformly good record, because in this instance "some obscure form of discontinuous motion" has baffled ingenuity, and disclosed the incompleteness of the data. It is needless to say that Mr. Eliot has a very satisfactory reply to the journalist, or that his reputation stands above any need of our support. The only point which it does seem worth while to make, is to express a regret that a good opportunity has been missed by this influential newspaper for urging upon the Government the necessity of increasing the area over which observations are made, and of educating intelligent opinion as to the direction in which additional information is to be sought. This we conceive to be the proper attitude to assume with regard to the unfortunate forecast. To strengthen the hands of the scientific advisers of the Government would be a worthy and generous motive; to sneer at the energetic officials, and to sow increased distrust on the credibility of weather forecasting, is not only to betray the writer's ignorance, but is criminal, so far as it hinders the collection of data which alone can introduce greater certainty into the forecasts, and give the Government the means of dealing with the enormous suffering that follows the failure of the monsoon rains.

W. E. P.

NOTES.

The death is announced of Prof. E. Beltrami, professor of mathematical physics in the University of Rome, president of the R. Accademia dei Lincei, and correspondant of the Paris Academy of Sciences.

Lord Rayleigh will not deliver the second of his course of lectures on "Polarised Light" at the Royal Institution on Saturday afternoon next (March 10), owing to the sudden death of his mother, the Dowager Lady Rayleigh. There will be no lecture on Saturday afternoon.

The German Society of Naturalists and Physicians will meet this year at Aachen, on September 17–21.

The next meeting of the French Association for the Advancement of Science will be held at Paris, on August 2–9, under the presidency of General Sebert.

Astronomers will regret to see the announcement of the death of Dr. C. T. R. Luther, Director of the Düsseldorf Observatory, and the discoverer of many minor planets.

THE Paris correspondent of the *Times* announces the death, at the age of seventy-four, of M. Emmanuel Liais, Mayor of Cherbourg. For many years he held posts at the Paris Observatory, and he was sent in 1857 to South America to observe the solar eclipse. He organised telegraphic meteorology in France, and devised the use of chronographs in determining longitude by electricity. He also devised a system of automatic magnetic registration by photography, and applied the method of the polarisation of light to the investigation of the solar corona. He bequeaths his property to the municipality of Cherbourg in trust for scientific purposes.

THE death of the distinguished geologist, Dr. Hans Bruno Geinitz, is announced in the *Geological Magazine* for March. Born on October 16, 1814, at Altenburg, in Saxony, he was educated at the Universities of Berlin and Jena, and gained the foundations of his geological knowledge under Quenstedt. In 1850 he became Professor of Mineralogy and Geology in the University of Dresden. He was elected a Foreign Member of the Geological Society of London in 1857, and received the Murchison Medal in 1878. His labours were devoted mainly to the geology and palæontology of the Palæozoic and Cretaceous rocks of Saxony, and in particular to the fauna and flora of the Dyas or Permian formation. He died at Dresden, on January 28, aged eighty-five.

A RATHER severe earthquake was felt throughout the greater part of Venetia on March 4, at about 5 p.m. (G.M.T.), strong enough to produce a stampede from the churches in Padua, Venice and Verona, but not causing much damage to buildings, and, so far as known, unaccompanied by loss of life. The epicentre of the earthquake appears to have been not far from Monte Baldo, near Verona. This is a well-known seismic district, the earthquakes of which, and especially that of June 7, 1891, have been discussed in a valuable memoir by Dr. M. Baratta, published in the *Annali* of the Central Office of Meteorology and Geodynamics of Rome.

THE last letters received from Mr. J. E. S. Moore's expedition are dated from Ujiji, on Lake Tanganyika, on November 12, 1899. The other members of the party had proceeded to the north end of the lake, where Mr. Moore was proposing to join them so soon as the necessary number of porters had been assembled. The expedition had been fairly successful both in collecting zoological specimens from the lake and in studying the geological features of the surrounding district. They had obtained numerous living specimens of the curious forms of mollusca of the lake, besides a good series of fishes and crustaceans. The celebrated jelly-fish (*Limnocnida tanganjicae*) had been met with in great numbers. Mr. Moore had escaped fever altogether, but most of the other members of the party had had a touch of it.

THE pair of Grevy's zebras presented to the Queen by the Emperor Menelek, and placed by Her Majesty under the care of the Zoological Society of London, on August 14 last, have now completely recovered the effects of their journey, and appear to be in fine health and condition. It will be evident to all who see these splendid animals that Grevy's zebra (*Equus grevii*) is by far the finest and most distinct species of the group of "striped asses," excelling its brethren both in size and in beauty of markings. There are pairs of both the Mountain zebra (*Equus zebra*) and the Burchell's zebra (*E. burchelli*) in the Society's zebra-house, only the extinct Quagga (*E. quagga*) being unrepresented in the series.

THE "Zoological Lectures" of the Zoological Society of London will be delivered this year in the Meeting-room at Hanover Square, instead of at the Gardens. They will be given on Thursdays, April 19, May 17, June 21 and July 19, at 4.30 p.m. (after the General Meeting). The first lecture, on April 19, on the "Animals of Australia," will be delivered by Mr. Smith-Woodward, of the British Museum.

DURING the last week, Mr. Garstang, of the Marine Biological Laboratory, Plymouth, carried out the fifth of his periodic surveys of the plankton and physical conditions of the mouth of the English Channel. This concludes the series provided for by the British Association at the Bristol and Dover meetings, and the Committee may be congratulated on the successful termination of an interesting series of experiments, a full account of which is promised for the Bradford meeting. Compared with the corresponding observations made at the same stations in February 1899, the water temperatures at all four stations on the last cruise showed a distinct fall, which amounted to a mean reduction of 1·3° F. in mid-Channel, 2·0° F. off Ushant, 0·7° F. off Parson's Bank, and 1·5° off Mount's Bay. Nevertheless, an axis of warm water running up Channel in a north-east direction was again observed, thus tending to establish this condition as a normal phenomenon for the winter period. The vertical and closing nets showed the existence of suspended sand and mud in the water to a height of more than 40 fathoms above the bottom—a convincing testimony of the force of recent gales.

A FRENCH translation of two of Prof. W. H. Corfield's three Harveian Lectures on disease and defective house sanitation, delivered in 1893, has been published in the *Bulletin* of the Royal Society of Public Health of Belgium, of which Society Prof. Corfield is a "Membre d'honneur."

THE Istituto Lombardo announces the following as the subjects for future prizes:—The Institution prize for 1900 will be awarded for an essay on collective proprietorship in Italy; competition closes April 30, 1900; for 1901, on differential equations occurring in electrical problems; closing April 1, 1901. The two triennial medals for 1900 are for industrial and agricultural innovations in Lombardy. One Cagnola prize for 1900 is for an essay on "toxin and antitoxin"; closing April 30; and the subject for 1901 is a study of the storms, especially hail-storms, on the slopes of the Alps; last day, April 1. For the remaining Cagnola prizes the subjects have been chosen by the founder, viz. the cure of pelagra, the nature of miasma and contagion, the control of flying balloons, and the methods of preventing the forgery of a document; the closing day being December 31. The Brambilla prize, as in preceding years, is awarded for improvements in manufacturing industries in Lombardy. For the Fossati prize, the themes for next year is "regeneration of the peripheric nervous fibres in vertebrates," and for the two succeeding years, "illustration of some fact in the macro- or microscopic anatomy of the encephalus of the higher animals; entries close about the end of April. The Kramer prize is restricted to Italian engineers. For the Secco Comneno prize for 1902 the subject is a description of the deposits of natural phosphates in Italy, the competition closing on April 30, 1902. The subjects for the Pizzamiglio prize are, for 1901, secondary education; and for 1902, influence of socialistic doctrines. The Ciani prizes are to be given for the best Italian popular book, the type of book selected being scientific or educational for 1901, historical for 1904, and "narrative or dramatic" for 1907. The Tommasoni prize is to be given for the best life of Leonardo da Vinci; and the Zanetti prize for Italian improvements in pharmaceutical chemistry. The prizes, with certain specified exceptions, are open to competitors of every nationality, and the essays may be written in French, Italian, or Latin; but for full particulars we must refer to the Society's *Rendiconti*, vol. 33, part 1, or to the Secretary, Signor Ferrini, Palazzo di Brera, Milan.

Prof. A. Heilprin points out in the *Scientific American* that a source of doubt which attaches to the Nicaragua Canal and involves the question of permanency is furnished by the level of Lake Nicaragua—the fountain-head of the San Juan River, and the summit and feeder of the proposed canal. The regulation of its level is necessarily a matter of absolute or vital importance to the canal. The very elaborate measurements of American engineers that have been made during the last fifteen years indicate for the surface of the lake an average elevation at this time of approximately 105 feet above tide. This is nearly twenty per cent. less than the value obtained some years ago; and as the result of a consideration of the subject, Prof. Heilprin thinks it would not be safe to assume that the earlier measurements of the lake were erroneous. He thinks it more probable that the level of Lake Nicaragua is inconstant, and that the surface has dropped 15 to 20 feet in a period of little more than half a century.

The effects of the great dynamite explosions at Avigliana (near Turin), on January 16, are described by Dr. M. Baratta in a privately printed pamphlet. About 400 kg. of nitro-glycerine and 12,000 kg. of dynamite and gun-cotton were blown up. The first and stronger explosion, though it lasted little more than a second, presented three maxima of intensity, due probably to the successive explosions of magazines a hundred metres from that in which the nitro-glycerine was stored. Owing to the situation of the manufactory, the zone of greatest damage was very small; that in which windows were almost totally destroyed extended to a distance of $5\frac{1}{2}$ km.; doors and windows were made to rattle as far as Crescentino (60 km. distant); and the sound of the explosion was heard at Pavia (140 km.), Varzi (145 km.) and Lugano (160 km.).

We have received from Prof. Albin Belar the first part (for January 1900) of a monthly report on the earthquakes recorded at the seismological observatory of Laibach, of which he is the director. Some brief notices of earthquakes which occurred in other countries during the same month are also included. As Laibach is one of the most important earthquake centres in Europe, the reports issued from the observatory cannot fail to be of considerable interest and value.

An interesting lecture was recently delivered by Dr. J. M. Pernter before the Austrian Meteorological Society, upon some extensive experiments made in several Italian provinces last year for the prevention of damage by hail by gun-firing. The idea is an old one, but the apparatus, constructed by Mr. A. Stiger, burgomaster of Windisch-Feistritz, Steirmark, consisting of a mortar provided with an iron funnel about six feet long, appears to have obtained very satisfactory results. The experiments were witnessed by Dr. Trabert, of the Vienna Meteorological Office, and it was found that a timely commencement of the firing effectually prevented the fall of hail, whereas in districts where the experiments were not made much damage was caused by hail-storms. The immunity from damage may have been due to the force of the air-whirls, the sound of which could be heard for twenty or thirty seconds, or to the fact that the electrical discharge between the earth and the clouds was quietly effected by the shooting, and thus the chief factor of hail formation removed.

The Victor Meyer Memorial Lecture, delivered by Dr. T. E. Thorpe, F.R.S., before the Chemical Society on February 8, is published in full in the March number of the *Journal* of the Society, with an excellent portrait of the lamented investigator. Many scientific societies, both abroad and at home, issue their publications in so tardy and irregular a manner that the example of the Chemical Society in publishing the *Journal* regularly every month might be followed with advantage. Few societies publish discourses so elaborate as that of Dr. Thorpe's within three weeks of their delivery. It is unnecessary for us to do more than briefly refer to the address, as a notice of the work and personal characteristics of Victor Meyer appeared in these columns in September 1897, shortly after his death (vol. lvi. p. 449). As a friend of nearly thirty years' standing, and as one who studied with him under Bunsen, Dr. Thorpe was in the position to give an excellent account of the remarkable services Victor Meyer rendered to science during his life. Meyer contributed to the literature of chemistry, either alone or in conjunction with his pupils, upwards of three hundred memoirs and papers. As an investigator, he was original as well as active; as the director of a large chemical laboratory and a laboratory teacher, he worthily followed in the footsteps of Bunsen; and, as a lecturer, he was brilliant as well as lucid. Dr. Thorpe's lecture is a worthy appreciation of the genius of a gifted man who devoted his energies to the advancement of science.

Mr. T. Southwell contributes to the *Zoologist* his annual account of the seal and whale fishery. From this we learn that the pursuit of the Greenland Bight Whale was fairly successful during the past season; a remarkable feature being that although none of these Cetaceans were seen in the Greenland seas, they were comparatively plentiful in Davis Strait and the adjacent waters. The majority of the twenty-eight whales taken were of good size, some of them being of very large dimensions. During the year the price of whalebone fell to 1400*l.* per ton, although more is now asked; in past years more than 2500*l.* per ton has been realised. Mr. Southwell points out, as a matter for regret, that the sealers have recently taken to collecting musk-ox hides, which may easily lead to the extermination of that remarkable animal, unless efficient measures be promptly taken for its protection.

In the March number of *Photography*, Mr. Douglas English gives the results of his experiments on photographing living fish—an art that has hitherto received but little attention. How necessary is this art, if we wish to have correct portraits of fish, will be apparent when the remarks of the author are read as to the immense alteration which takes place in their bodily form and proportions immediately after death. The difficulties with which the photographer has to contend are the mobility of the fish, which necessitates very short exposures; the great loss of actinic power in white light resulting from its passage through glass and water; and, in some instances, the delicacy of the subject and its terror under the operation. In order to counteract the first of these difficulties, Mr. English has adopted the principle of the "animalcule-tank" employed in connection with the optical lantern. After several attempts, a tank was invented capable of confining a living fish within a space sufficiently limited to enable the photographer to keep it in some degree in focus, the sides being constructed of two parallel plates of the thinnest and whitest plate-glass procurable, with provision for increasing or narrowing its diameter, within certain limits, according to the size of the fish. Several examples of the photographs thus obtained are reproduced; and although their definition is not as sharp as might be desired, they are life-like portraits which ought to be of the highest value to the naturalist.

Mr. Barrett-Hamilton is turning his attention to the cause of the colour-change in animals which turn white in winter. In a recent issue of the *Proc. Zool. Soc.* he corroborates the view that the darker colour of the summer coat of the Arctic hare is due to the casting off of the white winter hairs and their replacement by a new growth. In the January number of the *Annals and Magazine of Nat. Hist.*, Mr. Hamilton discusses the local colour-phases of the Weasel. In the far north, as is well known, this animal turns white in winter; in the north temperate regions the reddish-brown of the upper parts is permanently retained, although the under surface is pure white; but as we proceed further south, we find weasels with the under parts more and more suffused with yellow, till in parts of the Mediterranean area the colour is buff or orange. Such increased richness of coloration in the southern part of the habitat of the weasel is paralleled among many birds.

ON the delivery of the Hunterian collections into the custody of the Royal College of Surgeons, by Government, at the beginning of the century, it was stipulated that lectures illustrative of the series should be annually delivered in the theatre. According to a list prepared by the Librarian, the lectures commenced in 1810, when those on comparative anatomy were delivered by Sir Everard (then Mr.) Home, and those on pathology by Sir William Blizzard. Since that date they have been continued almost without intermission; the roll of lecturers including the names of many of the most eminent comparative anatomists and surgeons.

WE have received from the author, Monsieur H. de Varigny, a paper published in the Jubilee volume of the Société de Biologie, entitled "Sur le Notion Physiologico-Chimique de l'Espèce," which contains much curious speculation.

FROM Prof. R. Collett we have received the second part of his contributions to the natural history of those small blenny-like fishes known as *Lycodes*, published in the *Vid.-Selsk. Skrifter Christiania*, 1899, No. 6. He there describes the life-history of *L. gracilis* from an early period till it is capable of propagation. The question is, however, mooted whether we yet know the fully adult stage of this little fish, which may possibly reveal itself in some familiar type of which the youthful condition is unknown.

DR. HERMANN VON SCHRENK has made a minute investigation of a wide-spread disease, known as peckiness and pin-rot, affecting the heart wood of the bald cypress and the incense cedar, and his observations are contained in a thesis published in the eleventh annual report of the Missouri Botanical Garden, of which Mr. W. Trelease is the director. Both these trees are representatives of a race of trees the majority of which are extinct, and in both a fungus mycelium occurs with strongly marked characteristics. The peculiar decay to which the two kinds of trees are subject appears to be caused by this fungus, the fruiting form of which has not yet been found. Dr. Schrenk has examined logs of the cypress dug up from various points in the Mississippi valley, several miles from the river, and at an average depth of ten feet below Gulf level, and he has found unmistakable evidence of the disease, which is prevalent wherever cypress grows in abundance at the present day. It therefore seems that the disease is one which has extended back for some thousand years at least, and probably further. As few fungi are known in the fossil condition, the observations are of particular interest, for they suggest that this peculiar fungus disease of the cypress and cedar has come down with its host from geologic times.

"EINE Landschaft der Steinkohlen Zeit" is the title of an explanatory pamphlet accompanying Dr. H. Potonié's recently issued wall-diagram to illustrate the leading features of the Coal-Measure flora. A reduced facsimile of the diagram itself, with an accompanying outline key-plate, forms a suitable frontispiece, and the forty pages of the pamphlet are further enriched by numerous excellently reproduced figures in illustration of the structural and morphological details briefly referred to in the text. In accordance with the author's view, which supposes an autochthonous origin for coal, the restoration here put forward represents a rich assemblage of typical coal plants growing upon a perfectly flat and more or less marshy surface. It is claimed that the reconstruction of the types here depicted is in all cases founded upon the soundest evidence as regards the actual relationship of parts.

IN the first instalment of a work on the geology of the oil-bearing strata of Galicia ("Geologie der Erdöl-Ablagerungen in den galizischen Karpathen." Lemberg, 1899), Prof. Rudolf Zuber deals with the stratigraphy of the Galician Carpathians. Of importance, as regards the yield of petroleum, is that group of beds known as the "Ropianka-Schichten," concerning the age of which, however, there has been considerable controversy. Classed originally as Tertiary, these beds, by the discovery of unmistakable though somewhat scanty palæontological evidence, were subsequently recognised as Cretaceous, but their position in the Cretaceous System has long remained a matter for dispute. In the present paper the author, after reviewing the results of previous writers, brings forward his reasons for considering these Ropianka-beds as the undoubted equivalents of the Neocomian stage in Silesia. The Tertiary rocks are well represented in Galicia, and include oil-bearing strata at several horizons. The Eocene System, which shows a locally developed nummulitic facies, comprises the most important petroleum-yielding beds. Oil occurs also at horizons of Oligocene and Miocene age.

A PAPER upon "Life under other conditions" is contributed by Mr. Geoffrey Martin to *Science Gossip* for March. The subject is one which has been recently worked out by Dr. F. J. Allen; and Mr. Martin's general conclusions seem to agree up to a certain point with Mr. Allen's, at any rate in the view that vital processes depend on the existence of an element, the compounds of which are in a condition of critical equilibrium at the temperatures at which life exists. But Mr. Martin appears to regard carbon as the substance which acts the *rôle* of the fundamental element in the animal organism; while, according to Dr. Allen, nitrogen plays an all-important part in determining vital phenomena. Mr. Martin suggests that at the higher temperatures which may exist on other celestial bodies, or which may have existed at one time on our earth, silicon may give rise to a series of compounds analogous in their complexity and instability to our "organic" carbon compounds, and under such conditions what we may call "silicon life" may exist. In connection with this view it is somewhat interesting to notice that the power of secreting silica is now possessed by what we may regard as among the lowest types of vegetable and animal life, diatoms and sponges. But of course there is a wide difference between the temperatures required for carbon life, or, as Dr. Allen calls it, nitrogen life, and Mr. Martin's hypothetical silicon life.

THE Oxford University Junior Scientific Club has just issued its *Transactions* for the Summer and Michaelmas Terms of 1899, containing papers by Mr. H. E. Stapleton, on "An Extension of Dulong and Petit's Law," and by Mr. A. Gibson, on "The Retention of Plant-food in the Soil."

THE latest report of the U.S. National Museum is a volume of 1021 pages. One quarter of the volume deals with the condition and progress of the Museum during the year ending with June 1897; the remaining three quarters consists of seven elaborate papers describing collections in the Museum, and illustrated with the liberality and excellence which distinguishes the publications of the Smithsonian Institution and of the various official Bureaux of the United States. Dr. J. M. Flint describes the specimens of foraminifera obtained during the dredging operations of the U.S. Fish Commission steamer *Albatross*; and his paper is illustrated by no less than eighty collotype plates, each containing several figures reproduced from photographs of mounted specimens, enlarged by about fifteen diameters. The pipes and smoking customs of the American aborigines form the subject of a paper by Mr. J. D. McGuire. Mr. W. Tassin contributes a descriptive catalogue of minerals classified according to their chemical and physical properties. Easter Island and its inhabitants are described by Dr. G. H. Cooke. Dr. O. T. Mason has a short paper on the forms of the man's knife among North American Indians, and Dr. Thomas Wilson describes arrowpoints, spearheads, and knives of prehistoric times, his paper being illustrated by sixty-five plates, and two hundred text figures. Each of the papers is filled with information, and their attractive setting will excite the unstinted admiration of every student of science who sees the volume.

SEVERAL new editions of established scientific works have lately been received. The sixteenth edition of "Kirkes' Hand-book of Physiology," by Prof W. D. Halliburton, has just been published by Mr. John Murray. The fifteenth edition was only published a year ago, so few changes were necessary; but where required, the subject-matter has been brought up to date.—The fourth German edition of Prof. O. Hammarsten's "Text-book of Physiological Chemistry" has been translated by Prof. J. A. Mandel, New York University. The translation, which is published by Messrs. J. Wiley and Sons, is now in its third edition, and most of the available literature up to April last year is taken into account.—A second and enlarged edition of Prof. S. P. Thompson's work on "Polyphase Electric Currents and Alternate Current Motors" has been published by Messrs. E. and F. N. Spon, Ltd. The book has undergone revision, and has been improved in several respects. The chapters on graphic theory have been developed by Mr. Miles Walker, and the theory is now presented in such a shape as to be directly available for practical calculations. Many of the illustrations are new, and coloured plates are now used to elucidate various types of polyphase windings.—The third edition of Prof. J. R. Ainsworth Davis's book on "The Flowering Plant, as illustrating the First Principles of Botany" has been published by Messrs. C. Griffin and Co., Ltd. New illustrations have been added; and also a chapter on ferns and mosses, which, though not comprehended by the title, will assist students to understand the life-history and classificatory position of flowering plants.—The first part of a second revised and enlarged edition of Dr. Julius Wiesner's work on "Die Rohstoffe des Pflanzenreiches" has been published by W. Engelmann, Leipzig. The first edition appeared in 1873, and it is expected that the present one will be completed during this year. The book appeals more particularly to students of economic botany and pharmacy.—A revised edition of "The Photographer's Note-book and Index, with Tables and Exposure Rules," by Sir David Salomons, Bart., has been issued by Messrs. Marion and Co.

SINCE the discovery by Curtius of the remarkable compound of hydrogen and nitrogen, hydrazoic acid, numerous attempts have been made to obtain from it the condensation product N_6, and during the discussion at a recent meeting of the Chemical Society, Prof. Ramsay gave a short account of some experiments made in this direction in his laboratory by the interaction of silver azoimide and iodine. The wished-for substance could not be isolated, but Prof. Hantzsch, in the current number of the *Berichte*, has now succeeded in isolating a definite iodide of nitrogen from the products of this reaction. By working at a low temperature and as rapidly as possible in the presence of ether, the new iodide is taken into solution by the latter, and can be obtained as a yellowish solid in minute quantities, not exceeding 0·2 gram, by the rapid evaporation of the ether. The solid is too unstable to submit to analysis, but an examination of the solution showed that its composition was N_3I. As might be expected from this formula, the iodide is violently explosive, 0·2 gram on one occasion completely pulverising a glass desiccator. Attempts to prepare N_6 by the action of the iodide upon silver azoimide, or by the spontaneous decomposition of the iodide, were unsuccessful.

THE theory of electrolytic solution pressure of Nernst has opened a wide field of research, and has led to many interesting developments. It is still, however, open to question whether the osmotic pressure analogy has not been pushed too far, and in the current number of the *Zeitschrift für Physikalische Chemie* is a short criticism by Prof. Lehfeldt on this point. Taking the solution pressures calculated for zinc, nickel and palladium from the observed electromotive forces as $9{\cdot}9 \times 10^{18}$, $1{\cdot}3$, and $1{\cdot}5 \times 10^{-36}$ atmospheres respectively, it is pointed out that although the first number is enormous it is not necessarily impossible. It is otherwise with the figure for palladium. Since pressure is a statistical effect, a considerable number of molecules must act on unit area. $1{\cdot}5 \times 10^{-36}$ atmospheres would give one or two molecules of palladium in a volume the size of the earth.

THE fact that such common alkaloids as cocaine, atropine and nicotine are derivatives of pyrrol lends considerable interest to syntheses of derivatives of the latter substance. Pyrrol-aldehyde, the analogue of benzaldehyde and furfuraldehyde, has hitherto been wanting, but its preparation has now been successfully attempted by Bamberger and Djierdjian by the use of Reimer's reaction with chloroform and potash, and is described by them in a preliminary note in the current number of the *Berichte*. The new aldehyde forms a well-crystallised hydrazone, oxime, and also an insoluble sodium sulphite compound, but differs markedly from its analogues in crystallising readily, prisms several centimetres long being obtainable, and also in possessing no smell. Many important synthetical products may be expected with pyrrol-aldehyde as a starting-point.

THE additions to the Zoological Society's Gardens during the past week include a Vervet Monkey (*Cercopithecus lalandii*), a Serval (*Felis serval*) from South Africa, presented by Mr. J. E. Matcham; a Vervet Monkey (*Cercopithecus lalandii*) from South Africa, presented by Mr. Dudley B. Myers; a Common Marmoset (*Hapale jacchus*) from South-east Brazil, presented by Miss M. C. Glover; a Greater Sulphur-crested Cockatoo (*Cacatua galerita*) from Australia, presented by Lieut.-Colonel Hopton; four Black-bellied Sand-Grouse (*Pterocles arenarius*) from Spain, presented by Mr. G. P. Torrens; a Purplish Death Adder (*Pseudechis porphyriacus*) from Australia, purchased.

OUR ASTRONOMICAL COLUMN.

OCCULTATION OF NEPTUNE.—There will be an occultation of Neptune on the evening of March 8, the moon having just passed its first quarter.

	Mean Time. h. m.	Angle from North Point. °	Angle from Vertex. °
Disappearance	6 13	101	107
Reappearance	7 34	268	249

As the moon passes the meridian of London about 6.30 p.m., the occultation is a favourable one for observation should the weather permit.

OPPOSITION OF MINOR PLANET (434), HUNGARIA.—Herr A. Berberich, of Berlin, gives in the *Astronomische Nachrichten* (Bd. 151, No. 3624) a revised set of elements and the deduced ephemeris of this body, to facilitate its detection during the coming opposition about March 23.

Elements for 1900 *March* 5, *Berlin Mean Time.*

$$\begin{aligned} M &= 244^\circ\ 34'\ 15''\cdot3 \\ \omega &= 122\ 55\ 42\cdot3 \\ \Omega &= 174\ 39\ 17\cdot4 \\ i &= 22\ 30\ 32\cdot0 \\ \phi &= 4\ 15\ 30\cdot9 \\ \mu &= 1308''\cdot6777 \\ \log a &= 0\cdot2887826 \end{aligned}$$

(ω, Ω, i: 1900·0)

Ephemeris for 12*h*. *Berlin Mean Time.*

1900.	R.A. h. m. s.	Decl. ° ′
March 7	12 14 55	−0 50·1
11	11 56	+0 36·5
15	8 40	2 6·1
19	5 13	3 37·3
23	12 1 41	5 8·5
27	11 58 10	6 38·1
31	11 54 45	+8 4·5

CERASKI'S SECOND ALGOL VARIABLE.—In the *Harvard College Observatory Circular*, No. 47, Prof. E. C. Pickering furnishes the additional data respecting this variable which are available from the photometric records of the Henry Draper Memorial. The Moscow photographs furnish the means of determining the period from an interval of *four* years; the Harvard records increase this interval to *nine* years. With the aid of the latter it is found that the formula of Prof. Ceraski only satisfies the later observations, and to remedy this the period he gives should be shortened by 0·6m.; the resulting period of 6d. 0h. 8·8m. satisfying all the observations since 1890 very accurately, but more observations of the minima will give a still closer value. The period, however, differs so slightly from exactly six days that for a long time the minima cannot be observed in certain longitudes. Accordingly, while observations may be obtained in the ensuing autumn in Europe, or better still in Asia, minima cannot be observed in America until the following year.

Five stars of the Algol class, viz. S Cancri, U Cephei, W Delphini, +45°·3062 and the star here under discussion are especially interesting owing to the large variation in their light, which amounts to about two magnitudes in each case. It is noteworthy that of these two were found by Mdme. Ceraski, and one by her distinguished husband.

THE NEW ODESSA OBSERVATORY.—Herr A. Orbinski, who has been appointed director of the new astronomical observatory at Odessa, has recently issued his first report, dealing with the foundation of the institution, its instrumental equipment, and the scope of the proposed programme of investigation.

The observatory has been established as a branch to the great national institution by the governing body of the Pulkova Observatory, chiefly owing to the efforts of Prof. O. Backlund during 1895 and afterwards.

In the summer of 1897 the building operations were commenced, and in August of the following year, 1898, the transit instrument was installed, the vertical circle being set in position during February 1899. The buildings are three in number—a transit house, and two buildings for housing the meridian marks, or collimators. The instrumental equipment consists of a transit circle, with clock, chronograph and meridian marks, and a vertical circle.

The transit has an objective of 108 mm. aperture and 1·30 m. focal length, by Steinheil, and is furnished with a self-registering micrometer, by Repsold. The meridian marks are situated about 119 metres north and south of the transit pier, and consist of round plates, each pierced with a small hole 1·5 mm. in diameter, which being illuminated from behind by an electric lamp, forms an artificial star of about 2-1 magnitude.

The vertical circle, by Repsold, has a Steinheil objective of 108 mm. aperture and 1·40 m. focal length. Both these instruments are mounted in the same transit house, which is so constructed that, the central portion remaining stationary, the ends may be traversed eastwards and westwards respectively, thus uncovering the instruments.

The programme of the observatory is to be somewhat similar to that at Pulkova, except that observations of stars are to be made alternately with each instrument night by night, and not with both together, the first list of 176 stars being included in the report.

HARTLEY BOTANICAL LABORATORIES OF UNIVERSITY COLLEGE, LIVERPOOL.

AFTER occupying for twelve years small and, in many respects, unsuitable rooms in the old College buildings, the botanical department of University College, Liverpool, is at length to be housed in a new and commodious institute, the munificent gift of Mr. W. P. Hartley, of Aintree, Liverpool.

The site of the new buildings, also purchased by Mr. Hartley for the College, is a very fine one. The buildings have an east frontage of 37 feet and a north frontage of 85 feet. The total height to the eaves is 54 feet, divided into three principal stories, with two mezzanines in addition to a basement.

The main entrance leads through a vestibule, 8 feet wide, into a hall, 23 feet by 20 feet, in which is placed the staircase, 6 feet wide, open by means of a well to the lantern light at the top of the building.

The basement floor is occupied by store-rooms, lavatories and heating chamber.

The ground floor is mainly occupied by the museum, 45 feet long by 34 feet broad. This is surrounded at a height of 10 feet 6 inches by a balcony with open ironwork balustrade, which can be entered from the mezzanine floor or by an iron spiral staircase from the ground floor of the museum. The museum will throughout be fitted with cases made of American canary wood with movable glass shelves. It is intended that these cases shall contain not only morphological specimens illustrative of the scientific aspect of botany, but also specimens of all products of the vegetable kingdom used in the arts, such as timbers, pharmaceutical products, cottons, hemp, flax, and food products, both in the raw and in the manufactured state. It is hoped that by this means the new botanical laboratories will become a centre of information for the general public on matters of economic botany as well as on the more strictly scientific aspects of the science.

The museum will be provided with a lift running to all the floors above, so enabling specimens to be expeditiously and conveniently made available for teaching purposes in the laboratories and class-rooms.

On the ground floor also there is a workshop fitted with lathe, carpenter's bench and tools, so that small repairs may be carried out and simple machinery constructed without necessitating the calling in of special workmen.

There is also, in connection with the museum, a preparation room, in which stock museum jars and boxes will be kept, and in which the various specimens to be exhibited in the museum will be mounted, prepared and labelled.

The first mezzanine floor is partly occupied, as already mentioned, by the museum balcony; but there is also on this floor a small class-room fitted for about twenty students, furnished with the necessary fittings for the teaching of advanced lecture classes; and the herbarium fitted throughout with dust-tight cases and boxes for dried plants. Room is also provided on this floor for a staff lavatory.

On the first floor is placed the large lecture theatre. This room, which is 45 feet long by 34 feet broad, will accommodate 100 students. The seats are raised at the back by a gradually increasing upward curve, and the room is fitted with a specially designed lecture table, carrying electric switches, gas, water, and other needful appliances for public lectures. Opening off the theatre is the professor's private room, with an adjacent private laboratory, both of which will be furnished and equipped with the requisite bookcases, apparatus cases, and laboratory appliances. On this floor also is situated the departmental library, whose shelves will be furnished with not only the best known botanical text-books for reference, but also with several of the more important botanical journals.

The second mezzanine floor carries the research laboratory, the experimental physiology laboratory, and the dark room. These rooms, perhaps the most important in the building, will be fitted with all the more essential appliances for anatomical and physiological research, whilst the dark room will be available both for microphotographic work and for such physiological experiments as can be conducted only in the absence of light.

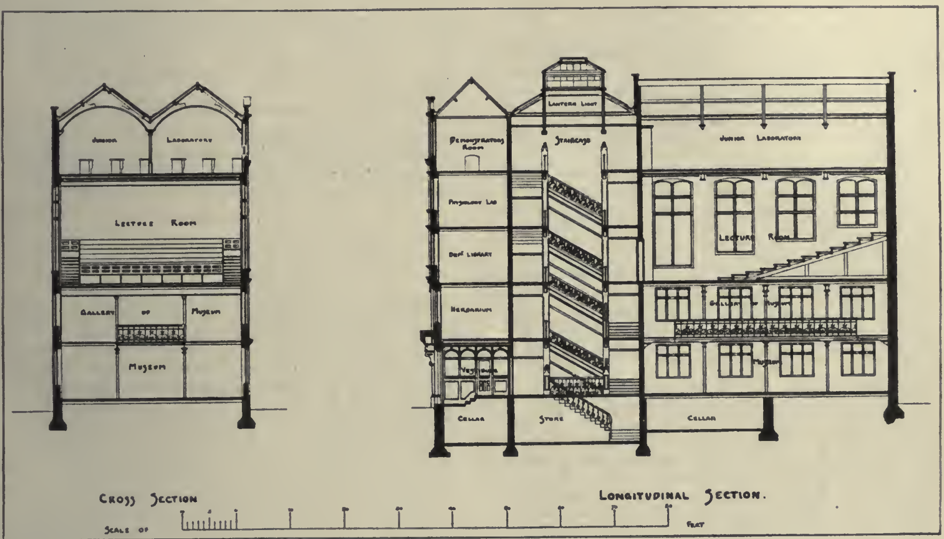
On the second or top floor is placed the large and magnificently lighted junior laboratory, capable of accommodating sixty-five students at one time, and fitted with specially constructed benches, cases for microscopes and apparatus, and the necessary teaching appliances. There will also be placed on this floor a fully equipped senior laboratory, capable of accommodating twelve students, as well as demonstrators' private room and laboratory.

On the roof there will be a small greenhouse with access from the junior laboratory.

The buildings will be lit throughout with electric light, and there will be electric bell and speaking-tube communication between the different private rooms, porter's room, and workshop.

The whole of the furniture and fittings have been designed by Professor Harvey Gibson and Mr. F. W. Dixon, the architect, so as to facilitate in every possible way the work both of students and teachers.

The furniture generally will be of pitch pine, and the cases of polished Canary wood. The staircase will have solid polished stone steps, and the walls will be plastered and painted. Externally the buildings will be faced with 2½-inch Ruabon brick with red sandstone dressings.



Hartley Botanical Laboratories, University College, Liverpool.

Altogether it may be said that Mr. Hartley's gift will provide University College, Liverpool, with a botanical laboratory worthy to stand alongside of the pathological and physiological laboratories, the recent splendid gift to the College of Mr. Thompson Yates. The building will be taken in hand immediately, and will, in all probability, be ready for occupation before the beginning of the autumn term of 1901.

SCHOOL GARDENS.

As attention is being given to the question as to the subjects which should be taught in rural primary schools, and as the observation of living things under natural conditions is slowly coming to be regarded as an essential part of the education of a child in the country, a description of a course of instruction of this kind, given in a German elementary school, is of interest at the present time. Such an account, by Mr. C. B. Smith, has been published by the U.S. Department of Agriculture as *Circular* No 42, and is here summarised.

The school is situated at Alfter, a village of some 2000 inhabitants, in the German Rhine Province, between Bonn and Cologne, and is what is known as a "people's school," which is equivalent to our public elementary school. Only the fundamental branches are taught in these schools, and the whole course is completed in eight years.

The Alfter common school contains 400 pupils and six teachers. In this school, as in all others in this province, two hours' instruction weekly in fruit culture, gardening, and general farming during the last two years of the course is required. This has been compulsory by law since 1895. Outline suggestions for this work are sent the principal of the school by the provincial government, as follows:—

OUTLINE OF AGRICULTURAL COURSE IN THE HIGHER GRADES OF RURAL SCHOOLS IN THE GERMAN RHINE PROVINCE.

First Year.

April and May.—(1) Inner structure of plants; plant cells and tissues and their functions. (2) Outer divisions of plants: (*a*) The roots—their function in the nourishment of plants by the absorption of mineral matter, as phosphorus, potassium, sodium, iron, chlorine, and water; (*b*) the trunk—its branches and buds, the structure of the cambium, and the occurrence of ring growths.

June.—(1) The leaf; the nature and function of chlorophyll in the life of the plant and the effect of light on chlorophyll development; breathing of plants; nourishment of plants from atmospheric constituents—carbon, nitrogen, oxygen. (2) The blossom and its fertilisation. (3) The fruit; seeds; reproduction of plants by seeds and by division of members.

July.—(1) The soil and its improvement—lime soil, clay soil, loams, sand. (2) The using up of plant food and its replacement by barnyard manure, compost, wood ashes, and indirect manures, as lime and gypsum. (3) Influence of the climate on plants.

August.—(A) Fruit culture. (1) Planting and nursery management of seedlings. (2) The most important methods of fruit improvement—root and stem grafting and budding with active and dormant buds. (3) Management of improved seedlings in the nursery—formation of the trunk and top; transplanting; handling of trained trees, especially espalier forms, with reference to their training against schoolhouse walls. (4) Culture of small fruits—gooseberries, currants, raspberries, strawberries and blackberries; setting grape-vines and their afterculture.

September.—(B) Fruit utilisation. (1) Ripening of the fruit; gathering, sorting, and storing winter fruits. (2) Fruit varieties—selection of the more commendable sorts with regard to their suitableness to different climates and soils and at varying altitudes. (3) Drying fruits; preserving; making fruit syrups; wine making. This work is planned especially for the girls.

October and November.—(C) Fruit-tree management. (1) Planting trees; pruning the roots and branches; watering newly-set trees and tying to stakes. (2) Care during the first year; top pruning. (3) Management of old trees—rejuvenating by pruning, grafting and scraping the bark. (4) Diseases of fruit trees and their prevention—knot growths, blights, gum excrescences, and frost injuries.

December.—(1) Enemies of fruit trees in the vegetable kingdom—mistletoe, mildew, lichens and moss. (2) Animal enemies of fruit trees—rabbit, mole, marmot.

January.—June bug; plum, apple and pear curculios; wasps; white butterfly; woolly aphis; and winter canker-worm.

February.—Minerals: soft coal; stone coal; petroleum; clay and its application in the manufacture of pottery and bricks; table salt.

March.—Iron, lead, copper, nickel, gold, silver; German coins.

April and May.—(1) Garden work—laying out plats, spading, manuring, sowing seed, watering plants, hoeing. (2) Vegetables—white and red cabbage, savoy cabbage, lettuce, spinach, carrots and onions.

June.—(1) Legumes—beans, peas. (2) Asparagus, cucumbers. (3) Utilisation of vegetables—drying, pickling, making into kraut and preserving. (4) Field work—plowing, harrowing, rolling.

July.—Field crops: (1) Cereals—rye, wheat, oats. (2) Potatoes, beets. (3) Fodder crops—clovers, grasses.

August.—(1) Necessity of crop rotation and consequent methods of manuring. (2) Weeds in garden and field and their eradication. (3) Animal enemies of plants and their control—field mice, phylloxera, asparagus fly, ground flea.

September.—(1) Cabbage butterfly, gooseberry measuring worm, pea weevil, army worm. (2) Useful insects: bees, ichneumon fly; useful mammals—mole, hedgehog.

October and November.—Plant enemies among the birds—swallow, nightingale, lark, robin, owls.

December.—Domestic animals—dogs, cattle, horses, chicken, doves.

January, February, and March.—Physiology of man.

The whole work of spading the soil, planting, seeding, cultitivating, pruning and harvesting the crop in this garden, is done entirely by the boys of the sixth, seventh and eighth grades under the direction of the principal, who always works with them. Two hours a week are given to this work during the growing season and at such times as the conditions of the garden may require. · About twenty boys work in the garden at one time, while the remainder of the pupils of the principal's room are having exercises in gymnastics At the time of Mr. Smith's visit to this school a part of the pupils were sowing seed, others were covering them with soil to the required depth, while still others were laying out paths, picking off the dead leaves from flower stems, replanting beds, watering seeds already sown, &c. A few days later the fruits required attention; wall, espalier, and dwarf fruits require to be summer pruned, the fruits to be thinned, insects to be gathered and destroyed.

The children use the pruning shears and do the actual pruning, each pupil being given an opportunity to trim some portion of a tree; but no twig was allowed to be pruned until it was perfectly clear that that particular twig required pruning, and, indeed, to be pruned in a particular place which the pupil himself first determined upon. When it comes time for budding each pupil buds trees in the nursery. The fall pruning is always done by the children, and small fruits, vines and shrubs put in order for the winter by wrapping some with straw, laying others on the earth and covering, and the like.

The garden is intensively farmed and made a source of revenue. The same soil is utilised for two or three crops during the growing season and the produce sold. This gives the pupils an opportunity to learn what crops best form a succession with each other during the season, and also gives them practice in a limited way in preparing and putting up fruits, flowers, and vegetables for the market.

The principal is accustomed to walk through the garden each morning before school. Should he discover a harmful insect or disease, a specimen is immediately taken to the schoolroom and the nature and work of the injurious agent shown to the pupils and discussed. This enemy is especially hunted for during the following work hour, and the children are asked to search the gardens at home for similar insects or diseases. Thus by daily association with the garden, daily watching for every new development and daily discussions and explanations, all the phenomena of the garden are encountered and brought to the attention of the pupils before the year's cycle is at an end.

Occasionally the bees are made the subject of a special lesson in apiculture. One morning a hive swarmed and flew by the school window, alighting on a small tree. The school was taken to observe this phenomena. The queen was found among the mass of clustering bees and was placed in the hive, the workers were gathered and placed with her, and a new colony was formed. Work in the apiary is incidental, but no opportunity is lost to make available anything of an especially instructive nature concerned therewith, and in the nature work the history of bees is considered.

So likewise flowering plants in the school windows are incidentally made a means of instruction. The principal's room contains three windows. These are filled with potted plants. The children (boys) are allowed to tend these flowers, to water them, guard them from insects, remove dead leaves and blossoms, and are permitted to have all the cuttings from the plants, either to take home for themselves or to plant in the school garden.

Very few of the schools in the Rhine province have such a practical course of agricultural instruction, the tendency being to confine the work to the schoolroom. This is the usual case in British schools, and only in a few districts is the school garden used as a means to interest pupils in nature and instruct them in some of the principles of husbandry.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The Smith's Prizes are awarded to Mr. J. F. Cameron, of Caius College, for an essay "On molecules considered as electric oscillators," and to Mr. R. W. H. T. Hudson, of St. John's College, for an essay on "Ordinary differential equations of the second order and their singular solutions." The names are in alphabetical order. Mr. Hudson was Senior Wrangler, and Mr. Cameron bracketed Second Wrangler in the Mathematical Tripos of 1898; and they were placed alone in the first division of the First Class in Part II. 1899.

Mr. J. H. Jeans, of Trinity College, has been elected to the Isaac Newton Studentship in astronomy and physical optics. Mr. Jeans was bracketed Second Wrangler in 1898

The Council of the Senate report that the Benefaction Fund initiated by the Cambridge University Association now amounts to 55,430*l.* They suggest that of this sum 35,280*l.* should be appropriated to buildings for the departments of Botany, Law and Medicine, in addition to 8070*l.* specifically assigned to Law and Medicine by the donors.

Dr. J. N. Langley is to be appointed deputy-professor of Physiology for Sir Michael Foster, M.P., until Michaelmas 1901, at a stipend of 300*l.* a year.

Mr. F. G. Hopkins, University lecturer in Chemical Physiology, was admitted to the degree of M.A. *honoris causa* on March 1.

THE Council of Bedford College will in June next award an additional science scholarship, the "Henry Tate Scholarship," of the value of 50*l.* per annum for three years. This scholarship was endowed by the late Sir Henry Tate, and is to be for the first time awarded in science.

IN answer to a question asked by Sir Michael Foster in the House of Commons on Thursday last, Sir J. Gorst said the Government is fully alive to the importance of scientific teaching in secondary schools, and will take care that nothing is done in the organisation of the Board of Education to impede its efficiency and progress.

THE policy of the Michigan State Agricultural College, a report upon which is included in the Report of the Michigan Board of Agriculture just received, is to educate youths and young women for the farm, and to give them such knowledge and inspiration along the various lines of agricultural work as will induce them to follow this calling after leaving the College. When the College was opened forty years ago, many students partially supported themselves by work upon the College farm during summer, and during the long winter vacation they taught district schools, thereby earning enough to pay their expenses at College. But conditions in Michigan have very much changed since that time, and the long vacation is not now in winter, as was formerly the case, but in summer. Students, who have not learned the ordinary operations of farm work before entering the College, have to spend one long vacation on the College farm. As the College farm and park cover an area of 676 acres, there is plenty of opportunity to study practical agriculture. The report of the Experimental Station provides the students and the farmers of the State with much useful information. The influence which the Station exerts upon the agriculture of the State may be estimated from the fact that more than 24,000 copies of the bulletins are distributed. These bulletins, which deal with such subjects as "Sugar Beets in Michigan," "Experiments in Corn Raising," "Commercial Fertilisers," "Bacteria and the Dairy," "Feeding Dairy Cows," "Injurious Insects," and "Tuberculosis in Cattle," are in no wise compilations, but records of results of original investigations; their value as a factor in the development of the agriculture of the State must be very important.

SCIENTIFIC SERIALS.

American Journal of Mathematics, vol. xxii. No. 1, January.—Appareil à liquide pour l'intégration graphique de certains types d'équations différentielles, by M. Petrovitch, is a continuation of the article, "Sur l'intégration hydraulique des equations différentielles," by the same author (vol. xx. No. 4). The article describes an apparatus, exceedingly easy to construct, which gives a means of solving certain equations, "intégrables analytiquement, mais il est commode pour les applications d'avoir une methode rapide et sûre pour la construction mécanique de leurs courbes intégrales."—The next paper, proof that there is no simple group whose order lies between 1092 and 2001, by G. H. Ling and G. A. Miller, continues the search begun by Hölder, and carried on by F. N. Cole and Burnside.—T. F. Holgate contributes a note additional to a former paper on certain ruled surfaces of the fourth order. The surface for which the nodal lines are real and distinct, F_5^4, and that for which the nodal lines are coincident, F_6^4, were previously discussed, but no mention was made of the surface for which the nodal lines are imaginary, though the existence of such a surface must have been in mind at the time. From the geometrical standpoint a study of the separate surfaces is of considerable interest.—H. F. Stecker's non-Euclidian properties of plane cubics is an interesting discussion on the lines of Clifford and Story.—Dr. E. O. Lovett gives two notes (1) on the differential invariants of Goursat and Painlevé, and (2) a supplementary note on projective invariants (see the April No. of the last volume).—Certain sub-groups of the Betti-Mathieu group is a slight addition to a dissertation by Dr. L. E. Dickson (*Annals of Mathematics*, 1897; *cf.* also the July No. (1899) of the *American Journal*).—Dr. W. H. Metzger gives a brief note on the excess of the number of combinations in a set which have an even number of inversions over those which have an odd number.—On Lie's theory of continuous groups, by E. W. Rettger, following up Study's and Taber's work, investigates the two- and three-parameter sub-groups of the general projective group in two variables, and of the general homogeneous linear groups in three variables, enumerated by Lie on pp. 288, 519 of his *Continuerliche Gruppen*, and his aim is to show that singular transformations occur among the transformations of many of these sub-groups.—V. Snyder writes on lines of curvature on annular surfaces having two spherical directrices. Several interesting geometrical results are given.

Symons's Monthly Meteorological Magazine, February.—Climatological records for the British Empire for 1898. Of the eighteen representative stations from which observations are regularly received, the highest shade temperature was recorded at Adelaide, 113°·3 on January 11, and the lowest at Winnipeg, −34°·6 on December 31, with the greatest range in the year, 126°·1, the least being at Grenada, 19°·8. The driest station was Adelaide, mean humidity 59, and the dampest place, Colombo (Ceylon) and Trinidad, mean humidity 80. Adelaide also registered the highest temperature in the sun, 173°·7. The greatest rainfall occurred at Colombo, 103·1 inches, and the least, 15·6 inches, at Melbourne. The most cloudy place was London, the average amount being 6·4. The table shows a remarkable similarity to that for 1897; there are only three changes in the summary of extreme values. Malta, in 1898, had a rainfall (29·2 inches) nearly ten inches above the average of 15 years, and probably the greatest on record.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society.—Special meeting held by invitation of Prof. Callendar in the Physical Laboratory of University College, March 2.—Prof. G. Carey Foster, F.R.S., Vice-President, in the chair.—Dr. F. G. Donnan read a paper on the relative rates of effusion of argon, helium, and other gases. The introduction to this paper contains a short account of the work which has been done on the effusion of gases. This is followed by a theoretical investigation of the subject, upon the assumption that the ideal gas laws are obeyed, and that the back pressure never rises above a certain fraction of the internal pressure. This gives rise to formulæ which are different from the square root of the density law of Graham. The formula derived from Hugoniot and Reynold's work gives the ratio of the times of effusion of two gases whose specific heat ratios are 1·408 and 1·67, equal to 1·06 times the square root of the ratio of the densities. The constant derived from Parenty's work is 1·084. The theory therefore indicates that argon should effuse faster than would be calculated from Graham's law. The gases used were oxygen, hydrogen, nitrogen, carbon-mon-oxide, carbon-dioxide, cyanogen, argon and helium, and they effused through small holes pierced in platinum foil. When the holes are large compared with molecular dimensions the phenomenon is one of efflux on a small scale. In the actual experiments this was the case, although the holes were sufficiently small to cause appreciable viscosity effects. By employing two or more observations in conjunction with the relative viscosities of the gases used, an apparatus constant was determined which allowed these effects to be eliminated. The observations showed that argon effused 3½ per cent. faster than as calculated from the densities alone. This agrees qualitatively with theory, and affords a confirmation of the high specific heat ratio of argon. Hydrogen, oxygen and carbon-mon-oxide effuse in the manner predicted by the theory for gases having the same, or nearly the same, specific heat ratios. Carbon-dioxide when compared with oxygen appears to effuse 1 per cent. faster than as calculated from the densities. This result is not in accordance with the adiabatic theory of the efflux of ideal gases. The results for helium are not uniform, but show that its behaviour is unlike that of argon, a result not foreseen by the theory. If account be taken of the deviation of ordinary gases from the ideal laws, it is possible to obtain an expression for the efflux which contains a correction term involving the constant K of the Joule-Thomson effect. The sign of this correction term shows that a real gas will effuse more rapidly or more slowly than an ideal gas of equal density and specific heat ratio, according as K is positive or negative. The suggestion is made that possibly the anomalous results obtained with carbon dioxide and helium may be thus explained. The deviations of the observed results from the results calculated for an ideal gas are, in the case of carbon dioxide, in qualitative agreement with the theory proposed. In the case of helium, they would be so if that gas possesses a negative K.—Lord Rayleigh congratulated the author, and pointed out that in the case of very small apertures the gas laws might not be obeyed. The ratio of the dimensions of the aperture to the length of the mean free path determined this, and not the ratio of aperture to molecular dimensions.—Prof. Ramsay and Prof. Everett expressed their interest in the work.—Dr. Donnan thanked Lord Rayleigh for his correction, and stated that the apertures used were about $\frac{1}{30}$ mm. in diameter.—Mr. E. C. C. Baly read a paper on the distillation of liquid air and the composition of the gaseous and liquid phases. From the experiments described in this paper, the author has drawn curves showing the relation between the composition of the gas evolved by boiling liquid air and the temperature, and between the composition of the liquid and the temperature, both at constant (atmospheric) pressure. These curves enable the temperature of boiling liquid air to be at once accurately determined by means of an analysis either of the liquid or of the gas evolved. The measurements of temperature were made with a Callendar compensated constant pressure hydrogen thermometer. The correction for the contraction of the glass bulb was determined by measuring directly the linear expansion of glass between $-190°$ C. and $20°$ C. This was found to be ·0000073, Regnault's measurement between 0° and 10° being ·0000085. The values for the boiling points of oxygen and nitrogen agree fairly well with those given by Olszewski and Estreicher. Boiling nitrogen has a great tendency to superheat. This can be obviated by passing a rapid current through the boiling liquid, or by dropping in pieces of copper. There does not appear to be any connection between the ratio of the vapour-pressures and the composition of the gaseous phase in the distillation of oxygen and nitrogen at constant pressure. It is proposed to investigate the distillation at constant temperature. Prof. Ramsay drew attention to the uses of liquid air for carrying on researches at low temperatures. It is non-explosive, easy to work with, and is easily kept either by means of a vacuum jacket or by surrounding it with cotton-wool. Prof. Callendar referred to the question of superheating, and stated that the constant pressure thermometer was more accurate than the constant volume one for measuring low temperatures.—A paper on the reversibility of galvanic cells, by Mr. T. S. Moore, was read by Dr. Lehfeldt. In these experiments the reversibility of cells, such as the Daniell and the Clark, which are assumed to be reversible, was tested by allowing the cell to send a current, and by sending a current through the cell. The E.M.F.'s of the cells were determined by means of a Crompton potentiometer, and from the E.M.F.'s on open and closed circuits the internal resistances of the cells were calculated. Prof. S. P. Thompson asked if experiments had been made upon Leclanché cells where the products of the action escape. Dr. Lehfeldt said that experiments were not made upon these cells because they were known not to be reversible.—A paper on the damping of galvanometer needles, by Mr. M. Solomon, was postponed until the next meeting.

Zoological Society, February 20.—Dr. Henry Woodward, F.R.S., Vice-President, in the chair.—Mr. Oldfield Thomas exhibited a specimen of a kangaroo from Northern Australia allied to *Macropus eugenii*, but distinguished by its pale colour and long soft fur. It was proposed to name the species *M. bedfordi*, after the Society's President, who had given the specimen to the British Museum.—Mr. Thomas also exhibited a kangaroo from Western Australia, apparently referable to *Macropus robustus*, but separable sub-specifically by its nearly uniform rufous fawn-colour. It was named *Macropus robustus cervinus*.—Mr. R. Lydekker exhibited, on behalf of Mr. Rowland Ward, the horns and skins of a male and female, in the winter coat, of the sheep which, on the evidence of specimens in the summer dress, he had recently named *Ovis sairensis*.—Mr. Lydekker also exhibited, on behalf of Mr. Rowland Ward, the skull, horns, and skin of a remarkable ibex obtained in the Altai, which he was inclined to refer provisionally to *Capra sibirica dauvergnei*.—Mr. C. W. Andrews gave a brief account of the land fauna and the general physical features of Christmas Island, accompanied by some lantern illustrations. He then read a paper on the marine fauna of that island, and pointed out that, the conditions being unfavourable, no systematic attempt to collect marine animals had been made, but that, nevertheless, a certain number of specimens had been obtained, which were enumerated and described in this paper by various specialists. Mr. E. A. Smith had determined twenty-seven species of Mollusca, all common Indo-Pacific forms. Of the corals Mr. H. M. Bernard had described about twenty-two species, referable to fifteen genera, two of them, viz. *Goniastraea auricularis* and *Montiporo spongilla*, being new. The sponges had been determined by Mr. R. Kirkpatrick, and were referred to thirty-one species and twenty-four genera, of which six new species and two new varieties were described. From sand dredged from a depth of eleven fathoms Mr. F. C. Chapman had determined twenty-four species of Foraminifera.—Mr. R. Lydekker communicated a paper by Dr. Einar Lönnberg, of Upsala, containing the results of the dissection of the soft parts of several specimens of the musk-ox (*Ovibos moschatus*), obtained in Greenland during the recent Swedish Expedition under the direction of Prof. Nathorst. The result of his observations was to indicate that this animal could not be regarded as a member of the Caprine group, while it was equally widely separated from the *Bovinae*. In the absence of a knowledge of the soft parts of the Takin (*Budorcas*), the author was unable to accept the suggested affinity of the musk-ox with that animal. Consequently, for the present at least, it might be regarded as representing a subfamily by itself.—Mr. F. E. Beddard read a paper on the anatomy of an earthworm, *Benhamia caecifera*, a specimen of which he had lately had sent to him from Ashanti. This species had been described by Dr. Benham in 1895, chiefly from external characters, no detailed account of its internal structure having been given.—A paper was read by Mr. Oldfield Thomas on the mammals obtained by Mr. H. J. Mackinder during his recent expedition to Mount Kenya, British East Africa. Fourteen species from the mountain were enumerated, besides five others specimens of which had been obtained at Niarobi. Three species of Dassy (*Procavia*) were described: one (*P. jacksoni*) from the Eldoma Ravine, like *P. abyssinica*, but with coarser fur and more prominent dorsal spot; a second (*P. mackinderi*) from the alpine zone high up on Mount Kenya, like *P. jacksoni*, but larger and with much longer fur; and a third (*P. crawshayi*) from the forests at the foot of Mount Kenya, allied to *P. valida*, but more rufous and with a whitish dorsal spot.

Linnean Society, February 15.—Mr. C. B. Clarke, F.R.S., Vice-President, in the chair.—Mr. R. Morton Middleton, exhibited a series of specimens of *Asplenium Bradleyi*, Eaton, one of the rarer rock ferns from Tennessee, to show its extreme variability. The simplest fronds exhibited were found in a damp, cold, perpendicular rift, which no sunshine could enter, at an elevation of about 1700 feet; these fronds had the simple pinnate structure, with green rhachis and rounded, toothed pinnæ of *A. viride*, Hudson, but were more coriaceous than in that species. Dr. Gattinger, author of the "Tennessee Flora," was satisfied that the plant was *A. viride*; and General Kirby Smith, who had had ample opportunity of studying *A. Bradleyi* on the eastern slopes of the Cumberland Plateau, remarked that *A. viride* and *A. Bradleyi* were so much alike that they might be varieties. The other plants exhibited, however, showed a gradual tendency to become more and more compound, culminating in a luxuriant specimen with pinnatifid fronds 10 inches long, the green rhachis becoming purple and shining in all the plants exposed to the sun's rays.—Mr. J. C. Shenstone exhibited a collection of 700 photographs of British flowering plants, to show what could be accomplished by means of the camera in the direction of botanical illustration. He contended that photography was the only means by which the lines and masses of our flowering plants, as truly characteristic as the less subtle characters by means of which botanists group and arrange plants into orders, genera and species, could be readily reproduced. He explained the various technical processes and apparatus necessary for successful plant photography, and alluded to the difficulties inseparable from the photography of plants in their natural habits, &c. His remarks were illustrated by means of lantern-slides.—The Zoological Secretary gave an account of a paper by Dr. R. F. Scharff, Keeper of the Natural History Collections in the Science and Art Museum, Dublin, describing a Land Planarian discovered by the author in the Pyrenees during the autumn of 1899, which he had named *Rhynchodesmus Howesi*. The paper contains a description of the leading facts of structure of the worm, which is a colossal representative of the genus to which it belongs, since it measures 130 millim. in length—*i.e.* twice that of the largest species of the genus hitherto known. It was found at Eaux Chaudes, 2000 feet above sea-level, coiled round the shell of a *Helix nemoralis*, which it had overcome and was about to devour.—Mr. J. B. Carruthers exhibited specimens and lantern-slides to illustrate the growth of the vegetable canker *Nectria ditissima* on the cocoa-plant, and gave an account of certain experiments which he had made to destroy it without injury to the tree which it attacked.

CAMBRIDGE.

Philosophical Society, February 5.—Mr. Larmor, President, in the chair.—Ionisation of gases in an electric field, Prof. J. J. Thomson. The view put forward in this paper is that the ionisation of a gas in an electric field is brought about by the presence of ions already in the field. These ions move under the electric force and acquire energy which can be spent in ionising the gas. It is shown that this view would explain why an electric field of definite strength is required to produce discharge, why a thin layer of gas is electrically stronger than a thick one, why the electric strength diminishes with the pressure of the gas until a critical pressure is reached when the strength is a minimum, as well as many phenomena connected with the discharge through gases at low pressure.—On differential equations with two independent variables, Dr.

A. C. Dixon. The results include those of Hamburger's paper (*Crelle's Journal*, vol. xciii.), but are somewhat wider in application and point to a further generalisation.—On the calculation of the double integral expressing normal correlation, W. F. Sheppard. When the measures of two organs vary about their mean value according to the normal law, and the statistical correlation of the two sets of variations is also normal, the frequency of joint variation within any selected imits is expressed by the integral considered in the paper. —On the hemihedrism and twinning of crystals of Dolomite from the Binnenthal, R. H. Solly. Mr. Solly exhibited a number of crystals with diagrams and models to explain the hemihedrism and twinning. Some new forms were notified.—Apparatus for measuring the extension of wires, G. F. C. Searle. Two wires A, B are hung side by side from the same support; the apparatus is designed to measure the extension of B relative to A, which is treated as a standard. To the lower ends of A and B are attached the upper ends of two brass frames C, D, and from the lower ends of these frames there hang respectively a constant weight and a scale pan. The two frames are kept parallel by a pair of links so arranged that the frames are capable of small relative vertical displacements. To the frame C is pivoted one end of a spirit level, of which the other end rests upon the end of a screw working in a nut fixed to D. When a load is placed in the pan hanging from D, the wire B is stretched and the bubble of the level is displaced. To bring the bubble back to its zero position the screw must be advanced through a distance which is exactly equal to the extension of the wire B. In this manner an extension of 1/1000 millimetre can be detected. With copper wire it is possible to detect hysteresis when the maximum extension is only 1/100 per cent. of the total length. —Magnetic disturbances in the Isle of Skye, Alfred Harker. It has long been known to climbers that in the Cuillin Hills the compass often becomes useless as a guide. On examination it is found that the most violent disturbances are localised at the summits and salient points on the ridges, and are due to intense permanent magnetisation with a curiously irregular distribution in the mass of the rock. This is ascribed to atmospheric electricity. It is found not only in the Cuillins, but equally on the moorland hills which make up all the north-western half of Skye; the gabbro of the former tract and the basalt of the latter are both rocks rich in iron. It is next shown that areas sometimes hundreds of yards in extent exhibit disturbances of a lower order, but still easily verified with a pocket-compass. Such an area includes one or more centres of violent local disturbance, and there appear to be evident relations between the two orders of phenomena. Finally, it is suggested that much smaller and more widespread disturbances, such as those revealed by Rücker and Thorpe's magnetic survey, may also be referable to permanent magnetisation of the rocks. The alternative hypothesis of induction seems inadequate in view of the known geological constitution of the district.

PARIS.

Academy of Sciences, February 26.—M. van Tieghem in the chair.—On the law of diurnal rotation of the optical field furnished by the siderostat and heliostat, by M. A. Cornu. It is shown that the rotation of the field has the same period as the diurnal movement, and is continuous and always in the same sense. The field of vision of the siderostat remains absolutely stationary when the polar distance of the star under examination is equal to the supplement of the polar distance of the reflected direction; the field of the heliostat, when it can be used, turns with an angular velocity which is always greater than that of the daily movement.—On the composition of hydrofluoric acid by volume, by M. Henri Moissan. Preliminary attempts were made to make fluorine act directly upon a known volume of hydrogen, but as the reaction proved to be too vigorous, the fluorine was passed into water and the liberated oxygen, after being freed from ozone by heating, measured. The fluorine and hydrogen were found to be evolved on electrolysis in exactly equal volumes.—Study of the serotherapy of anthrax, by M. S. Arloing. Experiments carried out with the serum upon sheep show that unless the serum is injected immediately after infection with anthrax, no curative effects are produced, thus rendering the serum of little practical value. Great differences were noticed in the effects when the injection of the serum was made at different places, one cubic centimetre in the veins having the same effects as ten times this amount injected into the conjunctive tissue.—The new observatory of Tananarive, by M. R. P. Collin.—The Perpetual Secretary announced to the Academy the loss it had sustained by the death of M. Eug. Beltrami, Correspondant for the Section of Mechanics.—Observations of the Giacobini comet (January 31, 1900), made at the Observatory of Paris with the 30·5 cm. equatorial, by M. G. Bigourdan.—Observations of the Giacobini comet (1900, *a*), made at the Observatory of Besancon, by M. P. Chofardet. —On the application of nomography to the prediction of occultations of stars by the moon, by M. Maurice d'Ocagne.—On the method of Neumann and the problem of Dirichlet, by M. A. Korn.—On the fundamental kinematic equations of varieties in space of n dimensions, by M. N. J. Hatizidakis.—On the movement of light waves and the formulæ of Fourier, by M. Gouy. A discussion of some recent papers of M. Carvallo upon the same subject.—The interpretation of the thermomagnetic effect in the theory of Voigt, by M. G. Moureau.—Remark on a recent note of M. Th. Tomasina on the metallic crystallisation by electrical transport of certain metals in distilled water, by M. D. Tommasi. A reclamation of priority.—The association of molecules in liquid bodies, by M. Daniel Berthelot. The author applies his modified Van der Waal's formula, in which the co-volume is regarded as a function of the temperature, to determine the coefficient of association of liquids at the critical point. For methyl, ethyl and propyl alcohols this coefficient is clearly greater than unity, a fact which has been previously pointed out by Dr. S. Young.—Oxidation by means of ferricyanides. Oxidation of camphor, by M. A. Étard. The action of potassium ferricyanide in alkaline solution is regarded by the author not as an addition of oxygen, but a simple loss of hydrogen. Camphoric acid is readily produced from camphor by this reagent.—On the anhydrous dimercurammoniun iodide in its amorphous and crystalline forms, by M. Maurice Francois.—On the estimation of ammonia and of nitrogen, by MM. A. Villiers and E. Dumesnil. The ammonia is distilled into an excess of hydrochloric acid, evaporated to dryness, heated for twenty hours at 105°, and weighed as ammonium chloride. It was found that even if the period of final drying was prolonged to seventy-two hours, no loss of weight occurred.—On the chemical equilibrium of a system in which four gases are present, by M. H. Pélabon. The formulæ developed were tested experimentally by a study of the interaction of mercury selenide and hydrogen at a temperature of 540° C. The influence of pressure upon the constant obtained, which in this case was considerable, was also studied.—On the contaminated waters of the wells of Guillotière and Brotteaux at Lyons, by M. H. Causse. From the water from these sources, which has caused typhoid fever, cystine was isolated.—Elimination of sodium cacodylate by the urine after absorption through the stomach, by MM. H. Imbert and E. Badel.—A new colour reaction of tyrosine, by M. G. Denigès. Tyrosine treated with aldehyde in a solution strongly acidified with sulphuric acid, yields a condensation derivative possessing a fine rose carmine colour, with a characteristic absorption spectrum.—On the rotatory power of active valeric acid, by M. Ph. A. Guye and Miss E. Aston.—On the plurality of species in the cultivated red currant, by M. Ed. de Janczewski.—On the parasitism of *Phoma reniformis*, by MM. L. Ravaz and A. Bonnet. The authors conclude that the spores of *P. reniformis* cannot be the primary cause of the vine disease in the Caucasus.—Examination of the fossils collected in China by the Leclère mission, by M. H. Douvillé.—On the Oligocene of the region between Issoire and Brioude, by M. J. Giroud.—The denudation of the whole of the Lorraine plateau, and on some of its consequences, by M. Bleicher.—On the comparative delivery of the two kidneys, by MM. E. Bardier and H. Frenkel.—Action of high-tension currents of high frequency upon chronic pulmonary tuberculosis, by M. E. Doumer. Considerable improvement followed the application of these currents to tuberculous subjects, the nocturnal sweats being reduced after the fifth or sixth application, and disappearing completetly after the fifteenth. The feverish symptoms are reduced in about the same time, the appetite commencing to improve after the fifteenth application. The expectoration became less abundant, and in the few cases that were systematically examined the number of bacteria diminished. Occasionally, however, the numbers would increase again. Sufficient time has not yet elapsed to be able to speak of the permanency of the improvements noted.—The treatment of tuberculous infection by muscular plasma, or zomotherapy, by MM. J. Héricourt and Charles Richet. Curves are given showing the relative effects of cooked and uncooked meat as a diet for the tuberculous, the active part of the meat consisting of the parts soluble in water.

AMSTERDAM.

Royal Academy of Sciences, January 27.—Prof. H. G. van de Sande Bakhuyzen in the chair.—Prof. J. C. Kapteyn explained a new method of determining the direction of the sun's motion in space, and criticised the methods of Argelander, Airy and Kobold.—Prof. Van der Waals made a communication concerning the cooling down of a gas current on the pressure being suddenly lowered.—Prof. Franchimont presented to the Library of the Academy the dissertation of Dr. P. J. Montagne, entitled "The action of strong nitric acid upon the three isomeric chloro-benzoic acids and some of their derivatives," and orally elucidated the contents of this work.—The following papers were presented for publication in the *Proceedings*:—(*a*) By Prof. Van der Waals; first, on behalf of Mr. Hamburger, a paper, entitled "Lipolytic ferment in human ascitic fluid." Secondly, a paper by Mr. H. Hulshof, entitled "The direct deduction of the value of the molecular constant σ considered as tension in the surface." (*b*) By Prof. Kamerlingh Onnes, a paper, entitled "Methods and apparatus employed in the Cryogene Laboratory (II.). Mercury pump for compressing pure and expensive gases at high pressure." (*c*) By Mr. E. F. van de Sande Bakhuyzen, on behalf of Mr. C. Sanders, a paper on the determination of the geographical latitude of Ambriz and of San Salvador in Portuguese West Africa. (*d*) By Prof. Bakhuis Roozeboom; first, on behalf of Dr. Ernst Cohen, a paper, entitled "The supposed identity of red and yellow mercury monoxide (II.)," and secondly, on behalf of Dr. A. Smits, a paper on "Determination of the decreases of the tension of solution vapours by means of determining the rises of the boiling point." (*e*) By Prof. Jan de Vries, a paper, entitled "On twisted Quintics of deficiency one."—A treatise by Prof. Schoute, entitled "Les hyperquadriques dans l'espace à quatre dimensions (Étude de géométrie énumerative)" was presented for publication in the Academy's *Transactions*.

DIARY OF SOCIETIES.

THURSDAY, MARCH 8.

ROYAL SOCIETY, at 4.30.—Bakerian Lecture: The Specific Heat of Metals and the Relation of Specific Heat to Atomic Weight: Prof. W. A. Tilden, F.R.S.

ROYAL INSTITUTION, at 3.

MATHEMATICAL SOCIETY, at 8.—On the Use of the Curve of Error as an Auxiliary Curve in Statistics with Tables: W. F. Sheppard.—Problems relating to the Impact of Waves on a Spherical Obstacle in an Elastic Medium: Prof. Lamb, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—On the Applications of Electricity in Medical and Surgical Practice: Dr. H. Lewis Jones.

CAMERA CLUB, at 8.—Steam Turbines, Land and Marine: A. A. Campbell Swinton.

FRIDAY, MARCH 9.

ROYAL INSTITUTION, at 9.—Bacteria and Sewage: Prof. Frank Clowes

ROYAL ASTRONOMICAL SOCIETY, at 8.—Photographic Observations of Hinel's Variable Nebula in Taurus, made with the Crossley Reflector of the Lick Observatory: Prof. J. E. Keeler.—Ephemeris for Physical Observations of the Moon for the Second Half of 1900: A. C. D. Crommelin.—On a Simple Method of Comparing the Bonn Durchmusterung with Photographic Plates: Prof. H. H. Turner, F.R.S.—The Maximum Duration possible for a Total Solar Eclipse: C. T. Whitmell.—Note on a Possible Occultation of A Geminorum on 1900 May 27–28: W. W. Bryant.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Distribution of Stress in the Walls of a Thick Cylinder: John Duncan, W. A. Wales, and G. J. Day.

PHYSICAL SOCIETY at 5.—On the Damping of Galvanometer Needles: M. Solomon.—On the Distribution of a Gas in an Electric Field: G. W. Walker.—Exhibition of a Surface Tension Lecture Experiment: C. E. S. Phillips.

MALACOLOGICAL SOCIETY, at 8.—Further Notes on Helicoid Land-shells from Japan, the Loo Choo and Bonin Islands, with Description of New Species: G. K. Gude.—Note on the Genera *Callocardia* and *Vesicomya*: E. A. Smith.—The Genus *Mytilus* and its South American Species: H. von Jhering.

MONDAY, MARCH 12.

SOCIETY OF ARTS, at 8.—The Photography of Colour: E. Sanger Shepherd.

TUESDAY, MARCH 13.

ROYAL INSTITUTION, at 3.—Structure and Classification of Fishes: Prof. E. Ray Lankester, F.R.S.

ANTHROPOLOGICAL INSTITUTE, at 8.30.—Stone Circles of Scotland: A. L. Lewis.—Exhibit of Photographs of Megalithic Buildings in Malta and Gozo: J. L. Myres.

INSTITUTION OF CIVIL ENGINEERS, at 8.—A Short History of the Engineering Works of the Suez Canal: Sir Charles Hartley, K.C.M.G.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—The Illumination of Developing Rooms: E. Howard Farmer.

THURSDAY, MARCH 15.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: Total Eclipse of the Sun, January 22, 1898. Observations at Viziadrug: Sir N. Lockyer, K.C.B., F.R.S., Captain Chisholm-Batten, R.N., and Prof. Pedler, F.R.S.—A Comparative Crystallographical Study of the Double Selenates of the Series $R_2M(SeO_4)_2, 6H_2O$. Part I. Salts in which M is Zinc: A. E. Tutton, F.R.S.—The Theory of the Double Gamma Function: E. W. Barnes.

ROYAL INSTITUTION, at 3.—Recent Excavations in Greece: Dr. C. Waldstein.

LINNEAN SOCIETY, at 8.—Report on the Botanical Results of an Expedition to Mount Roraima, in British Guiana, undertaken by F. V. McConnell and J. J. Quelch, W. Botting Hemsley, F.R.S., and others.—Bryozoa from Franz Josef Land, collected by the Jackson-Harmsworth Expedition, 1896–97: A. W. Waters.

CHEMICAL SOCIETY, at 8.—The Vapour Densities of Dried Mercury and Mercurous Chloride: H. Brereton Baker.—(1) The Preparation of Pure Hydrobromic Acid; (2) A New Sulphide of Arsenic: Dr. A. Scott, F.R.S.—The Action of Iodine on Alkalis: R. L. Taylor.—The Interaction between Sulphites and Nitrites: Dr. Edward Divers, F.R.S., and Dr. Tamemasa Haga.—New Polysaccharides: Manno-galactan and Lævulo-mannan: Julian L. Baker and Thomas H. Pope.

FRIDAY, MARCH 16.

ROYAL INSTITUTION, at 9.—Pictorial Historical Records: Sir Benjamin Stone.

EPIDEMIOLOGICAL SOCIETY, at 8.30—Measles: its Distribution and Control: Dr. Robinson.

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THURSDAY, MARCH 15, 1900.

SUGARS AND THEIR DERIVATIVES.

Les Sucres et leurs principaux Dérivés. Par L. Maquenne, Professeur au Muséum d'Histoire Naturelle. Pp. ii + 1032. (Paris: Georges Carré and C. Naud, 1900.)

THERE is no class of carbon compounds of greater interest to chemists and biologists than the sugars or, in the wider sense, the carbohydrates which form the subject of Prof. Maquenne's volume. Whether regarded from the point of view of the physiologist, who concerns himself with the part played by these compounds in the vital processes of animals and plants, or whether considered in their chemical aspect, as furnishing the most striking illustrations of the new stereo-chemistry of Le Bel and Van 't Hoff, the sugars will always be found most fascinating subjects for study and research. The great impetus to the development of our knowledge of these compounds, given by the classical researches of Emil Fischer, is one of the most remarkable examples of the interdependence of hypothesis and experiment that can be furnished by modern science—a point which is recognised by the author of the present work in the preface:—

"C'est en effet sur les travaux de E. Fischer que les considérations d'isomérie dans l'espace ont trouvé leur plus solide appui et la doctrine du carbone asymétrique ses plus sérieuses vérifications."

The continuously growing knowledge of the carbohydrates resulting from the labours of many chemists and physiologists, renders it impossible for the non-expert student to keep pace with the numerous discoveries which are being announced in rapid succession in the various publications recognised by scientific workers. As with every branch of science in which the rate of development is a measure of its vitality, specialisation must be recognised as a necessary condition of progress, and all workers must be grateful when specialists like Prof. Maquenne go through the laborious process of taking stock of existing knowledge, and of bringing together into a coherent form the scattered information which is otherwise so difficult to obtain without a large library at one's elbow. Such monographs form landmarks in the history of science; if in a few years this or any similar work is found to be behind the actual state of knowledge, it is no disparagement to the author, but an indication of progress which every worker in science cannot but welcome. As examples of the way in which the subject is growing, it may be mentioned that even while the present work has been in the hands of its reviewer, a new synthesis of glucose, fructose and mannose has been made possible by the discovery by Messrs. Fenton and Jackson, that glycollic aldehyde gives a mixture of α- and β-acrose under the influence of alkali; while, still more recently, a transition from glucose to *d*-erythrose and *i*-erythritol *viâ d*-arabinose and *d*-arabonic acid has been effected by Ruff.[1]

The name of M. Maquenne is familiar in this department of chemistry, and his qualifications for the task which he has undertaken will be generally admitted. A critical review of such a work as that before us is out of the question; we can only indicate its contents and describe the author's mode of treatment. In classification and logical sequence and general clearness the work is up to that high standard which is characteristic of French writers on scientific subjects. The twenty chapters into which the book is divided are classified under six parts. The first part (two chapters) deals with generalities and syntheses; the second part (six chapters) with the polyatomic (in our nomenclature polyhydric) alcohols classified according to the number of carbon atoms, as tetrites, pentites, hexites, &c.; the third part (four chapters) comprises reducing sugars, again classified as trioses, tetroses, &c.; the fourth part (two chapters) deals with hydrolysable sugars, such as bioses, trioses and polyoses; the fifth part (three chapters) with acid derivatives of the sugars; and the sixth part (three chapters) with miscellaneous compounds, such as osones, osamines and saccharines.

As a work of the present class is, in the first place, valuable as a book of reference, it may be pointed out that there is a fairly ample index alphabetically arranged, the very excellent plan of printing the number of the page containing the main reference to the compound in thick type being systematically adopted. The French custom of printing the table of contents at the end of the volume, instead of at the beginning, appears to us, without prejudice (insular or otherwise), to be a bad one. It will be noticed also that the nomenclature adopted for the "sugars" proper leads to the use of the term triose in two distinct senses—viz. for compounds like glyceraldehyde and dioxyacetone, which contain three atoms of carbon, and for sugars like raffinose and melizitose, which contain three hexose complexes. But these are minor points. The general arrangement of the chapters will be found, on detailed examination, to be carried out on a uniform plan, so that the reader who is searching for any particular kind of information concerning any individual carbohydrate will soon become familiar with the author's arrangement, and will know where to look for such information. We have had occasion frequently to test the book in this way, and, so far as our experience goes, M. Maquenne has never failed us. Beyond this, of course, a reviewer cannot go in praise of the work which has been submitted to his judgment.

The arrangement of the subject-matter is capable of being briefly explained. Each part begins with a chapter of generalities relating to the whole group comprised under the part, and each succeeding chapter treats of the individual compounds in the same systematic way, viz. occurrence and natural history, preparation, synthesis when accomplished, chemical constitution and configuration, physical properties, chemical properties such as action of heat, oxidation, reduction, action of acids, action of bases and salts, action of alcohols (*i.e.* etherification), phenols, aldehydes and ketones, amines, hydrazines, and miscellaneous reagents, fermentability and methods of detection and estimation. From this synopsis, which may be taken as representative for the most complete case of a widely distributed and well-known sugar, such

[1] *Ber. deutsch. ch. Gesell.*, January 1900, vol. 32, p. 3672.

as *d*-glucose, it is evident that the chemist and physicist, the physiologist, the analyst and the technologist concerned with fermentation industries are all catered for by the author, and in such a way that there should be very little difficulty in finding out what is known concerning any particular sugar or carbohydrate from the special point of view from which the reader consults the volume.

There are a few other points to which attention may be directed. The systematising of the nomenclature, so as to bring the latter into harmony with the stereochemical formulæ, is more complete than has hitherto been attempted in any work dealing with this class of compounds. The numerical system of indicating position in the space-formula is certainly to be commended. We give a couple of examples to illustrate the value of the method:—

d-Glucose.

$$\begin{array}{ccccccccccccc} & & HO & & H & & HO & & HO & & & & \\ CHO & . & \dot{C} & . & \dot{C} & . & \dot{C} & . & \dot{C} & . & CH_2 & . & OH \\ & & H & & HO & & H & & H & & & & \end{array}$$

$$\text{Hexanepentolal } \frac{2.4.5}{3}\, 6$$

d-Fructose.

$$\begin{array}{ccccccccccc} & & & & H & & HO & & HO & & \\ CH_2OH & . & CO & . & \dot{C} & . & \dot{C} & . & \dot{C} & . & CH_2 . OH \\ & & & & HO & & H & & H & & \end{array}$$

$$\text{Hexanepentol} - 1\, \frac{4.5}{3}\, \text{6-one-2}$$

Another point which those who have occasion to consult such works will appreciate, is the distribution of the references to original papers among the text, instead of relegating them to footnotes, or, worse still, to the end of the book. Some readers may not agree with this view, but it has been impossible, in writing this notice, to avoid comparing M. Maquenne's volume with a somewhat similar work at present in existence, viz. the "Kurzes Handbuch der Kohlenhydrate," by Dr. Tollens, the first volume of which was published in 1888, and the second in 1895. In the German work the references consist of densely-packed and absolutely bewildering series of pages at the end of the volume, so that in hunting up a reference the reader must turn from the page which he is reading and wade through the serried ranks of numbered references till he finds the one he wants, by which time he will have, no doubt, mislaid the paragraph from which he set out. In making use of such works as the one under consideration, in which the authority for every statement is referred to, it is certainly more convenient to have the references in brackets immediately under the notice of the reader. If the references are not wanted, the reader has only to pass on to the end of the bracket, and begin the following sentence.

This comparison of the French and German works brings out another point, however, in which Dr. Tollens will be found to have the advantage. The complex polyoses, such as starch and cellulose, are treated of much less completely by the French than by the German author, so that in this division Dr. Tollens's book will take precedence as a work of reference. In fact, M. Maquenne refers his readers to the German work for more complete information on these subjects. The other standard German authority on this subject, "Die Chemie der Zuckerarten," by E. O. v. Lippmann (1895), will find a serious rival in the present work.

In favourably recommending this latest contribution to the chemical literature of the carbohydrates to the attention of English chemists as a work of the greatest value to the general student, and as indispensable to the specialist, we have only to utter the caution—perhaps somewhat unnecessarily—that M. Maquenne does not profess to deal with his subject from the technological point of view. It may prevent disappointment if we point out that the manufacturer who is seeking for information concerning construction of plant, processes of extraction, refining, and so forth, will have to look elsewhere for guidance. Of the general value of the present volume as a literary production, we have only to say that the information given is complete, accurate, and up to date. The only omission that we have been enabled to detect relates to *d*-mannose, of which the author says (p. 559):—

"Malgré ses rapports avec celle-ci [*d*-mannite] et ses analogies de constitution avec le glucose et le lévulose, il ne parait exister chez les plantes, comme le galactose, qu'à l'état de *mannosides* complexes," &c.

The occurrence of free mannose in plants is, therefore, not recognised by M. Maquenne. Nevertheless, Messrs. Tsukamoto, Tsuji, and Kinoshita are said to have extracted this sugar from the stalks of the Japanese *Amorphophallus konjak*, and Messrs. Flatau and Labbé have recently announced that the sugar contained in orange peel is mannose.[1] The author may have overlooked these statements, or he may not accept them; at any rate, it seems worth while calling attention to the omission.

R. MELDOLA.

A NEW BOOK ON MAN.

The Races of Man: an Outline of Anthropology and Ethnography. By J. Deniker. With 176 illustrations and two maps. Pp. 611. (London: Walter Scott, Ltd., 1900).

THE Contemporary Science Series has been enriched by the addition of this very valuable work on general anthropology by Dr. J. Deniker, the distinguished Chief Librarian of the Museum of Natural History in Paris, who is well known for his original contributions to that science. Dr. Deniker has read widely, and at various times has systematised the writings of others. These are necessary qualifications for the writer of a general survey of the science of man; but in addition, our author has made investigations in various departments of physical anthropology which give a precision to his treatment, and this element of first-hand knowledge causes the reader to feel more reliance on his judgment than might otherwise have been the case.

The book is fairly evenly divided between a summary of the scope of physical anthropology and ethnography, and a systematic account of races and peoples. The former section deals with somatic characters, such as the distinctive characters of man and apes, the morpho-

[1] *Bull. Soc. Chim.* [3] xix. 408.

logical characters of human races, and their physiological and psychological characters. The chapters on the social life of men are prefaced by a useful classification of states of civilisation. One chapter is devoted to the various methods of the exchange of ideas, and others deal with the factors of material life, such as food, fire, pottery and habitations; in the latter section, the author draws attention to the essential distinction between fixed and removable dwellings. The view is adopted that, in warm climates, vanity begot ornaments which became transformed little by little into dress.

The chapter on the psychic life alludes to games and recreations, fine arts, religion, myths and science. Finally, there is one chapter devoted to family life, and another to social life.

With such a wide field to cover, the accounts of the multitudinous aspects of human life must of necessity be brief; but the author has maintained an admirable perspective, and his descriptions are written clearly and tersely, with no attempt at "fine writing." As Dr. Deniker gives copious references, the reader will have no difficulty in finding fuller information on any particular subject, and his hope that "even professional anthropologists" will be able to consult his works profitably is well founded; the tables of measurements and indices are in this respect particularly useful. The book is well illustrated, the racial types being very carefully chosen. The introduction of more maps illustrating the distribution of the principal groups would have increased the value of the book.

It is impossible in a book of this nature to avoid slips of various kinds. For example, on p. 65, in the explanation of Fig. 13, K is twice printed for X; Bornea is printed for Borneo, pp. 486, 487; and there are a few other obvious misprints. On dealing with the question of anthropophagy (p. 147), it should be noted that the abandonment of cannibalism by the Fijians is very recent, and that was due to the pressure brought to bear on them by Europeans; the same applies to several tribes in New Guinea, but in others the practice still continues. The fire-syringe (p. 150) is known in Java, and the sawing method of making fire in New Guinea. The fish-hook ornament of Torres Straits (p. 204) was made of tortoiseshell, not of mother-o'-pearl. Flinders Petrie has for some time abandoned the view that the "new race" was of Libyan origin, and has shown that these people were the neolithic ancestors of the Egyptians (footnote, p. 429).

It is scarcely fair to charge Dr. A. B. Meyer (footnote, p. 483) with supporting the Negrito origin of the Kalangs of Java, as in his original paper in 1877 he did so "with a certain reservation," and he candidly admitted his mistake in his fine monograph on the Negritos in 1893. Although Dr. Deniker is usually so careful in his references, he has omitted to refer the reader to any of Dr. Meyer's valuable publications, with the exception of this unfortunate instance.

Like most anthropologists, Dr. Deniker employs the term Dyak to signify a native of Borneo. Since the publication of Ling Roth's book on "The Natives of Sarawak," there is little excuse for employing that term in an ambiguous manner, unless, of course, an author, who may be quoted, gives no more precise information. The Land Dayaks inhabit the original Sarawak territory. The Sea Dayaks are a very different people, and equally distinct are the extensive groups of Kenyahs, Punans, Muruts, &c.; but, as no precise anthropometrical data were available when the book was written, it is unreasonable to expect a thorough disentangling of the complex of peoples in this large island. Suffice it to say, that a pronounced dolichocephalic element is present, which is probably that recognised by Dr. Deniker as Indonesian.

Dr. Deniker states (p. 486):—

"It is even possible that the Malays are a mixed nation, sprung from the intermixture of Indonesians with various Burmese, Negrito, Hindu, Chinese, Papuan, and other elements. In this case, the Indonesians would be the pure Malay type, the real proto-Malays."

It is probable that the "Malays" everywhere are a mixed people, and have a different composition in various localities, but our author appears to have overlooked what would be the probable effect of a mixture of most of these elements on the cephalic index of his proto-Malays. He states that the Indonesians have a cephalic index of 78·5 while the Malays have an index of 85. The Burmese index and that of the Aeta Negritos is somewhat less than this, while that of the Sakais is about 79. The Southern Chinese have an index of 81, and Hindus (*i.e.* Talugus or Klings) and the Papuans are markedly dolichocephalic. It is, then, difficult to see how the brachycephaly could have arisen; on p. 590 the presumably fairly pure Sumatran Malays are put down as 82·8, but though this lessens, it does not do away with this difficulty.

There is no particular reason for the surprise of M. Sénart (p. 404) at Brahmans offering water to travellers at railway stations; a high caste Hindu could not receive water from one of low caste, and by the simple expedient of avoiding absolute contact of person or vessel no contamination is received from giving water to low caste Hindus.

The Kolarians (p. 408) have a tradition that they came from the North-east, and they may be the remains of one of the various migrations which have assisted towards forming the complex population of India. This does not necessarily imply that they have a Mongolian strain. Sir William Turner has recently[1] investigated the craniology of the Hill Tribes of the North-east Frontier, and he identifies a dolichocephalic, non-Mongolian element, which appears to the present writer to be akin to the Indonesian stock. Some authorities regard the true Dravidians as the more or less modified relics of another, and possibly later, migration from the North-west, which partially replaced and submerged the Kolarian stock.

A special feature in the book is the classification of the peoples of Europe. He recognises: (1) a Northern Race (fair, dolichocephalic, very tall); (2) an Eastern Race (fair, sub-brachycephalic, short); (3) an Ibero-Insular Race (dark, dolichocephalic, short); (4) a Western or Cevenole Race (dark, very brachycephalic, short); (5) a Littoral or Atlanto-Mediterranean Race (dark, mesocephalic, tall); (6) an Adriatic or Dinaric Race (dark, brachycephalic, tall), and several sub-races. The first, third, and fourth of these races are commonly accepted, and there will probably be some discussion concerning

[1] "Contributions to the Craniology of the People of the Empire of India. Part I." *Trans.* Roy. Soc. Edinb. xxxix. 1899, pp. 703.

the other three; but those who are interested in this subject will have to study the series of memoirs on "Les Races de l'Europe," by Dr. Deniker, of which the first instalment on the cephalic index has been published by l'Association Française pour l'Avancement des Sciences (26e Session, 1897), 1899. In the volume under review there are, owing to the necessary limits of space, insufficient data to profitably discuss the author's position. It is evident that Dr. Deniker has published the conclusions which he has already arrived at from a study of the large amount of facts he has accumulated, and of which one valuable section has alone yet been published. Unfortunately, many anthropological terms are insufficiently fixed, and all authors are not careful to promote uniformity of definition—the term "race" is a case in point—and our author admits of more races in Europe than do other anthropologists; indeed, in his treatment of European ethnography he is more analytic than synthetic.

It is always easy to criticise; especially does a book like this lend itself to captious reviewing; but it is not every one who could write so sound and clear a summary of the scattered information that has been accumulated on an intricate subject. A. C. HADDON.

SYSTEMATIC BACTERIOLOGY.

System der Bakterien. Von Dr. W. Migula. Zweiter Band, Specielle Systematik der Bakterien. Pp. x + 1068 + xviii Plates. (Jena: Gustav Fischer, 1900.)

THIS volume is the second part of a work, of which the first part was reviewed in this journal in June 1898. It was then pointed out how meritorious was this undertaking of Prof. Migula, well known by his researches into the morphology of bacteria and allied organisms, in attempting to scientifically group the enormous number of forms of bacteria that had been discovered and described. No better index for the great difficulties of classifying bacteria in a scientific manner need be adduced than the fact that bacteriology within the last fifteen or twenty years has advanced by leaps and bounds, and that a host of workers—botanists, chemists, and last, but not least, pathologists—have been busy in discovering new forms, and describing and classifying them in any but a scientific manner, and on principles widely differing according to the actual point of view of the individual observers.

To classify and systematise on scientific principles, such as obtain in other departments of natural history, is a task which demands an enormous amount of labour and a comprehensive knowledge, which few observers would be willing to spare or able to command. Prof. Migula is to be congratulated on having, with his thorough grasp of this new and ever-widening field of research, and with a truly prodigious industry, achieved this result in as thorough a manner as can be expected in a branch of natural history so new and so growing as systematic bacteriology.

It will be remembered that in the first volume bacteria were considered in a general way as to their morphology and activity, and by these studies the endless number of bacterial species received their proper and scientific allocation. Thus the bacteria, as a "class," were arranged in two great groups or "orders," viz.: (1) Eubacteria, free of sulfurgranules and bacteriopurpurin, and (2) Thiobacteria, including sulfurgranules, and their protoplasm either colourless or coloured by bacteriopurpurin (pink, red or violet).

The "order" of Eubacteria comprises four "families": (*a*) Coccaceæ, cells spherical; (*b*) Bacteriaceæ, cells rod-shaped or cylindrical; (*c*) Spirillaceæ, cells more or less curved and spiral; (*d*) Chlamydobacteriaceæ, cells cylindrical, arranged in threads surrounded by a common sheath.

The first family, Coccaceæ, comprises five "genera," viz.: genus 1, Streptococcus or Chaincocci; genus 2, Micrococcus; genus 3, Sarcina; genus 4, Planococcus; genus 5, Planosarcina.

Genus Streptococcus comprises 50 different known species; genus Micrococcus comprises 228; genus Sarcina comprises 55; genus Planococcus, 7; and genus Planosarcina three distinct known species.

The second family, Bacteriaceæ, is divided into three genera, viz.: genus 1, Bacterium, without flagella, comprising 302 different species; genus 2, Bacillus, flagella more or less over the whole body, comprising 452 species; and genus 3, Pseudomonas, flagella only at the ends, comprising 79 different species.

The third family, Spirillaceæ, is divided into four genera, viz.: genus 1, Spirosoma, with 7 species; genus 2, Microspira, with 68; genus 3, Spirilla, with 16; and genus 4, Spirochæta, with five different species. These three families are minutely dealt with in 1030 pages; the whole of the fourth family of Chlamydobacteriaceæ, with its four genera and nine species, and the whole of the second "order" of Thiobacteria, with its two families (five genera), and comprising twelve species, altogether receive only twenty pages, so that practically the volume is devoted to a description of Coccaceæ, Bacteriaceæ and Spirillaceæ.

In looking over the description of the 1272 species belonging to these three families, and while admiring the prodigious labour, one cannot help sympathising with the author in the difficulties to determine which is, and which is not, a true species; which is, or is not, merely a variety; so much so that it seems as if in distinguishing "species" from "varieties," and *vice versa*, a certain arbitrary plan had to be followed. For, in some instances, the distinction between one "true" species and another is based chiefly on very slight cultural differences in one or the other artificial medium; in others on minute details of artificial staining, or on slight differences in size on one or the other artificial mediums; or even slight shades of natural colouring on a particular medium, or slight differences in physiological action. That is to say, numerous instances occur where one or the other of these points is used for distinguishing one species from another, and other equally conspicuous instances occur where these differences only suffice to mark off a "variety." One example will suffice to illustrate this difficulty. In the genus Streptococcus, the first species dealt with is that of "Streptococcus pyogenes" of Rosenbach; to this "species" the author assigns as "varieties" the Streptococcus erysipelatos, the Streptococcus conglomeratus (Streptoc. scarlatinæ), the Streptococcus brevis and longus, Streptococcus murisepticus, and Streptococcus septo-pyæmicus. According to the author, the differences in size, arrangement, cultural characters and physiological action of these "varieties" and the "Streptococcus pyogenes" are slight, and do not justify a separation as true species. Now, any one who has had sufficient experience in the matter of these so-called "varieties" must know that the cultural and physiological differences between these "varieties" and the "species" are sufficiently definite and conspicuous; in fact, quite as definite as those described of several others of the author's true "species" of Streptococcus.

The same difficulty is met with in looking over some of the species of the genus Micrococcus, Bacterium and Bacillus. As mentioned above, the chief distinction between genus Bacterium and Bacillus is the absence or presence of flagella; now looking through the description of some of the species belonging to "Bacterium," we find several in which the absence of flagella is deduced apparently solely from the fact that in the fresh state (hanging drop) no mobility is observed; but this, as is well known, is deceptive for a true diagnosis, and no safe reliance can be placed on it. In the same way we find some species of "bacillus," *e.g.* bacillus pestis, as being surrounded by flagella. I have no doubt this statement will come to many as a surprise, and one would like to know whether this bacillus pestis of Migula had been tested on animals and had caused the typical disease.

The volume contains at the end eighteen plates, each with eight figures of clear and good prints of photographic representations of many species of Coccaceæ, Bacteriaceæ and Spirillaceæ. Many of the figures are excellent, *e.g.* those of Flagellate bacilli, Pseudomonas and Spirillaceæ; some others might without disadvantage have been omitted as not representative or too little representative; *e.g.* there occur five figures of *Vibrio cholerae asiaticae* [Microspira Comma (Migula)], not one of which is really characteristic of the microbe.

The important points of the formation, appearance and distributions of spores in many bacillary species, is represented by a single figure (Fig. 2, Plate iv.) showing dots in anthrax threads supposed to have been photographed at a magnification of 1000 (!).

The book on the whole must occupy an important place not only as a thoroughly systematic work, but also as a book of reference, there being attached to each species a valuable paragraph of bibliography.

E. KLEIN.

COLLECTED WORKS OF L. LORENZ.

Ouvres Scientifiques de L. Lorenz. Revues et Annotées. Par H. Valentiner. Tome Premier, Deuxième Fascicule; Tome Sécond, Premier Fascicule. Pp. 213+529 and 315. (Copenhague: Lehmann and Stage, 1898 and 1899.)

THE custom of collecting into convenient form the works of a distinguished writer has much to recommend it. We in England have realised its importance, and we gladly welcome this edition of the collected works of Prof. L. Lorenz, two parts of which are now before us, published in French, at Copenhagen, under the editorship of Dr. H. Valentiner, and at the cost of the Carlsberg Foundation. The two volumes cover a wide period of time; the first paper, that containing Prof. Lorenz's theoretical and experimental researches on indices of refraction, was printed in 1869. The author's name is well known as one who has worked at optical theory, and has carried out experiments of great importance with a view to the verification of crucial points in that theory. The phenomena of dispersion, and the relations between the optical properties and the physical conditions of a substance, offer a fascinating field of research; and it is of real service to have here, in accessible form, the elaborate series of papers which led Lorenz to the conclusion that the quantity $(\mu^2-1)/(\mu^2+2)\rho$ was a constant for the various states of a refracting medium. This is hardly the place to discuss at length the various steps that lead the author to that conclusion. In Lorenz's view the ether inside a transparent medium, such as glass or water, cannot be treated as homogeneous. His solution of the problem is most easily followed in the paper, "Ueber die Refractions Constante" (*Wied. Ann.* tome xi.), the mathematical developments of which are given on p. 360 of the first volume now under consideration. Lorenz assumes, in this paper, that within the molecules of a transparent body the velocity of light is constant, and in the interspaces between the molecules it is also constant; the actually observed velocity will depend on these two constants. In the paper now before us it is assumed further, though this is shown not to be vital to the result, that the molecules are spheres. The problem thus discussed is that of the transmission of light through a complex medium consisting of transparent spheres embedded in a homogeneous medium, and with these assumptions it is shown that the quantity $(\mu_\infty{}^2-1)/(\mu_\infty{}^2+2)$ is proportional to the mass per unit volume of the compound medium. In obtaining the above equation, the effects of dispersion are neglected; a later paper (*Wied. Ann.* tome xx.) discusses these on the assumptions (1) that the density of the ether near any molecule is a function of the distance from the centre of the molecule, so that the ether is arranged round each molecule in spherical layers, which change in density on passing from one layer to the next; and (2) that Fresnel's sine and tangent formulæ hold for each such transition.

From this Lorenz obtains the equation

$$(\mu^2-\mu_\infty{}^2)/(\mu^2+2\mu_\infty{}^2)\rho=a/\lambda^2+b/\lambda^4+\ \dots$$

μ being the refractive index for waves of length λ, and μ_∞ that for infinite waves.

Other papers in the volume before us are concerned with experimental investigations into the truth of these formulæ. As a result of one series of experiments, it appears probable (p. 245) that the refractive index of water is a function of the density of the water, and not of the temperature, except so far as that produces change of density; while, in general, Lorenz concludes that for a number of gases and vapours the equation

$$(\mu_\infty{}^2-1)/(\mu_\infty{}^2+2)\rho=a \text{ constant}$$

is satisfied with considerable accuracy.

With regard to this result, it should be noted that (p. 323) the formula is treated as equivalent to

$$2(\mu_\infty - 1)/3\rho = \text{constant},$$

so that the experiments do not decide between the simpler law due to Dr. Gladstone and that given by Lorenz.

In the second volume we have an important memoir, on the solution of the equations of motion of a homogeneous elastic solid, published in 1860 in *Crelle's Journal*, and some interesting speculations on the relation of thermal conductivity to electric conductivity in pure metals; but the papers which will attract most attention are two on the absolute resistance of mercury (*Pogg. Ann.* cxlix., and *Wied. Ann.* xxv.). The first of these gives the original account of the now well-known Lorenz method of measuring absolute resistance; while the second is a statement of the results of Prof. Lorenz's own experiments made at the request of the International Congress of Electricians in 1882.

The first paper is most interesting; the contrast between the original Lorenz apparatus, as figured on p. 88, and the instrument designed by Professors Viriamu Jones and Ayrton for the McGill University is most instructive. Lorenz, from the beginning, was alive to the merits of his method and to the difficulties of carrying it into practice; the first preliminary experiments, in which the diameters of the tubes of mercury, used as resistances to be measured, were 7 millimetres and 14 millimetres respectively, led to the result that the length of a column of mercury one square millimetre in cross-section, and having a resistance of one ohm, is 107 centimetres, a result surprisingly near the truth when all things are considered; while in his definitive paper the result arrived at is 105·9 centimetres; the value which has been universally agreed upon as representing the result of all the best experiments is, as is well known, 106·3 centimetres.

Space compels only the briefest mention of another interesting paper, "On the Propagation of Electricity" (*Wied. Ann.* tome vii.); but enough has been written to show the high value and real interest of these volumes. Students of physics owe a debt of gratitude to Dr. Valentiner for the care with which he has done his work as editor, and for the labour he has spent in explaining difficulties and in making Lorenz's meaning quite clear.

OUR BOOK SHELF.

Theory and Practice of Art Enamelling upon Metals. By Henry Cunynghame. Pp. xvi + 135. (Westminster: Archibald Constable and Co., 1899.)

THIS book treats of enamels and of their employment in artistic work from several points of view. The introductory chapter, which extends to 33 pages out of the 133 which the volume contains, is mainly historical and archæological. The eight plates which illustrate this section of the book are unsatisfactory, while the text is open to serious criticism. The author is mistaken when he describes the Alfred Jewel in the Ashmolean Museum at Oxford as a ring, and when he affirms that it contains a "Byzantine enamel in a Saxon setting." A strange passage, which is too funny to be missed, will be found on p. 7, where the mosque of Santa Sophia at Constantinople is stated to have suffered the destruction of many of its splendid enamels through the "fanaticism of the followers of Dost Mahommed." The practical and technological details of Chapters i. to iv., with the illustrations which explain the operations described in the text, or represent the tools and apparatus employed, constitute the valuable portion of this treatise. One can discern throughout these pages the skilful and intelligent worker who has fought his way to success. We cannot speak of the final chapter, "The Manufacture of Enamels," with equal confidence. It would be wiser to omit chemical formulæ altogether rather than to give $NaO2BO_3+10Aq.$ for borax, $HOBO_3$ for boric acid, Cu_2O for black oxide of copper, Cr_2O_2 for sesquioxide of chromium, and $KOCrO_3$ for bichromate of potash. And what is the meaning of this sentence (p. 124), "Manganese is called in German, brown-stone, and by the French, peridot, after a town near Limoges where it was found"?

The Witness of Creation: Nature Sketches from the Book of Job. By M. Cordelia Leigh. Pp. 167. (London: Jarrold and Sons, 1900.)

WE hope this book will be widely read by the Sunday-school teachers and leaders of Bible classes, for whom it is primarily intended; for they will derive from it many lessons which will create and foster a love of nature in the members of their classes. The chapters in the book originally appeared in *The Sunday at Home*, each chapter being based on a passage in the Book of Job or the eighth Psalm, in which some natural force or object is referred to, such as the sun, snow, rain, wind, ice, the lion, the wild ass, &c.

The poem of Job is full of references to nature, and Miss Leigh has interpreted these references in the light of modern science. For instance, the words "foundations of the earth" suggest remarks upon the earth's physical structure; "Hast thou entered into the springs of the sea? or hast thou walked in the recesses of the deep?" forms the text for a chapter on the sea; and "Canst thou send forth lightnings, that they may go, and say unto thee, Here we are?" heads a short chapter on electricity. This chapter, however, is a disappointing one, and a writer with a real knowledge of what has been accomplished in electrical science could have given a brilliant answer to the poet's inquiry. The texts dealing with physical science are, as a rule, not so well expounded as those referring to natural history objects. The idea of viewing the sublime poem of the Book of Job from the aspect of latter-day scientific knowledge is, however, an excellent one, and we trust the book will be read by priests as well as the laity; for the contents will be found a source of inspiration to all interpreters of Holy Scripture.

La Céramique Ancienne et Moderne. Par E. Guignet et E. Garnier. Pp. 311. (Paris: F. Alcan, 1899.)

THE author of the second section of this work, M. Garnier, is already well known as a writer on ceramic art. Filling the important post of Keeper of the Sèvres Museum, he enjoys ample opportunities of becoming familiar with the development of earthenwares and porcelains and the characteristics of the several kinds. But a couple of hundred pages illustrated by fifty poor process-blocks have not afforded M. Garnier the chance of treating his subject adequately. The essay by M. Guignet on materials and manufacture, though far too slight and unequal in treatment, is good so far as it goes. Unfortunately, he omits much that one expected to find in his pages, *e.g.* the process and rationale of salt-glazing, while he repeats (p. 86) the exploded theory that Josiah Spode, about the year 1800, first introduced bone-ash into the body of English porcelain. Several other Continental writers on ceramics, when they give any account of English porcelain and earthenware, do not fail to reproduce this error. But in point of fact this phosphatic porcelain, called by the French *Porcelaine tendre naturelle ou Anglaise*, dates back to the year 1748, and was made largely at Bow, and at other English china factories long before the time of Spode. Numerous chemical analyses of authentic specimens have proved this point without the shadow of a doubt. The volume would have gained greatly in scientific interest had the authors introduced plates representing the microscopic structure of the chief porcelains and wares One such plate only is given, and that is poor.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Acoustic Analysis of the Vowels from the Phonographic Record.

Many attempts have been made to determine vowel timbre from the phonographic record, with more or less of success. The difficulties of transcription on a sufficiently large scale has proved considerable. With the aid of Dr. F. C. Van Dyck,

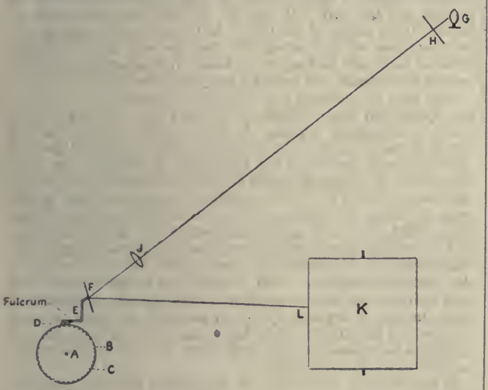

FIG. 1.—A, section of phonograph wax cylinder; B, surface of the wax; C, bottom of the furrow, with undulations much exaggerated; D, sapphire knob of tracer; E, rigid lever bearing adjustable mirror; F, adjustable plane mirror; G, source of light; H, plate with pin-hole through which light passes; J, convex lens with conjugate foci at H and L; K, revolving drum carrying bromide paper; L, surface of paper on which point of light leaves the sinuous trace.

Professor of Physics, in Rutgers College, I have succeeded in constructing an apparatus at once simple and satisfactory, and have reached results that seem worthy of consideration.

The vowel curves obtained are large enough to be measured with precision, and the method employed allows greatly increased enlargement if desired. The apparatus I have used is illustrated diagrammatically in the accompanying figure (Fig. 1). The most essential part is simply the automatic reproducer of the Edison Phonograph from which the diaphragm is removed, and upon the tracing lever of which a rigid arm is fastened which bears an adjustable mirror. If now the sapphire knob of the tracer is made to follow a record *very slowly*, the mirror will be deflected back and forth in correspondence with the undulations of the record furrow, and by means of a narrow beam of light reflected from it, and focussed upon a strip of moving bromide paper, a sinuous photographic trace is obtained exactly corresponding to the bottom of the furrow in the wax cylinder.

It is manifest that this method of transcription makes possible a very great enlargement. In the reproducer the short arm of the lever, *i.e.* the difference between the sapphire tracing knob and the fulcrum, is about one-eighth of an inch in length. Working with a beam of light of the length of ten feet gives therefore an enlargement of about one thousand times. By making the short arm one-sixteenth of an inch and the working distance thirty feet we may without great difficulty multiply ordinates by six thousand. As yet I have not found it necessary to enlarge more than one thousand times.

Since the actual depths of the hollows made by the phonograph recorder in the wax for a good vowel tone are often as much as one two-thousandth of an inch, and are generally greater than one twenty-thousandth of an inch, an enlargement of one thousand times gives for such tones a curve of which the ordinates are easily measured with precision.

It is not possible in the space at my command here to describe the details of my apparatus or of my experiments. Those who may be interested I refer to a more extended account which

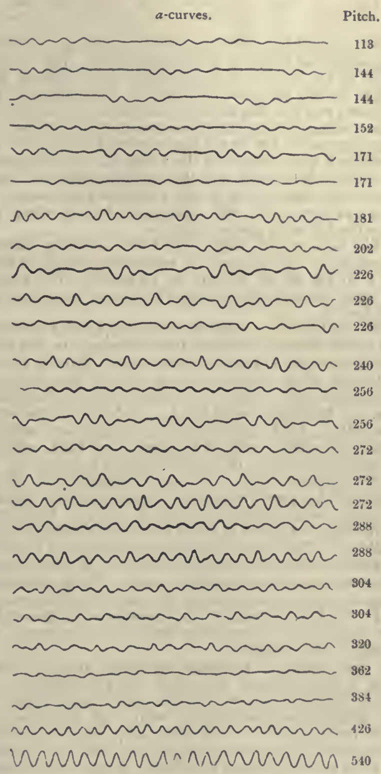

FIG. 2.

will shortly appear in the German Phonetic Journal, *Die Neueren Sprachen*, and to a short description of apparatus and results in the *Physical Review*.

I have obtained many records of all the principal vowels of English speech, but have not yet completed work on any vowel save *a* (as in f*a*ther) far enough to make even a preliminary report. The accompanying diagram gives a few specimen *a*-curves (Fig. 2). The pitch is indicated by the vibration number at the side of each wave-section. The quality of the vowel represented is the same in each case, as far as possible, at different pitches, and by different voices. The record in each case gave in phonographic reproduction a clear and unmistakable *a* (as in f*a*ther). The sections shown represent about the one fifty-sixth part of a second, and the whole sheet has been reduced for convenience to about one-quarter of the actual size. The traces which I obtained and measured for analysis, by means of the Fourier theorem, were therefore four times as large as the curves here shown.

I subjoin herewith a few specimen analyses. In the table, column I. contains the vibration number of the fundamental, *i.e.* the pitch at which the vowel was sung, and its amplitude percentage; column II. contains the vibration number of the first overtone, *i.e.* the octave of the fundamental, and its amplitude percentage, and so on.

I	II	III	IV	V	VI	VII	VIII	IX	X	XI
113	226	339	452	565	678	791	904	1017	1130	1243
9·9	15·4	2·5	0·8	**11·5**	**16·1**	3·3	8·1	**21·2**	7·2	3·2
144	288	432	576	720	864	1008	1152	1296	1440	1584
33·9	4·3	1·9	8·5	**14·8**	2·1	8·8	**13·5**	7·2	1·3	4·7
171	342	513	684	855	1026	1197	1368	1539	1710	1881
5·6	4·8	2·9	**17·5**	5·0	**33·1**	**19·9**	2·1	6·1	1·9	1·1
226	452	678	904	1130	1356	1582	1808	2034	2260	2486
9·2	3·6	**34·6**	8·0	**31·0**	2·6	6·2	1·4	0·8	1·2	1·4

It will be sufficient here to state as briefly as possible the conclusions which I believe to be warranted. The vowels as produced by the human organs of speech are composed in the first place of two elements, that due to the vibration of the vocal chords and that due to the resonance of the mouth, throat and nose cavities. It is not always possible to separate clearly these two elements, but at the pitches shown in the above table the problem is quite simple for the vowel *a*. The fundamental is due to the vocal chords, and the overtones that are strongly reinforced are due to the mouth and throat resonance. The vowel *a*, at any pitch, and pronounced by any clear voice, contains the following partial tones:—

(1) The fundamental, with the first two or three overtones. The fundamental varies greatly in relative amplitude for reasons which I do not as yet attempt to formulate. The overtones are all weak, unless reinforced by the mouth resonance as set forth below.

(2) The overtone or overtones whose frequencies of vibration chance to fall between 1000 and 1300 vibrations to the second, the maximum seeming to lie at about 1150. This is the main characteristic of *a*, which serves to identify it to the ear, and remains remarkably constant, no matter what the fundamental may be. If the fundamental has 144 vibrations to the second, overtones VII., VIII. and IX., with frequencies of 1008, 1152 and 1296 respectively, will all be present, but VIII., with 1152 vibrations to the second, in much the largest amplitude.

(3) The overtone or overtones whose frequencies of vibration chance to fall between 575 and 800 vibrations to the second for men's voices, with a maximum at about 675; or between 675 and 900 with a maximum at about 800, for the voices of women and children. This is presumably the resonance of mouth and throat cavities resounding as one vessel, and is not as constant as the main resonance described above. If the fundamental has 144 vibrations to the second, we shall therefore find overtones IV. and V. present, with frequencies of 576 and 720 respectively, but V., being nearer the point of maximum resonance, will be the stronger.

The two regions of resonance are indicated in the table by printing in larger figures the amplitude percentages of those overtones which fall at or near the points of maximum resonance, and are therefore present with large amplitudes. My analyses reveal for the vowel *a* no other region of resonance that is constant or important except these two. On the basis of many observations it would be possible to plot a curve which would represent the mouth resonance for the *a*-position. A tentative chart of this sort will be found in the articles already cited, and in general for a fuller discussion of the whole subject the reader is referred to those articles. LOUIS BEVIER.

Rutgers College, New Brunswick, N.J.

Illustrations of Lepidoptera.

CAN any of your readers assist me in finding some artist who is really competent to produce, by any process which combines extreme accuracy with a reasonable cost, a large series of illustrations of variation in butterflies? The difficulty of getting such work done in the country under my own eye is very great, and I am unwilling to do as some of my friends advise, and get them made in Germany. Where the variation is a question of pattern only, photography would probably be the most satisfactory process; but where colour is the leading feature of the variation, chromo-lithography seems the most likely to succeed. The number of works on natural history which are privately published in England seems to point to a want of enterprise among English publishers which I cannot understand, as the market for really well illustrated works on ornithology, botany and entomology is certainly increasing. Any suggestions addressed to me will be gratefully received. H. J. ELWES.

Colesborne, Andoversford R.S.O., Gloucestershire.

"Billiards Mathematically Treated."

THE review, in your issue of March 1, of Mr. Hemming's book on billiards reminds me that I have never yet seen a satisfactory explanation of the following question:—

Why does a billiard ball when struck to the right or left of its vertical axis nevertheless travel in the direction in which the cue travels?

It only does so when the cue tip is chalked, otherwise it travels in a direction of a line through the centre of the ball and the point of contact with the top of the cue, as may be expected from the laws of dynamics. The chalking of the cue of course enables the striker to put on what is known as side, *i.e.* to make the ball revolve on its vertical axis; but why does it also allow the ball to travel in a straight line instead of going off at an angle? ENQUIRER.

THE answer to "Enquirer's" puzzle is very simple. If you let a perfectly hard and smooth cue tip impinge at any angle on a perfectly hard and smooth ball, the only force exerted will be normal, and the ball will start in the line from the point of impact to the centre of the ball. At the same time, during the brief duration of the impact the cue tip will slide a minute distance along the surface of the ball, but in consequence of the perfect smoothness will exert no tangential force on the ball.

Now take the extreme case in the opposite direction. Let the cue tip be such that it bites on the ball without any sliding whatever during the impact. In this case the point of the ball struck moves exactly in the direction of the motion of the cue—the centre of gravity of the ball moves in precisely the same direction with a rotation added which is familiar to us as side—and this will be so (if the bite is perfect), whatever may be the angle between the direction of the cue and the surface of the ball. With the ivory tips in use more than a century ago, you had something approaching, though not quite reaching, perfect smoothness—and the ball flew off not quite, but very nearly, in the normal direction. With modern tips in good order and well chalked the bite is sufficient to prevent any slipping and drive the ball in the line of the cue, provided the angle between the cue and the surface of the ball is not too small; and if this condition is fulfilled the ball will start in a direction exactly parallel to the line of the cue.

If the angle is too small, as by playing side too near the edge of the ball, there will be some slip and the ball will go wrong (not quite normally, but a long way from the desired direction). It will be a miss-cue. The nearness to the edge which can be played without miss-cueing is different for different players, and depends upon some nicety in the handling of the cue which does not admit of definition.

Roberts can play side vastly nearer to the edge of the ball than I should dream of attempting, and I daresay a good deal nearer than "Enquirer" could try with success. But the broad fact is, that with a well chalked cue you can insure (within certain limits of angle) that there shall be no slip.

If the cue is not chalked you can still do the same thing within very much narrower limits, that is to say, you can put on a very little side.

The ivory tip, the chalked tip, and the unchalked tip, are three different cases intermediate between the extreme theoretical cases of perfect smoothness with unresisted slip and perfect bite with no slip at any angle however small.

I do not think that any one could have foreseen that a cue tip could be made to bite to the extent to which it does. But somebody in America or France found it out by experiment, and for the first time made billiards the scientific game which it has now become. G. W. HEMMING.

The Micro-Organism of Faulty Rum.

IN the course of our investigations upon this organism, first alluded to by us (NATURE, vol. lvi. p. 197, June 1897), and subsequently by others (vol. lix. p. 339, February 1899), we have found that from spirit of 70 per cent. of alcohol, which has been in our possession for three years, we can still obtain successful cultures in gelatine; the various forms, which we have previously described, have been observed as before.

Our object in sending this note is to call attention to the extraordinary vitality of this organism under such untoward circumstances, owing doubtless to its carefully entrenched position.

V. H. VELEY,
Oxford, March 10. LILIAN J. VELEY.

Drunkenness and the Weather.

ON reading the letter of Prof. Dexter on "Assaults and Dunkenness" (p. 365), I notice that there is one great fallacy in the argument.

When a man is intoxicated and commits an assault, the result is entered in police reports as "assault," the more serious offence overshadowing the less. So that, in all probability, many of the cases of assault referred to in the statement were also cases of drunkenness, but were not tabulated as such.

The temperature is an important element; for its variations are probably the cause of the change of character of the offences recorded. The same quantity of alcohol will, as has often been noticed, have very different effects in the summer and in the winter. In hot weather alcohol has a stimulating influence; this is much less marked in the winter, and during this season the sedative effect is certainly more noticeable.

Studying Prof. Dexter's curves in this light, and assuming the absence of any other fallacies, we may reasonably conclude that the number of those arrested for drunkenness or its results varies but little throughout the year. Probably the same people supply the cases of drunkenness in winter and of assaults in summer.

R. C. T. EVANS.
9 Heathcote Street, Gray's Inn Road, W.C., March 3.

Mechanical Methods of Calculating Logarithms.

THE following mechanical method of finding logarithms seems to be as simple as any that have been proposed, and has the advantage that it gives the logarithms of all numbers without interpolation, and at the same time affords a proof of the fundamental property of the function.

Let a flat ruler AB be provided at one end, A, with a hatchet edge (like that of the hatchet planimeter), so arranged that when the ruler is held horizontally, and the hatchet allowed to touch the paper, it touches at a point vertically below the edge of the ruler. The hatchet must lie in a vertical plane inclined at a convenient angle (say 45°) to the ruler. Let the ruler be held thus, with its edge touching a pin. On moving the ruler so that the hatchet does not slip sideways, the latter will trace a spiral curve on the paper. From its mode of generation the spiral clearly cuts all radii vectores at the same angle, and thus is the well-known equiangular spiral. Let OA be a radius vector of unit length, and OP one of length r. Let $AOP=\theta$ where θ may be expressed in terms of any convenient unit, then we may define the logarithm by the equation $\theta=\log r$. Of course, θ depends on the angle of the spiral and on the unit of angle adopted as well as on r, and so is not yet completely defined. We can, however, immediately prove the fundamental property of the logarithmic function.

Imagine a copy O′A′P′ of the diagram to be made on some extensible material, and to be extended equally in all directions in the ratio R : 1. All angles remain unaltered, and the new curve is an equiangular spiral with the same angle as before. If, now, O′ be placed on O, and the new diagram turned till A′ lies on the old spiral, the two spirals, having the same angle, must coincide, and hence P′ lies on the old spiral. Now $OA'=R$, $OP'=rR$. $AOP'=AOA'+A'OP'=AOA'+AOP$, which gives $\log rR=\log r+\log R$, the fundamental property. If we further chose our unit angle so that $\log 10=1$, the spiral will give Briggian logarithms. It would, perhaps, be more convenient practically to adjust the angle of inclination of the hatchet so that log 10 is represented by 100°, or perhaps by 360° if we divide the circle centesimally. It may seem that the logarithm, as defined above, still depends on the angle of the spiral, but this idea can be readily disproved by means of the equation $\log rR=\log r+\log R$. The logarithm, having been defined without reference to indices, may now be used to define the quantity x^n, where n is negative or fractional, and to give the index laws in a manner rather less artificial than that usually adopted (the fact that no indication is given of the many-valued character of a fractional power is, however, a drawback).

The hatchet planimeter may be used to obtain logarithms, but in a less simple manner. If the planimeter be placed with its point on a given straight line, and its length perpendicular to the line, and the point be moved through a distance x along this line, the inclination θ of the planimeter to the line is given by $x=a\log\cot\theta/2$, where a is the length of the planimeter. This gives an obvious mechanical construction for a logarithm.

Leeds, March 5. H. C. POCKLINGTON.

THE CENTENARY OF THE BERLIN ACADEMY OF SCIENCES.[1]

IT is with feelings of pleasure that we call the attention of our readers to the fact that rather more than one month ago the Academy of Sciences at Berlin, at its meeting on the 25th of January, commemorated with great rejoicing and some very pardonable pride the work which its members have done in the world during the last hundred years. The subjects which have been investigated by this distinguished body include almost every branch of human knowledge, and although at this date we are too near in point of time to be able to judge definitely and finally as to the value of the work which the German scholars and men of science, whose names are written on its books, have done, there is no room for doubting that they have enlarged the bounds of human knowledge in every direction, and have brought us many degrees nearer to the goal sought by all honest investigators.

The Berlin Academy has kept in mind what the true functions of an Academy of Sciences should be, for it has not sought to limit the number of subjects which its members desired to investigate, and it has not attempted to patronise or to foster the growth of one class of sciences, or of one branch of learning, to the exclusion of all others. It has encouraged knowledge of every kind, and has supported by its influence and money the workers in the most recondite branches of human learning, and its influence for good has been so far-reaching that it would need a volume if we attempted to describe the work which has been well and efficiently performed under its auspices. And the Academy of Sciences at Berlin has not only helped the world positively, as it may be termed, that is to say, by enabling its members to formulate and build up sciences, but negatively, by making it impossible for the faddist, and crank, and charlatan to press his views upon the non-expert, but well-educated, section of the German public. In this last capacity it has performed, very quietly and unobtrusively, but effectively, a most important duty, and it has succeeded in obtaining and holding a position of *authority* which cannot be gainsaid. It has proved to all the world that when it sets its seal of approval on a man's methods or works, those methods and works have permanent value. We may almost say that the work of German scholars and thinkers is so good because they possess in their country a high authority for the approval of which they are content to toil long and arduously, knowing well that its stamp is a hall-mark which the intellectual world will honour, and the full value of which will be duly credited to it. Of the universality of learning the Academy at Berlin has been a consistent and powerful patron, and the long list of great names which Herr Waldeyer, one of the secretaries of the Physical Section, brought to the notice of the members at its festival meeting is a splendid proof of this statement. Among historical investigators and jurists may be mentioned Fichte, Schleiermacher, Schelling and Trendellenburg; among students of linguistics and archæologists, Boeckh, Bekker, Bopp, Curtius,

[1] *Sitzungsberichte der Königlich Preussischen Akademie der Wissenschaften zu Berlin.* 25 *Januar. Öffentliche Sitzung zur Feier des Geburtsfestes Sr. Majestät des Kaisers und Königs und des Jahrestages König Friedrich's II.* In Commission bei Georg Reimer, Berlin.

Haupt, Dillmann, Müllenhoff and Lepsius; among mathematicians and physicists, Dirichlet, Kronecker, Erman, Dove, Kirchhoff, Kundt and Helmholtz; among chemists, Mitscherlich and Hofmann; among astronomers, Bode, Ideler, Encke; among geographers and cartographers, Ritter and Kiepert; and among biologists, Link, Braun, Lichtenstein, Ehrenberg, Müller and du Bois-Raymond. The above names represent only a selection, but these eminent members by their works have permanently influenced, and have stamped their individualities upon, the various sciences to the investigation of which they devoted their best powers and their lives. The Berlin Academy, and the very few institutions which resemble it, are the only places where men of such diverse qualifications and acquirements as Schleiermacher, Ranke, Lepsius, Dillmann, Seebeck, Kirchhoff, Helmholtz, Hofmann and Encke could be found sitting together as members and discussing the best methods for furthering the universality of knowledge. In Berlin, Vienna and St. Petersburg the past and present members of the Academies have carried out the intentions of their founders, and every branch of human knowledge has been considered worthy of recognition and encouragement at their hands.

The Academy at Paris was originally founded for the preservation of the French language, but the French savants soon found that it was necessary to establish other bodies which should represent the arts, and sciences, and archæology. Hence the Académie des Inscriptions, the Académie des Sciences, and the Académie des Beaux Arts came into being; in 1795 these Royal Academies were combined under the general title of Institut National. Thus together they represent all natural knowledge, and the various Academies really form sections of one great controlling and directing intellectual power in France. The operations of this power are so extensive that even a writer like M. Zola thinks himself entitled to enrolment among the members of one of its great sections.

When Herr Waldeyer had read his festival address he proceeded to report to the meeting what works the Academy had in hand, and to describe the progress which had been achieved in them. These included a *Corpus* of Greek inscriptions under the direction of Kirchhoff, a *Corpus* of Latin inscriptions under the direction of HH. Mommsen and Hirschfeld, the publication of the Commentaries on Aristotle, of the political correspondence of Frederick the Great, of the *Acta Berussica*, of the Latin Thesaurus by Diels, of an edition of the works of Weierstrass, of the work of Kant, of the Arabic history of Ibn Saad, of an Egyptian Dictionary, &c.; to give a list of all the works upon which the Academy is engaged would exhaust our space, and the curious reader will find them all mentioned on p. 45 ff. of the *Sitzungsberichte*.

The writing of these remarks causes many disquieting facts to cross the mind; foremost among them is that which tells us that there is no equivalent in England of the Academy of Sciences at Berlin. In its earlier years the Royal Society in a measure occupied in England the position now held by the Academy at Berlin in Germany, but such is no longer the case. The founders of the Royal Society apparently intended its members to be recruited from the ranks of scientific men of every kind, and the first seventy volumes of the *Philosophical Transactions* bear testimony to the truth of this assertion. The pages of that work were open to every scholar and man of science, provided that he had something to say and knew how to say it, and as a result the earlier volumes of the *Philosophical Transactions* are wider in their scope than the later ones.

Thus if the reader will take the trouble to turn over their pages, he will find papers on Latin, Greek, French, Irish, Phœnician, Etruscan and Runic inscriptions; accounts of pigs of lead, a tesselated pavement, a leaden coffin, Irish urns, &c.; an extract from a letter comparing the Egyptian and Chinese languages, and even a paper "On judging of the age of learned authors by style." Mr. P. H. Maty's Index of the first seventy volumes of the *Philosophical Transactions*, published in 1787, will supply many other examples of the extreme comprehensiveness of the scope and view of the Royal Society in its earlier years.

Slowly but surely the view of the Society has narrowed itself, and almost the only welcome guests are the mathematician, and physicist, and biologist; in like manner the *Philosophical Transactions* and *Proceedings* have become the home of "papers" in which letterpress and figures and algebraic signs appear in almost equal proportions. Papers on philology and archæology are extremely few, whilst those on physics and physiology greatly preponderate. Is it too late for the Royal Society to come back to the original field of its investigations? And although everything "made in Germany" is not necessarily good, it would probably gain more power and increase its influence if it imitated the excellent example afforded by the Academy of Sciences at Berlin in its efforts to further the universality of knowledge.

THE POTENCY AND PREPOTENCY OF POLLEN.

IN his book on "Cross and Self-fertilisation of Plants" (pp. 393-401), Charles Darwin called special attention to the subject of pollen-prepotency, and showed that numerous cases occur where the ovary of a given flower is more effectually pollinated by means of pollen-grains from some other flower, or from particular anthers, than by grains from its own anthers. If the two kinds of grains be present together on the stigma, the prepotent pollen is able to drive its tubes down the stigma more rapidly than the other, and so the ovules are reached first, and the egg-cells fertilised by the contents of the favoured or successful tubes—a point of great significance in crossing. Numerous examples were also given by Darwin, which indicate far-reaching effects of pollen on various parts of the flower and ripening fruit; these may be termed pollen-potency. Since Darwin's time we have learnt much more of the processes which go on in pollination and fertilisation, and, among other things, that the pollen tube of, for instance, a lily, carries down in its end, floating in its protoplasm, two active nuclei (generative nuclei) which bear in themselves the hereditable properties of the parent plant of the pollen, as well as remains of another nucleus (vegetative nucleus) of no use in fertilisation.

No fact in the domain of plant histology is better established than that fertilisation consists in the union of one of these generative nuclei with the nucleus of the egg-cell in the embryo-sac, and the researches of Strasburger, Guignard, Farmer and others have rendered the whole process of this nuclear fusion and its consequences so clear, that even minute details can be correlated with what occurs in organisms other than the flowering plants. In this connection I need only recall the demonstration by Ikeno and Irase,[1] and by Webber,[2] that the generative nucleus in the pollen tube is a spermatozoid, and in *Gingko* and some other gymnosperms is even ciliated and motile, and escapes as a true spermatozoid. This important discovery has lately been extended by Nawaschin,[3] who found that the two generative nuclei in the pollen tube of *Fritillaria* and *Lilium* are elongated, and are emptied into the embryo-sac as writhing worm-like bodies, and the same has been demonstrated by Guignard[4] for *Lilium Martagon*. The main point was also demonstrated by Miss Sargent at the last meeting of the British Association at Dover (September 1899).[5]

[1] Hirase, *Bot. Cent.* 1897, p. 34.
[2] Webber, *Bot. Gaz.* 1897, p. 16.
[3] *Bot. Centralb.* 1899, B. 77, p. 62.
[4] *Rev. Gén. de Bot.* 1899, vol. ii. p. 129.
[5] *Proc. R. S.* vol. lxv. 1899, p. 163.

But Nawaschin and Guignard have further shown that, in addition to the normal fertilisation of the *egg-cell* by one of these pollen-nuclei (spermatozoid), the other spermatozoid fuses with the *upper polar nucleus* of the embryo-sac, and thus brings about a sort of secondary fertilisation—a fertilisation of the cell which, by further division, produces the endosperm. For it will be remembered that the secondary nucleus arises by the fusion of the two polar nuclei.

Divested of details, while one spermatozoid nucleus carries material from the pollen into the *egg-cell*, and so transfers the influence of the male to the egg and its resulting *embryo-plant*, the other spermatozoid carries a similar share of material from the pollen into the *polar nucleus*, and thus transfers the influence of the male to the *secondary nucleus of the embryo-sac*, and thus to the *endosperm*.

Now the endosperm is regarded as the representative of the prothallus of the higher Cryptogams, and acts as the nurse for the embryo; and the upshot of the foregoing is that not only is the embryo (and through it the future plant) affected by the male hereditary substance, which can be easily seen eventually in cross-bred plants and hybrids of all sorts, but the rudimentary prothallus generation also receives its dose of male substance, and the question arises whether the effect of this dose can be traced in any visible way.

Let us now turn to another set of events. It has been known for some time that different varieties or races of the maize or "Indian corn," although all belonging to the same species, show remarkable differences, not only in the size, shape, colour, &c., of their well-known grains, but also in the nature of their nutritious contents—*i.e.* what is usually termed the "flour" or "meal." Now, this "flour" is the endosperm, and contains the nutritious substances for the growing embryo. In the typical case its cells are crammed with starch grains, well known in domestic economy as "corn-flour." But in certain races of maize there are no (or very few and small) starch grains, but a slimy substance (dextrin ?), mixed with sugar, fills the cells. Again, the outermost layer of cells bounding the endosperm—the so-called *aleurone layer*—has, not starch grains, but nitrogenous reserve stores for its principal contents, and in some races bright purple or other colouring material as well, which shines through the skin of the grain (testa and pericarp), and so gives the hue to the fruit.

The economical importance of the maize[1] has stimulated many observers to experiment in hybridising the existing races, and the principal object of this article is to show how some recently observed results in this connection have—quite unexpectedly—come to cast new lights on the phenomena above referred to, and to illustrate the potency of pollen in a way not hitherto suspected.

These researches are due to De Vries,[2] and to Correns,[3] who have found that if cross-breeding is carried on between races of maize with a starchy yellow endosperm and violet aleurone layer, and races with a sugary hyaline endosperm and colourless aleurone layer, for instance, very marked effects of the pollen can be traced *in the endosperm of the directly resulting grain*, quite apart from the effects eventually discernible in the resulting cross-bred plant to which the embryo gives rise, and which, of course, are only visible in the succeeding crop. These visible effects of the pollen are expressed only in the colour and chemical contents of the endosperm.

[1] The meal is used for Polenta, corn-flower, pop-corn, &c., and after the manner of malt in distilling spirits. The young grains are cooked. The sugary sap is used for fermented drinks, Chica, Pulque de Mahiz, &c. The straw for paper, &c. The raw grain, young shoots, &c., for fodder. Some races are of horticultural value, and so on. In 1893, 32,000,000 cwts. were imported into this country (see "Official Guide to the Museums of Economic Botany, Kew." No. 2, 1895, p. 64).

[2] *Comptes rendus*, 4/12/99, No. 23. vol. cxxix. p. 973.

[3] *Ber. d. d. Bot. Ges.* 1899, vol. xvii. p. 410.

Thus, the result of pollinating a race (A) which has a colourless aleurone layer, by a race (B) with a coloured one, may be that the ripening grain of A now obtains an endosperm with its aleurone layer the same colour as B; or if A has a starchy endosperm and B a slimy and sugary one, the endosperm of A becomes slimy and sugary, and so on.

The effect of the pollen of B, so directly expressed in the resulting endosperm of A, does not necessarily show itself in the converse case, however; and if the pollen of B alters the colour of the aleurone layer in the grain of A, the effect of the reciprocal cross may be that the pollen of A alters—not the colour of the aleurone, but—the contents of the endosperm of B, *e.g.* from starchy to sugary, and so on.

Correns points out that no visible change in the embryo, or in the size of the endosperm, or size and shape of the grain can be thus directly produced—whatever may be the more distant effects visible in the cross-breed resulting from the sowing of the grain next year.

There seem to be two possible ways of explaining these remarkable phenomena.

First, we may suppose that the spermatozoid nucleus of the pollen tube, having fused with the egg-cell, so alters the embryo that as it grows it affects the endosperm (*e.g.* by secreting some enzyme) and so alters the colour of the aleurone layer on the nature of the cell-contents; this hypothesis is supported in part by the fact that while it is easy to produce sugary endosperms in grains of races which normally develop starchy ones, the converse action is not obtained.

The second hypothesis is that we have in these phenomena the direct visible effects of the fusion of the second pollen tube nucleus (spermatozoid) with the polar nuclei (from which the endosperm results). In other words, we have here a *hybrid endosperm* as well as a *hybrid embryo*.

Both De Vries and Correns regard the latter explanation as the right one, and Correns points out that similar cases have been observed by Giltay in rye.

On the other hand, no visible results in the endosperm were obtained in peas and lilies, and the deep blue colour of the yellow seeds of species of *Leucojum* or of *Peas* crossed with the pollen of deep blue seeded races of the same in each case depends on the formation of blue proteid grains in the epidermis of the cotyledons.

That these positive results will lead to renewed investigations of other cases of nuclear fusion—*e.g.* graft-hybrids and other examples of the reactions between scion and stock—may be confidently predicted, and interesting discoveries must await us. My present object is to call attention also to this excellent example of the reciprocal advantages botanical science obtains by the cooperation of workers in two totally different fields—the results from the laboratory here throwing suggestive lights on those from the seed-bed and garden, and *vice versa*. (See, also, Address to Botanical Section of British Association, Toronto, 1897, p. 3.)

H. MARSHALL WARD.

ATMOSPHERIC ELECTRICITY AND DISEASE.

LAST summer I had the honour of making the acquaintance of Dr. Schliep, of Baden-Baden. He is well known to English medical specialists. He urged me to design a recording electrometer, such as would enable medical men to study atmospheric electricity. I found that he himself had made daily observations for twenty years, using a gold-leaf electroscope, which enabled him to say whether the air had strong or weak, positive or negative, electric potential, at the end of a water-dropping collector. He showed me that he had made an earnest study of the connection between atmospheric electricity and diseases, and I am convinced that his conclusions are of great importance. I feel, therefore, that I am doing a service in bringing before the notice of readers of NATURE the following account of a paper, by Dr. Schliep, in *Sonderabdruck aus Deutsche Medizinal-Zeitung*.

He first refers to the meteorological observations usually made, and goes on to say that our knowledge of atmospheric electricity is now as vague as was the knowledge of warmth before thermometric observation became systematic. Dove, in 1837, and Humboldt, in his *Cosmos*, mention the importance of the study of atmospheric electricity. Dr. Graves, of Dublin, made observations and said: "Practically these experiments are of importance, because some causes of the periodicity of certain acute diseases, their decrease and increase at certain hours of the day, may be deduced from them." Hufeland also refers to this matter. Dr. Buzorine, of Würtemburg, in 1841, drew attention to the fact that during the cholera epidemics of the third decade of this century, there was a prevalence of negative electrification of the atmosphere. Dr. Pallas, a French physician, wrote on this subject in 1847, and Dr. Craig, an Englishman, wrote about it in 1859.

Dr. Schliep now describes his method of observation with the gold-leaf electroscope, and gives the following results. The first part of these may be said to be well known to us. What seems to me of most importance is the effect on organisms.

Atmospheric electricity is generally positive. If the sky is covered, the potential decreases or shows variations, and is from time to time negative. During rain, negative potential is often observed. The approach of a thunderstorm is generally marked by great alteration towards the negative, followed by considerable oscillations in both directions, with a predominance of negative. Usually the positive potential is higher and more regular during the night than during the daytime. From 9 p.m. to 3 a.m. the potential changes little. It diminishes by daybreak, reaches its lowest value at 3 p.m., then increases and reaches the maximum at 9 p.m. There is, therefore, a minimum during the day, and an almost constant maximum during the greater part of the night; that is to say, there is only one daily period. These facts are deduced from the use of the registering apparatus of Mascart. Other observers have found two maxima and two minima, but they are probably only accidental variations. In every month there are a number of days on which negative electrification can be observed, others, and they are rare, when there is scarcely any electrification noticeable. On most days there is positive potential.

According to Marié Davy's observations in Paris, and Dr. Schliep's at Baden, there are two days of positive electrification for 28 negative. The winter shows higher potential than the summer.

Many terrestrial phenomena, such as earthquakes, are said by trustworthy observers (Schubler, Humboldt) to greatly influence atmospheric electricity. After an auroral display there is strong positive electrification. At greater elevations, especially on steep and high mountains, the electrification is greater.

Dr. Schliep makes the following statements about the influence of atmospheric electricity on human beings:—Negative electrification is tiring, positive is exciting. Positive is favourable to the process of oxidation, increases metabolism, circulation and secretion. It may be that the increased formation of ozone has an influence in this way also, but we can imagine a direct stimulating influence of positive electricity on the nervous system. We may affirm the existence of this influence as, during strong electrification, disturbances of the normal condition are noticeable, as in sleeplessness, the existence of states of anxiety, hysteria, neuralgia, and even sometimes inflammation of the respiratory organs. One interesting confirmation of this opinion is found in the observations which Eyselein has made regarding the behaviour of nervous people, as influenced by the amount of ozone in the air. It seems that if there is too little ozone, and especially if it completely and suddenly disappears, there is considerable bodily disturbance; whilst its sudden reappearance causes a quick return of healthy feeling. It has also been proved that a continuance of much ozone is not unfavourable to health. Ozone intensity less than No. 10 of Zender's scale, but not much less, has a tonic effect on nervous people, but intensities from 9 to 4 cause disturbances. These facts agree with the observations I have made in regard to the health of my patients, as affected by atmospheric electricity. From these observations I conclude that a certain amount of nervous disorder, as well as a power of resistance, are associated with positive electrification. As in many other cases, there is therefore in this instance the possibility of having too much of a good thing.

Unhealthy symptoms, unfavourable to tissue-change, accompany negative electrification. Feelings of fatigue and lassitude, exhaustion of the nervous system, arrest of perspiration, loss of tone in the blood-vessels, accompany negative electrification. Congestion, bilious and apoplectic attacks and hæmorrhages are the results. The development of bad gas, processes of decomposition, and increase of bacilli are the accompanying phenomena. Certain forms of disease, as angina, pneumonia, herpes, may, to extents depending upon local conditions, increase with negative electricity, and seem to be related to the souring of milk, the decomposition of meat, and the development of bad smells in the street gutters and drains. If we say that the bacilli are the cause of these things, it may be true; but it does not explain why bacilli find more favourable conditions for their existence on some days than on others with equal warmth, moisture, air-pressure, &c. Dr. Schliep goes on to say that we get clearer notions if we consider the difference between animal and plant metabolism.

We know the astonishing effect of a close thunderstorm-day on vegetation, the sudden breaking forth of buds, leaves and flowers, the quick development of the young seed, and the sometimes rapid growth of such plants as asparagus. Light, warmth and moisture are of course the first conditions. The observation of this remarkable phenomenon gave rise to an interesting experiment of Becquerel. He selected four hyacinth roots of equal size and sort, which he put in a weak salt solution, two in a frame of glass, the third in a frame of zinc, and the fourth in a frame of copper. The copper and zinc were attached to each other by a wire. The vegetation developed most at the negative pole, less in the neutral frame, and was least at the positive pole. It seems that the roots of plants need a negative electric medium, and the crust of the earth is constantly negative. What increases the tissue-change in plants, decreases that of the animal organism. Thus, very often, days good for vegetation become tiresome for us. Walking in the streets causes great fatigue. All animals are tired on these days. They are the days of negative atmospheric electricity, days on which the bacilli are triumphant; wounds become septic, and germs of epidemic diseases find favourable conditions for development. It will concern bacteriology to pay attention to the facts. In balneo-meteorology, the most important object is the influence of atmospheric electricity on the anomalies of the constitution. From its better study we shall be able to derive hypotheses for our hygienic and therapeutic study, and besides the importance of geographical position, warmth, moisture, &c., atmospheric electricity will also play an important part in the classification of climates. We shall not only have to distinguish between land and sea-climates, wet and dry climates, cold and warm climates, but we shall also have to characterise a climate by its electrification and define with greater exactness the terms "relaxing" and "bracing."

Perhaps we shall also be able to speak of a "spending" and a "saving" climate. We must not separate one characteristic of the climate from another and prefer it; in nature all phenomena work more or less together, they depend on one another and exercise mutual influences on one another. The electric conditions of the air are indicated by other meteorologic records, and hence we have important sources of information which ought not to be neglected, as our methods of making direct electric observations are not yet satisfactory. One can, from the daily increase or diminution of pressure, warmth and moisture of the air, say something of its electrification.

In this connection it is of no importance whether the barometer is high or low, but whether it rises or falls. It is not important to know whether the moisture of the air is great or not; it is important to know whether the moisture decreases or increases, whether the process of condensation or of evaporation prevails.

Dr. Schliep here described at length the meaning of dew-point in hygrometric observations. He exhibited also a reduction disc made by Lambrecht, of Göttingen, a sort of circular slide rule, to facilitate the reduction of observations. He showed that the atmospheric electrification becomes negative if the average temperature and dew-point rise and if the barometer falls at the same time. If, however, the temperature and dew-point fall whilst the barometer rises, one may assume a positive electrification. He pointed out on the curves which represent his registrations at Baden during the previous ten years, that the air-pressure on one hand, and the temperature and moisture on the other, altered mostly in opposite directions. It was noticeable also that an exceptional steadiness for a few days was accompanied by the reverse of these movements as soon as the lines went far asunder. The graphic representations of meteorological phenomena show more than one would think at first sight. More plainly than lists of numbers, they allow a comparison of climatic conditions of different years or of certain periods with the statistics of the prevalent diseases during those periods.

Without a good graphic representation such statistics are never complete, however valuable the material which has been collected may be. Thus, for example, consider the work of Hippius, published in the *Archives for Clin. Medic.* vol. xl., about dysentery and meteorological influences upon it, in which there was an inquiry about the relation between meteorological changes and bleedings of the lungs with no apparent result. May not the failure of this inquiry be due to the fact that the meteorologic information was incomplete?

Dr. Schliep finishes his paper by pointing out the importance of the general meteorological observations at watering-places being under a central governmental control. The health resorts ought not to rest until they have obtained this aid from Government. But he distinguishes general meteorology from the simple kind of observation which it is in the power, and ought to be the duty, of every medical man to make for himself.

JOHN PERRY.

PROFESSOR ÉMILE BLANCHARD.

BY the death on February 11, at the ripe age of 84 years, of Prof. Émile Blanchard, France has lost the *doyen* of its zoologists, the French Academy one of its oldest and most esteemed members, and the Paris Museum a famous entomologist. Blanchard's career was a somewhat remarkable one, and at the same time a noble example to others; for he rose to distinction from the ranks, and, when stricken by one of the most terrible of all afflictions, never swerved for an instant from the course he had to run.

Entering, at the age of fourteen, the department of entomology of the Paris Museum, in the humble capacity of what would be termed an "attendant" in our own Museum, Blanchard soon developed such a capacity for zoological work that he was transferred to the scientific staff. His first great chance of distinguishing himself occurred when he accompanied, in 1844, Prof. H. Milne-Edwards on his celebrated expedition in the *Santa Rosalia* to Sicily, for the purpose of studying the marine fauna of the coasts. Shortly after this he was appointed Professor of Entomology to the Museum; and in 1862 received the honour of election to the French Academy of Sciences. Throughout life his chief study was entomology, the Coleoptera being his especial favourites; but he also devoted a considerable amount of attention to other branches of zoology, as well as to comparative anatomy, and in his latter years entered on the study of the geographical distribution of animals, both in past and present times. His works on Madagascar and New Zealand are well-known examples of his devotion to the latter branch of science. As a token of the esteem in which his labours were held by his fellow-workers, it may be mentioned that a genus of Carboniferous Neuroptera was named *Blanchardia* in his honour; while several of the fossil birds from the Miocene of France described by Milne-Edwards, such as *Anas blanchardi* and *Palaeortyx blanchardi*, received their specific titles after the subject of this notice. In addition to purely scientific memoirs (of which a long roll stands against his name) Prof. Blanchard was a frequent and admired contributor to the *Revue des Deux Mondes* on general subjects.

But the most remarkable circumstance connected with a large portion of his work yet remains to be told. In early life Blanchard was gifted with extraordinary acuteness of vision, and was thus enabled to make dissections of extreme delicacy (of which he has left numerous drawings and sketches) without the aid of lenses. In fact, his eyes were described by one of his early contemporaries as veritable microscopes. At the age of forty his visual powers showed serious signs of weakening. Year by year the failure of power increased, with the result that at 45 he became nearly, and at 50 totally blind. In the words of Professor Gaudry, "What more frightful affliction could have befallen a man whose life was passed in the investigation of Nature's secrets? The existence of a naturalist, who seemed specially favoured by his natural gifts and by the honours received at an age when they are obtained by few, was delivered over to the misery of darkness. If only Blanchard could have still enjoyed the delights of family life, if, while unable to see them, he could have listened to the voices of a devoted wife and beloved children! But all was gone; he no longer saw, no longer heard anything! The visits of a few friends could alone, from time to time, afford solace to his lonely existence."

Amid the unfeigned sorrow of his *confrères*, his remains, on February 14, were consigned to their last resting place.

Perhaps his best-known works are "Histoire des Insectes," 1845; "Catalogue des Coléoptères du Museum d'Histoire Naturelle de Paris," 1850; and "Metamorphoses des Insectes," 1868.

R. L.

DRS. C. T. R. LUTHER AND G. RÜMKER.

WITHIN a few weeks, two observatories which have played a worthy part in the past history of astronomy have, by the death of their respective directors, suffered a notable loss, and science will deplore the removal of two well-known names from the roll of worthies, who are remembered with gratitude for much indefatigable, if not brilliant, work.

For forty-eight years Dr. Carl Theodor Robert Luther worked unremittingly with the small instruments of the Düsseldorf Observatory, and few men have won so much satisfaction and rendered such essential services with apparently inadequate means. When, a half century ago, he began to direct the fortunes of the little Observatory of Bilk, the discovery and the observation of small planets still awakened considerable interest in the astronomical world, and he perceived that a small observatory, somewhat meanly equipped, could not undertake a more meritorious service than to devote itself methodically to the study of the movement of these bodies. Resolved to devote himself to this work, he never swerved from it. How well he worked with a six foot equatorial and a simple ring micrometer will readily be admitted by those who have had to use his observations in the discussion of planetary orbits. In this one subject, which he had made his own, his untiring devotion enabled him to compete in accuracy, and in quantity of observations, with other observatories possessing greater optical power and employing more delicate apparatus. He lived to see the branch of astronomical science that he loved and supported become somewhat discredited by the very wealth of material with which the possessors of larger optical means and improved star-charts were able to startle and to overwhelm plodding computers and observers. If observation did outrun computation, Luther, however, made some effort to withstand the onrush, and he succeeded in placing the theory of five of the planets—Hebe, Parthenope, Melete, Danae and Glauke—in such a satisfactory position that they are not likely to be lost.

But Luther's work began long before he went to Bilk. He was attached to the staff of the Berlin Observatory before Neptune was discovered. He took a share in the construction of the Berlin star-charts, that rendered the actual detection of the planet so simple; and every one who has used Olbers' method for computing comet orbits will recall with satisfaction Barker's Table of Parabolic Anomalies, "von neuem berechnet von Herrn Stud. Luther."

Modest honours followed Luther in his simple-minded devotion to astronomy. In 1854, he was elected a Foreign Associate of the Royal Astronomical Society, and in the following year the Bonn University elected him a Doctor of Philosophy. Seven times did the Paris Academy vote him the Lalande Prize for his discoveries, and when the same Academy struck a medal to commemorate the completion of the first hundred small planets, his portrait appeared on the medal side by side with those of Hind and Goldschmidt, the representatives of Germany, England and France in this special field of research.

The death of Dr. George Rümker, Emeritus Director of the Hamburg Observatory, is also announced—a name long and honourably connected with the Hamburg Observatory, and associated with much good work. The late director was born at the Observatory, where his father, after his return from Paramatta, was in residence. Early trained to astronomical methods, Dr. George Rümker had the advantage of experience in various observatories, spending some time at the Durham Observatory under the late Prof. Chevallier. On his return to Germany he was attached to the Hamburg Observatory, and busied himself with the preparation of a catalogue of circumpolar nebulæ. After his appointment as director, the energies of the observatory have been mainly devoted to the observation of planets and comets. These observations, which have been mainly published in the *Astronomische Nachrichten*, display a considerable amount of activity; but in addition to researches of a purely astronomical character, Dr. Rümker had given very considerable attention to all questions connected with the improvement of navigation, and to the testing of instruments required in the service of the marine. The rapid development of the Port of Hamburg has made the testing of chronometers and accurate time distribution matters of prime importance, and the late director fully recognised the desirability of ministering to the necessities of the port.

DR. THOMAS PRESTON, F.R.S.

WITH sincere regret we announce the death of Prof. Thomas Preston, which occurred at his residence in Dublin on March 7. Still a young man, the event, although preceded by a tedious illness, came as a shock to his friends, and we believe will be learned with sorrow by every scientific man in this country. Abroad, too, his name had recently become well-known in connection with his researches on radiation in the magnetic field.

Thomas Preston was born in co. Armagh in 1860. He graduated both in the Royal University and in Trinity College, Dublin, in each University gaining high distinction in mathematics and experimental science. The first edition of his well-known "Theory of Light", appeared in 1890; his "Theory of Heat" in 1895. He filled the post of Science and Art Inspector for Ireland since 1894. He held a Fellowship in the Royal University, and also the degree of Doctor of Science of that University; and was elected a Fellow of the Royal Society in 1898.

What great promise was in Thomas Preston is known to all who are acquainted with the good scientific work he had already accomplished. The Royal Dublin Society recently conferred upon him the Boyle Medal for distinguished work in the domain of pure science. On that occasion the Science Committee of the Society reported on his work in terms a quotation from which will best serve to convey in a brief notice the scope of Preston's contributions to science. The report more especially relates to his services in connection with radiation in a strong magnetic field, and summarises the part he took in this recent branch of research, as follows:—

"Early in 1897 the broadening of the spectral lines arising from radiation in a strong magnetic field was announced by Dr. P. Zeeman; and about the middle of that year, Dr. Zeeman further announced the fact that the triple nature of some of these lines had been established by aid of the differing polarisation of the central and lateral bands. This important experimental work was the first completely successful accomplishment of an experiment undertaken by Faraday, so long ago as 1862. The theoretical aspect of Zeeman's first experiments had been examined by Prof. Lorentz and by Dr. Larmor. The threefold nature of the broadened lines as well as their polarisation phenomena had been predicted by these mathematicians, and also the probability that the change of wave-length introduced by the magnetic force should be proportional to the square of the wave-length of the affected lines.

"Such, briefly, was the state of the inquiry, when Prof. Preston—working with the Rowland Grating of the Royal University—brought his first research before this Society towards the close of 1897. ('Radiation Phenomena in a Strong Magnetic Field,' *Trans.* R.D.S. vol. vi. Ser. ii. p. 358).

"Members of this Society who were present on that occasion will recollect that they were treated to no second-hand account of the phenomena, but were shown—a feat not before attempted—the triplication and quadruplication of the lines of cadmium and zinc, by means of photographs projected on the screen.

"In this communication, Prof. Preston not only showed that he had attained a higher degree of resolution of the lines than had up to this been accomplished, but he was able to announce the existence of quartet and sextet forms for the first time. In his paper he seeks for explanation of the quartet variation from the normal triplet, and the fact that the difference of wave-length introduced by the magnetic force is not proportional generally to the square of the wave-length (as the simple theory seemed to suggest) was forced upon him at this early stage of his work.

"Although these matters were laid before the Royal Dublin Society in December 1897, Prof. Preston can lay still earlier claim to these observations, as appears from a short communication to NATURE in November of the same year. (NATURE, vol. lvii. p. 173).

"The second memoir on the subject appeared in the *Transactions* of the Royal Dublin Society for June 1899 (vol. iii. Ser. ii. pp. 7 *et seq.*), having been read by Prof. Preston in June of that year.

"He here offers an explanation of the quartet form analogous to Prof. FitzGerald's suggestion that the ionic orbits will vibrate with definite period about their position of rest in the magnetic field, and records the observation that, for corresponding lines of the natural groups or series of Kayser and Runge, the theoretic condition obtains.

"He further, in this communication, suggests a law which apparently involves the far-reaching conclusion that structural features in common are possessed by chemically related atoms. Although such a conclusion commends itself for other well-known reasons, so direct a proof as is involved in 'Preston's Law' had hardly been hitherto adduced. This law he illustrates by the case of three substances:—magnesium, cadmium and zinc. The law expresses the fact that not only are similar lines in the series of chemically related elements similarly modified by the magnetic field, but that the value

$$\frac{d\lambda}{\lambda^2}$$

is, in these cases, the same. The importance of this law, whether the theory of ions is accepted or not, is accentuated in M. Cotton's able review of the present state of the investigation. (Le Phénomène de Zeeman, *Scientia*, October 1899.)

"In the course of these researches Prof. Preston was gradually increasing the strength of his magnetic field, and lately was using a magnet built to his own design attaining a field of 40,000 C.G.S. units. The design of this magnet is original, but a published account of it has not yet appeared.

"With the aid of this powerful instrument he was able to announce, in the addendum to his paper in the *Trans.* R.D.S. last referred to, that the quartet form hitherto noticed is really a sextet, the outer lines being feebly bipartate, that the normal triplets are not further resolved, and that the diffuse triplets are, in fact, nonets, consisting of unequally luminous lines.

"Contemporaneously with these papers, others, mainly recapitulatory, appeared in the *Philosophical Magazine* and in NATURE.

"A clear and lucid account of the whole matter is also to be found in the report of Prof. Preston's lecture before the Royal Institution, appearing in NATURE (vol. lx. June 22, 1899).

"It is satisfactory to find how clearly in his later papers Prof. Preston recognises the pioneer work of Dr. G. J. Stoney (upon whom this Society conferred the Boyle Medal last year).

"We have in the foregoing referred to Prof. Preston's leading work and to that specially qualifying him to receive the Boyle Medal, but before this work appeared, he was already known as a writer on science of high standing. His text-books on Light and Heat are at once characterised by a clear and pleasant style and a thorough grasp of the subjects treated. These works may each fairly claim to be advances on any previous English text-books of the same scope.

"Prof. Preston is also the author, in part, of a well-known text-book on 'Spherical Trigonometry,' as well as of several scientific papers, which are all marked by his ingenuity and thoroughness."

All who have known Thomas Preston will share in a feeling more deeply founded in human nature than the regret for his "unfulfilled renown"—regretful as this assuredly is. The loss of his friendship will be felt even more keenly than the strong sense of the great loss science has experienced by his early death.

GEORGE JAMES SYMONS, F.R.S.

SCIENCE in general, and Meteorology in particular, has lost an ardent worker by the death of Mr. G. J. Symons, F.R.S., the indefatigable founder of the British Rainfall Organisation. He had been enjoying good health until the evening of February 14, when he was stricken with paralysis, from which he never rallied, but passed peacefully away on the afternoon of Saturday last, March 10.

George James Symons was born at Pimlico on August 6, 1838. While quite a lad he became interested in natural phenomena, and very early commenced regular weather observations. His love of this became so strong that his parents were ultimately obliged to permit him to follow this branch of science, although he was warned by such a high authority as Mr. James Glaisher, F.R.S., that "science would not pay." He served under Admiral FitzRoy in the Meteorological Department of the Board of Trade for a few years, and then began his life-work of collecting rainfall statistics. His first annual volume of "British Rainfall" was for the year 1860, and this contained records from 168 stations. How this work grew under his guidance and ceaseless energy is seen from the fact that in the volume for 1871 he published records from 1504 stations; for 1881, from 2145 stations; for 1891, from 2799 stations; while for 1898 he was able to publish records from 3404 stations. The information and data thus collected soon became of great assistance to civil engineers and others engaged in questions of water supply. In the course of time Mr. Symons became the greatest authority on the distribution of rainfall over the country, and was an indispensable witness at Parliamentary Committees on questions of water supply. The Albert Medal of the Society of Arts was, in 1897, awarded to Mr. Symons "for the services he had rendered to the United Kingdom by affording to engineers engaged in the water supply and the sewage of towns a trustworthy basis for their work, by establishing and carrying on during nearly forty years systematic observations (now at over 3000 stations) of the rainfall of the British Isles, and by recording, tabulating, and graphically indicating the results of these observations in the annual volumes published by himself." It is a satisfaction to know that the rainfall organisation will not cease with his death, but will be carried on by his co-adjutor, Mr. H. Sowerby Wallis.

In 1866 he commenced the publication of *Symons's Monthly Meteorological Magazine*, which has been continued up to the present time.

Mr. Symons was elected a Fellow of the Royal Meteorological Society in 1856, and served on the Council from 1863. He was President in 1880–81, and Secretary in 1873–79, and also in 1882–99. He was elected President a second time in January last, in view of the Jubilee of the Society taking place during the present year; but, owing to his being seized with paralysis, he had to resign this office at the following Council meeting. He was elected a Fellow of the Royal Society in 1878, and at the last anniversary meeting was made a member of the Council.

Mr. Symons was a regular attendant at the meetings of the British Association, and served on several of the committees. He was also for some time on the Council of the Royal Botanic Society and of the Sanitary Institute. He was also Chevalier de la Légion d'Honneur.

Mr. Symons was a keen bibliophile, and had a very valuable meteorological library. Among his publications may be mentioned: Merle's MSS. "Consideraciones Temperiei pro 7: annis 1337–1344"; "Rain—how, when, where, why it is measured"; "Pocket Altitude Tables" (3 editions); "The Floating Island of Derwentwater"; and "The East Anglia Earthquake." He was a most genial and amiable man, and had the power of drawing around him a vast number of friends and voluntary observers, who will deeply mourn his loss.

NOTES.

PROF. E. FISCHER, of the University of Berlin, has been elected a correspondant of the Paris Academy of Sciences, in the Section of Chemistry.

WE regret to see the announcement of the death of Dr. William Marcet, F.R.S., at Luxor, Egypt, in his seventy-second year. The death is also announced of Mr. William Thorpe, a vice-president of the Society of Chemical Industry.

PROF. D. E. HUGHES, F.R.S., whose whole estate has been valued at 473,034*l.* gross, including personality of the net value of 472,704*l.*, has left the greater part of his property to the Middlesex Hospital, London Hospital, King's College Hospital, and Charing Cross Hospital. A considerable sum has also been left to various scientific societies. By his will of May 9, 1893, he bequeathed to the Institution of Electrical Engineers, of which he was a past president, 2000*l.* for a David Hughes Scholarship Fund, similar to the Sir David Solomons Scholarship Fund; to the Société internationale des Electriciens in Paris, of which he was a member, 2000*l.* for a scholarship fund; to the Royal Society, 4000*l.* to apply the income in prizes for original discoveries in physical sciences, particularly in electricity and magnetism; to the Paris Academy of Sciences, 4000*l.* for the same purposes; and to the Royal Institution of Great Britain, in Albemarle-street, 1000*l.* for its general purposes. The sum at present available for the Hughes Hospital Fund seems likely to be between 300,000*l.* and 350,000*l*, and eventually over 400,000*l.*

REFERRING to the death of Mr. Leander J. McCormick, of Chicago, at the age of eighty-one, the *Athenaeum* recalls the fact that he was an inventor of agricultural machinery as well as a munificent patron of astronomical science. His father was the well-known Robert McCormick, of Virginia, a pioneer in the construction of apparatus for reaping by machinery. At his death, in 1846, the development and improvement of the mechanism of the original reaper devolved upon the son, himself a man of skill and resource. As regards the encouragement of astronomical research Mr. McCormick was no laggard, and he stands out prominently among those American citizens who have liberally contributed to the promotion of the work of observation. He gave to the University of Virginia the existing astronomical observatory which bears his name, the cost of building and equipment reaching the total of 20,000*l.* It was the desire of Mr. McCormick that the telescope and equipment should be the best of the kind in the world, and at the time of inauguration such was probably the case.

THE Memorandum by the Financial Secretary to the Treasury on the estimates for Civil Services for the year ending March 31, 1901, has just been issued as a Parliamentary paper. Among the works entailing additional expenditure are included the adaptation of the Imperial Institute (London University) buildings, 8770*l.*; a new Die and Medal Department of the Royal Mint, 8300*l.*; and Census Office buildings, 4000*l.* The addition of 5751*l.* for the Local Government Board includes 4000*l.* for extended arrangements for the supply of glycerinated calf-lymph. An interesting item is that on the Science and Art Department services the increase of 26,643*l.* is required mainly to meet the growing requirement for grants to science classes and schools of science. It is further mentioned that provision has been made for changes of organisation which have been adopted on the recommendation of the Departmental Committee appointed to consider measures for carrying into effect the Board of Education Act, which comes into force on April 1. A new item in the vote for scientific investigation is that of 11,250*l.* for a grant in aid of the National Antarctic Expedition, being the first of four annual instalments which are proposed to make up a total Government contribution of 45,000*l.* Reference is made to the fact that the total Government contribution in aid of the expenses of the Royal Commission for the British Section at the Paris International Exhibition, 1900, will be made up to 125,000*l.*

WE learn from *Science* that the Committee of Mines and Mining of the House of Representatives has reported favourably on a bill creating a department of mines and mining, with a cabinet minister. The Geological Survey would be transferred to this department. There is also a bill before Congress establishing a department of Commerce and Manufactures, to which it is proposed to transfer the U.S. Geological Survey, as well as the U.S. Coast and Geodetic Survey, the Patent Office, the Commission of Fish and Fisheries, and the Bureau of Navigation. The Treasury Bureau of Statistics and the Bureau of Foreign Commerce of the State Department are to be consolidated into a single bureau of the department. The principal new offices created are the secretary and assistant secretary of commerce and industries, the secretary receiving a salary of 8000 dollars and the assistant secretary 4000 dollars.

THE report of the Council of the National Association for the Prevention of Consumption and other forms of tuberculosis, presented to the first annual meeting on Tuesday, was a very satisfactory expression of the growth and activity of the Association since its foundation. With the object of focussing the information obtained concerning tuberculosis, an international congress will be held in London next year, under the presidency of the Prince of Wales, who will open it in person. The Council have received many representations, both from individuals and societies, as to the wide-spread habit of spitting on pavements, and more especially in vehicles and closed public places. As this habit is not only offensive, but a direct cause of spreading consumption, the Council have asked the various railway companies to post up on their premises a card printed by the Association urging persons to repress as far as possible the highly dangerous habit. Consideration has been given to the preparation of a leaflet on the treatment of milk, but in view of the researches that are still being made as to methods of sterilisation, publication has been postponed until some more definite results have been arrived at. Despite correspondence urging them to bring pressure on the Government for more stringent legislation in respect of supervision of milk and meat, the Council have considered it advisable to confine their efforts, for the present, more to the enlightenment of public opinion than to agitation of a political character.

A MEMORIAL pamphlet in appreciation of the late Josef Loschmidt, Professor of Physics in the University of Vienna from 1868 to 1891, has been issued by the Vienna Loschmidt Memorial Committee. This Committee was formed largely at the instigation of the Chemical and Physical Society of Vienna, for erecting a monumental tablet to the illustrious physicist within the precints of the University, and the object of the Committee was achieved on November 5 of last year, when the monument was unveiled in the presence of a large assembly. It occupies a fitting place opposite the memorial to Stefan, by whom Loschmidt was first put in the way of prosecuting scientific researches in 1867. The pamphlet now issued by the Committee includes the obituary discourse delivered to the Society by Prof. Boltzmann shortly after Loschmidt's death, and an account of the proceedings at the unveiling of the memorial, including speeches by the Oberst von Obermayer, Chairman of the Committee, Prof. Neumann, Rector of the University, and an oration on the work of Loschmidt by Prof. Boltzmann, than whom none could better appreciate his contributions to the advancement of our knowledge of molecular physics.

AN interesting series of observations on the temperature of the animal body during fasting, and the rate of assimilation of carbohydrates, is described by Prof. Ugolino Mosso in the *Atti dei Lincei*, the experiments being conducted in the University of Genoa. The experiments are particularly interesting in establishing the efficacy of sugar in raising the temperature of an animal which has fallen during a period of fasting. Thus, from one to four grammes of sugar per kilogramme cause a rapid rise o temperature in the first ten or fifteen minutes; in from one to two hours the temperature reaches its maximum, and remains constant or elevated for an interval of time varying with the amount of sugar introduced. This effect of sugar is most marked after a long fast when the temperature is lowest. The action of bread is, in some respects, opposite in character. The temperature rises more slowly after the introduction of bread than after sugar; and the rise in this case is most rapid for animals whose period of starvation has been short, and whose temperature is not too low. These results are in accordance with the view that sugar is more readily assimilated by a starving animal than bread. Indeed, Prof. Mosso states that with sugar he has succeeded in restoring the vitality of dogs in a serious state of hypothermia, while the administration of albumen to others failed to save their life.

THE *Annuaire* of the Royal Observatory of Belgium for the year 1900 contains an interesting article on the employment of kites in meteorology, by J. Vincent. The paper is divided into several sections and includes: (1) a description of the different kites in use, with particulars relating to their construction, accompanied by diagrams, and a discussion of the objects to be attained by the ascents; (2) a chronological list of the ascents made since 1749; and (3) a bibliographical sketch containing over 100 references to articles which have appeared in various journals from 1896–9, and other useful information. The paper is also reprinted separately in pamphlet form.

WE have received from the Manila Observatory a discussion of the typhoons of the Philippine Archipelago and adjacent seas for the years 1895 and 1896, by the Rev. J. P. Doyle. The experience gained at the Observatory shows that these cyclones have a distinct zone of origin, and that the tracks follow an average definite course according to each of the following three groups of months in which they occur:—(1) December to March; (2) April, May, October and November; (3) June to September. The three zones in which the storms originate are included between lat. 4° and 20° N., and long. 129° and 144° E., and these have been accordingly discussed with reference to those groups of months, especial attention being given to those storms which have particularly affected the Archipelago. The discussions are accompanied by maps showing the tracks, and the whole work is a valuable contribution to our knowledge of tropical storms and to maritime meteorology.

IN a paper published in the *Bollettino* of the Italian Seismological Society, Dr. E. Oddone discusses the long-period oscillations of distant earthquakes. He considers that the problem of their origin is still unsolved. We have not yet succeeded in deducing with certainty the true movement of the ground from the diagrams supplied by microseismographs. The suggestion that they are slow undulations of the earth's surface is not universally accepted; but, on the other hand, the attempt to explain the records by horizontal movements only has also failed.

THE *Journal* (vol. xi. part iv.) of the College of Science, Imperial University, Tokyo, has been received. It contains three papers, the first, by Dr. K. Honda, on the mutual influence between longitudinal and circular magnetisations in iron and nickel. The other two papers, by the late Prof. Sekiya and by Prof. Omori, deal with the catalogue of Japanese earthquakes prepared by the Earthquake Investigation Committee, and have been noticed already in these columns (p. 282).

ANY information about the natives of the mysterious Easter Island is welcome, and we note with pleasure a paper by Dr. H. Stolpe, on their tatuing. In this paper (*Abhandl. u. Berichte . K. Zool. u. Anth. zu Mus. Dresden*, 1899. Bd. viii Festschrift für A. B. Meyer. Nr. 6) the author brings together all that is known on the subject. This consists mainly of some original observations made when Dr. Stolpe was voyaging in the Pacific, and he also gives details of a remarkable tapa figure which was in the museum of the Lit. and Phil. Society of Belfast, but is now in the British Museum. A degraded human face and a bird enter into the scheme of tatuing, but there is no information as to the signification of the ornamentation. In the same volume is a list of words relating to Philippino ethnographical and zoological objects, by Prof. F. Blumentritt; and some ethnographical notes, by R. Parkinson and Dr. W. Foy, on the natives of "Neu Pommern," New Britain. Drs. W. Foy and O. Richter have prepared a memoir on the decorative art of Timor, illustrated with 38 figures; this is a useful addition to the literature on the decorative art of Malaysia. The authors trace the degeneration of one or two simple patterns, and they demonstrate the presence of a lizard or crocodile *motive*; but in all such investigations it is highly desirable to obtain information on the spot as to the significance of local designs, for otherwise one is working very much in the dark.

To the *Biologisches Centralblatt* for March, Dr. von Linden contributes a paper on the developmental history of the newts and salamanders of Germany, in which the various larval stages, and in some cases the adults, of the different forms are illustrated. Especial attention is directed to the development of the spotting, which always commences as longitudinal lines.

THE last two parts of *Indian Museum Notes* for 1899 are just to hand. No. 4 should attract a more than ordinarily wide share of interest from the fact that the greater portion of it is devoted to a report on Indian insect-pests by Mr. E. Barlow, of the Museum. It includes notes on insects harmful to tea, cereals, cotton, poppy, indigo and sugar-cane, as well as locusts, insects infesting fruit-trees, &c. Very serious damage appears to have been done to the tea industry in the Darjiling district, in the spring of 1897, by the caterpillars of a moth which appeared in millions and stripped the bushes of their old leaves. Although the species is fully diagnosed in his report, Mr. Barlow, as in the case of other pests, has omitted to suggest any remedy for its devastations.

JUDGING from its sixty-eighth *Annual Report*, which has just been issued, the Royal Zoological Society of Ireland appears to be in a flourishing condition, the receipts for the past year showing a noticeable increase over the average. The lion-breeding, which forms such a notable feature in the menagerie, was at one time in a somewhat unsatisfactory condition, but by the importation of fresh blood and the assistance of foster-mothers in cases where the female parents would not nurse their own cubs, the difficulties have been overcome. It is satisfactory to note that the Cape Hunting-Dog bred in the menagerie the previous season is growing apace, and will soon rival its parents in size. A feature of the *Report* is the inclusion of photogravures of several of the more interesting animals now living in the Society's gardens.

WE have received from the Royal Dublin Society a memoir, on Jamaican Actiniaria, by Mr. J. E. Duerden, who was, if we mistake not, a student at the Royal College of Science, London, and afterwards one of Prof. Haddon's pupils or assistants at Dublin. Since his appointment as curator of the museum at Jamaica, Mr. Duerden has published quite a series of papers on the zoology of his neighbourhood—papers ranging over a wide field, from sea-anemones to the mongoose. The present memoir is the second part of a systematic account of the Actiniaria of the seas around Jamaica, and it deals mainly with the Stichodactylinæ, of which seven species are described. Part i., published two years ago, treated of the Zoantheæ, to which group three new species are now added. The descriptions are full, the drawings on the plates are admirable, and we are glad to notice long and important sections on the "anatomy and histology" of each species.

Mr. Lester F. Ward describes a new genus (*Cycadella*), and twenty new species of fossil Cycadean trunks from the Upper Jurassic freshwater beds of Wyoming, in the *Proceedings* of the Washington Academy of Sciences for February.

The Wellington College Natural History Society continues to encourage an interest in scientific matters among members of the school. The latest report shows that during last year instructive lectures were given upon a number of scientific subjects, such as bacteria, extinct animals, ants, and Röntgen rays. The Pender prize, for the best essay on a scientific subject, was awarded to H. O. O'Hagan for a thoughtful paper on "Thames Fish, and their Habits," containing original observations of much interest. In order to further aid natural history work in the school, a field club has been started, the members of which propose to thoroughly explore the immediate neighbourhood for the purpose of making new, and revising old, lists of objects, and to start a local museum.

The number of the *Irish Naturalist* for February 1900 contains a description by Mr. David McArdle, with an illustrative plate of the rare and little-known liverwort, *Lejeunia Rossettiana*, distinguished by the remarkable echinate hygroscopic hairs on the capsule. It was found on Ross Island, Killarney.

Scientific bibliophiles will be interested to know that Messrs. H. Sotheran and Co., and Messrs. John Wheldon and Co., have just issued catalogues containing many rare and second-hand scientific books which they offer for sale.

New editions of Mr. W. T. Lynn's handy booklets on "Remarkable Eclipses" and "Remarkable Comets" have been published by Mr. E. Stanford. At the end of the latter a list of the dates of the next returns of comets observed at more than one appearance is given. The comets due this year are:—Summer, De Vico's comet, rediscovered by Swift in 1894 (period $5\frac{1}{2}$ years); and towards winter, Barnard's comet (period $5\frac{1}{2}$ years).

The first part of a work on "L'électricité en Physiologie," by Prof. L. Morokhowetz, professor of physiology and director of the physiological institute of the Imperial University of Moscow, has just been received. It is proposed in the complete work to describe the present state of knowledge of the influence of electricity on the animal organism and in animal electricity. The present chapter deals with electrostatic principles and instruments used in electro-physiology. The publishers of the work are A. Lang and F. Tastevin, Moscow.

We have received *The Naturalist's Directory* (Upcott Gill) for 1900. It contains a large number of names, and is undoubtedly a useful little volume. But there seems a tendency to glorify the pushing amateur at the expense of the real scientific worker. In the list of British zoologists we notice, for example, the absence of the names of Mr. W. T. Blanford and the editor of the "Royal Natural History"; while the foreign list, when it omits names like Bocage, Collett, Merriam and Milne-Edwards, is ludicrously inadequate to its purpose.

An enlarged and revised edition of Huxley's "Lessons in Elementary Physiology," prepared by Sir Michael Foster, K.C.B., and Dr. Sheridan Lea, F.R.S., will be published almost immediately by Messrs. Macmillan and Co. The book originally appeared in 1866, and the last new edition was issued in 1885, though since then it has been reprinted six times. Revision was therefore urgently needed in order to bring the book in line with progress in science and education during more recent years. This has been carried out in sympathy with Huxley's original aims and methods, so that the book should have as successful a career in the future as it has had in the past.

Messrs. Everett and Co. have issued a catalogue of some of the instruments made by them for use in electrical and physical laboratories and workshops. Galvanometers, resistance coils and Wheatstone Bridges, electrometers, rheostats, and other instruments required in electrical work in the laboratory and testing-room, form a prominent feature of the catalogue. Among the apparatus specially designed for laboratory tuition we notice arrangements for demonstrating the laws of the galvanometer, for measuring the temperature coefficients of electrical alloys, and for determining the linear expansions of metal rods.

The methods employed by Prof. Moissan in the preparation of diamonds by artificial means, using his electric furnace, are popularly described by Mr. R. H. Sherard in the March number of *Pearson's Magazine*. Expressions such as "the highest degree of heat," and "a heat of from 4000 to 5000 degrees Centigrade," suggest that the revision of the article by some one acquainted with the distinction between heat and temperature would have prevented a confusion of ideas. Another contribution to the same magazine is "Stories of other Worlds," by Mr. George Griffith. A trip is made (in imagination) to the planet Venus, and fact is combined with fancy in describing the features of the planet and inhabitants. But the human element looms so large that the story lacks the verisimilitude which characterises Mr. H. G. Wells's treatment of scientific themes.

Messrs. Macmillan and Co. are about to publish a third and completely revised edition of a work on "Micro-organisms and Fermentation," by Dr. Alfred Jorgenson, Director of the Laboratory for the Physiology and Technology of Fermentation at Copenhagen. The original aim of the book was to give an account of the morphology and biology of the micro-organisms of fermentation, and so to supplement the treatment in text-books of the chemical side of the subject. To the new edition have been added a biological treatment, performed in the author's laboratory, of several English high-fermentation yeasts, isolated from yeast used in breweries and distilleries in various parts; a summary of observations on the variations which yeast undergoes during its use in factories; and a concise account of the organisms occurring in milk, and of the use of lactic acid bacteria in dairies and distilleries. The book thus appeals to chemists, botanists and biologists, as well as to technologists engaged in the fermentation industries.

A new gas furnace has been designed by M. Armand Gautier which will be of great service in researches in which a tube has to be kept at a constant high temperature for long periods of time. The principle of the muffle is applied to the ordinary tube combustion furnace, and M. Gautier has been able to keep a tube at any temperature between 150° and 800° for hours together without a greater variation than ± 5°. Even at 1200°, if a good governor is interposed between the gas main and the furnace, the variations do not exceed 20°. A detailed description, with drawings, is given in the current number of the *Comptes rendus*.

Since M. Moissan has found that the original platinum-iridium apparatus may be replaced by a U-tube of copper, it has been possible to study without difficulty reactions requiring considerable quantities of fluorine. In the current number of the *Comptes rendus*, M. Moissan gives an account of a new fluoride of manganese he has obtained, which is of interest from the point of view of the valency of the metal. Fluorine gas reacts readily with powdered manganese, and analyses of the resulting product showed that a higher fluoride than MnF_2 was formed, but owing to the violence of the reaction this fluoride was not of constant composition. The interaction of fluorine and manganous iodide, however, gave a definite fluoride, Mn_2F_6, which in many of its reactions behaves like free fluorine, pentachloride of phosphorus giving PF_5, and amorphous carbon a fluoride of carbon. On heating it splits up into MnF_2 and fluorine gas.

THE additions to the Zoological Society's Gardens during the past week include a Patas Monkey (*Cercopithecus patas*, ♀) from Nigeria, presented by Mr. Cecil Masters; a Macaque Monkey (*Macacus cynomolgus*, ♂) from India, presented by Mrs. Herbert Griffith; a Vulpine Phalanger (*Trichosurus vulpecula*) from Australia, presented by Mrs. Walter Crane; a Persian Gazelle (*Gazella subgutturosa*, ♂) from the Persian Gulf, presented by Mr. B. T. Ffinch; an Alligator (*Alligator mississippiensis*) from North America, presented by Mr. J. Turner Turner; a Ludio Monkey (*Cercopithecus ludio*) from West Africa, a Brown Capuchin (*Cebus fatuellus*) from Guiana, deposited; four Cockateels (*Callopsittacus novae-hollandiae*) from Australia, purchased.

OUR ASTRONOMICAL COLUMN.

SEARCH FOR AN INTRAMERCURIAL PLANET.—*Harvard College Observatory Circular*, No. 48, consists of a description of a plan, prepared by Prof. W. H. Pickering, for observations during the coming eclipse of the sun, with the object of making a thoroughly systematic search for a possible planet revolving between Mercury and the sun. It is not usual for the observatory to arrange expeditions for solar eclipses, except in the case of the trial of a new problem, when grants of money and instruments are made especially for such work.

In explanation of his plan, Prof. Pickering starts with the statement of the observed fact that "the faintness of a star that may be photographed with a given instrument against a *bright* background of sky depends, within certain limits, directly on the focal length of the lens, and is independent of its aperture." It has also been previously pointed out (*Harvard Observatory Annals*, xviii. p. 104) that "three minutes after the pole star first becomes visible to the naked eye in the evening, the sky surrounding it is of about the same photographic intensity as that of the sky near the sun during a total solar eclipse."

Using a photographic lens of 3 inches aperture and 11 feet 4 inches focal length, the field was large enough to cover nine 8 × 10 inch plates. With an exposure of one minute to the region of the pole, about three minutes after the pole star became visible, was sufficient to appreciably darken the plate, but not enough to obscure the images of stars down to the eighth magnitude. *Four* of these instruments will be employed in May next, all attached to the same mounting, and arranged so as to photograph a region about 32° × 10°, having the sun as centre.

As the earth passes through the equatorial plane of the sun only about *one week* after the eclipse, this will be a favourable time for such a search, as the planet would appear somewhere on the narrow line forming the projection of this plane upon the celestial sphere.

The Harvard Expedition for this purpose will be stationed in the State of Alabama, but as even a successful observation at *only one* station will be insufficient to compute the orbit or determine its distance from the sun, it is therefore hoped that some other observer will be able to duplicate the work in Spain or Algeria. Although, of course, it would be desirable to also employ four cameras, if possible, this is not necessary, and two lenses, one photographing the region on each side of the sun, would, in conjunction with the Harvard plates, be sufficient to confirm the discovery and permit the computation of an approximate circular orbit, which could then be more accurately determined at the next eclipse in 1901.

THE NEW TWIN REFRACTOR AT POTSDAM.—The great refractor which has been installed at the Astrophysical Observatory at Potsdam was recently formally dedicated and prepared for its assigned work. Director H. C. Vogel gave the inaugural address, after which the instrument and its observatory were explained by Prof. Scheiner. The telescope has two objectives, one of 80 cm. (32 inches) aperture and 12 m. (39·4 feet) focal length, and another of 50 cm. (20 inches) aperture and 12½ m. (41·2 feet) focal length. Both objectives were made by C. A. Steinheil and Sons, of Munich, the larger being corrected for photographic, the smaller for visual use. The mounting is by Repsold and Sons, of Hamburg. The dome is 22 m. in diameter and 18 m. high, the hemispherical movable part being of iron with an inner lining of wood; this may be rotated either by hand or by means of electric power. The observing platform is rather unusual, being suspended from the dome, with which it moves, directly opposite the observing slit. The motion of this platform, and the opening or closing of the slit in the dome, are controlled electrically from the eye end of the telescope. The instrument is to be primarily devoted to the determination of the velocity in the line of sight of 500 stars, and the two spectrographs, built specially for the telescope by Toepfer, have passed successfully the preliminary tests. An excellent reproduction of the instrument in position forms the frontispiece of the *Astrophysical Journal* for January 1900, from which the above details have been abstracted.

THE BENJAMIN ALTHORP GOULD FUND.—In the *Astronomical Journal*, No. 477, Messrs. Lewis Boss, Seth C. Chandler and Asaph Hall, Directors of the Fund, make the following announcement:—"Since making appropriations, in March 1899, of 500 dollars to Prof. Charles L. Doolittle, and of 300 dollars to Mr. Henry M. Parkhurst, from the Benjamin Althorp Gould Fund, a considerable amount of income has accrued, for the distribution of which the Directors are prepared immediately to arrange. Applications for appropriations may be made by letter to any of the aforesaid directors, stating the amount desired, the nature of the proposed investigation, and the manner in which the appropriation is to be expended. Full information with regard to the Fund may be found in the announcement pertaining thereto in *A.J.* 453, a copy of which will be mailed, on request, to assist in framing applications."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Mr. H. Woods, St. John's College, has been appointed University Lecturer in Palæozoology.

The Medical School Buildings' Syndicate report in favour of plans for the schools of pathology, pharmacology, public health and medicine, prepared by Mr. E. S. Prior. The estimated cost is about 35,000*l.*

The degree of Doctor of Science is to be conferred on Mr. Charles Hose, of Saráwak, whose contributions to the ethnology, zoology and botany of Borneo have won for him a high reputation.

THE honorary degree of Doctor of Laws has been conferred upon Prof. A. R. Forsyth, F.R.S., and Prof. A. S. Woodward, by Glasgow University.

EVERY student before graduating from the Massachusetts Institute of Technology has to present a satisfactory thesis. Time is allowed for this work in the second term of the fourth year. The theses thus afford students an excellent opportunity to perform original research work. In the course of electrical engineering, a Japanese student has chosen for his subject a study of the size of wire necessary when aluminium is used for a conductor of electricity. He is to study the relative capacity of aluminium as compared with that of copper. As the price of copper has risen so much, and as the price of aluminium has fallen, the use of the latter metal has already begun to compete with that of copper in electrical manufacture. Insurance companies have appointed a committee to follow the results of such tests, and to make tables from them, as it is most important to know, when buildings are wired, the safe limit of the amount of current which any wire covered or uncovered may be made to carry. In the method chosen for determining the relative capacity of the aluminium, the temperature of the wire is measured directly, while the wire is carrying different amounts of electricity.

EVIDENCE of progress in various departments and grades of education in Liverpool is afforded by the report of the Technical Instruction Committee for the year 1899. Though nothing has yet been done by legislation to improve the local organisation of education, or to promote the unification of local administration, steps have been taken in Liverpool towards the co-ordination of educational effort in the City, and so promote harmonious development. By reconstituting its Technical Instruction Committee so as to include not only educational experts nominated by the City Council itself, but also a considerable proportion of representatives of the School Board, and others nominated by the University College and the secondary schools, a local authority has been established for the administration of technical and secondary education—though the functions of the Committee as regards the latter branch are necessarily for the present mainly consultative and advisory. By bringing within the influence of one administrative body, consisting of representatives from all the recognised important public and professional educational organisations in the City, the various special branches of Technical Education, the Committee hope to ensure the continued success and the progressive development of such work as is required by the needs of the City. As the Committee has been recognised by the Department of Science and Art as an organisation for the promotion of secondary education, it will be free to encourage any branches of technical and higher education which are considered deserving of support.

A RETURN just published as a Blue Book shows that the total amount expended on technical education during the year 1897–8 in England, Wales and Ireland was 860,105*l.*; and that the estimated total expenditure on technical education during the year 1898–9 was 874,612*l.* These amounts are exclusive of the sums allocated to intermediate and technical education under the Welsh Intermediate Education Act, 1889. The amounts raised by loan on the security of the local rate under the Technical Instruction Acts were—in 1897–8, 69,334*l.*; in 1898–9, 133,583*l.* The total amount of the residue received under the Local Taxation (Customs and Excise) Act, by the councils of counties and county boroughs in England (excepting the County of Monmouth) in respect of the financial year 1897–8 was 834,827*l.*, of which 759,400*l.* was appropriated to educational purposes, and 75,426*l.* to relief of rates; the latter sum including 42,108*l.* devoted by the London County Council to relief of rates. The total amount expended on technical education during the year 1897–8 was 826,450*l.*, and the estimated total expenditure during the year 1898–9 was 834,908*l.* The total amount of the residue paid to the thirteen County Councils and the Councils of the three County Boroughs in Wales and Monmouth was 40,062*l.*, and these local authorities are devoting the whole of it to intermediate and technical education, chiefly under the Welsh Intermediate Education Act, 1889. The estimated total amount to be devoted annually to intermediate and technical education, under the Welsh Intermediate Education Act—*i.e.* out of the residue and the local rate—is 43,304*l.* In the case of Ireland, the return shows that the total amount expended on technical education by twelve local authorities during the year 1897–8 was 5649*l.*, and that the estimated total expenditure on technical education by twelve local authorities during the year 1898–9 was 4523*l.*

PROF. ROBERT WALLACE, professor of agriculture and rural economy in the University of Edinburgh, does not agree with the suggestion of the Agricultural Education Committee that, in connection with elementary schools, provision should be made for practical work on plots of ground attached to the schools. In an address delivered a few weeks ago on "Nature Knowledge Teaching introduced by the Scotch Code of 1899" (Edinburgh: The Darien Press), he showed that many educational authorities at home and abroad are of the opinion that farm work at school as a means for training the sons of those who are engaged in agricultural pursuits is impracticable and valueless. Such work would only be playing at farming, and would not rouse into full vigour the real working power of a boy any more than playing at shops develops a knowledge of the laws of commerce. What is wanted is individual interest and responsibility, and a knowledge of principles. The practical work which might usefully be done is stated by Prof. Wallace as follows:—(*a*) Laboratory work, the collection of specimens of all sorts of suitable interesting objects, to form local school museums and home collections. (*b*) The systematic examination of specimens by the aid of lenses and other means. (*c*) The growth, for experimental purposes or for ornament, of a great variety of seeds, and of a select number of plants from bulbs, roots, and cuttings in flower-pots, which, on a scale suitable to the local circumstances, could be duplicated at home by individual pupils, by the pupils from one household, and even by groups of pupils who live contiguous to each other—it being so arranged that each member of the combination should have a right to claim the necessary attention to one or more pots as exclusively his or her own, while the lessons to be learned from all the pots would be common to every one. (*d*) Field demonstrations, in which the objects of interest would be, so to say, infinite in variety. (*e*) And for the benefit of older children and those who have left school, as well as the more enlightened of their parents, school libraries of useful books on rural subjects, which every one could not be expected to possess.

THE address delivered before the Association of Technical Institutions, on January 24, by the President, Sir Swire Smith, just published by the Association, contains many sound remarks upon technical education from the commercial and industrial aspects, and reasons why it should receive the most liberal national encouragement. A University Don once remarked to the parent who wished his son to take up some scientific subject: "Sir, we know nothing of science here, we don't even teach it," and this spirit (unfortunately, not unknown at the present time) is responsible for the prejudice which manufacturers have against the schools and higher education. Place by the side of the disdainful expression referred to, the following testimony of Sir Swire Smith as to the methods and benefits of education in the principles of science:—"In the dual enquiry of the Royal Commission on technical instruction, in which we investigated not only systems of education, but their effect upon industry in this and competing countries, we visited in each foreign country, wherever possible, those eminent industrial establishments whose products were largely exported to the United Kingdom. We followed the processes from the raw material to the finished product, and we interviewed the specialists responsible for excellence or superiority, nearly all of whom had been trained in technical schools. In visiting the schools in which this special knowledge had been obtained, we found students qualifying themselves for their special work in the factory, by pursuing courses of training under excellent teachers and with the most perfect apparatus. We did not see much of what may be called 'trade teaching,' although in some departments of industry, in textiles, for example, the designing, weaving, dyeing and finishing departments were in some cases very complete. The schools in their fundamental principles were claimed to be schools of science or art, *applied* to industry, and in many of the smaller towns the most important schools were teaching pure science and pure art as a basis, with departments for the application of science and art to local industries. The teaching of principles was the same in all the great schools, but in their application there was as much variety as in the industries and crafts to which the teaching was applied. But in following the students from the schools to the workshops and factories, and in ascertaining the effect of their instruction upon their calling, the evidence to my mind was conclusive that the great progress of our rivals may be traced directly to the influences of their schools. And not less convincing were the illustrations of technical training afforded under less-favourable conditions than in our own country, proving that the same educational influences had been at work in advancing our own industries." No more sound expression as to what technical education should mean, and what may be expected from it, could be given than is included in Sir Swire Smith's remarks, and they should receive careful consideration from all who are concerned with the progress of national education and the development of our industries.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, January 25.—"On the Effects of Strain on the Thermo-electric Qualities of Metals. Part ii." By Prof. Magnus Maclean, D.Sc. Communicated by Lord Kelvin, G.C.V.O., F.R.S.

A.—"Thermo-electric difference between free wires and wires previously subjected to longitudinal extension and lateral compression, by drawing them through the holes of a draw-plate."

In Part i. of this paper, read to the Society on February 2, 1899, the object of the experiments was stated to be the determination of the *magnitude* of the thermo-electric effects obtained from any one metal strained and unstrained. The results then given were obtained from two wires of the same material, one wire being previously drawn through a draw-plate, so as to reduce it in size from No. 18 standard gauge (0·122 cm. diameter) to about No. 24 standard gauge (0·0559 cm. diameter).

The metals for which results were given in Part i. were copper (six specimens), lead (two specimens), platinoid, German silver, reostene and manganin.[1]

The present paper gives results of similar experiments made on specimens of commercial[2] and pure lead, obtained from Messrs. Johnson and Matthey; and specimens of annealed steel, of aluminium, and of nickel.

B.—"Thermo-electric difference between free wires and wires previously permanently elongated by longitudinal stresses."

Attempts were made to determine the thermo-electric difference between free wires and wires previously permanently elongated by a longitudinal stress. It was found difficult to elongate the hard wires permanently to any appreciable extent before they broke.

The greatest percentage permanent elongation that could be got in hard drawn copper, manganin, nickel and German silver was 0·7, 0·5, 0·7 and 0·5 respectively. The thermo-electric difference between the stretched and the unstretched wires was then determined, and the results are given.

C.—"Thermo-electric difference between free wires and wires under stress, producing (1) temporary elongation, (2) permanent elongation."

The hot junction was kept permanently at steam temperature during each set of experiments by an arrangement described. Increasing weights were added on to the wire to produce (1) temporary elongation, (2) permanent elongation. Three readings of the galvanometer were taken: (1) with a weight on the wire, (2) with a weight off, and (3) with the circuit broken. A heavier weight was hung on, and other three readings taken, and so on to the heaviest weight used in the experiments.

The readings of the galvanometer were in the same direction for all the wires tried with weights on and off, except for soft copper and iron. The greatest permanent elongation produced in any of the hard copper wires experimented on was 0·17 per cent., and for this permanent elongation the reading on the galvanometer was in the same direction for weights off and on, though always greater for the latter.

For the soft copper wire the readings were in the same direction for weights on and off up to a permanent elongation of 1 per cent. After a permanent elongation of 4·72 per cent. the current with weight on was 0·00103 mikroampere per degree from *stretched* to *unstretched* through the hot junction, while with the weight off the current was 0·00075 mikroampere per degree from *unstretched* to *stretched* through the hot junction.

For iron wire the current was in the same direction for weights on and off up to a permanent elongation of 0·35 per cent.; but after a permanent elongation of 3·41 per cent. the current with weight on was 0·00461 mikroampere per degree from *unstretched* to *stretched* through the hot jnnction, and with weight off 0·0069 mikroampere per degree from *stretched* to *unstretched* through the hot junction.

In "Mathematical and Physical Papers," vol. 2, p. 270, § 109, Kelvin says:—"I have thus arrived at the remarkable conclusion that when a permanent elongation is left after the withdrawal of a longitudinal force which has been applied to an iron or copper wire, the residual thermo-electric effect is the reverse of the thermo-electric effect which is induced by the force, and which subsists as long as the force acts."

It seems (1) that for small longitudinal strain in copper or in iron the direction of the current through the hot junction is the same, whether the force which produced the permaneut strain is on or off, (2) that as the permanent elongation is increased by increased longitudinal forces, a stage is reached which gives zero current when the forces are removed, and (3) that for greater longitudinal forces and permanent elongations the direction of the current is opposite with the pulling forces off and on. It seems, in fact, that the permanent elongation must exceed a definite limit to produce the reverse thermo-electric effects which Kelvin observed with the longitudinal force on and removed. I hope to further investigate this point and to report the results to the Society.

[1] Dr. Anderson, Chemical Laboratory, the University, Glasgow, gave me the following analyses for reostene and for manganin:—

Reostene.		
Si	0·61	per cent.
Fe	79·95	,,
Ni	16·53	,,
Mn	1·21	,,
Total	98·30	

Manganin.		
Sn	0·073	per cent.
Fe	0·6	,,
Cu	86·62	,,
Mn	8·031	,,
Ni	3·261	,,
Total	98·585	

[2] Dr. Anderson analysed the commercial lead, and found it contained 99·12 per cent. of lead.

Physical Society, March 9.—Prof. Everett, F.R.S., Vice President, in the chair.—A paper on the damping of galvanometer needles was read by Mr. M. Solomon. The solution of the equation of motion for a magnetic needle, swinging in a uniform magnetic field, points to the conclusion that the ratio of the period to the logarithmic decrement is independent of either the moment of the needle or the strength of the controlling field, and is simply a function of the damping coefficient and the moment of inertia of the moving system. This ratio should therefore be constant if these latter quantities are constant. Experiments to test the constancy of period to logarithmic decrement have been conducted at the Central Technical College at various times since 1891, and they have invariably pointed to a variation in the value of the ratio. The object of the present paper is to discover the cause of this variation. It may be due to an alteration in the moment of inertia or to an alteration in the damping coefficient. If the control magnets are either directly above or directly below the needle, there is no chance of any change in moment of inertia. The damping coefficient depends on three things: (1) Viscosity of the air; (2) viscosity of the suspension; and (3) eddy currents. The author has carried out experiments with a galvanometer on open circuit, and finds a constant value for the ratio. The viscosity of the air and suspension therefore cause no variation. Upon closing the circuit and repeating the experiments, the value of period over logarithmic decrements alters. The variation is therefore due to eddy currents. The damping factor due to eddy currents may vary owing to three causes: (1) Change in moment of needle due to change in field strength; (2) effects of self-induction; (3) effects of rise of temperature on the resistance of the coils. The author points out that the two latter causes would tend to alter the ratio in the wrong direction, and he therefore concludes that the variation is due to an alteration in the strength of the swinging needle produced by altering the strength of the controlling field. Mr. Blakesley said it was interesting to note the fact that the ratio of period to decrement was independent of the controlling field. In the case of a condenser discharging this ratio is independent of the capacity; in the case of a tuning fork, of the rigidity; and in the case of water oscillating up and down in a U-tube, of the acceleration due to gravity. Mr. Rosenbaum said that the ratio considered was constant in the case of a Nalder D'Arsonval galvanometer. Mr. Solomon said that his arguments did not apply to a galvanometer of this description, because the swinging system was not a magnetic needle but simply a coil.—A paper on the distribution of a gas in an electric field was read by Mr. G. W. Walker. The author has considered a gas as consisting of a number of molecules each containing two atoms of equal mass, one positively and the other negatively charged with electricity. When under the action of electrical forces some of the molecules split up, and we arrive eventually at a steady state in which there is a definite number of undissociated molecules and of free positive and free negative atoms. Treating the problem as one-dimensional the potential at any point is expressed in general by elliptic functions, and is therefore periodic. Applying the results to the case of a vacuum tube, it is found that there is superimposed upon the gradual fall of potential along the tube minor periodic variations which it is suggested are connected with the striæ of discharge. Both the matter density and the electric density are periodic along the tube. If the places of maximum matter density coincide with the places of minimum electrical action, then whether luminosity is due to collisions or recombinations there will be maximum luminosity at these points. In general these points do not coincide, and thus the positions of maximum luminosity are not clearly defined. The analysis leads to the conclusion that the distance between the striæ is inversely proportional to the density of the gas and to the current strength, and these facts have been experimentally verified.—Mr. C. E. S. Phillips exhibited a surface tension lecture experiment. The effects of surface tension were exhibited by placing water between two pieces of microscope cover glass. When the glasses are circular they set in any position, and one can be made to rotate upon the other. If the plates are square or elliptical they set in a definite position, to which they immediately return if displaced. Mr. Phillips pointed out how two circular discs with liquid between could be used from which to suspend the moving system of a galvanometer. Mr. Cochrane suggested the use of some liquid which would evaporate less quickly than water. Mr. Blakesley asked what accuracy could be obtained with such an arrangement, and what weight it would be possible to support without squeezing out the water.—The meeting then adjourned until March 23.

Zoological Society, March 6.—Dr. W. T. Blanford, F.R.S., Vice-President, in the chair.—Mr. G. A. Boulenger, F.R.S., described eight new species of reptiles and batrachians from Borneo, which had been forwarded to him by Mr. R. Shelford, the curator of the Sarawak Museum. One of them formed the type of a new genus proposed to be named *Lepturophis*.—Mr. F. E. Beddard, F.R.S., read a description of the brain of the Siamang (*Hylobates syndactylus*), based upon a specimen taken from an animal which had recently died in the Society's Gardens. The form of the brain did not appear to differ materially from that of other species of *Hylobates*.—A communication from Miss E. M. Bowdler Sharpe contained a list of twenty-nine species of butterflies, of which specimens had been collected by Mr. J. Lewis Bonhote in the Bahama Islands in 1898. Of these, one species, viz. *Papilio bonhotei*, was described as new.—A communication was read from Mr. J. Lewis Bonhote, containing an account of the mammals collected by Mr. T. H. Lyle in Siam. The collection comprised specimens of twenty species, one of which, viz. *Petaurista lylei*, was described as new, and the others were enumerated in the paper. A large series of specimens of a squirrel (*Sciurus finlaysoni*) was contained in the collection, and from an examination of them the author was able to corroborate Mr. Thomas's remarks (*P.Z.S.* 1898, p. 245) that, so far as our present knowledge is concerned, the variations met with in this species follow, apparently, none of the ordinary laws which are usually supposed to govern such cases.—Mr. G. E. H. Barrett-Hamilton contributed a paper on a small collection of mammals brought home by Captain H. H. P. Deasy from Central Asia. The most interesting specimens were three examples of the rare *Euchoreutes naso*, a novelty to the collection in the British Museum, and specimens of new species of Vole and Jerboa.—Mr. Martin Jacoby read a paper on new species, one hundred in number, of Phytophagous Coleoptera from South and Central Africa.

CAMBRIDGE.

Philosophical Society, February 19.—Mr. Larmor, President, in the chair.—The President announced that the adjudicators of the Hopkins Prize for the period 1891–1894 have awarded the prize to W. D. Niven, F.R.S., formerly Fellow of Trinity College, for his memoir on ellipsoidal harmonics (*Phil. Trans.* 1891) and other valuable contributions to applied mathematics. The following communications were made to the Society:—A suggestion as to a possible explanation of the origin of some secondary sexual characters in animals as afforded by observations on certain salmonids, G. E. H. Barrett-Hamilton. Attention was directed to the phenomena attendant upon the spawning of the anadromous salmonids of the genus Onchorhynchus, which, it was suggested, would be found to throw light on the origin of secondary and other sexual characters in animals.—On supernumerary teeth, W. L. H. Duckworth and D. H. Fraser. The observations which were brought before the notice of the Society dealt with the occurrence of supernumerary teeth in adult human crania. The essential fact demonstrated was the frequent presence of small dental masses in a particular position on the alveolar margin of the upper jaw, viz. between the second pre-molar and the first molar teeth. The authors thought they were justified in the conclusion that some of these masses are to be regarded as vestiges of what would be third pre-molars, and inferred that the condition is consequently to be considered as constituting an approximation to the Platyrrhine type of primate dentition.—On the physical characteristics of some Eskimo from Labrador, W. L. H. Duckworth and B. H. Pain. The subjects of this communication are a party of Eskimo, some twenty-five in number, who were exhibited in the "Eskimo encampment" at "Olympia," in London, at the latter end of last year and in January of the present year. The observations dealt with the external characters of these people; measurements were obtained which conveyed an idea of their physical proportions, and some of their words were recorded by means of the phonograph. The measurements bear an interesting relation to those obtained from the skeletons of Eskimo from Labrador presented by Dr. Curwen, of St. John's College, to the University Anatomical Department.—On the zoological position of *Palaeospondylus*, J. Graham Kerr. Evidence was brought forward which suggested the possibility of *Palaeospondylus* being really a young Dipnoan fish.—On the extraction of gases from small quantities of blood, J. Barcroft. The principle of the apparatus demonstrated is the ordinary one of extracting the gases from measured quantities of blood in vacuous receivers with an air pump. The leading feature of the apparatus is that the measuring burette, the vacuous receivers and the gas pump are in one piece, so that there is no opportunity for the blood or the gases to be contaminated with air.—On the separation of a pure proteid from egg-white, F. G. Hopkins. A process was described by means of which a crystalline albumen can be obtained from egg-white, which upon repeated fractional crystallisation shows complete constancy of rotatory power and of percentage composition. It yields therefore satisfactory evidence of being a chemical individual, and should form satisfactory material for chemical study.

EDINBURGH.

Royal Society, February 5.—Prof. Duns in the chair.—Prof. J. Gibson and Mr. A. W. C. Menzies exhibited their form of thermostat, which is heated and regulated by electricity. The heating is effected by means of four or five ordinary incandescent electric lamps, set below the jacketed tank containing the water, whose temperature is to be kept steady. After the temperature has been raised to the desired point, a simple form of automatic cut-out is arranged to work an electric relay, which puts out the electric lamps when the temperature rises slightly above the desired temperature, and allows them to be re-lighted when the temperature falls slightly below that point. One important practical advantage of the method lay in the fact that the operator was rendered quite independent of the gas supply. By its means they had been able to keep the temperature steady within a range of a tenth of a degree for months, and at comparatively little cost.—Dr. W. Peddie read a paper on the law of elastic fatigue. In a former paper on the torsional oscillations of wires it was pointed out that the empirical formula, which very accurately represents the relation between amplitude of oscillation and the number of oscillations that have taken place since the wire was left to itself, indicates the existence of a condition in which elastic fatigue is diminished by previous oscillations of the wire. But the truth of this result depended, in the series of experiments then discussed, upon the formula applying, with unmodified parameters, to a range outside that dealt with in the experiments. It was now shown that, with one exception, fatigue had been induced by previous oscillations in all series of experiments hitherto made upon both steel and iron wires. In the exceptional case the reverse may be true in part of the experimental range. The angle of oscillation (provisionally called the *critical angle* in the former paper), which separates the two conditions, occurs well within the experimental range. At larger angles fatigue is induced by previous oscillations; at smaller angles it seems to be increased.—In a note on magnetic screening, Dr. C. G. Knott gave an account of a new method of exploring the field inside a hollow tube or sphere of magnetic metal, specially applicable to cases in which the interior is very narrow or difficult of access. The idea had been in his mind for many years, but only recently, in connection with an investigation on magnetic strains in small iron and nickel spherical shells, had he found occasion to test the method experimentally. The method consisted in comparing the twist produced in a nickel wire carrying a given current and magnetised longitudinally in various fields: (1) when the nickel wire alone occupied the heart of the magnetising coil; (2) when either the iron or nickel shell was introduced so that the nickel wire lay wholly within it. This required the nickel wire to be shorter than the diameter of the spherical shell. It was found, for example, that it required a field 660 when the iron shell surrounded the wire to produce the same twist effect as was produced by field 200 when the nickel shell surrounded the wire; and that the same effect was produced by field 50 when the wire was surrounded by neither shell.—Dr. John Henderson communicated a paper on the Clark cell *versus* the cadmium cell as a standard of electromotive force. In addition to an account of the various modifications of Clark cell which had been made with a view to improve it as a satisfactory standard of E.M.F., and a discussion of the work done by others in regard to the cadmium cell, the author gave a full description of his own elaborate experiments. He experimented on a great variety of modifications; and his conclusions were that as regards constancy of E.M.F., smallness of temperature coefficient, power of recovery after being short-circuited, its practical identity though made of materials supplied commercially by different manufacturers, and other essential characteristics of a practical standard of electromotive force, the cadmium cell was in all respects superior to the Clark cell.—Dr. Hugh Marshall communicated a short paper on the action of silver salts on solution of ammonium persulphate, in which he called attention to two striking reactions which he had recently observed and was investigating. When a small quantity of silver salt is added to a strong ammoniacal solution of persulphate, nitrogen is evolved almost immediately; the temperature rises rapidly, and the action may soon become violent. Apparently the silver is rapidly peroxidised by the persulphate and reduced by the ammonia. An aqueous solution of ammonium persulphate is steadily decomposed at the ordinary temperature in presence of small quantities of silver salts; there is no evolution of gas, *part of the nitrogen of the ammonium salt being converted into nitric acid*, as shown by the equation:

$$8(NH_4)_2S_2O_8 + 6H_2O = 7(NH_4)_2SO_4 + 9H_2SO_4 + 2HNO_3.$$

It was found that, in the space of two to three days a milligram-equivalent of silver salt per litre of solution decomposed one-half of the persulphate originally present, the temperature being 20°.

PARIS.

Academy of Sciences, March 3.—Mr. Maurice Lévy in the chair.—Remarks by M. Picard on his work on the theory of algebraic functions of two variables.—On the tetrahedral symmetry of the terrestrial globe, by M. de Lapparent. Remarks on a paper on the same subject by M. Marcel Bertrand. The author thinks that while the original view of Lothian Green groups the main facts of the geography of the earth round a remarkably simple idea, an idea which moreover follows from the principle of least action, the modifications introduced by M. Bertrand into the original hypothesis have the effect of destroying its simplicity and usefulness. The idea that the effect is due to a slow cooling would also have to be abandoned.—Observations on the preceding note, by M. Marcel Bertrand. A detailed reply to the criticisms of M. de Lapparent.—Preparation and properties of a manganese perfluoride, by M. Henri Moissan. The new fluoride has the composition Mn_2F_6, and is formed by the action of fluorine gas upon manganese iodide.—A tubular furnace, working at any fixed temperature, by M. Armand Gautiër. An application of the reverberatory principle to a combustion furnace.—Morphology of the pelvic girdle in Amphibia, by M. Arm. Sabatier.—On the Dinosaurians in the strata of Rognar and Vitrolles at the foot of Montagne-Noire, by M. Charles Depéret.—Prof. E. Fischer was elected a Correspondant for the Section of Chemistry.—Observations of the Giacobini comet (1900 *a*) made at the Observatory at Algiers with the 31·8 cm. equatorial, by MM. Rambaud and Sy.—New determinations of g, by M. J. Collet. A study of the deviations from the normal value in the neighbourhood of a mountain mass. The mean results at Grenoble, Saint-Agrève, and Le Lautaret are given.—On a theory of systems of total differential equations of the second order, by M. Ernst Pascal.—On the electric charge of the deviable rays of radium, by M. P. Curie and Mme. M. P. Curie. The authors prove that that part of the radiation from radium which is deviated in a magnetic field carries a negative charge of electricity, in a similar manner to the kathode rays. Parallel experiments carried out with the Röntgen rays showed similar effects, but to a very slight extent, and the conclusion is drawn that if the X-rays are charged with electricity, they are much more feebly charged than the radium rays.—Disymmetry in the polarised emission of a Geissler tube submitted to the action of a magnetic field, by M. R. Dongier.—On the constitution of the yellow sodium rays, by MM. Ch. Fabry and A. Perot. An application of the interferential spectroscope previously described by the authors. The complicated and variable results obtained by M. Michelson with the D-lines are here shown to be due to the reversal of the rays. Sodium vapour possesses an enormous absorptive power, even at a low temperature and very feeble pressure.—On the spectra of the polar aurora, by M. Paulsen.—On the preparation of the phosphides of iron, nickel, cobalt and chromium, by M. Georges Maronneau. Phosphide of copper heated in the electric furnace with either of these four metals to a temperature above the boiling point of copper, gives the phosphide of the metal added, which can be extracted in a pure state by treating the fused mass with nitric acid. The properties of Fe_2P, Ni_2P, Co_2P and CrP are described.—On eugenol, safrol and propylpyrocatechol, by M. Raymond Delange. The methyl ether of eugenol, reduced with sodium and boiling alcohol, gives propylveratrol, which on hydrolysis with hydrochloric acid furnishes propylpyrocatechol.—On the diazotising of safranine, by M. George F. Jaubert. When diazotised under ordinary conditions the monodiazo-compound is the only product. Both the red mono-acid salt and the blue di-acid salt give the same result, but the green tri-acid salt uses twice as much sodium nitrite, and hence corresponds to an azonium base of orthoquinonoid structure.—The modifications brought about by a longitudinal traction in the stems of plants, by M. Thouvenin. In the plant studied, *Zinnia elegans*, a moderate longitudinal pull retards the development of the secondary fibro-vascular bundles.—Variations in the characters of species of haricots under the influence of grafting, by M. Lucien Daniel. An investigation to determine how far the properties acquired by grafting can be transmitted in the case of an annual, such as haricots, by the seed. It is found that grafting always produces variation in the plants grown from seed, this variation being less marked in wild species grafted between themselves, and more accentuated in the cultivated plant.—The work of spinal nervous centres, by Mlle. J. Joteyko. The nerve may be excited for more than four times the period producing fatigue in the muscle, without showing signs of fatigue. The spinal nervous centres thus show a very high resistance.—New method of measuring the tactile sensibility to pressure of mucous and cutaneous surfaces, by MM. Ed. Toulouse and N. Vaschide.—Concerning the physiological alternation of the kidneys, by MM. E. Bardier and H. Frenkel. The experiments quoted show that there is no real physiological alternation of the kidneys, neither from the point of view of the vaso-motor phenomena nor from that of the flow of urine.—Hepatic glycogen during pregnancy, by MM. A. Charrin and A. Guillemonat.

NEW SOUTH WALES.

Royal Society, December 6, 1899.—The President, W. M. Hamlet, in the chair.—On the Darwinias of Port Jackson and their essential oils, by R. T. Baker and H. G. Smith. The authors show that one of the species of the genus—the shrub, botanically known as *Darwinia fascicularis*, A. Rudge—which occurs plentifully on the sandstone formation around Port Jackson, is a plant of great commercial importance in regard to its essential oil. This plant belongs to the natural order Myrtaceæ, a genus so prolific in oil-yielding species. The oil consists principally of the important ester geranyl acetate, the least amount of this constituent being 56·7 per cent. and the greatest 65·1 per cent., obtained from the oil distilled in November. Besides this ester, 13·11 per cent. of free alcohol was determined, calculated as geraniol.—On New South Wales copper ores containing iodine, by Arthur Dieseldorff. The author (who was on a visit to New South Wales a few years ago) was interested in the discovery of iodine in a sample of cuprite from Cobar by Dr. W. Autenrieth, of the University of Freiberg, Baden. He made further investigations himself as shown by the paper, resulting in his proving the presence of iodine in several different samples sent to him from the colony.—Orbit elements Comet I. 1899 (Swift), by C. J. Merfield. The orbit elements have been deduced from the observations taken at most of the leading observatories. Sixteen equations of condition have been employed in finding the corrections to the assumed parabolic elements. The result of the investigation seems to indicate that the geometrical figure described by this comet is an hyperbola.—On the composition of New South Wales labradorite and topazes, with a comparison of methods for the estimation of fluorine, by G. Harker. The paper gives the composition and properties of a typical labradorite from New England, New South Wales, and also the composition including the water of constitution of two varieties of topazes found in New South Wales, one from the Mudgee the other from the New England district. It describes also the results obtained for the percentage of fluorine in topaz by three different methods, viz. by fusing the topaz with alkaline carbonates alone (Wöhler), by liberating the fluorine as silicon tetra-fluoride and weighing as potassium silicon-fluoride (Liversidge), and by decomposing with alkaline carbonates and silica (Berzelius-Rose). The last method gave the best results, and very probably the whole of the fluorine is obtained by this method.—Note on a remarkable increase of temperature after dark at Seven Oaks, Macleay River, by Hugh Charles Kiddle.—Records of rock temperatures at Sydney Harbour Colliery Birthday Shaft, Balmain, Sydney, by J. L. C. Rae, E. F. Pittman and Prof. T. W. E. David.—The deep sinking now being carried on at the Sydney Harbour Colliery, Balmain, with which one of the authors is actively associated, affords a very favourable opportunity of noting the nature and temperatures of the various rocks underlying the neighbourhood of Sydney, and this the authors are utilising. The paper read deals with the temperatures noted to a depth of 1450 feet, which was the depth reached in the shaft at the middle of November. The thermometers used were specially supplied by Prof. Everett, F.R.S., Secretary of the British Association Committee on the subject of underground temperatures. If the mean annual temperature of Sydney be taken as 63° Fahr., the rate of increase is shown, by the observations made, to be at the rate of 1° Fahr. for every 90½ feet. A remarkable increase of temperature was noted as the sinking passed from the Hawkesbury Sandstones into the Narrabeen Beds, the upper section of which consists of chocolate shales.—Note on the edible earth from Fiji, by the Hon. B. G. Corney, Prof. David and F. B. Guthrie. The sample of edible earth, a soft, pale pink, clayey material, with occasional lumps of chalcedony, was collected by Dr. Corney, near the northern coast of Vanua Levu. Silica, alumina and combined water are present in approximately the proportion required by the formula $Al_2O_3(SiO_2)_2(H_2O)_2$; the substance appears, therefore, to be a silicate of that composition—probably kaolinite—with about 7·6 per cent. of uncombined ferric oxide as mechanical impurity.

DIARY OF SOCIETIES.

THURSDAY, MARCH 15.

ROYAL SOCIETY, at 4.30.—Total Eclipse of the Sun, January 22, 1898. Observations at Viziadrug: Sir N. Lockyer, K.C.B., F.R.S., Captain Chisholm-Batten, R.N., and Prof. Pedler, F.R.S.—A Comparative Crystallographical Study of the Double Selenates of the Series $R_2M(SeO_4)_2, 6H_2O$. Part I. Salts in which M is Zinc: A. E. Tutton, F.R.S.—The Theory of the Double Gamma Function: E. W. Barnes.

ROYAL INSTITUTION, at 3.—Recent Excavations in Greece: Dr. C. Waldstein.

LINNEAN SOCIETY, at 8.—Report on the Botanical Results of an Expedition to Mount Roraima, in British Guiana, undertaken by F. V. McConnell and J. J. Quelch, W. Botting Hemsley, F.R.S., and others. —Bryozoa from Franz Josef Land, collected by the Jackson-Harmsworth Expedition, 1896–97: A. W. Waters.

CHEMICAL SOCIETY, at 8.—The Vapour Densities of Dried Mercury and Mercurous Chloride: H. Brereton Baker.—(1) The Preparation of Pure Hydrobromic Acid; (2) A New Sulphide of Arsenic: Dr. A. Scott, F.R.S.—The Action of Iodine on Alkalis: R. L. Taylor.—The Interaction between Sulphites and Nitrites: Dr. Edward Divers, F.R.S., and Dr. Tamemasa Haga.—New Polysaccharides: Manno-galactan and Lævulo-mannan: Julian L. Baker and Thomas H. Pope.

FRIDAY, MARCH 16.

ROYAL INSTITUTION, at 9.—Pictorial Historical Records: Sir Benjamin Stone.

EPIDEMIOLOGICAL SOCIETY, at 8.30.—Measles: its Distribution and Control: Dr Robinson.

SATURDAY, MARCH 17.

ROYAL INSTITUTION, at 3.—Polarised Light: Lord Rayleigh.

MONDAY, MARCH 19.

SOCIETY OF ARTS, at 8.—The Photography of Colour: E. Sanger Shepherd.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Explorations in the Patagonian Cordilleras: Dr. Hans Steffen.

TUESDAY, MARCH 20.

ROYAL INSTITUTION, at 3.—Structure and Classification of Fishes: Prof. E. Ray Lankester, F.R.S.

SOCIETY OF ARTS (Foreign and Colonial Section), at 4.30.—Imperial Telegraph Communication: Sir Edward A. Sassoon, Bart.

ZOOLOGICAL SOCIETY, at 8.30.—Field Notes on some of the East African Mammals (illustrated with Lantern Slides): S. L. Hinde.—On a Case of Homœosis in *Asellus*—Antennule replaced by a Mandible: W. Bateson, F.R.S.—On Echinoderms from Singapore and Malacca: F. P. Bedford.

ROYAL GEOGRAPHICAL SOCIETY, at 4.—Twelve Years' Work of the Ordnance Survey: Colonel Sir John Farquharson, K.C.B.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Great Central Railway Extension—Northern Division: F. W. Bidder.—The Great Central Railway Extension—Southern Division: F. Douglas Fox.

ROYAL PHOTOGRAPHIC SOCIETY.—A Demonstration of the Heliogravure Process: Ignatz Herbst.

ROYAL STATISTICAL SOCIETY, at 5.30.

WEDNESDAY, MARCH 21.

SOCIETY OF ARTS, at 8.—The Use and Abuse of Food Preservatives: Dr. Samuel Rideal.

GEOLOGICAL SOCIETY, at 8.—On a Bird from the Stonesfield Slate: Prof. H. G. Seeley, F.R.S.—The Lower Ludlow Formation and its Graptolite-Fauna: Miss Ethel M. R. Wood.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—The Ether Sunshine Recorder: W. H. Dines.—Remarks on the Weather Conditions of the Steamship Track between Fiji and Hawaii: Captain M. W. C. Hepworth.—Comparison by means of Dots: Alexander B. MacDowall.

ROYAL MICROSCOPICAL SOCIETY, at 7.30.—Exhibition of Slides of New, Rare, and Foreign Rotifera, by C. F. Rousselet.

ENTOMOLOGICAL SOCIETY, at 8.

THURSDAY, MARCH 22.

ROYAL SOCIETY, at 4.30.—The Croonian Lecture: Immunity, with Special Reference to Cell Life: Prof. Paul Ehrlich (of Frankfort-on-Main).

ROYAL INSTITUTION, at 3.—Equatorial East Africa and Mount Kenya: H. J. Mackinder.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Storage Battery Problems: E. J. Wade.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Adjourned Discussion on Improvements in the Longworth Power-Hammer, and Portable Pneumatic Tools.—*Paper to be read:* Observations on an Improved Glass Revealer, for Studying Condensation in Steam-Engine Cylinders and rendering the Effects Visible: Bryan Donkin.

FRIDAY, MARCH 23.

ROYAL INSTITUTION, at 9.—Some Modern Explosives: Sir Andrew Noble.

PHYSICAL SOCIETY, at 5.—An Electromagnetic Experiment: Prof. S. P. Thompson, F.R.S.—(1) Some Experiments illustrating Syntony; (2) An Electrical Micrometer: P. E. Shaw.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Development of the Modern Locomotive Engine: J. W. Cross.

SATURDAY, MARCH 24.

ROYAL INSTITUTION, at 3.—Polarised Light: Lord Rayleigh.

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THURSDAY, MARCH 22, 1900.

THE CAMBRIDGE CRYSTALLOGRAPHY.

A Treatise on Crystallography. By W. J. Lewis, M.A., Professor of Mineralogy in the University of Cambridge. Pp. xii + 612; 553 figures. (Cambridge: University Press, 1899.)

IT is now more than sixty years since Prof. Miller, of Cambridge, published his famous "Treatise on Crystallography." At that time crystallography was a new science, and studied by few. Since that date it has entered into the educational programme of most universities, and at Cambridge is now (combined with mineralogy) a recognised Tripos subject, pursued by a considerable number of students.

Miller's successor, under whose hands the Cambridge School has developed its present activity, now issues a volume the substantial dimensions and weighty contents of which are worthy of a university publication; this volume and Maskelyne's "Morphology of Crystals" provide English students with a pair of adequate text-books on the geometry of crystals.

Prof. Lewis preserves in his book all Miller's results and methods; his treatment of the subject, however, resembles that of Maskelyne and other recent authors, in attaching primary importance to the subject of symmetry; the general relations of crystal symmetry are, in fact, briefly stated in the third chapter; although the mathematical development of these principles is reserved for Chapter ix. Chapters iv. to viii., being devoted to the law of rational indices, the relation of zones, the methods of drawing and projecting crystals, and the anharmonic ratio of four planes, are almost necessarily an exposition of the work of Miller, Mohs and Naumann.

It is to Chapter ix. that the critical student will first turn for possible novelty of treatment; here he will find a series of thirteen propositions establishing the nature, order, number and disposition of axes and planes of symmetry; a footnote on p. 119 gives for the first time the interesting information that the trigonometrical proof now familiar to all students is due to Prof. Story-Maskelyne, and was given by him in lectures in 1869, two years before the *publication* of Gadolin's classical memoir, in which a similar proof was independently employed. The author calls the reader's attention to the assumption that an axis of symmetry is parallel to a possible edge and perpendicular to a possible face of the crystal, and points out that this cannot be proved for a three-fold axis. The fact is commonly ignored, but does not affect the main object of the argument, which is to show that four-fold and six-fold axes are the only axes of symmetry of degree higher than three which are possible. Euler's theorem is then employed to show how axes of symmetry may be combined, and how two or more such axes involve the presence of others; and the number possible in a crystal is deduced from the expression for the area of a regular closed polygon on a sphere. At this point complaint may fairly be made of a serious omission, for the whole course of the argument in Chapter ix. prepares the reader to expect that the thirty-two classes of crystals are about to be established, whereas the following chapters which contain the detailed description of the various classes are not preceded by any proof that they alone are possible. A link is wanting in the logical sequence, and since the principle of merohedrism is expressly rejected (see p. 259), there remains no principle of development or classification to correlate the thirty-two classes.

The author, in his preface, expresses the opinion that the accurate drawing of crystals develops the student's power of solving crystallographic problems, and his book differs from other text-books above all in the attention paid to the construction of diagrams, and in the number of examples by which this subject is illustrated. An early chapter describes the methods of crystal drawing, including orthographic and clinographic projections, and they are constantly illustrated in the subsequent chapters. The greater portion, the systematic section of the book, consists of a detailed discussion of the various classes; each of these is treated in a very complete manner; formulæ and methods of calculation are established; numerous propositions concerning the elements of symmetry and their mutual relations are proved, many of them new; crystals of many substances are figured and described, and (a special feature of the book) a number of fully worked examples are given as exercises in computation and drawing; this affords opportunity for the description of several specimens in the University collection. Excellent also in its wealth of detail is the long chapter on twin crystals, which follows the systematic section, and here again each substance described is treated as an exercise in crystallographic determination, calculation and drawing. To gain an idea of the unusually elaborate, as well as practical, manner in which these various problems are treated, let the reader refer, for example, to the geometrical propositions concerning rhombohedral crystals on pp. 365-403, to the four pages relating to Gypsum in Chapter xii., and to the nine pages devoted to the twinning of Cassiterite in Chapter xviii.

In the systematic treatment of the thirty-two classes, the less symmetrical systems are treated first, an arrangement introduced by Groth in a non-mathematical treatise, but one which introduces the most difficult calculations at the outset; unfortunately also, the somewhat arbitrary sequence adopted in the present book does not bring the most symmetrical (holohedral) class to the end, or even to the same place, in each system.

It is really difficult to make an elementary treatise on geometrical crystallography a readable book. The principles of symmetry must be established by the aid of the zone law, so that propositions on indices and anharmonic ratios must precede the description of the crystals and their symmetry, and yet these propositions are scarcely intelligible without some knowledge of the crystals. Prof. Lewis makes no attempt to surmount this difficulty—and, in fact, recommends his reader to travel backwards and forwards rather than to read consecutively; but he succeeds in his main object of presenting the essential features of the science to a student who is not required to possess more than elementary mathematical knowledge, and gives him a handbook full of information, and illustrated by examples excellently chosen and ably elaborated.

A little adverse criticism may be devoted to the following points:—Proof should surely be given of the important problem (5) on p. 82, for which the reader is referred to works on spherical trigonometry, where he may not find it, or to Reusch's treatise on stereographic projection, which is probably not accessible to him; tetrahedral is a misleading name for the class to which sodium chlorate belongs; τ, being used to indicate tetartohedral classes (p. 149), should scarcely be applied to the trigonal bipyramidal class considered as belonging to the rhombohedral system; the nature of this class and of some others would be much simplified by the modern conception of the simultaneous action of an axis and plane known as "composite symmetry," as one of the general elements of crystal symmetry; this is only alluded to on p. 274, but its introduction as a mode of crystal symmetry would render possible a definition of the tetragonal system by means of its tetragonal axis instead of the somewhat awkward definition on p. 139. Similarly, the joint action of an axis and plane of *twinning* has to be taken into account to explain certain twins of sodium periodate mentioned on p. 359, and is overlooked in the discussion on p. 463. Most readers will find the argument on pp. 258–9 that the conception of merohedrism leads to inconsistencies far from convincing.

In describing the stereographic projection, it is really confusing to the student, and unnecessary, to speak of his eye as being situated on the surface of the sphere. Mention might have been made of the convenient device for crystal drawing described by Maskelyne, under the name crystallograph; and the method of finding the edge between two faces in a perspective drawing by reducing them to a common intercept on an axis, and finding their trace on the other two, might have been introduced into Chapter vi.

If the above be some defects of the book, many are the features in which it is superior to its predecessors.

Among new or specially instructive propositions may be noted the proof relating to tetrad axes on pp. 276–278, and the discussion of indices on pp. 288–295; the proof of the relation between a face and its inverse on p. 356; the propositions in the rhombohedral system relating to Millerian and Naumannian symbols, to indices referred to three and four axes, and to the drawing of the rhombohedron (p. 376). The useful proposition relating to a small circle (p. 83), and its application, are not generally found in text-books. Especially to be commended are the examples illustrative of the drawing of twin crystals. Among the new terms introduced, "stereogram" will doubtless be found serviceable. Finally, as evidence of the up-to-date character of the book, we may note the adoption of Cesaro's proof of the anharmonic ratio, the discussion of Wellsite, and the description of Mr. Smith's three-circle goniometer.

Owing to the author's desire to avoid analytical methods and spherical trigonometry, many of the proofs are somewhat tedious; but Chapter xix. contains analytical proofs and much suggestive material for the more mathematical reader, particularly some propositions relating to the rhombohedral system; *e.g.* the expression for the length of a trapezohedron edge (p. 578).

The book is an eloquent witness to the scientific method of the teaching which Prof. Lewis has carried on at Cambridge for nearly twenty years—teaching to which the present writer is glad to acknowledge his own indebtedness.

The author and the University Press may be congratulated on the completion of a treatise worthy of the subject and of the University. H. A. MIERS.

THE CORRESPONDENCE OF OLBERS AND GAUSS.

Wilhelm Olbers, sein Leben und seine Werke. Im Auftrage der Nachkommen herausgegeben von Dr. C. Schilling. Zweiter Band. Briefwechsel zwischen Olbers und Gauss, Erste Abtheilung. Pp. viii + 767. 8vo. (Berlin: Springer, 1900.)

THE first volume of this work, published in 1894 (NATURE, li. p. 74), contained the collected scientific papers of Olbers; the present one gives the first half (1802–19) of his correspondence with Gauss. These old letters will nearly all be read with great attention by any one interested in the history of astronomy during the early part of this century, as the two correspondents were equally devoted to theoretical and practical astronomy, and discussed new publications and new discoveries in all their bearings. Many readers will perhaps think with the reviewer that here and there some parts of the letters might with advantage have been omitted, and that the editor when leaving out ephemerides of comets and minor planets might have gone further, and have omitted many results of observations, &c., which have been published elsewhere.

The correspondence began in January 1802, when Olbers had just succeeded in recovering the lost planet Ceres by means of the elliptic elements calculated by the young mathematician Gauss by a new method devised by himself. The great sensation which Piazzi's discovery had produced was kept up for some years by the discovery of Pallas, Juno and Vesta, the first and last of these minor planets being found by Olbers, and Juno by Harding, so that (as Gauss remarks) of five planets found in the years 1781 to 1807, the four were found by natives of Hanover. The great respect in which the wonderful success of the computations of Gauss with regard to Ceres were held by astronomers, naturally led to his being left to compute orbits and ephemerides of all the four minor planets, and they consequently occupy a very large part of the letters for the first seven or eight years, until Gauss gradually handed over this work to his pupils. Among many interesting matters connected with the minor planets, which are touched on in the letters, we may mention Olbers' well-known hypothesis as to the origin of these bodies, which directly led him to the discovery of Vesta, also the annoyance of Bode at the discovery of a second planet between Mars and Jupiter, whereby his ideas about the harmony in the solar system were upset. That these new bodies were not followed with the same attention outside Germany is evident from the fact that Vidal, of

Mirepoix, found a planet in December 1804 and observed it for three weeks, without its identity with Ceres being noticed either by him or by Lalande, who christened the new planet by the name of the discoverer, and sent the observations to Germany. Already, in 1802, Gauss sent Olbers a sketch of his new method of computing elliptic elements, and after being more than once urged to bring out a detailed account, he began to work at the "Theoria Motus Corporum Cœlestium" early in 1806, and had it nearly finished in March 1807, when the discovery of Vesta gave him a welcome opportunity to apply his method once more, and particularly to compute an orbit of small inclination from four observations.

As comets were the favourite celestial objects of Olbers, observations and computations on them were on every occasion exchanged by the two correspondents. In 1806 we find Gauss pointing out that Olbers' method of finding a parabolic orbit fails when the direction of the apparent motion of the comet nearly passes through the place of the sun, a fact which Olbers had, however, already noticed, having had his attention drawn to it by a remark of La Place, which had reached him through Burckhardt, and apparently in a mutilated form.

Unlike most great mathematicians, Gauss was exceedingly fond of observatory work, and before his appointment to the Göttingen professorship (in 1807) he repeatedly expressed the wish to become attached to some large observatory, and be relieved from teaching and lecturing, for which he felt no taste. Owing to the disturbed times, the building of the new observatory at Göttingen made very little progress for some years, and Gauss had only the old instruments of Tobias Mayer's Observatory at his disposal. He made diligent use of a small refractor furnished with an annular micrometer; and in January 1808, shortly before Bessel published his paper on this subject, Gauss communicated to Olbers very convenient formulæ for correcting observations with this micrometer for the effect of refraction, based on the idea that within the ring there is visible a part of the sky which may be considered as an ellipse with the major axis vertical. He never published anything on this subject; but in 1830 C. A. F. Peters gave formulæ based on the same idea, though this is not explicitly stated. Again, in 1874, Dr. C. Schrader, in an inaugural dissertation issued at Göttingen, developed similar formulæ without alluding to Gauss, whose ideas on this, as on other methods of reducing observations, have doubtless not been forgotten at the Göttingen Observatory. In a review of this paper (*Vierteljahrschrift*, x. p. 214), Prof. Schönfeld, however, called attention to Gauss' method, with which he had become acquainted through MS. notes of one of Gauss' lectures. The tardy publication of the method in the present volume is most welcome. We notice also some interesting remarks about a small heliometer by Fraunhofer and Reichenbach, received in 1814, and an instructive comparison between it and the old so-called object glass micrometers. This heliometer was in 1874 and 1882 still capable of doing good work in connection with the transits of Venus.

Towards the end of the volume we find Gauss very much occupied with the three new meridian instruments mounted in 1818 and 1819, of which the Repsold transit circle of seven feet focal length and four inches aperture, with a circle read by two microscopes, deserves special mention as the first modern instrument of its kind. It banished mural quadrants and mural circles from the Continent; but, unfortunately, English astronomers thought it necessary to wait a good many years yet before adopting the idea put forward by Römer towards the end of the seventeenth century. In 1817 Gauss expresses the hope that a circle of this kind may soon be established at the Cape, an idea warmly taken up by Olbers, and which bore fruit a few years later when the Royal Observatory at the Cape of Good Hope was established. The Göttingen instruments were almost immediately put to good use in the continuation of the Danish geodetic survey through Hanover, which occupied Gauss (perhaps far too much, as a smaller mind could have done most of the work equally well) for a number of years.

The political events of the time are not infrequently alluded to, though with a certain caution, as it was doubtless not safe to be too outspoken even in private letters. In 1807, we learn, the Leipzig Academy proposed to make a Napoleon constellation of the central part of Orion, and Gauss remarks that this chopping up of old star groups would fitly correspond to the state of things on the earth at that moment. Göttingen formed part of the ephemeral kingdom of Westphalia; while Bremen was, in December 1810, annexed to the French Empire, and formed part of the Département des Bouches du Weser, to the great grief of Olbers, who clung to the old institutions of the free town. He askes Gauss, in August 1811, to tell him as many astronomical news as possible, as scientific and medical journals (except French ones) are strictly forbidden in Bremen. As a member of the Legislative Corps, he had to pay two lengthy visits to Paris in 1812 and 1813, whence he wrote some interesting letters about the meetings of the Academy and the Bureau des Longitudes.

The editor has confined himself to seeing the letters through the press, and appears to have performed this task well; we have only noticed a curious error on p. 504, Bredebour for Lerebours. But he has not given any bibliographical or other references, for which the contents of the letters offer many opportunities, but has only in footnotes given some references to Gauss' collected works and the correspondence between Olbers and Bessel. In one of his few footnotes he makes a mistake, which looks strange in a German book (p. 522); it was in April 1813, during the war of liberation, that Schröter's Observatory was destroyed, and not in December 1812, when everything was quiet throughout Germany. As an example of a place where a footnote ought to have been inserted, we may mention p. 337. Gauss here states that a star occuring in the Histoire Céleste is missing, and suggests that it may have been Vesta. This star (LL46570) is not missing, its place is quite correct, and so far no variability seems to have been detected.

For nearly fifty years the correspondence between Olbers and Bessel has been an astronomical classic, supplemented in 1880 by the publication of that of Bessel and Gauss. The chain is now being completed by the correspondence between Olbers and Gauss, the promised second half of which will no doubt give much valuable information about Gauss' geodetic and magnetic work.

J. L. E. Dreyer.

MEXICAN FOLK-LORE.

Catalogue of a Collection of Objects illustrating the Folk-lore of Mexico. By Prof. Frederick Starr. With 32 Figures. Pp. xiii + 132. (London: Folk-lore Society D. Nutt, 1899.)

THE Museum of Archæology and Ethnology in Cambridge has recently been enriched by the permanent loan from the Folk-lore Society of a valuable collection illustrating the folk-lore of Mexico, which had been generously given to that society by Prof. Starr, the energetic and enthusiastic Professor of Anthropology in the University of Chicago.

Prof. Starr enhanced the value of the collection by writing a full and descriptive catalogue, which has just been issued by the Folk-Lore Society as one of their publications. Owing to the labour Prof. Starr has expended upon it, this catalogue will prove of permanent value to students of folk-lore, although the author modestly disclaims it to be a treatise on Mexican folk-lore.

There are three main groups in the population of Mexico: the enlightened and progressive Mexicans, of whom Prof. Starr speaks in high terms, the Indians of the south, and the common Mestizos or mixed bloods of Northern and Central Mexico. The six hundred and more objects in the collection illustrate the customs and beliefs of this last group, whose daily life is a mixture of that of Spain in the fifteenth and of America at the end of the nineteenth centuries, and whose religion is a mixture of native paganism and imported Christianity, the latter being itself a complex of Old-World beliefs and practices. "Here," as Prof. Starr writes, "are proverbs, witty and wise; here are folk-songs, sweet and touching; here are folk-tales untouched by scepticism; here are charms and formulæ; here are witches and fairies in the full height of their power; here are popular street celebrations and dramas; here are a hundred Oberammergaus with passion-plays and miracle-plays unspoiled by the crowds of visitors; here are a thousand strange survivals of pagan barbarism in the midst of Christian civilisation."

One-third of the book is devoted to children's toys and games, illustrated by over a hundred specimens; but, in addition, there are descriptions of numerous outdoor and indoor children's games, which will be of great interest to those who pay attention to this not unimportant branch of ethnography. Many of the popular ceremonies are very quaint, especially those connected with Holy Week. From Thursday to Saturday the church bells cease ringing, as on the Friday "the spirits of the bells have gone to Rome." During this interval great rattles are sprung in the church towers, and innumerable small rattles are sold in the streets, and the noise they make must be dreadful. On the "Saturday of Glory" the gaiety reaches its culmination in the public destruction of Judas, the betrayer. Thousands of images of Judas are sold annually, of all sorts and grades, and from a few inches to ten feet or more in length. In some places a drama is played in the streets on St. James's Day, representing the victory of Christianity over paganism; the heathen wear hideous masks.

The Feast of the Dead is a famous festival, and the collection contains a large number of skulls, skeletons, funeral processions, and toys that delight the people on that occasion. Enough has now been said to indicate the great interest of this unique collection, more complete than any hitherto made in Mexico. The Cambridge Museum cannot now be safely neglected by students of comparative religion, as, in addition to other folk-lore collections, there are the collections presented by Mr. Skeat from the Malay Peninsula, and by Mr. C. Hose from Sarawak, as well as the specimens obtained by Dr. A. C. Haddon's expedition.

ORGANIC EVOLUTION.

A First Book in Organic Evolution. By D. Kerfoot Shute, A.B., M.D. Pp. xvi + 285, 12 plates (10 coloured), and 27 figures. (London: Kegan Paul Trench, Trübner and Co., Ltd., 1899.)

THE aim of this little book is an interesting one—to supply a handy introduction to evolution-doctrine, which will be of use to over-burdened students of medicine and to others who may not have time to read the classic works. "The author makes no claim for originality, unless it be in the manner of presenting the subject. He has utilised the facts collated by other observers, and sometimes quoted the exact language and expressions of well-known writers on evolution, and has endeavoured to put them together in a way that may be helpful to those who are beginning the study of the evolution-theory." It seems to us that the author has attained no small success in his difficult task, for the book is clear and interesting; it is neither too simple nor too difficult; it is conspicuously free from crankiness and dogmatism; and it is evidently the work of one who has had experience in the task of teaching.

The plan of the book may be indicated by an enumeration of the sections:—Organic cells, heredity with variation, unstable environment, transmutations of living forms, natural selection, evolution of man, classification of animals and plants, works of reference, and glossary. There are ten coloured plates, which to some eyes will add attractiveness to the volume, though several of them show an unnatural and unpleasant predominance of red tint, *e.g.* in the pouter pigeon on the frontispiece, the birds of paradise, and the *Kallima* butterflies.

A thoroughly good introduction to the study of organic evolution might be written, even at the present youthful stage of ætiology, by an author of real genius, like Goethe, but the probability is that he would not write it; it might also be written by a genius according to Buffon's mistaken definition,—a man of persistent patience, but he would probably die niggling at his task; it might more feasibly be written as a co-operative work by six experts who were not very good friends. Then we should have a work that would endure. For what we have, however, let us be grateful; and Prof. Shute's book is a very useful introduction.

At the same time we must make two criticisms. (*a*) Is it wise in "a first book in organic evolution" to have any talk either about religion or the castration of habitual criminals? We admire the author's courage of conviction, but in regard to the subjects referred to we doubt the relevancy of the virtue here. And might not the dry classification chapter have been left out to advantage, especially when it tells us that "sponges possess, essentially, a bilateral symmetry," and various other things which are not true? (*b*) In an elementary work of this sort it is of the utmost importance that there should be precision in the use of words, and though the author has been unusually careful we do not think that he has always succeeded. Thus, he speaks about "the forces of heredity"; he tells us that "Darwin convinced naturalists that the great underlying principle of the tree-like system of classification was heredity"; he calls the nucleus of the fertilised ovum "hermaphroditic," and so on. Is it wise at present to call the chromosomes "the hereditary threads"? is it fair to speak of "the gastrula phase in man's existence," and to refer to a figure of a typical gastrula, as if it were all plain sailing? is it warrantable to say "the evidence seems to favour the view that acquired characters can be transmitted"? is anything gained by making a special category of "insect-selection"? Without criticising the exposition of the Pangenesis hypothesis, we should also like to ask if it is not the case that Darwin expressly said that he thought of the gemmules not as circulating in the blood, but as diffusing from cell to cell? But a book should be judged relatively to its aim, and Prof. Shute is to be congratulated on the success with which he has accomplished a difficult and serviceable piece of work.

J. A. T.

OUR BOOK SHELF.

Mining Engineers' Report Book and Directors' and Shareholders' Guide to Mining Reports. By Edwin R. Field. Pp. 39. (London: Charles Griffin and Co., Ltd., 1900.)

EVER since the search for the gold mines of El Dorado in 1595 was described by Sir Walter Raleigh in his work on the discovery of Guiana, the prototype of modern mining reports, experts have constantly been engaged in reporting on mineral deposits with a view to induce capitalists to invest money. A report on a mining property should set forth clearly details of the position, means of access, fuel, water and timber supply, amount of development, and the character, value and form of the deposit. It should, moreover, be written in so lucid a manner as to be intelligible to the educated investor. Unfortunately, this is not always done. Many so-called experts of eminence have been known to fill up their reports with a bewildering mass of abstruse technicalities and theories, and to omit many essential details requisite for arriving at the value of the mine. While it is obvious that a thorough examination of a mine cannot be covered by a set of rules, it is highly desirable that the work should be carried out in a systematic manner, and errors of omission avoided. With this object in view, Mr. Field has drawn up a series of suggestions in a convenient form. He enumerates 126 queries that should be answered as far as possible in the report on any mine. Blank pages are appended; and it is recommended that the various heads should simply be indicated by numbers during the inspection of the property, and subsequently incorporated in the observations recorded in the report. The volume is issued in pocket-book form so arranged that the blank pages, which can be replaced by others, shall be facing the page of questions. The right hand pages, which would be covered when the book is in use, are devoted to selected tables and memoranda. The volume is of handy size—it measures 5 by 3½ inches—and will undoubtedly prove useful to experienced mining engineers. Whether it will also be of assistance to directors and shareholders, as the title-page suggests, may be questioned.

B. H. B.

Flora of Kent. By F. J. Hanbury, F.L.S., and E. S Marshall, M.A., F.L.S. Pp. 444; with two maps. (London: F. J. Hanbury, 1899.)

MANY years ago "The Flora of Middlesex," by Trimen and Dyer, showed the way for a scientific construction of a local flora, and it has served as a model for all the best works of this kind which have appeared since its publication. To say then that the present volume strongly recalls the best features in the Middlesex Flora is to pay it a well-earned compliment, and, indeed, from cover to cover Messrs. Hanbury and Marshall's book exhibits abundant evidence of a careful, sound and successfully accomplished sifting of an immense body of facts, with the result that the reader is furnished with an exceedingly able and interesting account of the flora of the south-eastern county of England. The introduction includes a sketch of the physiography and geology of the county, and then follows the customary delimitation of the botanical districts into which the whole area is divided. These divisions are, as the authors admit, not entirely based on scientific considerations, but are partly determined by convenience, and some of them are consequently somewhat artificial in character. It would, perhaps, have been advantageous to have added another chapter on the more purely natural geographical distribution of the plants.

The body of the flora is devoted to an account of the plants found growing in the county, together with brief topographical and historical notes.

The work is excellently printed, and will be found of great service to those who care to know about the flora of one of the most interesting counties in England.

Leitfaden für den Unterricht in der Anorganischen Chemie. Didaktisch bearbeitet von Dr. Joachim Sperber. Erster Teil. Pp. 120. (Zurich: E. Speidel, 1899.)

A BOOK expressly "didaktisch bearbeitet," and bearing a motto *Repetitio est mater doctrinarum*, would be expected to disclose some novelty of treatment for good or ill. This expectation is, however, not realised in Dr. Sperber's book. It may be described as an aggregation of condensed chemical information, from which it is impossible to augur any good educational result. We have already had a surfeit of this kind of book in England, and can only regret that the improvements now so evident here do not seem to have spread to Switzerland. The illustrations in the book are unnecessarily elaborate, and in some cases altogether superfluous. There are, for example, two striking full-page illustrations—one to show the holding of a platinum spiral in a bunsen flame, the other to show a burning magnesium ribbon. It is really difficult to understand the attitude of mind of a teacher who considers that any intellectual or practical value can lie in pictures of this kind.

A. S.

Aufgaben aus der Chemie und der physikalischen Chemie. Von Dr. P. Bräuer. Pp. 70. (Leipzig: B. G. Teubner, 1900.)

THE author has collected a number of exercises dealing with some of the most important provinces of general chemistry. The book differs from previous attempts in this direction, inasmuch as attention is paid not only to purely chemical problems, but also, and more especially, to such points as the Laws of Avogadro, Faraday, Joule, &c., together with the elements of thermal chemistry. The explanatory notes at the head of the various sections will be found of great assistance to students working without the aid of a teacher.

N.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Rostrum of "Mesoplodon."

IN Mr. Beddard's recent and very interesting "Book of Whales," I observe that on p. 214 he gives as a character of *Mesoplodon* (one of the Ziphioid genera) "the thorough ossification of the mesethmoid," and in describing *Berardius* he states that "the mesethmoid plate is short, comparatively speaking; that is to say, compared with what we find in *Mesoplodon*." Here Mr. Beddard undoubtedly compares two structures which are entirely different. As I have shown and figured in the *P.Z.S.*, February 1893, the "mesorostral bone" is not the result of the ossification of the cartilaginous bar occupying in early life the spout of the animal's vomer. I have examined a number of these Cetaceans in the flesh, and have made sections of the dried beaks (a series of which I deposited in the British Museum) of individuals of ages from the quite young calf's to that of the very adult male, and I have shown in the paper referred to that the first appearance of the mesorostral bone is due to an increase in the walls of the premaxillaries by which the sides of the vomerine-spout are pressed towards each other, and, proliferation being apparently induced, both the vomer and the premaxillaries increase in size, and very variously in form, according to pressure unequally acting on them, till the cartilaginous bar is entirely absorbed or, at all events, disappears. The increase—from some pathological cause, probably—in the premaxillaries is apparently the main cause of the solidification of the beak.

Now what happens in *Berardius* is of an entirely different character. In *B. arnuxii* an ossified bar lies, often to a length of twelve inches, in the vomerine trough; but this is unmistakably an ossification of the anterior part of the mesethmoid cartilage. It takes place in a very different way, also, from the ossification in *Mesoplodon*. It is an ossification of the upper and outer layers of the mesethmoid cartilage; it is of an open and spongy texture; it never becomes ivory-fied, so that in the dried skull it is a mere prolongation of the mesethmoid—hardly seen in *Mesoplodon*—and merely covers in to some extent the gape of the vomerine trough, which underneath is quite empty, with its sides and bottom entirely unaffected. Indeed, the mesethmoid plate, with its extension, is in *Berardius* much longer than in *Mesoplodon*. What takes place in the former genus is precisely what occurs so frequently in *Clymenia*.

In a note on page 280, Mr. Beddard writes, "the Scottish vernacular for this creature [Globiocephalus] 'Ca'aing Whale' means Driving Whale." The proper orthography of "ca'aing" should be "ca' in" (two words), which being interpreted out of, to the Southerner, its foreign tongue, means "the drive in- or driven in-whale." Ca'a is entirely erroneous. Ca' (in Orkney, Kaa), as it should be printed, stands for "call." In the common order to the herd on a Scottish farm of "Ca' in the Kye" (meaning "Drive in the Cows") the expression arises, doubtless, from the custom of the past—which is the custom to-day, as I have seen in New Guinea in regard to their pigs, and in Sokotra last year in regard to the flocks and herds—of actually by voice "calling in" the cattle. The phrase has now become the common one to "drive in," by some one going for them. The method of capturing the *Globiocephalus* in the north of Scotland is for the fishers, when they see a school, to hurry out in their boats, surround and drive on to the beach the Blackfish, which is, therefore, always spoken of there as the "Ca' in Whale," *i.e.* the whale they can *drive in*, in contradistinction to a species which they have to harpoon or chase in the open.

HENRY O. FORBES.

The Museums, Liverpool, March 2.

Vector Diagrams.

IN a paragraph on the last number of *Terrestrial Magnetism*, in NATURE of March 1, p. 421, I notice the following sentence: "Dr. Lüdeling investigates graphically the phenomenon of the diurnal variation of the earth's magnetism for eleven stations with the aid of von Bezold's vector diagrams." These diagrams are curves in which the radius vector represents in magnitude and direction the resultant of the disturbing forces to which we may attribute the diurnal variation of the horizontal component of the earth's magnetic force at any particular station.

So far as I know, the earliest use of these curves by von Bezold was in a paper in the *Berlin Sitzungsberichte* of 1897. This may have been their first appearance in Germany, and if so, their association with the well-known name of von Bezold in that country need hardly occasion surprise. In England, however, their use dates from at least 1863, when Airy employed them in discussing the diurnal variation at Greenwich in different years and at different seasons of the year (see *Phil. Trans.* for 1863). Airy used them again in the *Phil. Trans.* for 1885, and they also appear on p. 186 and on Plate iii. of Lloyd's "Treatise on Magnetism, General and Terrestrial." More recently I employed them myself in discussing the diurnal variation of the magnetic elements at Kew Observatory (*B. A. Report* for 1895, pp. 209–227).

The only apparent difference between Airy and von Bezold is, that the former made use of the recorded variations of horizontal force and declination, drawing his magnetic meridian towards the top of the page, whereas the latter made use of the northerly and easterly (or westerly) components of the force, and drew his astronomical meridian towards the top of the page. The curves given by Airy and by myself show the positions of both the magnetic and astronomical meridians, and if it is preferred that the astronomical meridian should point to the top of the page, all that is necessary is a bodily rotation of the curves through an angle equal to the declination.

When comparing results at different stations, or at the same station at different epochs, there *may* be an advantage—as, in fact, I pointed out myself (*B. A. Report*, *loc. cit.* pp. 218, 219)—in taking the astronomical meridian as the line of departure; but as yet this is largely problematical. The interesting tables and diagrams for polar stations given by Lüdeling—as Lüdeling, I think, has himself noticed—seem to indicate, on the whole, less symmetry about the astronomical than about the magnetic meridian. If so, it is open to doubt whether Airy's original practice might not, after all, have been the better fitted to bring out points of resemblance.

C. CHREE.

Richmond, March 8.

Similar Geological Structures in South Tyrol and the Isle of Man.

IT may be of interest to Alpine geologists to note that the general results now obtained by Mr. Lamplugh in the Isle of Man are, in respect of the origin of the "Crush-Conglomerates" and the causes and effects of differential movements between subjacent series of rock, practically the same as the results previously obtained and described by me in maps and sections of the Enneberg area in South Tyrol (*Quart. Journ. Geol. Soc.*, *cf.* M. M. Ogilvie Gordon, 1899, and G. W. Lamplugh, 1900). In both cases the geologist deals with *resultant* local effects combining the pressure-components of at least two epochs of disturbance. In both cases the geologist is presented with strongly-marked lithological contrasts in the original succession, and, as a consequence, with highly complex superinduced structures due to differential movements between subjacent beds. This remarkable parallelism between the essential geological structures in two neighbourhoods so remote from one another, and in belts of strata belonging to utterly distinct geological epochs, is well worthy of comment and consideration by our present school of geologists.

Aberdeen, March 16. MARIA M. GORDON.

Tides along the Antarctic Continent.

IN Prof. Drygalski's statements (NATURE, February 1) of the work mapped out for the proposed German Antarctic Expedition, no mention is made of obtaining tidal observations along the Antarctic Continent. In ascertaining the *verae causae* of tides which occur along many shores, even along the eastern coast of the United States, I believe this region to be of great importance.

Hourly readings of the height of the surface of the sea above an arbitrary datum for even so short a period as twenty-four hours at each station occupied for the purpose, would be of value.

It seems to me especially desirable to have the following questions answered:—

(1) Along the Antarctic lands from long. 20° W. to about 40° E., is the (Greenwich) co tidal hour vi.?

(2) Near long. 80° E., is the co-tidal hour ix.?

(3) Near long. 135° E., is the tide chiefly solar? If so, is the co-tidal (solar) hour xii.?

(4) On the western coast of Graham Land, is the co-tidal hour vi.?

Although it seems that no observations have been made farther south than Kerguelen, South Georgia, and Cape Horn, there are reasons for believing that the above questions can be answered in the affirmative. If so, then certain logical connections between the tides in this region and elsewhere would be fairly well established. At any rate, such observations would be valuable; and it is believed that the results would compare favourably in importance with those obtained in almost any one of the lines of inquiry alluded to by the leader of the expedition. R. A. HARRIS.

Washington, D.C., February 28.

Crab Ravages in China.

IN the "Kwoh-Wu," or "Good Words from the States," attributed to Tso Kiu-Ming (6th century B.C.), a king of Yueh (now the province of Cheh-Kiang) is said to have been advised by his counsellor to postpone his warlike preparation with "good words," in which the officer adverts to the "Rice-Crab (*Tau-Hiai*) that spared for man not a seed [of rice] in late years." A Japanese naturalist, Aoki Kon-yō, quoting a Chinese work, "Ping-Kiang Ki-Sze," speaks of a crab-devastation which took place in the Wu District (now Kiang-Su) in 1297 A.D., "when all plains were full of crabs, wasting all crops of rice." ("Kon-yō Manro Ku," written 1763, ed. 1891, p. 164.)

Twan Ching-Shih (died 863 A.D.) briefly speaks of this crab, thus: "In the eighth moon of the year, the crab has in its belly an ear, really that of rice, about an inch long, which it carries eastwards as a present to the 'God of the Sea'[1]; before the carriage is accomplished, the crab is not edible" ("Yu-Yang Tsah-tsu," Jap. reprint, 1697, bk. xvii. fol. 4, *a*). Contemporaneously, Luh Kwei-Mung (died *c.* 881 A.D.), in his "Notes on the Crabs" (*ap.* "Yuen-Kien-lui-han," 1701, bk. 444, fol. 18) narrates:—"These crabs live in holes, which they dig in bogs, until the season that intervenes the autumn and winter, when they emanate from their homes. The people of Kiang-Tung say, when rice is ripening, the crabs take each one ear in order to pay court to their chief. Every morning and every evening they all run towards the river, when men fish them by setting weirs across the affluents. Yet six or seven out of ten crabs would pass over the dams, and in the river they grow larger; whence they proceed to the sea in the same manner as their previous march, also being persecuted as before, which, however, they escape with more skill than in former occasions." Later, in the dynasty of Sung (961—1279 A.D.), appeared a "Monograph of Crabs," by a certain Fu Kwang, who relates in it:—"In the crevices on rocks along mountain streams occurs a small crab, red and hard, and so named *Shih-hiai* (Stone Crab). When still young, in midsummer, owing to absence of any edible cereals, it feeds on the root of reed, whence its name *Lu-kan-hiai* (Reed-root Crab), and is meagre in size and taste. About the eighth month it grows larger after moulting, and, when rice or millet is mature, every one crab bellied with one spike of the cereal runs to the river, when it is termed *Loh-Hiai* (Merry Crab), and is very fat and best to eat. Thus it goes to the sea where it presents the spike to its chief" (*ibid.* fol. 19, *a*). These are very good samples of the celebrated celestial whims, which once expressed, no literatus doubts; for, to me, it is too clear that the tribute which these so-called "grain crabs" are said to pay to their king is nothing but their spawn, which they carry under the abdomen to lay down in the sea.

I do not know whether the rice-carrying crab is the same with what devastates the plantations, as is supposed by Aoki (*l.c.*), although very probably so. And I shall be very much obliged if, through your medium, some one will answer my questions: (1) What species of crabs is the cause of such stories? and (2) Is such a crab-ravage reported in modern times from China? From De Rochefort's "Historie . . . des Iles Antilles," Rotterdam, 1665, p. 255, I gather the renowned Violet Land-Crabs of the West Indies to make some damage to tobacco farms, but not to grain as is so vastly attributed to the Chinese crabs; while F. Legnat, about the end of the 17th century, described a land-crab of Rodriquez, whose destructive power during its emigrating period appears to equal that of its Chinese kin (see his "Voyages," ed. 1891, p. 92).

Yu Pau (4th century A.D.) writes in his "Sau-shin-ki":—"In the year 283 A.D. all crabs in the District of Hwui-Ki were turned into rats, whose group covered the rice-farms and made an extensive devastation. When yet immature, these rats had hair and flesh but no bones, and unable to pass over the ridges in the farms, but became vigorous after a few days." This erroneous exposition, to account for the origin of rats or field-mice, would seem partly to originate in some similarity of the fur of rats with that of the so-called Hair-Crab (see Stebbing, "Crustacea," Pl. III.), but more in the people's familiarity with the land-ravaging crabs[2] in ancient times.

KUMAGUSU MINAKATA.

1 Crescent Place, South Kensington, S.W.

[1] The Japanese who worship the deity of Kotohira (the patron-god of mariners) taboo the eating of crabs.

[2] The "Hair-Crab" of Japan is caught in the same way as the Chinese mode of fishing the rice-carrying crab. The Japanese well know its descent down the river in autumn, and have well noticed it never to reascend it afterwards as some fish do (Kaibara, "Yamato Honzô," 1708, bk. xiv. fol. 48), but never possessed a belief in a crab carrying grain to the sea. Only one case that slightly approaches that of the latter, I find in "Hokusô Sadan," where it is narrated that near the end of the last century the river Yodo, near Kyōto, was one day so swarmed with small crabs that every handful of water was full of these creatures.

Leonid Meteor Showers.

I HAVE nowhere seen an account of a very remarkable display of these meteors visible here (in Shanghai) on the morning of November 15, 1886. Though the date is distant, it may be of use to record it, as it may throw light on the conditions of the orbit.

I was sleeping in a room with an almost due north exposure looking into an open compound, and chanced to wake up about three in the morning, when I saw a number of meteors flashing across the window. I got up on recollecting the date, and for about an hour witnessed the most brilliant pyrotechnic display I have ever seen.

The meteors were flying in every direction from the radiant point in numbers past all calculation, and the intensity of the shower was keep up without intermission the whole of the time I was gazing.

I expected to hear from other quarters an account of the phenomenon, and was much surprised to find it had apparently not been noticed elsewhere. I had to leave shortly after for the interior, where I was practically cut off from communication with the outer world for some months, and hence did not at the time report the fact.

As much stress is laid on the appearance of the meteors in Europe in 1833 and 1866, the shower may be some of interest.

Shanghai, February 12. THOS. W. KINGSMILL.

The Capture of Butterflies by Birds.

CONCERNING the capture of butterflies by birds, permit me to relate an incident which I witnessed in the summer of 1899 at the Deserted Village, near Scotch Plains, N.J.

My attention was attracted to a maple tree on a lawn by a violent fluttering of the wings of a robin among the leaves. Presently a large brown butterfly, evidently wounded, but still attempting to fly, fell from the branches. The robin pursued the butterfly eagerly, and attacked it upon the ground, alternately striking with its beak, with lowered wings, and running off a short distance to observe developments. Finally, the butterfly ceased to move. The robin thereupon tore the body from the wings and devoured it. I picked up the mutilated wings and showed them later when narrating the incident.

29 Broadway, New York. GEORGE A. SOPER.

The Smell emitted by Quartz when Rubbed.

WHEN two quartz pebbles are rubbed hardly, or ground together, so as to give an electric spark, that seems under their surface, and then smelt, they emit a very peculiar smell, which some people call a sulphurous smell, but I cannot trace any resemblance to sulphur, or ozone, or phosphorus. What is it supposed to be? E. L. GARBETT.

25 Claremont Square, N., March 7.

THE UNIVERSITY OF LONDON.

AT last, after six-and-thirty years of discussion, after the formulation of some twenty different schemes of reform and the report of two previous Royal Commissions, the Statutes and Regulations of the reconstituted University of London have been framed by the Commissioners appointed under the Act of 1898, and the new University is created. The institution thus established is in its way unique; there is nothing else exactly like it in the world, and it is therefore impossible to predict with any confidence what will be the extent or the nature of the influence it will exert on the progress of education either in the United Kingdom or in the restricted area over which its newly-created functions will be specially exercised. The old Examining Board will continue to exist almost as heretofore, and the famous system of examinations, which has undoubtedly been in its day potent for good, will be continued under safeguards and conditions but slightly altered. But in addition there is to be a new and distinct system administered by the same supreme authority, the Senate, which has hitherto directed the examinational machine.

Under this system students who pursue certain definite courses of instruction in recognised institutions or under recognised teachers will be admitted to degrees after passing certain examinations in which their own teachers will directly or indirectly take part. The institutions and teachers so recognised are situated within a radius of thirty miles from the central office of the University.

The purposes of the new University of London are declared by the Commissioners to be threefold: (1) "to hold forth to all classes and denominations, both in the United Kingdom and elsewhere, without any distinction whatsoever, an encouragement for pursuing a regular and liberal course of education"; (2) "to promote research and the advancement of science and learning," and (3) "to organise, improve and extend higher education within the appointed radius." Broadly, it may be said that of these three purposes the first has been more or less completely fulfilled by the previously existent system of examining all comers in subjects selected according to a definite scheme in orderly succession, from matriculation to the final examination for a degree. Without doubt the existence of this scheme, whatever drawbacks there may be to a pure system of examination which does not stop to enquire how the knowledge of the candidate has been gained, nor to ask too curiously as to its reality, has done great service to large numbers of industrious, intelligent and deserving students. Times, however, during the last quarter of a century, have changed considerably in respect to the opportunities of higher instruction, and while the greater part of the United Kingdom has been divided into academic provinces, each with its own university and their affiliated colleges, London and the South have remained without many of the advantages which such institutions provide. London, however, possesses all the materials which are required for the equipment of a great university. The metropolis is the home of the great learned societies; it is also the central depository of the chief treasures of science, art, antiquities and industry in the national museums, and without disrespect to the many distinguished men connected with other parts of the kingdom, it is inevitable that a certain concentration of intellectual eminence should result from the attractions offered by the greatest city of the world. The third purpose of the new university will therefore surely be inseparably connected with (2) "the advancement of science and learning."

Under the new Statutes the University will consist of the Chancellor, the existing Fellows, for their respective lives, the Senate, the Graduates and the Students. It is enacted that the Chancellor of the old University shall continue to be Chancellor. The University will thus retain the advantage of Lord Kimberley's long experience as a member of the Senate. All else, however, will be changed. The existing Fellows are to retain their fellowships for life, but will cease as such to be members of the Senate, and probably many of them will drop out. The new Senate will be composed of the Chancellor, the Chairman of Convocation, and fifty-four persons who may or may not be graduates of the University. Of the fifty-four senators, sixteen will be elected by Convocation (chiefly graduates of the University), and sixteen by the Faculties (composed of teachers of the University). Of the remaining twenty-two, four are to be appointed by the Crown, and eighteen by various institutions, including six by the Inns of Court and the Incorporated Law Society. After the first two years the term of office of each senator will be four years. The Vice-Chancellor will be elected annually by the Senate from among its own members.

The work of administration will be accomplished chiefly through the medium of three standing committees of the Senate—namely, the Academic Council, the Council for External Students, and the Board to Promote the Extension of University Teaching. Concerning the last, it may be said, with considerable confidence, though not, of course, without fear of contradiction, that, however good its intentions, it cannot afford much assistance in the development of serious university work. The chief business of the University will be done by the two councils.

The Academic Council will consist of the Chancellor, the Vice-Chancellor, the Chairman of Convocation, the sixteen members of the Senate appointed by the Faculties, and an additional member or members to make up the number to twenty. Four-fifths of this council, therefore, consist of teachers. Their duties are advisory, and will relate to all that appertains to the Schools of the University, the appointment of Teachers, the organisation and regulation of the teaching, and generally to all matters which relate to the Internal Students—that is, to those students who have matriculated and are pursuing a course of study in a School or under Teachers of the University. The functions of the Academic Council are, therefore, the most important exercised on the part of the new University, and upon the care and judgment with which they are discharged will hang all the future development and usefulness of the University.

The Council for External Students is to consist of twenty-eight members of the Senate, whereof sixteen are the nominees of Convocation. The duty of this body is to watch over the interests of the External Students, who are defined as all matriculated students who are not Internal Students. Among the duties assigned to both these councils the difficult task is appointed of equalising, as far as possible, the standards of knowledge and attainments prescribed for the degrees conferred upon Internal and External Students respectively. But the Academic Council has nothing to do with External Students, and the other council has nothing to do with Internal Students; and unless provision is made by the new Senate for frequent conferences between the two councils, it is difficult to see how this equalisation is to be effected, for a mere inspection of syllabuses or of the questions set in examination papers would be, as every teacher or examiner could point out, a most delusive and inadequate test of equality. It is to be hoped that the Senate will bear in mind the importance of bringing these two councils into frequent contact, and that they will not be unduly influenced by fanatical adherents, if there be any, of the pure system of examination with its detailed limited syllabus, and its superstitious reverence for marks. Every encouragement should be given to External Students to become Internal, and if in time the University acquires the means and the power to administer its own funds, the External Student may become an extinct species, so far as the science faculties are concerned. Then shall chemical analysis no longer be taught by post, and "correspondence" colleges fatten only on the ingenuous arts.

One or two points deserve to be noticed in connection with the examinations or qualifications for degrees. One novelty is the proposal to hold "separate matriculation examinations for different classes of students, having regard to the courses of study which the students propose to follow." This power will doubtless be exercised by the Senate with great deliberation. A loose interpretation of this provision might lead to consequences which would be disastrous for the future dignity and reputation of the University. It is easy to recognise here the influence of the "practical" man who is anxious to get rid of the incubus of the classical languages.

This is not the place to enter upon the discussion of that question, but coupling this suggestion of relaxation with the provision relating to the Bachelor of Science degree, it is easy enough to smell danger. For the degree of B.Sc., the Senate may accept in place of the whole or part of the final examination, the results of the study or research of any candidate who, in the opinion of the Senate, has thereby made a distinct contribution to the advancement of learning or science in any of the subjects in which that degree is conferred. Whatever may be the fate of Latin under the new arrangements, it is to be hoped that more care than ever will be taken to insist upon a real and practical command by all candidates at matriculation of the orthography and syntax, if not the etymology, of their own language.

Another important statute gives power to the Senate to make arrangements to hold any intermediate examination or part thereof for the students of any School of the University jointly with the governing body of such School. In all such cases the examination would be conducted by the professor of the subject jointly with an external examiner appointed or recognised by the University. This recognition of college examinations was recommended by both the previous Royal Commissions.

The "Regulations" made by the Commissioners form a separate issue. They contain schedules of the Boards of Studies, of the recognised Teachers, of the provisionally recognised Teachers, and of the members of the Faculties, also details relating to the B.Sc. degree by research. It remains to be seen what will be the effect of requiring a student to submit to the Senate, before he begins his work, a statement of the nature of the research upon which he proposes to enter, and having started the research to carry it on for a period of not less than two years. Those who have a practical acquaintance with the prosecution of research, and the unexpected turns which inquiry often takes, will see some difficulties in these requirements; but it is, perhaps, worth while to make the attempt to develop a scheme by which successful work of this kind may receive academic distinction.

The business of the new University, like that of the old which it supersedes, still relates wholly to curricula, to studies, to examinations and degrees. The real value of a university in helping to form character and building up the intellectual and moral constitution of the man has no place, and could have no place, in the work of a Royal Commission. Nevertheless, the association of a number of institutions, individual and separate, though geographically near together, in a common interest and united effort cannot but have an effect in quickening the collegiate life of each, in promoting the mutual interest of teacher and student, in stimulating research, and in fostering schools of thought. Such ends the new University must keep clearly in view. The Senate must see to it that amid the clamour of contending interests, which for a few years can hardly be expected to be satisfied and silenced, the claims of true education shall not be forgotten.

W. A. T.

DIFFICULTIES OF THE CALENDAR.

THE DATE OF EASTER.

SOME interest has been excited by the fact that Easter appears to fall this year on a date not in accordance with the rule in the Prayer-Book; and a question was even asked about it in the House of Commons on Thursday last. The Attorney-General, of course, explained that the full moon of the Prayer-Book is not the real full moon, but the fourteenth day of the moon according to certain rules, confessedly not very simple or generally "understanded of the people." The same difficulty was stated on the last occasion (in 1846) when this calendar or ecclesiastical full moon fell on a different day at Greenwich from that of the real full moon. But it may serve as an object-lesson on the futility of attempting to regulate Easter by the real moon, which would often produce the consequence of making it fall on a different day (that is, as it must be on a Sunday, a different week) at places some of which would be not far apart.

On the present occasion the absolute time of the full moon, which follows the vernal equinox, corresponds by Greenwich time to 2 minutes past 1 o'clock on the morning of April 15. All over Europe its time will be on the morning of that day: at Paris, at 1h. 11m.; at Berlin, at 1h. 56m.; at Rome, at 1h. 52m.; even so far west as Lisbon, at 0h. 25m. (25 minutes past midnight on April 14), and therefore by civil time reckoning as April 15. But on the west coast of Africa the local time of full moon will be before midnight on April 14; and in America, of course, still more so, its time at New York being 6 minutes before 8 o'clock on the evening of that day. The ecclesiastical full moon (artificially formed and tabulated) will be April 14, so that the Sunday following, *i.e.* the next day, April 15, will be Easter Day.

THE RUSSIAN CALENDAR.

It is well known that the question has again been recently discussed of assimilating the Russian calendar with that of the rest of Europe; but after consideration the Russian Government again decided against adopting the Gregorian reformation of the Julian calendar, according to which a leap-year is dropped in the last year of three centuries out of every four, the exception being those of which the century-number is divisible by four without remainder. The Russian non-adoption of this is the cause that their calendar is several days behind ours, and has this year become one day more so than heretofore in consequence of their having a 29th of February in 1900, which those who follow the Gregorian reckoning have not. But they now propose to invite other nations to join them in adopting a rule for the calendar which will make it more accurate than the reckoning in question. Prof. Glazenap explained this at a meeting of the Russian Astronomical Society; and, as it consists in dropping a leap-year at regular intervals instead of having an exception of an exception, which (as Sir John Herschel pointed out) needs, to be quite accurate, an exception again, we have no hesitation, on our part, in expressing approval of it. Prof. Newcomb, it may be remembered, in his "Popular Astronomy," suggested that there was no sufficient reason for abandoning the Julian reckoning, on the ground that it was more simple than the Gregorian, and that there was no object in keeping the date of the month and day of any year corresponding exactly to the season in years several centuries apart; and no doubt Julius Cæsar was aware that the tropical year (as we call that on which the seasons depend) was several minutes short of three hundred and sixty-five days and a quarter in length. No doubt also the omission of several days on the greatest part of the continent in the sixteenth century, and in England in the middle of the eighteenth century, owing to the supposed necessity of making the seasonal dates correspond to what they were at the epoch of the Council of Nicæa, must have caused much confusion. But all that has long been a thing of the past; and it would seem best now to have, if possible, a general usage keeping the year in accordance with its true length.

W. T. LYNN.

THE MELBOURNE MEETING OF THE AUSTRALASIAN ASSOCIATION.

THE eighth annual meeting of the Australasian Association for the Advancement of Science was opened in Melbourne on January 9, in the University buildings, which were placed at the disposal of the Association. At the inaugural meeting, the President of the last session, Prof. Liversidge, F.R.S., vacated the chair in favour of the President-elect, Mr. R. L. J. Ellery, C.M.G., F.R.S., the late Government Astronomer of Victoria, who delivered an address on "The beginnings and growth of astronomy in Australia," in which he sketched the progress of astronomical science from the days of Captain Cook up to the foundation of well-equipped observatories in Melbourne, Sydney, Adelaide, and, more recently, in Perth, concluding with a reference to the co-operation, at the present time, of the three first observatories in the international survey of the heavens by means of photography, for the purpose of forming a chart of all stars down to the fourteenth magnitude.

The following Presidential addresses were delivered in the various sections: Astronomy, Mathematics and Physics, by Mr. G. H. Knibbs, on "The development of the atomic theory of matter"; Chemistry, by Mr. F. B. Guthrie, on "Some landmarks in the progress of chemical science"; Geology, by Prof. R. Tate, on "An attempt at a refutation of the doctrine of homotaxy"; Biology, by Mr. J. J. Fletcher, on "The rise and early progress of our knowledge of the Australian fauna"; Geography, by Mr. W. H. Tietkins, on "A review of geographical research during the past two years"; Ethnology, by Mr. F. J. Gillen, on "Magic amongst the Central Australian natives"; Economic Science, by Prof. Jethro Brown, on "Loyalty, liberty, brotherhood: a study in the political ideal"; Agriculture, by Prof. Lowrie, "That in our practice of agriculture the determining influence of climatic conditions is not sufficiently recognised"; Engineering, by Mr. H. Deane, on "The George Street tramway, Sydney"; Sanitary Science, by Dr. Jamieson, on "The advance of sanitary science"; Mental Science, by Dr. Cleland, on "The anatomy of mind as bearing upon education." In the various sections 160 papers were read. Public lectures were delivered by Prof. Morris, on "Early men of science in Australia"; by Dr. George Brown, on "An anthropologist in the South Seas"; and by Mr. H. W. Jenvey (to working men), on "The Marconi system of wireless telegraphy."

Reports were received upon the magnetic survey of New Zealand, and also from the seismological committee, the photographic geological survey committee, and the glacial committee. Amongst others, committees were formed to investigate and report upon the following subjects: the best method of utilising diamond drill bores for the determination of underground temperatures; the drawing up of a catalogue of recent Australian and Tasmanian marine shells; the collecting and cataloguing of geological photographs of interest in Australia and Tasmania; the need of separate State education for defective children. It was determined to urge the various Colonial Governments to adopt a uniform system of spelling native names of places in accordance with that adopted by the Admiralty and the Royal Geographical Society, and to approach the Governments of the several colonies with the object of trying to induce them to provide for the appointment of a properly qualified philological expert to make researches into the Australian and Papuan languages.

It was decided to hold the next session in Hobart, in January 1902, Captain Hutton being nominated as President. Prof. Liversidge was reappointed Permanent Secretary, and Mr. H. C. Russell, Treasurer. The arrangements for the meeting was made by Prof. Baldwin Spencer, the organising secretary for Victoria.

An instructive "Handbook of Melbourne," edited by Prof. Baldwin Spencer, was published for the use of members of the Association. Mr. A. Sutherland contributes the opening chapter, on the history of Victoria, and he concludes it with the following remarks, which show that there has always been enthusiasm for scientific work in the colony. "When the colony was but a couple of years old, a mechanics' institute was formed with its courses of scientific lectures and its little museum. A botanic garden was laid out when Melbourne was three years old, and when the goldfields had brought to its shores crowds of energetic and intelligent men, the fervour for knowledge increased. A National Museum, a University, a great Public Library, on a plan to cost eventually a million of money, and to form a vast national repository of all that science, literature and art could provide, were the notable features of that period; but amongst them must also be reckoned the Royal Society, the result of the amalgamation of two rival efforts in the cause of science. The Society has completed some forty years of existence, with a volume of papers for nearly every year."

The geology, biology in its various branches, ethnology, climate, commerce and manufactures of the colony form the subject of different chapters in the volume, and much valuable information is given in a concise form.

THE BI-CENTENARY OF THE BERLIN ACADEMY.

LAST week we referred to the history of the Berlin Academy during the present century. The celebration of the bi-centenary was commenced on Monday. From the telegraphic account which appears in the *Times*, we gather that the Emperor opened the celebration by receiving in state the members of the Academy as well as the foreign deputations which have come to Berlin. The reception took place in the White Hall of the Royal Castle in the presence of the German Crown Prince, many princes of the Prussian and other German Royal Houses, the foreign Ambassadors, the Imperial Chancellor, and the Ministers and Secretaries of State. His Majesty, who wore the white uniform of the Gardes du Corps, with the eagle-crested helmet, sat on the throne surrounded by the insignia of Empire, the crown, sceptre, sword, orb and seal, which had been brought in on cushions of gold and silver cloth by the Minister of War and other generals. On a table near the throne were a pile of books, globes, and scientific instruments "picturesquely arranged" and surmounted by an eagle carrying a twig of laurel. Before the proceedings were opened by the dutiful addresses of the secretary of the Academy (Prof. Auwers), and the Minister of Education (Dr. Studt), a choir from the Royal School of Music sang Haydn's "Du bist dem Ruhm und Ehre gebührt." At the close of the ceremony, Löwe's "Salvum fac Regem" was sung.

In the speech from the throne his Majesty welcomed the delegates and recalled the long and intimate connection which had existed between the Academy and the House of Hohenzollern, and its foundation by the Elector Frederick III. (King Frederick I. of Prussia) on the initiative of Leibnitz, its first president. All the Prussian kings had been protectors of the society. William I. had said:—"The interest in learning which is felt by every Prussian king is shared by me." These words had been illustrated in connection with the Academy. The Emperor was glad to be able to say that the society had now maintained its activity throughout two centuries, and had completely fulfilled the expectations which his ancestors had placed in it. There were, no doubt, good reasons for the fact that German science had developed in close connection with the Universities. As the immortal Helmholtz had borne witness, academic teaching and intercourse with the students furnished abundant sources of energy for scientific research. But none the less the organisation and conduct of scientific work by academies had proved itself to be an essential element of scientific progress, and one which could not be neglected if great objects were to be attained. The Academy had come into existence more than a century before the University of Berlin, and had at an earlier date undertaken the task of simultaneously promoting all branches of learning. The Emperor intimated that he would now extend the society by the addition to the philosophical and historical section of a number of chairs principally devoted to German philological research. German philological research, his Majesty considered, should be especially cultivated in the capital of the United German Empire. The physical and mathematical section was to be strengthened in the same way, in consideration of the importance of the technical sciences in the present day.

"The Academy," continued the Emperor, "has from the very beginning taken all knowledge to be its province, but, on the other hand, it can be said to its credit that it has refrained from the pursuit of every interest unconnected with learning. The great events of the national life have, indeed, been reflected in its activity, and have often found enthusiastic expression in the words of its speakers on festal occasions. But the Academy has always disdained to descend into the turmoil of political passions, and has regarded the pure and disinterested cultivation of science as its highest duty. In this unselfish devotion, to which it owes so much, and which is a guarantee for its further success, the Academy serves the divinely appointed object of all knowledge, which is to lead mankind to a more profound understanding of Divine truth. However, the natural sciences may seek as their final goal to discover the first cause of all being and phenomena, it still remains true that, in the words of Goethe, himself once a foreign member of this society, 'the real, the only, and the profoundest theme of the history of the world and of humanity, a theme to which all others are subordinate, is the conflict between belief and unbelief,' and—as should be added, in conformity with his meaning—the dealings of God with man. So it holds good of your work that, as was the desire of Liebnitz, 'the honour of God and the good of all humanity are constantly promoted' by science. May this always be so, and to that end may the blessing of the Most High rest upon you in the new century as in the past."

In connection with the bi-centenary the Emperor has conferred the Order of the Red Eagle, first-class, upon Prof. Mommsen; the star of the Royal Order of the Crown, second-class, upon Prof. Auwers, the permanent secretary of the Academy; the Order of the Red Eagle, third-class, upon Prof. Adolf Karnack; and a number of distinctions upon other eminent scholars and men of science who have rendered services to the Academy.

Lord Kelvin and Prof. Max Müller have been elected Foreign Members. The following Englishmen and Americans have been elected Corresponding Members:—Prof. Gibbs, of Newhaven; Prof. Rowland, of Baltimore; Sir J. Burdon-Sanderson, Bart., of Oxford; Prof. William James, of Cambridge, Mass.; Prof. Kenyon, of London; Prof. Mahaffy, of Dublin; Dr. A. S. Murray, of the British Museum; Mr. F. L. Griffith, of Ashton-under-Lyne; and Prof. F. W. Maitland, of Cambridge.

A special meeting of the Academy was held on Tuesday in the Prussian Chamber of Deputies, in celebration of the bi-centenary. Among those present were the Imperial Chancellor (Prince Hohenlohe), the Italian Ambassador (Count Lanza), the British Ambassador (Sir Frank Lascelles), and the Ambassador of Austria-Hungary (Herr von Szögyeny-Marich). The proceedings were opened and closed by wonderful performances of an orchestra from the Royal School of Music under Prof. Joachim, which played a sonata by Giovanni Gabrieli (1597) and Stadler's hymn, "Grosser Gott, Allmächtiger Gott." Prof. Harnack delivered an eloquent address on the history of the Academy, and concluded with the words:—"May the light which was in the beginning and the word which was in the beginning continue to illuminate the spirit of this institution in the third century of its existence!"

The representatives of foreign academies and learned societies then presented addresses of congratulation. The following were among the foreign deputations:—On behalf of the Royal Society of London, Dr. T. E. Thorpe and Prof. W. Ramsay; for the Royal Irish Academy, Dublin, Prof. R. Atkinson and Prof. Mahaffy; for the Royal Society of Edinburgh, Dr. J. Burgess and Dr. R. H. Traquair; for the Royal Asiatic Society of Great Britain and Ireland, Dr. M. Gasten and Mr. H. Lyon; for the Smithsonian Institution of Washington, the Ambassador of the United States of America, Mr. Andrew D. White; for the American Academy of Arts and Sciences, Prof. J. W. White and Prof. J. C. Wolff, of Harvard University; for the Académie des Inscriptions et Belles-Lettres de l'Institut de France, M. Gaston Paris and M. E. Senart; for the Académie des Sciences de l'Institut de France, M. G. Darboux, Doyen de la Faculté de Sciences de Paris; for the Académie des Sciences Morales et Politiques de l'Institut, M. Gréard, Rector de l'Université de Paris, and the Comte de Franqueville, Vice-Président de l'Academie. Dr. Nansen also presented congratulations.

In replying to the addresses of the deputations, Prof. Diels said that contemporaneous with the bi-centenary of the Berlin Academy was the birth of what he might call the "academy of the world," the international association of the academies of all countries, founded four weeks ago. After sketching the objects of this association, he announced that he was able to lay on the table the first fruits of its labours in the shape of the first printed sheets of the "Thesaurus Linguæ Latinæ." He expressed the hope that the nations might follow the example of the academies and the Universities by uniting in the peaceful task of extending to the whole world the civilisation and the culture of Europe and America.

INNERMOST ASIA.[1]

PROMPTED more by the love of sport than by any scientific aspiration, Mr. Cobbold undertook an adventurous (and in many respects an instructive) journey from India into the regions of High Asia; and regarded as a record of sport and adventure, he has told his tale so well that he is likely to produce an embarrassing demand on the Indian Foreign Department for leave to follow in his footsteps. He seems to have had no special difficulty in obtaining permission to visit the Pamirs, in spite of the well known reluctance of the Indian Government to entertain the risk of "complications" involved in the casual collisions of British and Russian officers on the far frontier. Indeed, he naturally finds it difficult to understand why so many more obstacles were placed in the way of his return than of his visit to the Pamirs.

In August 1897, he followed the high road through Kashmir to Gilgit and Hunza, crossing the Kilik Pass in the company of Captain Deasy, who was bent on a scientific mission in the same direction. After fair success with *Ovis poli* in the neighbourhood of the Tagdumbash Pamir, he passed on to Kashgar and started northward from that place to Vierney and Lake Balkash. In the reed beds that surround Balkash he achieved a notable feat, for he bagged a tiger under circumstances that were sufficiently exciting to satisfy the most ardent sportsman; and this may surely rank as

[1] "Innermost Asia." By Ralph P. Cobbold. Pp. xviii + 354. (London: Heinemann, 1900.)

the "farthest north" tiger ever bagged by an Englishman. On his way back to Kashgar he hunted in vain for the great Tian Shan stag (which he calls a Wapiti), and the close association which this form of sport promoted with the people of the country led to observations of their social life and condition which inspires some of the best writing in the book. At Kashgar he obtained a permit from the Russian Consul to visit the Russian Pamirs. This part of his story, illustrating the present position of the Russians on the Pamirs, is instructive. He followed the footsteps of Ney Elias down the vile mountain passes and pathways of the Bartang (or Murghab) river, reached Kila Wamar, where he was politely stopped by the Russian authorities; visited the new Russian post at Charog, and the Afghan fort of Kila Bar Panj; and after a detention, which was as courteously arranged as could well be expected under the circumstances (although the exact reason of the order which prevented him from crossing the Hindu Kush is not clear), he was given an escort of three Cossacks, and sent back again to the Chinese frontier. He recrossed the Hindu Kush by the Mintaka into the Hunza valley, and so returned to India.

FIG. 1.—*Ovis poli* alive.

Of the personal courtesy and hospitality of the Russian officials, Mr. Cobbold has certainly no cause to complain. Whatever may be the political ambition of the Russian nation, or the spirit of international rivalry, it never finds expression in the personal attitude of the Russian towards the Englishman. In this particular, Mr. Cobbold's evidence only confirms that of all English people who have had close personal relations with educated Russians. He was struck with the intelligence of the Russian officers; their frank avowal of their political views and aims; their knowledge of the frontier on both sides the border; and their rough but effective methods of dealing with frontier tribes-people. He was surprised to find that they were well acquainted with certain "confidential" reports of the Indian Government, and that they knew precisely the turn that daily affairs were taking from Kabul to the Afridi Tirah. But he admits that the rough and ready system of local administration, those methods which would enable a Petrovski to pacify our northwest frontier for us "with 1000 Cossacks," are not popular with the people; and that on the whole Russian rule is not much preferred to Afghan. One thing is, however, tolerably clear from Mr. Cobbold's book, *i.e.* that both Afghan and Chinese borders are carefully watched against Russian trespass. The officer in command of the Russian outposts at Charog (? Khorokh) was not on visiting terms with the Afghan commandant on the opposite side of the Panja; neither were matters altogether pleasant for Mr. Cobbold himself when he was mistaken for a Russian officer crossing the Chinese border to Tashkurghan.

Mr. Cobbold gives us his views at some length on the Russian position in High Asia, and even revives the moribund scare of an invasion from the Pamirs. The keynote of his views is expressed in the title of a photograph of the Kilik Pass, which is described as one of the few passes by which India might be invaded. We presume that the Mintaka is another. But both lead to the Hunza river defiles, and Mr. Cobbold, like many other more careful investigators, has failed to reckon up the requirements in provisions of the army of invasion, the number of baggage animals that would have to follow it, the amount of roadway necessary to get them along, and the exceeding facility with which even a small undisciplined force can stop a whole army, when acting in difficult ground and on the defensive. South Africa should emphasise the lessons learnt in Tirah, if such lessons are really necessary.[1]

There are just one or two points in this connection which require attention. The map given at the end of the book is that published by the Royal Geographical Society in 1896, and is, of course, not authoritative. But this hardly justifies the extension of the boundary between China and (presumably) Kashmir, by the red and yellow line which is depicted to the north-west of the Raskam river running right across the base of the Tagdumbash Pamir. Nor would any Russian authority admit the further extension of that line in yellow and green along the crest of the Sarikol range. These extensions are Mr. Cobbold's own. The Tagdumbash Pamir is thus included in Kanjut, and the Kashmir (or British) boundary is made to march with that of Russia at the Beyik Pass. Such an arrangement altogether nullifies the provisions of the Boundary Commission agreement of 1895 (quoted at the end of the book), which provides that the boundary between Russian and Afghanistan frontiers should be "prolonged in an easterly direction so as to meet the Chinese frontier." There is also a photograph of a "boundary pillar" on the Mintaka Pass which is misleading. There is no boundary pillar on the Mintaka. It is probably a pillar erected by Captain Deasy for purposes of observation. There is a curious misprint, too, in page 259, where Karakoram is written for Sarikoram, but as a matter of fact the latter is not a recognised pass at all. It is only a shikari's track. Again, in page 267, the Russians are credited with handing over Wakhan to Bokhara. Wakhan belongs to Afghanistan, and has never been in Russia's possession. Mr. Cobbold's etymology is likewise possibly open to question. In the regions of the Upper Oxus the Tajik meets the Tatar; the Aryan and Mongolian races here join hands. But the Chitrâli of the Yarkhun valley hardly acknowledges affinity with the Tajik of the Oxus. Both are of very ancient Aryan

[1] In the final chapters of his book Mr. Cobbold expresses contradictory opinions, and even advocates the opening of the Kilik as a trade route.

extraction, and may have been prehistorically connected, but the Chitrâli calls himself Kho, and speaks "Khowar," and his language (ordinarily known as Chitrâli) would not be understood in Wakhan. The Tajik (the original Persian stock) of Turkestan and the Oxus does not derive his designation from táj, "a crown," but from Tazi, a word which means "Arabic"—or "of Arab extraction," and which is more intelligible as applied by the pure bred Persian to the Tajik races of Baluchistan (where there has ever been much Arab admixture of blood) than to the people of the Oxus or of the Kabul basin. It practically means "half breed," and may be recognised again in the word Tazi, which Mr. Cobbold applies to the dogs which he brought with him from the highlands.

That the Hindu Kush may ultimately mark the geographical boundary between Russian and British spheres of interest in Asia, or even that Chinese Turkestan (or the New Dominion) may ultimately become as much a Russian province as Bokhara (and it certainly is a fact that Russian influence is already predominant in Kashgar), is an eventuality which many politicians have contemplated for years past. But it strikes no terror into the hearts of those who look upon a definite and final understanding with Russia as the best guarantee for peace and for the advancement of civilisation in Asia. Nor need we as yet concern ourselves with such a consummation as would be involved by the Cossacks gazing down on Kabul from their barracks "on the heights of the Kohistan."

Apart from his political views, Mr. Cobbold's book is instructive as well as interesting. He tells us much that is new about districts which are not within the reach of every traveller, and his chapter on the trade of Innermost Asia is specially worth study. T. H. H.

DR. WILLIAM MARCET, F.R.S.

ALL who are interested in medicine and the cognate sciences learnt with great regret of the death of Dr. William Marcet, which occurred on March 4, at Luxor, at the ripe age of seventy-two years. Dr. Marcet up till last summer continued to take that keen interest in matters scientific which had characterised him all his life, and it was only with a pronounced failure in his health that he discontinued active physiological research. His active scientific life in London was longer than the average, and exceeded half a century; and this, perhaps, accounts for his many friends, and also for the fact that he was brought into contact with successive generations of physiological workers. His ample means rendered time of less consequence to him than to many of his colleagues, and this good fortune was utilised by him to the full, in that his researches were for the most part directed to themes of a time-consuming nature, and also to those requiring for their adequate prosecution somewhat elaborate and expensive methods.

With the exception of his contributions to meteorology, his work was almost entirely directed to the chemical side of physiology and pathology; his additions to the literature of clinical medicine were relatively small; and although he was for some time on the staff of the Westminster and Brompton Hospitals, as a physician, he was by the present generation hardly known.

The first sphere of his chemico-physiological labours was a somewhat unæsthetic one—viz. the human fæces. In 1851 he published "Some observations on the fatty matters of human excrements in disease." In 1856 his first work upon dietetics appeared, entitled "The composition of food and how it is adulterated, with practical directions for its analysis." This book was one of the earliest systematic contributions to this subject, and must have been the expression of considerable labour and research. Dr. Marcet next directed his attention to the physiological and pathological properties of alcohol, and published two monographs upon the subject. His "Chronic alcoholic intoxication" includes a synoptical table of cases. In 1864 he made some observations upon a colloid acid, a normal constituent of human urine, and in the same year published a short essay upon the brine of salt meat and on the distribution of albumen through the muscular tissue. His dietetic researches extended, in 1867, to a description of a method for peptonising meat, and the employment of the formed product in diseases of the stomach.

Dr. Marcet, in this country, was one of the earliest workers with the laryngoscope, and wrote, in 1869, "Clinical notes on diseases of the larynx, investigated and treated with the assistance of the laryngoscope." In 1869 he published the results of some observations he made upon the temperature of the human body during climbing.

Dr. Marcet's two contributions to meteorology and climatology were a monograph on the weather at Cannes during the season 1875–76, which appeared in 1877, and a book of some four hundred pages on the "Principal Southern and Swiss health resorts," which was published in 1883. Although this book cannot be regarded as a systematic treatise on climatology, it is most readable, and contains a mass of useful hygienic information concerning the Riviera, Canary Islands, Madeira, Egypt, &c. Even a discussion of the cause of the green colour of Marennes oysters is to be found in it.

In spite of the somewhat extensive bibliography given above, it is nevertheless as a worker on respiration that the subject of this notice was, and will be, chiefly known. Years of researches upon this subject, both in London and at high altitudes, resulted in the appearance in 1897 of Dr. Marcet's "Contribution to the history of the respiration of man." The book consists essentially of the subject-matter of the Croonian Lectures which were delivered by Dr. Marcet before the Royal College of Physicians in 1895. As this book was fully reviewed in these columns at the time of its appearance, no further mention need be made of it here. Not only will physiology miss Dr. Marcet as a worker, but working physiologists will miss him as a personality; he was constantly to be seen at meetings of the Physiological Society, and kept up his interest in all the branches of that science which has extended so enormously the field of its knowledge since he joined the ranks of its workers.

F. W. TUNNICLIFFE.

SIR MICHAEL FOSTER AND HIS PUPILS.

WE have been asked to publish the following letter, addressed to Sir Michael Foster on the occasion of his entering Parliament. His biological friends at Cambridge have done well in expressing their loyalty towards Sir Michael, to whom the University owes so much. The signatures might doubtless have been indefinitely multiplied had the opportunity of adding their names been given to Sir Michael Foster's friends and pupils scattered over many lands. This, however, was not attempted, the letter not being circulated beyond the group of old pupils and friends, in Cambridge, with whom it originated.

TO SIR MICHAEL FOSTER, K.C.B., M.P.

DEAR SIR MICHAEL,—We, a few of your Cambridge friends, take the opportunity given by your entering Parliament to express our loyalty, respect, and cordial friendship towards you.

Though we regret anything which takes you from among us, yet we cannot but rejoice that the cause of learning has gained so strong an advocate in Parliament.

The work you have done in Cambridge during the last thirty years seems to us of unique value. You have taught us to recognise what is worth learning, and you have taught us how to learn. If we, in Cambridge, now value and seek after the advancement of natural knowledge, we owe it to you more than to any man living.

We beg you to believe that we are grateful, and we shall rejoice if we can in any way prove our sincerity.

We can ill afford to lose either the weight of your name or your guidance at our councils; we can indeed hardly imagine a greater misfortune than the breaking of the bond between you and us. But we cannot complain if, after many years of service, you have found it necessary to loosen your official ties to the University. We regret that your enlarged liberty has not come to you in a form which would have marked our sense of what we owe to you. But we rejoice that an arrangement has been arrived at which will allow your interests still to centre in Cambridge, giving you, at the same time, the opportunity of working in a wider field, where you may do for England what you have already done for Cambridge, and where your services to learning may benefit, not only England, but the whole English-speaking race.

We are proud to sign ourselves

Your friends and pupils,

H. K. ANDERSON.	J. N. LANGLEY.
FRANCIS DARWIN.	A. SHERIDAN LEA.
A. G. DEW-SMITH.	J. J. LISTER.
WALTER GARDINER.	A. SEDGWICK.
W. H. GASKELL.	A. C. SEWARD.
ALFRED C. HADDON.	ARTHUR E. SHIPLEY.
W. B. HARDY.	L. E. SHORE.
S. F. HARMER.	H. MARSHALL WARD.
WALTER HEAPE.	

March 9, 1900.

NOTES.

THE preliminary programme of the meeting of the British Association to be opened at Bradford, on September 5, has now been drawn up. The new president is Sir William Turner, F.R.S., and the sectional presidents will be as follows:—Mathematical and Physical Science, Dr. J. Larmor, F.R.S.; Chemistry, Prof. W. H. Perkin, F.R.S.; Geology, Prof. W. G. Sollas, F.R.S.; Zoology (and Physiology), Dr. R. H. Traquair, F.R.S.; Geography, Sir George S. Robertson; Economic Science and Statistics, Major P. G. Craigie; Mechanical Science, Sir Alexander R. Binnie; Anthropology, Prof. John Rhys; Botany, Prof. Sydney H. Vines, F.R.S.; and Corresponding Societies, Prof. E. B. Poulton, F.R.S. There will be a separate department of astronomy in Section A, with Dr. A. A. Common, F.R.S., as chairman. The two evening discourses will be delivered by Prof. Gotch, F.R.S., on "Animal Electricity," and Prof. W. Stroud, on "Range Finders." The lecture to working men will be delivered by Prof. S. P. Thompson, F.R.S., but the subject has not yet been announced.

AT the anniversary meeting of the Royal Irish Academy, on March 16, the following were elected honorary members of the Academy in the section of science:—Aleksandr O. Kovalevskij, St. Petersburg; J. A. Gaudry, Paris; P. G. Tait, Edinburgh; J. H. van t' Hoff, Berlin; J. J. Thomson, Cambridge.

ATTENTION has several times been drawn in these columns to the remarkable properties of Becquerel rays, and, in particular, of those rays emanating from radium. The theory that the radiations consist of material particles is supported by M. Becquerel's recent observations on the action of screens in cutting off the radiations deviated by a magnetic field. From the *Revue Générale des Sciences* for March 15, we learn that a decisive experiment has been performed on this point. It has been established beyond doubt that the emanations from radium communicate a negative charge to bodies on which they fall, while the radium itself becomes charged negatively, and it is inferred that the emanations from radium, or, at any rate, a portion of them, consist of material particles carrying negative charges.

IT will be remembered that the work of the Ben Nevis Observatories would have been brought to an abrupt conclusion in 1898, had not Mr. J. Mackay Bernard come forward with a donation of 500*l*., which secured its continuance for another year. In 1899, he gave another donation of 500*l*., under which the directors are now carrying on their important work. The following extract from the report of the Council of the Scottish Meteorological Society, read at the annual general meeting on Monday, shows the present position of the Observatories:—"The position of matters was taken into serious consideration by the council at their meeting on Monday, March 12, when Mr. Mackay Bernard, with a generosity which it is difficult to describe, intimated his wish of making a third donation of 500*l*. to complete the observations in the way desired by the directors in their previous report, and so covering the whole of a sun-spot period of eleven years, and securing at the same time good averages of the meteorological elements for the highest position in the British Islands, and an adjoining Sea-level Observatory at Fort-William. The Ben Nevis work has thus been singularly fortunate in securing very large support from a gentleman, moved by patriotism as well as by a love of knowledge, and the completion of the experiment is secured. This statement does not imply that the council does not continue to be strongly of opinion that the Observatories should not be continued permanently as a national institution, and they are strengthened in this opinion by the character of the results already obtained. The council have now to intimate that another gentleman has offered further support of a very substantial character. In August last, he wrote offering help to the extent, if necessary, of 300*l*., and the council are now in communication with him in regard to this most liberal offer."

WE learn from the *British Medical Journal* that Dr. W. Osler, F.R.S., professor of medicine in Johns Hopkins University, Baltimore, has sent in an application for the vacant chair of the practice of physic in the University of Edinburgh. Dr. Osler is a graduate of McGill University, Montreal. The other candidates are all graduates of the University of Edinburgh, and in order of seniority are as follows:—Dr. John Wyllie, Dr. Byrom Bramwell, Dr. Alexander James and Dr. G. A. Gibson. Dr. Osler is a Fellow of the Royal College of Physicians of London, while the other candidates are all Fellows of the Royal College of Physicians of Edinburgh.

THE second malaria expedition of the Liverpool School of Tropical Medicine, composed of Drs. Annett, Dutton and Elliott, started yesterday for Nigeria, where they will remain for some time studying malaria and health problems.

THE annual general meeting of the Chemical Society will be held on Thursday, March 29, at 3 p.m. At this meeting the Longstaff Medal will be presented to Prof. W. H. Perken, Junr., F.R.S. In the evening the Bunsen Memorial Lecture will be delivered by Sir Henry E. Roscoe, F.R.S.

SCIENCE has to regret the loss of another of its eminent votaries. Dr. E. J. Lowe, F.R.S., who died on the 10th inst. at Shirenewton Hall, Chepstow, was best known by his indefatigable labours for the determination of the climate of Nottingham, at which place he was born, in November 1825. His meteorological observations began in 1840, and were continued there until 1882, when he removed from Highfield House to Shirenewton Hall. The results of this long series of observations were published in several valuable works, including "The Climate of Nottinghamshire." He also published many other treatises, *e.g.* "Barometrical Tables," as early as 1857, "Weather Prognostics," and the "Natural Phenomena of the Seasons."

This latter work is frequently found very useful for reference to the extreme conditions of weather and unusual occurrences since A.D. 220. In 1856 he published in *Orr's Circle of the Sciences*, in conjunction with Mr. J. B. Scoffern, a "Practical Meteorology," which will well repay perusal at the present day. Mr. Lowe's labours were, however, in no way limited to meteorology. He communicated several joint papers on luminous meteors to the British Association, and assisted the late Prof. E. Forbes in the compilation of his well-known work on "The British Mollusca," and he also wrote several valuable works on British ferns and flowering plants. He was one of the founders and original fellows of the Meteorological Society, of which body he was a life member, and contributed many papers to its *Proceedings* on meteorological subjects and also on earthquake and astronomical phenomena. Mr. Lowe was the inventor of the dry powder tests for the determination of the amount of ozone present in the atmosphere.

THE census of Great Britain will be taken on Sunday, March 31, 1901. The Census Bill was read a third time in the House of Commons on Monday, and as it now stands, the schedules will require the following particulars to be filled in :—(*a*) The name, sex, age, profession or occupation, condition as to marriage, relation to head of family, birthplace, and (where the person was born abroad) nationality of every living person who abode in every house on the night of the census day; and (*b*) whether any person who so abode was blind or deaf and dumb, or imbecile or lunatic; and (*c*) where the occupier is in occupation of less than five rooms, the number of rooms occupied by him; and (*d*) in the case of Wales or the county of Monmouth, whether any person who so abode (being of three years of age or upwards) speaks English only or Welsh only, or both English and Welsh.

AS already announced, an International Congress of Botanists will be held in Paris from the 1st to the 10th of October, in connection with the Exposition. It is proposed to bring before the Congress special subjects for discussion; and the following have been already approved by the Committee :—(1) Monographic studies; (2) Species, hybrids and cross-breeds; (3) Unification of micrometric measures; (4) Influence of the nature of the substratum on the development of Fungi. The President of the Committee is M. E. Prillieux; the General Secretary, M. E. Perrot, l'École Supérieure de Pharmacie, Paris. All botanists who notify the General Secretary their desire to become members of the Congress, and who pay the fee (20 francs), will be enrolled as members. Public and general sessions, conferences and collecting trips, displays of fungi, and visits to botanical establishments, are planned.

IN accordance with a recommendation of the Columbus meeting of the Botanical Society of America, and Section G of the American Association for the Advancement of Science, at the Columbus meeting, Prof. W. Trelease, of the Missouri Botanic Garden, has contributed to *Science* (vol. x. No. 255, Nov. 17, 1899) a scheme for the classification of botanical publications. He proposes arranging them under nine heads :—(1) Works of miscellaneous contents; (2) Biographies of botanists; (3) Nomenclature, taxonomy and descriptive botany; (4) Morphology and organography; (5) Vegetable physiology, including ecology; (6) Vegetable pathology, including the injuries of plants and therapy; (7) Evolution, natural selection, &c.; (8) Man's influence on plants, artificial selection, &c.; (9) Phytogeography, floras, &c. These are again classified under a large number of subdivisions.

THE Botanical Society of France has elected M. Drake del Castillo President for the year 1900; M. Boudier, M. l'abbé Boullu, M. Morot and M. de Seynes, Vice-Presidents.

THE Italian botanical journal, *Erythea*, will be discontinued with the completion of the seventh volume.

A HERBARIUM, collected especially to illustrate the flora of the Rocky Mountains, is being organised in connection with the University of Wyoming.

Bulletin 62 of the West Virginia Agricultural Experiment Station, Morgantown, W. Va., consists of a paper, by Mr. L. C. Corbett, on the effect of incandescent gas-light on the growth of plants. He finds that the incandescent gas-light of the Welsbach burner is an active stimulus to the growth of plants when used at night to supplement daylight. The paper is illustrated by charts and photographs.

AN article of archæological interest appears in the March number of the *Engineering Magazine*, which, in discussing the "Gold-mining prospects in Rhodesia," treats of the discovery of gold ornaments found in ancient ruins in Rhodesia, and their probable age. From the text we gather that ornaments have been found in houses dating back, it is believed, three thousand years ago; it is also pointed out that the ignorant black population could not have made them. The group of objects representing trays, bracelets, beads, and other articles difficult to specify, has been carefully photographed and reproduced.

THOSE of our readers interested in foreign Lepidoptera may be glad to learn that Mr. E. Swinhoe has recently issued his ninth annual list of specimens for sale.

OUR namesake, *Die Natur*, in its issue of March 11, contains an interesting sketch of the collections in the Berlin Museum. From this we learn that the plan of placing a small map to each specimen, indicative of its geographical distribution, has been adopted; and likewise that a special saloon is devoted to the fauna of Germany. In the latter we further note that the Bats are exhibited in spirit, as is now the case with a large portion of those in the British Museum.

WE have to congratulate the Trustees of the South African Museum on the completion of the first volume of the *Annals* of that institution, the third and concluding part of which has just come to hand. The great bulk of this fasciculus is taken up by the description of various South African Scorpions and their distant cousins the Solifugæ, or "False Spiders," two genera of the latter being recorded for the first time from the Cape district. The volume closes with a short paper, by Dr. R. Broom, on two new species of Dicynodont Reptiles from the well-known Karoo series; and it is a matter of satisfaction to find not only that the study of extinct forms comes within the province of this useful publication, but that such a competent observer and anatomist as Dr. Broom has turned his attention to this branch of research.

CONFRONTED with the difficulty of mounting the bones of the limbs of extinct mammals at their proper angles of inclination, Prof. H. F. Osborn has undertaken a careful comparative investigation of those of the elephant and the rhinoceros, in the hope of finding a clue from the conformation of the bones themselves as to their true position in the mounted skeleton. The results of his studies are given to the public in the February number of the *American Naturalist*. In regard to the elephant, he makes the noteworthy statement "that the study of the skeleton alone would have given us a very faulty conception of the animal." He is led to conclude that in all primitive ungulates the long bones of the limbs were set at considerable angles to one another, as in the majority of the existing representatives of the order, and that the vertical position they occupy in the elephant is an acquired feature. To quote his own words :—"The straightening of the limb is an adaptation designed to transmit the increasing weight through a vertical shaft; correlated with it is the shifting of the facets [that is to say, the upper and lower articular surfaces] into the direct line of pressure, and the alteration of their planes from an oblique to a right or horizontal angle with relation to the vertical shaft."

MR. FREDERIC W. SIMONDS writes to us from the University of Texas with reference to the communications on "Floating Stones," which appeared in NATURE early in the present year (pp. 278, 318). He calls attention to a paper of his, entitled "Floating Sand: an Unusual Mode of River Transportation," published in the *American Geologist* (January 1896), in which he described experiments made to determine how sand may be floated, what sand will float, and why sand will float. It was found that sand grains will float in perfectly still water for an indefinite time, that the grains which float are not necessarily siliceous, and that the property of floating depends to a large extent upon the angularity, that is, the shape, of the grains. Several of the characteristics mentioned by our correspondents are referred to in Mr. Simonds's paper.

THE Statistics of Mineral Production in India for the five years 1894 to 1898 have just been issued by the Department of Revenue and Agriculture. About a million tons of salt are produced annually from rock-salt, from salt lakes and wells, and from sea-water. The coal industry is expanding rapidly, the output having increased from nearly three million tons in 1894 to over four and a half million tons in 1898. The coal is employed for railways, coasting and river steamers and factories, but the conditions of transport are not yet sufficiently developed. Nearly all the gold produced in India comes from the State of Mysore, and in 1898 it amounted to over four hundred thousand ounces, valued at 4*l.* an ounce. Nearly twenty million gallons of petroleum were obtained in 1898 from Burma and Assam. Other "minerals" of minor economic importance include iron-ores, tin-ores, saltpetre, gems and precious stones.

WE have received a catalogue of the first four thousand samples in the soil collection of the U.S. Department of Agriculture, prepared by Mr. Milton Whitney, chief of Division of Soils. To all interested in soil investigations this publication will be a useful and suggestive work of reference. Not only does the collection contain specimens of soils from the chief geological formations of the United States, it also includes samples from many of the important agricultural districts, and likewise special collections of wheat soils, tobacco soils, &c., from all parts of the world. Remarks are made concerning the collecting of specimens, their arrangement and classification; and it is stated that sets of representative soils are arranged in boxes, to be distributed to agricultural colleges and experiment stations, with explanatory text regarding their origin, chemical and physical peculiarities, &c. One object in publishing the catalogue is to suggest exchanges with institutions in other countries.

IN an article on the Lower Cambrian terrane in the Atlantic province (*Proc.* Washington Acad. Sciences, vol. i. February 1900), Mr. C. D. Walcott discusses some changes in grouping which have been proposed by Mr. G. F. Matthew, and would, if adopted, lead to the abandonment of the term Middle Cambrian, and to the placing of the *Olenellus*-zone in the Pre-Cambrian ("Etcheminian" terrane). Mr. Walcott maintains that the Etcheminian is in reality Lower Cambrian, and equivalent to strata which elsewhere hold the Olenellus fauna—the representatives of the genus having a range of over a thousand feet at the typical locality in Vermont.

AMONG the earthquakes felt in Asia Minor in 1896, one of the most interesting originated near Balikesri on September 14. This shock is described by Dr. G. Agamennone in a paper published in the last *Bollettino* of the Italian Seismological Society (vol. v. No. 6). Though its intensity was not more than 7 or 8 of the Rossi-Forel scale, the shock was felt over an area of about 400 km. in diameter, and was even recorded by a horizontal pendulum at Strassburg, which is 1850 km. from the epicentre. The mean surface-velocity of the preliminary tremors was about $8\frac{1}{2}$ km. per second, and of the slow undulations about $2\frac{1}{2}$ km. per second.

THE success which attended the "Illustrated Annual of Microscopy" last year has induced the publishers (Messrs. Percy Lund and Humphries) to bring out a second number this year. If for no other reason, it is valuable for its summary of new instruments and apparatus put on the market by the leading opticians during the twelvemonth. We are glad to see the popular side of microscopy well represented, since papers of a highly specialised character find a more appropriate medium of publication in the proceedings and transactions of societies. On the other hand, brief abstracts of technical methods are of interest to every one, and in this category we include Dr. Hollborn and Mr. Angus's history and theory of staining, Mr. W. H. Merrett's metallography of iron and steel, Mr. Strangways' hints on dental histology, Mr. Palmer's article on micro-spectrography, Mr. Rheinberg's multiple colour illumination; and notes by Mr. Harris on eucaine hydrochlorate, and by Prof. Hartog on saprolegnieæ. Photo-micrography receives treatment at the hands of Mr. Albert Norman, Don Domingo de Orueta, Mr. F. Noad Clarke (in connection with entomology) and Mr. E. R. Turner, who treats of "stereo-photo-micrography, chromo-photo-micrography, and stereo-chromo-photo-micrography"; while popular microscopy is well catered for by the beautiful coloured frontispiece of "Pond Life" and coloured plate of *Daphnia hyalina*, and by papers on freshwater mites, yeast, plant hairs, molluscan palates, polarised light and the variety of form of diatoms from an artistic standpoint, illustrated by outlines of Triceratia. Dr. M. C. Cooke's skits and songs resuscitated from the early annals of the Quekett Club are most amusing.

WE have received from the United States Weather Bureau the "Meteorological Chart of the Great Lakes," with a summary of the season of 1899. This work, which is accompanied by a large amount of explanatory text, in addition to tables and maps, contains much useful information relating to the storms, monthly rainfall, ice, &c., in the Lake region. The season of inter-lake navigation in 1899 began on April 29, the opening being late on account of the vast amount of ice during April. With the exception of Lake Erie, and probably Lake Ontario, the water was higher than in the two previous years; on Lake Superior the water was higher than that of any previous year since 1876. The work contains some interesting observations of fog. The most frequent formation reported is that of heavy banks, with intervals of clear weather, and narrow bands, which extend for many miles in length. One vessel will run for hours in the band of fog, while another several miles distant will be running parallel with it in clear weather, and can hear the fog whistle and see the wall of the fog bank.

THE *Annuaire* of the Municipal Observatory of Paris (Montsouris) for the year 1900 extends to 578 pages, and contains an immense amount of useful information, and a special analysis of the work relating to the year 1898. The Montsouris Observatory was established in 1871, and its operations embrace: (1) Meteorological physics, including atmospheric electricity, the distribution of rainfall and thunderstorms in the Department of the Seine, and the regular registration of all the usual meteorological elements at Montsouris and at the St. Jacques tower. In this section we may specially mention a useful comparative *résumé* of mean and extreme values for the twenty-five years 1873–98. (2) Chemical analyses of air and water in different parts of Paris, and researches relating to the comparative value of various disinfecting agents. (3) Micrographical investigations, with a view to determining the amount and nature of organic dust in open spaces and in dwelling houses. The work of each section is under the superintendence of an eminent scientific authority, and the control of the establishment is invested in a permanent Committee appointed by the Municipal Council of Paris.

THE earliest authentic record of bubonic plague has hitherto been accepted as dated 300 B.C. Drs. F. Tidswell and J. A. Dick have, however, recently brought evidence before the Royal Society of New South Wales to show that the epidemic of 1141 B.C., described in the First Book of Samuel (chs. iv.–vi.), was true bubonic plague. After the Philistines had captured the Ark of the Covenant and taken it to Ashdod, severe illness broke out among the people. "The hand of the Lord was heavy upon them of Ashdod, and He destroyed them and smote them with emerods." The Ark was afterwards taken to Ekron, and here again we are told "There was a deadly destruction throughout all the city . . . and the men that died not were smitten with the emerods, and the cry of the city went up to heaven." The word "emerod" has usually been taken to mean hæmorrhoids, but in the revised version of the Old Testament it is stated to mean tumour or plague boil. The epidemic in Philistia occurred at the time of the regular plague season, and mice are mentioned in connection with it, which furnishes additional evidence that the epidemic was plague, for a connection between the death of rats and plague at Bombay and elsewhere has been clearly established. Taking all the facts into consideration, there appears to be contained in the few chapters of I. Samuel an account of an epidemic of bubonic plague that occurred more than three thousand years ago, or more than eight hundred years previous to the hitherto accepted historic record.

PART IV. of the sixth revised edition of Foster's "Text-Book of Physiology" has been published by Messrs. Macmillan and Co., Ltd. It deals with the senses, under sight, hearing, taste and smell, and cutaneous and some other sensations. Dr. W. H. R. Rivers has assisted Sir Michael Foster in the revision of these chapters, and his name appears upon the title-page with that of the original author.

IN the *Transactions* of the Nova Scotian Institute of Science has appeared a series of papers, by Prof. MacGregor and his pupils, on the application of the ionic hypothesis to mixtures of solutions of electrolytes. Vol. x. contains a paper by Mr. J. Barnes treating of the viscosity of mixtures of solutions of various salts of sodium, potassium and barium, in which it is shown that general formulæ developed by Prof. MacGregor hold in this case also. Given data as to the viscosity and electrical conductivity of the constituent solutions, the viscosity of dilute solutions of the salts under consideration can be predicted by the dissociation theory within the limits of experimental error.

THE additions to the Zoological Society's Gardens during the past week include a Silver Pheasant (*Euplocamus nycthemerus*, ♂) from China, presented by the Rev. J. O. Coussmaker; a Greater Black-backed Gull (*Larus marinus*), European, presented by Mr. W. Baker; two Starred Lizards (*Agama stellio*) from Egypt, presented by Mr. Stanley S. Flower; a Green Lizard (*Lacerta viridis*), European, presented by Mr. W. J. R. Elgy; two Grey Struthideas (*Struthidea cinerea*) from Australia, a Bennett's Wallaby (*Macropus bennetti*) from Tasmania, deposited; a Black-faced Ibis (*Theristicus caudatus*) from South America, purchased.

OUR ASTRONOMICAL COLUMN.

COMET 1899 V.—Herr S. K. Winther, of Copenhagen, communicates an ephemeris of this comet to the *Astronomische Nachrichten* (Bd. 152. No. 3930), from which the following is abstracted:—

Ephemeris for 12*h*. *Berlin Mean Time.*

1900.	R.A. h. m. s.	Decl. ° ′
March 23	21 38 23	+51 58·7
25	42 36	52 43·1
27	46 50	53 27·3
29	51 5	54 11·2
31	21 55 22	+54 54·8

NEW VARIABLE IN CYGNUS.—In the *Astronomische Nachrichten* (Bd. 152, No. 3629), Mr. A. Stanley Williams, of Hove, draws attention to the variability of the star

$$\text{B.D.} + 46^\circ{\cdot}2966 \begin{cases} \text{R.A.} & 20\text{h. } 29\text{m. } 38{\cdot}0\text{s.} \\ \text{Decl.} + & 46^\circ \quad 15'{\cdot}2 \end{cases} (1900).$$

The variable was detected from photographs taken with a Grubb portrait lens of 4·4 inches aperture. The brightness was found to change from 9·1 magnitude, on 1899 October 2, to 10·0 magnitude, on 1900 February 11.

Inspection of reproductions from photographs of the star taken by Prof. Max Wolf confirms the variability. In a photograph taken June 1, 1891 (*Knowledge*, 1891, p. 189), the estimated magnitude of the star is 10·2, while on another taken September 9 and 10, 1891 (*Knowledge*, 1891, p. 188), the estimated magnitude is only 9·6. Most of the observations, visual and photographic, furnish an approximate period of 31·0 days.

ESCAPE OF GASES FROM PLANETARY ATMOSPHERES.—In the *Astrophysical Journal*, vol. xi. pp. 36-43, January 1900, Mr. S. R. Cook, of the University of Nebraska, particularises part of the investigation of Dr. G. Johnstone Stoney, who omitted from his discussions the determination, by the kinetic theory, of the number of molecules which would have a velocity sufficient to enable them to escape from the earth or planet, assuming retarding media to be absent. The present author, in commencing this discussion, refers to this velocity as the *critical velocity* of the gas.

The dynamical constants are computed for four different conditions, including those adopted by Dr. Stoney, Prof. Cleveland Abbe (from balloon ascensions at Paris and Berlin), and the recent theoretical conclusions of Ferrel. From the result, it is concluded that under the most probable conditions there would be practically no escape of the gases nitrogen, oxygen, hydrogen and helium from either the earth or the major planets. An atmosphere like that on the earth, however, would not remain on the moon. Tables are given showing the computed temperatures at which the above gases would possess the *critical velocity* for dissipation at the outer limits of the atmospheres of the various planets.

NEW MODE OF USING THE CONCAVE DIFFRACTION GRATING.—In the current number of the *Mem. Soc. degli Spettroscopisti Ital.* vol. xxviii. pp. 241-244, Dr. G. B. Rizzo, of the Physical Institute at Turin, gives a description of his successful experiments dealing with the manipulation of a Rowland Concave Grating in other than the usual manner. The spectroscope is generally so arranged that the grating and eyepiece or photographic plate are at opposite ends of a rigid beam which keeps them at the constant distance of the radius of curvature of the grating, the plate being placed tangential to the focal curve. This gives for a small distance on either side of the axis a practically *normal* spectrum, and although not normal, the other orders of spectra are all brought to focus on the same focal circle, having as diameter the radius of curvature of the grating. It is evident, then, that whatever order of spectrum is being observed *normally* at the end of the beam, there will be another image, of the same order, on the other side of the central image (which has been symmetrically reflected from the grating without diffraction or dispersion), the lines of which will be in focus along a circle having a radius equal to half the grating's radius of curvature. This second spectrum Dr. Rizzo designates the *internal* spectrum, and its position is defined by the condition that

$$\sin\theta = -2\sin i,$$

where θ is the angle of diffraction,
and i ,, ,, ,, incidence,
reckoned from the centre of the grating.

This spectrum is of *slightly larger* dispersion than the normal one, and may be brighter, although this will probably depend on the particular grating in question. In the grating used this is shown exceedingly clearly by the reproduction given with the paper of the spectrum of iron photographed in the two spectra, that given by the *internal* position being decidedly longer and more intense than the *normal* spectrum.

Dr. Rizzo investigated this disposition on account of being unable to use the instrument as usually set up, but it is possible that the fact of its being a practical arrangement may be of interest to other workers with the concave grating.

FORTHCOMING BOOKS OF SCIENCE.

Mr. Félix Alcan (Paris) promises:—"Minéralogie Agricole," by Prof. Houdaille; and "Manuel d'Histologie Pathologique," by Profs. Cornil and Ranvier.

Mr. Edward Arnold's list contains:—"A Manual of Elementary Chemistry," by W. A. Shenstone, F.R.S.; "A Manual of Physiography," by Dr. Andrew J. Herbertson; "A Manual of Botany," by David Houston; "A Text-Book of Domestic Science," by Mrs. S. J. Shaw; "The Dressing of Minerals," by Prof. Henry Louis; and a new edition of "Lectures on Sound, Light, and Heat," by Dr. Richard Wormell, Part ii., "Chemical Statics."

Messrs. George Bell and Sons announce:—"The Comparative Anatomy of Animals," by G. C. Bourne, vol. i.; "The Student's Dynamics," by Prof. G. M. Minchin, F.R.S.; "Elementary Science," by Dr. D. E. Jones and Dr. D. S. Macnair; and "Physiography," by H. N. Dickson.

Messrs. A. and C. Black's list includes:—"A Treatise on Zoology," by Prof. E. Ray Lankester, F.R.S. To be completed in ten parts, Part iii., "The Echinoderma," by F. A. Bather, assisted by Dr. J. W. Gregory and E. S. Goodrich; "Sexual Dimorphism in the Animal Kingdom: a Theory of the Evolution of Secondary Sexual Characters," by J. T. Cunningham, illustrated; "Studies in Fossil Botany," by Dr. D. H. Scott, F.R.S., illustrated; and new editions of:—"Travels through the Alps," by the late James D. Forbes, F.R.S., revised and annotated by W. A. B. Coolidge, illustrated; and "Introduction to Structural Botany," Part ii., "Flowerless Plants," by Dr. D. H. Scott, F.R.S.

Messrs. Cassell and Co., Ltd., give notice of:—"Electric Bells, how to make and fit them," illustrated.

Messrs. J. and A. Churchill's announcements are:—"An Introduction to Vegetable Physiology," by Prof. J. Reynolds Green, F.R.S., illustrated; "A Treatise on Physics," by Prof. A. Gray, F.R.S., in three parts, illustrated; "Chemistry, an exact Mechanical Philosophy," by Fred. G. Edwards; and new editions of:—"Carpenter's Microscope and its Revelations," edited by Rev. Dr. W. H. Dallinger, F.R.S., illustrated; "A Systematic Handbook of Volumetric Analysis," by Francis Sutton, illustrated; "The Microtomist's Vade-Mecum: a Handbook of the Methods of Microscopic Anatomy," by Arthur Bolles Lee, illustrated.

The Clarendon Press will publish:—"The Structure and Life History of the Harlequin Fly," by Prof. L. C. Miall, F.R.S., and A. R. Hammond; "A Catalogue of Eastern Lepidoptera Heterocera in the Oxford University Museum," Part ii., *Nocturna*, by Colonel C. Swinhoe; Goebel's "Organography of Plants," translated by Prof. I. Bayley Balfour, F.R.S.; and "A Text-Book of Arithmetic," by R. Hargreaves.

Mr. W. B. Clive's announcements include:—"The Tutorial Arithmetic," by W. P. Workman; "The Tutorial Algebra," Part i., by R. Deakin; "First Stage Physiology"; "Section One Physiography"; "First Stage Hygiene," by R. A. Lyster; "Advanced Inorganic Chemistry (Practical)"; "First Stage Mathematics," edited by William Briggs; and "First Stage Botany," by Dr. A. J. Ewart.

Messrs. A. Constable and Co. promise:—"Acetylene Gas," by Prof. Vivian B. Lewes, illustrated; "Auto-Cars and Horseless Carriages," by Worby Beaumont and Dugald Clerk, illustrated; an illustrated volume by Sir Dietrich Brandis, F.R.S., on Indian forest trees; a volume by Percy Newberry, giving a record of the exploration and full description, with hieroglyphics, &c., of the tomb of Rekhmara; and one by Bertram Blount, on the subject of electro-metallurgy.

In Messrs. J. M. Dent and Co.'s list we notice:—"The Races of Mankind," by Dr. Huberlandt; "Physiology and Hygiene," by Drs. Redman and Sieler; "An Essay on Mental Culture," by G. A. Hight; and "Forestry," by Dr. Nesbit.

Messrs. Duckworth and Co. give notice of:—"Agricultural Botany, Theoretical and Practical," by J. Percival; "A Glossary of Botanic Terms," by B. D. Jackson; and "A Handbook of British Rubi," by Rev. W. M. Rogers.

In Messrs. R. A. Everett and Co.'s list we find:—"A Handbook of Clinical Veterinary Medicine," by Frank T. Barton; and "A Handbook of Clinical Veterinary Surgery," by Frank T. Barton.

Mr. Gustav Fischer calls attention to:—"Die Ohrenheilkunde im Kreise der medizinischen Wissenschaften," by Dr. E. Bloch; "Untersuchungen über den Bau der Brachiopoden," by Dr. F. Blochmann, zweiter teil; "Bericht über die Thätigkeit des Königl. Instituts für Serumforschung und Serumprüfung zu Steglitz. Juli 1896–September 1899," by Dr. W. Dönitz; "Das Aether-Verfahren beim Frühtreiben mit besonderer Berücksichtigung der Fliedertreiberei," by W. Johannsen; "Jahresberichte über die Fortschritte der Anatomie und Entwicklungsgeschichte," edited by Dr. G. Schwalbe, o. ö. neue folge, vierter band, drei abteilungen, litteratur 1898; "Lehrbuch der klinischen Hydrotherapie," by Dr. Max Matthes; "Mitteilungen aus den Grenzgebieten der Medizin und Chirurgie," sechster band, erstes heft; "Untersuchungen über die Möller-Barlow'sche Krankheit," by Schoedel and Nauwerck; "Vorträge, Klinische, aus dem Gebiete der Otologie und Pharyngo-Rhinologie," edited by Dr. Haug; "Die diätetische Küche für Magen- und Darmkranke," by Dr. Carl Wegele.

Messrs. Gay and Bird announce:—"Comparative Physiology and Morphology of Animals," by Le Conte.

The announcements of Messrs. Charles Griffin and Co., Ltd., are:—"The Principles and Construction of Pumping Machinery: Steam and Water Pressure," by Henry Davey, illustrated; "Road Making and Maintenance," by Thomas Aitken, illustrated; "The Metallurgy of Steel," by F. W. Harbord, illustrated; "The Cyanide Process of Gold Extraction," by James Park, illustrated; "A Dictionary of Dye-Chemicals; a Compendium of Dyes, Mordants, and other substances employed in Dyeing, Calico-printing and Bleaching," by C. Rawson, W. M. Gardner and W. F. Laycock, with formulæ, properties, applications, &c.; "A Dictionary of Textile Fibres," by Wm. J. Hannan, illustrated; "Practical Coal Mining," by George L. Kerr, illustrated; "Flesh Foods, with Methods for their Chemical, Microscopical and Bacteriological Examinations," by C. Ainsworth Mitchell, illustrated; "Marine Meteorology, for Officers of the Merchant Navy," by William Allingham, illustrated; "Official Year-Book of Scientific and Learned Societies of Great Britain and Ireland," seventeenth annual issue; and new editions of "Gas, Oil, and Air Engines," by Bryan Donkin, illustrated.

Mr. John Lane promises:—"All About Dogs," by Charles Henry Lane, illustrated; and "Birds of My Parish," by E. Pollard, illustrated.

Messrs. Longmans and Co.'s list includes:—"Malaria, according to the New Researches," by Prof. Angelo Celli, translated by John Joseph Eyre, with corrections and additions; and "A Manual of Surgical Treatment," by Prof. W. Watson Cheyne, F.R.S., and Dr. F. F. Burghard.

The list of Messrs. Sampson Low and Co., Ltd., contains:—"The Diuturnal Theory of the Earth, or Nature's System of Constructing a Stratified Physical World," by William Andrews; "Artificial Ice Making and Refrigeration," by L. M. Schmidt; "The Surgical Diseases of the Genito-Urinary Tract," by Dr. Frank Lydston, illustrated; and a new edition of "Instruction in Photography," by Sir W. de W. Abney, K.C.B., F.R.S.

Messrs. Macmillan and Co., Ltd., give notice of:—"A Manual of Medicine," edited by Dr. W. H. Allchin, in 5 vols., vol. i.; "Micro-organisms and Fermentation," by Alfred Jorgensen, translated; and "Inorganic Evolution as studied by Spectrum Analysis," by Sir Norman Lockyer, K.C.B., F.R.S.

Mr. John Murray's list includes:—"Heredity," by Prof. J. Arthur Thomson, illustrated; and a new edition of "The Natural History of Religion, based on the Gifford Lectures delivered in Aberdeen in 1889-90 and 1890-91," by Prof. Edward Burnett Tylor, F.R.S.

Messrs. Geo. Newnes, Ltd., will add to their Library of Useful Stories:—"The Story of the Alphabet," by Edward Clodd, illustrated; "The Story of Bird Life," by W. P. Pycraft, illustrated; "The Story of Thought and Feeling," by F. Ryland.

Messrs. Sands and Co.'s list contains:—"The Animals of Africa," by H. A. Bryden, illustrated; "Types of British Plants," by C. S. Colman; and "Walks round the Zoo," by F. G. Aflalo, illustrated.

Messrs. Smith, Elder and Co. announce:—"Orthopædic Surgery," by C B. Keetley; and "Lectures on the Practice of Medicine," by Dr. W. B. Cheadle.

Messrs. Swan Sonnenschein and Co., Ltd., promise:—"The Antarctic," by Dr. Karl Fricker, illustrated; "Physiological Psychology," by Prof. W. Wundt, translated by Prof. E. B. Titchener, 2 vols., illustrated; "Text-Book of Palæontology for Zoological Students," by Theodore T. Groom, illustrated; "Text-Book of Embryology: Invertebrates," by Dr. E. Korschelt and Dr. K. Heider, translated from the German by Mrs. H. M. Bernard, and edited (with additions) by Martin J. Woodward, vol. iv., illustrated; "Mammalia," by the Rev. H. A. Macpherson; "Birds' Eggs and Nests," by W. J. C. Ruskin Butterfield; "The Romance of the Earth," by Prof. A. W. Bickerton, illustrated; "Biological Types in the Vegetable Kingdom," by Wilfred Mark Webb; and new editions of "Handbook of Practical Botany, for the Botanical Laboratory and Private Student," by Prof. E. Strasburger, edited by Prof. W. Hillhouse, illustrated; "The Dog: its Management and Diseases," by Prof. Woodroffe Hill, illustrated.

Mr. Fisher Unwin gives notice of:—"In Birdland with Field Glass and Camera," by Oliver G. Pike, illustrated.

Messrs. Whittaker and Co.'s announcements are:—"Wireless Telegraphy and Hertzian Waves," by S. R. Bottone; "English and American Lathes," by J. G. Horner; "Electric Wiring Tables," by W. Perren Maycock; "Electrical Engineers' Pocket Book," by Kenelm Edgcumbe; "Inspection of Railway Material," by G. R. Bodmer; and new editions of "British Locomotives, "by C. J. Bowen Cooke; and "The Atlantic Ferry," by A. J. Maginnis.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

A GRANT of 100*l*. has been made to Prof. Schafer from the Earl of Moray Endowment Fund, by the Edinburgh University Court, for purposes of original research.

ANOTHER Bill to establish a University of the United States has been introduced into the Senate. It proposes that University Square, recently occupied by the old U.S. naval observatory, be the site for the national observatory.

MR. W. E. PLUMMER, the director of the Bidston Observatory, Liverpool, under the control of the Dock Board, has been elected to an Honorary Readership in Astronomy at University College, Liverpool. The appointment has given equal satisfaction in the college and the city. It recognises Mr. Plummer's devoted and efficient service as a teacher, and the distinguished position he has attained in scientific observation and research. Without any violation of confidence, it may be said that his claims to such a recognition were cordially supported by some of the most distinguished astronomers in the kingdom.

SPEAKING at Derby on March 12, at the distribution of prizes to students of the Municipal Technical College, Sir William Abney, K.C.B., referred to the fact that at the end of this month the Department of Science and Art will come to an end. It will be merged in a department to be known as the Board of Education, which is to supervise all kinds of education—elementary, secondary and technological. He remarked: In the Queen's Speech they were promised that there should be an Education Bill introduced, reorganising the authorities for secondary education. The introduction of such a bill marked a great advance in public opinion as to the necessity of local co-ordination of the kind in question. Speaking in his private capacity, and not officially, he hoped that not only would secondary education be under a local authority, which would supervise it and look after its interests, but that all other education would be similarly managed.

MR. R. HEDGER WALLACE is entitled to speak with authority upon the subject of "Agricultural Education in Greater Britain," and his paper, published in the *Journal* of the Society of Arts of March 9, admirably summarises what is being done for agricultural education in our colonies and dependencies. The facts stated by Mr. Wallace in his survey afford sufficient evidence to justify the following conclusions:—First, that throughout Greater Britian, irrespective of climatic, racial and political divergences, there is a universal movement to give all interested in the culture of land every opportunity, facility and assistance possible to improve themselves, their art and craft, and the land and its produce. Secondly, that the purely educational or teaching facilities in agriculture offered by other portions of the Empire where the general agricultural conditions are somewhat akin to our own are not only so distributed as to cover fairly the area in question, but are also equal in educational value to any of the agricultural training or teaching institutions in this or the other countries of Europe.

THOUGH University College, Bristol, has not so many generous friends as some of the other provincial colleges of the same rank, the report of the Council shows that it not only continues to impart the highest kind of instruction in the arts and sciences, but also assists in extending the bounds of existing knowledge by means of research. As evidence of the original work carried on during the session 1898-99, an extract is given from the report of the faculty of arts and science. Among the subjects of researches mentioned are:—the physical properties of some hydrocarbons, properties of metal films, velocity of ions in non-conducting liquids, chemical composition of foods, mass of the ions in the silent electric discharge from points, the mammalian remains discovered in the Uphill Caves, and the relation of stimulus to sensation in visual impressions, involving a modification of the Weber-Fechner formula. Original work is the most valuable testimony to the efficiency of a University College; it prevents the members of the staff from falling into merely stereotyped methods of teaching, it is a valuable example and incentive to students, and it serves to make the college known as a centre of intellectual endeavour. Compared with former years, the college was exceptionally fortunate during the session covered by the present report, for it received a legacy of 5000*l*. from the late Mr. Stuckey Lean, and an anonymous donation of 1000*l*., as well as a generous legacy of scientific books from the late Mr. J. T. Exley, who also bequeathed to the college his collection of scientific apparatus. The council are looking forward with confidence to the newly-established Colston Society, which has for its object the endowment of Colston Chairs in connection with the college, or the assistance of the Institution in such other manner as the committee of the society may approve. It is to be hoped that the promotion of the cause of higher education in Bristol in this manner will receive the strong support of all classes of citizens. The president of the college, the Lord Bishop of Hereford, has been elected first president of the society.

THE following announcements from recent numbers of *Science* show that natural knowledge has many liberal friends in the United States:—Mr. John D. Rockefeller has given 100,000 dollars to Columbia University to endow the chair of psychology. Mr. Andrew Carnegie has given 300,000 dollars to Cooper Union, New York City, and 200,000 dollars has been contributed by Abram S. Hewitt and Mr. Edward Cooper; this will enable the Union to establish courses in mechanic arts. Syracuse University receives 25,000 dollars by the will of the late Mr. Erastus F. Holden, of Syracuse; the bequest will be used for the department of astronomy and for the observatory. Oberlin College receives 75,000 dollars by the will of the late Mrs. Caroline E. Haskell, of Michigan City, Indiana; and 40,000 dollars by the will of the late William Osborne, of Pittsburg. By provision of the will of the late Dr. John Stanford Sayre, Princeton University will receive 40,000 dollars, part of which is for the endowment of fellowships in applied chemistry and in applied electricity. President Schurman has announced an anonymous gift of 80,000 dollars for Cornell University to erect a building for physiology and anatomy. By a decision of the New York Court of Appeal, Yale University will receive the 150,000 dollars bequeathed by William Lampson. President Bashford, of the Ohio Wesleyan University, announces that Mrs. Elizabeth Mebarry, of Richmond, Ind., who recently gave 50,000 dollars to the University, has added 10,000 dollars to the fund, thus endowing two chairs. By the will of the late

Dorman B. Eaton, Columbia University receives 100,000 dollars to found a professorship of municipal science and administration, and Harvard University 100,000 dollars to endow a chair in the science of government. Mr. Louis H. Severance, of New York City, has given 60,000 dollars to Oberlin College for a chemical laboratory. The provision made for the college by Mrs. C. E. Haskell amounts to 77,000 dollars. St. Lawrence University has recently received a gift of 24,000 dollars from a friend of that institution. A half million dollars will be distributed by Dr. D. K. Pearsons, of Chicago, among fourteen colleges throughout the United States. Most of his donations will be made on condition that the colleges raise a certain amount, generally 50,000 dollars, or an amount equal to the gift, within a given time. Dr. Pearsons has already given 2,500,000 dollars to the cause of education.

SCIENTIFIC SERIALS.

Transactions of the American Mathematical Society, January.—At the February meeting of the Society last year, the President announced that the Council had reported that it was "desirable and feasible, and in all respects for the best interests of mathematical science in this country, that the Society should undertake the periodical publication of *Transactions*, beginning with January 1, 1900." The well-printed and altogether admirable first part is now before us, and we heartily wish good speed to the venture, "the success of which is already well assured." The size of the page is approximately 11×8 inches, and so is intermediate between the *Bulletin* and *American Journal of Mathematics* pages.—Conics and cubics connected with a plane cubic by certain co-variant relations, by H. S. White, is a paper which was read, with a slightly different title, at the August (1899) meeting. By employing the irrationality that occurs in Hesse's canonical form of the cubic, the writer is able to identify Hilbert's two systems of irrational co-variant conics, and to exhibit certain other relations, and thence to give explicitly co-variant equations of definition for the two cubics which have the same Hessian, and for those which have the same Cayleyan, as a given fundamental cubic. The results are attained by the aid of a canonical form of the cubic containing Hesse's irrationality. The conics discussed are Hilbert's co-variant conics (*cf.* letter addressed to M. Hermite, Liouville, vol. iv. 1888). The invariantive proofs of some of the foregoing results are given in the next paper, Formentheoretische entwickelung der in Herrn White's Abhandlung über curven dritter ordnung enthaltenen Sätze, by Paul Gordan.—Sur la définition générale des fonctions analytique, d'après Cauchy, by E. Goursat, has its object thus indicated.—J'ai reconnu depuis longtemps que la démonstration du théorème de Cauchy, que j'ai donné en 1883, ne suffisait pas la continuité de la dérivée. Pour répondre au désir qui m'a été exprimé par M. le Professeur W. F. Osgood, je vais indiquer ici rapidement comment on peut faire cette extension.—On a class of particular solutions of the problem of four bodies, by F. R. Moulton, treats the case of three bodies finite, moving in *circles* according to one or the other of the solutions of Lagrange, while the fourth is infinitesimal.—Definition of the Abelian, the two hypo-Abelian, and related linear groups as quotient groups of the groups of isomorphisms of certain elementary groups, by Dr. L. E. Dickson, aims at giving a natural definition of these groups based upon Jordan's "important, but artificial, conception of *exposants d'échange*." It is written in the author's usual thorough style.—H. Maschke gives a half-page note on the unilateral surface of Mœbius.—On regular singular points of linear differential equations of the second order whose coefficients are not necessarily analytic, by M. Bôcher. The writer remarks that since the time of Cauchy it has been considered of interest to establish the existence of solutions of differential equations whose coefficients are functions of a real variable x, and to do this without requiring these coefficients to be analytic functions of x, but merely continuous functions. It is a natural extension of this point of view to wish to investigate the nature of singular points of such equations, *i.e.* of points where the coefficients become discontinuous. It is M. Bôcher's object to carry through such an investigation in a special case, viz. that of

$$\frac{d^2y}{dx^2} + p\frac{dy}{dx} + qy = 0,$$

where the independent variable (x) is real, and p, q are functions of x, which are not required to be analytic.—The elliptic σ-functions considered as a special case of the hyperelliptic σ-functions, by O. Bolza. This paper has a two-fold object. In the first place it gives a sketch of the theory of the "elliptic" in the light of the theory of the "hyperelliptic" functions; and secondly, it serves as an introduction for a future paper in which an analogous presentation is given of the hyperelliptic σ-functions.—Dr. G. A. Miller writes on the groups which are the direct products of two sub-groups, and E. H. Moore discusses certain crinkly curves (reff. are made to papers by Peano, *Math. Ann.* vol. xxxvi.; Cesàro, *Bulletin des Sciences Math.*, vol. xxi. 1897; Hilbert, *Math. Ann.* vol. xxxviii.). There are several diagrams.—Dr. L. E. Dickson gives a new definition of the general Abelian linear group.—If the high character of the present number is maintained, it is safe to prophesy that the *Transactions* are come to stay.

Bollettino della Società Sismologica Italiana, vol. v. 1899–1900, No. 6.—On seismic registrations of long period, by E. Oddone (see p. 477).—The earthquake of Ventotine on March 27, 1899, and the tromometric records obtained at the Collegio Bianchi, in Naples, and at Reggio di Calabria, by P. G. Costanzo.—Earthquake of Balikesri, in the north-west part of Asia Minor, on September 14, 1896, by G. Agamennone.—Notices of earthquakes recorded in Italy (July 30–October 11, 1898), by A. Cancani, the most important being the earthquakes of Janina on July 31, Calabria-Sicily on August 6 and 12, and Umbria-Marches on August 25 and September 11, and distant earthquakes on September 1, 13 and 22.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 22.—"The Ionisation of Dilute Solutions at the Freezing-point." By W. C. D. Whetham, M.A., Fellow of Trinity College, Cambridge.

This paper contains a description of the electrical part of a joint research, by Mr. E. H. Griffiths and the author, on the freezing-points and electrical conductivities of very dilute solutions of the following substances:—Sulphuric acid, potassium chloride, barium chloride, copper sulphate, potassium permanganate, potassium ferricyanide and potassium bichromate. In order to eliminate the effect of dissolved glass, the water used as solvent was distilled in a platinum still and collected in platinum vessels; a known weight was then placed in a platinum cell, and weighed quantities of stock solution added, in successively increasing amounts. The concentration of the solutions thus prepared was calculated in terms of the number, m, of gram-equivalents of solute dissolved in one thousand grams of solution. In order to control the temperature, the platinum cell was surrounded by a coil of tubing through which evaporated ether vapour could be passed. The whole was surrounded by a brass case fixed in the middle of a large tank filled with broken ice. The walls of the platinum vessel formed one electrode, and a platinum cage suspended within it the other. Inside this cage revolved a platinum tube which contained a thermometer, and also served as the shaft of a screw. This screw kept the contents of the cell at a uniform temperature, and mixed the stock solutions with the liquid previously within the cell. The electrical resistances were measured by the method of alternating currents, the connections of the Wheatstone's bridge with a dry cell and with a D'Arsonval galvanometer being reversed simultaneously by means of a revolving commutator driven by a hand wheel and cord. This arrangement is more convenient and more sensitive than the usual telephone apparatus. The conductivity thus found was corrected for the conductivity of the solvent, and the result, k, divided by m, gave the equivalent conductivity of the solution. Curves were drawn between $\sqrt[3]{m}$ and k/m, and the maximum value of these taken to indicate complete ionisation. The ionisation, α, of the solutions was then calculated by dividing the maximum k/m into its actual value, and new curves were drawn between $\sqrt[3]{m}$ and α. The general form of these curves resembles that of the corresponding ones obtained by Kohlrausch and other observers at 18°, but the slant of the lines is different both from Kohlrausch's observations, and also from new observations made with the present apparatus at 18°. The abnormal type of curve found at 18° for acids and alkalies is shown to appear at 0° in the case of sulphuric acid, the ionisation reaching a maximum as the dilution is increased, and then suddenly becoming much less. Reasons are given for doubting the usual explanation of this effect, which refers it to interaction with the residual impurities of the solvent, the phenomena being different to those observed in the case of permanganate, a salt showing a somewhat similar drop in the curve, for which the usual explanation is satisfactory. Potassium bichromate gives a curve consisting of two well-marked parts—perhaps owing to a change in the nature of the ions at different concentrations. Mr. Griffiths is engaged in measuring the depression of the freezing-point of corresponding solutions, and, when his results are published, a comparison of the two sets of values will be made.

March 1.—"Mathematical Contributions to the Theory of Evolution. VIII. On the Correlation of Characters not Quantitatively Measurable." From the Department of Applied Mathematics, University College, London. Presented by Karl Pearson, F.R.S.

In August last I presented to the Royal Society a memoir on the inheritance of coat-colour in thoroughbred horses, and of eye-colour in man. This memoir, which was read in November of last year, presented the novel feature of determining correlation between characters which were not capable *à priori* of being quantitatively measured. The theoretical part of that memoir was somewhat brief, but I showed by illustrations that the method could be extended to deal with problems like the effectiveness of vaccination and of the antitoxin treatment in diphtheria. More recently, in studying the phenomena of reversion in Basset Hounds, Mr. Bramley-Moore indicated to me how my method, although correct in theory, differed sensibly in the numerical results with the processes of interpolating employed. I then proposed a new method, and the analytical discussion of its details was worked out in part by Mr. Bramley-Moore himself, by Mr. L. N. G. Filon, M.A., and by myself. Dr. Alice Lee also came to our assistance, and the result is the present joint paper. On the basis of the new methods, we have already worked out upwards of sixty coefficients of correlation, principally of heredity.

The theory of the present memoir depends upon a very simple feature of normal correlation. If $z\delta x_1 \delta x_2 \ldots \delta x_n$ be the frequency of a complex of characters lying between x_1 and $x_1+\delta x_1$, x_2 and $x_2+\delta x_2 \ldots$, x_n and $x_n+\delta x_n$, where x_p is the deviation of the pth character from its mean, then

$$\frac{dz}{dr_{pq}} = \frac{d^2z}{dx_p dx_q}$$

where r_{pq} is the correlation of the pth and qth organs.

This simple differential relation enables us to expand z for any number of characters in powers of the correlation coefficients (necessarily less than unity) by Maclaurin's theorem. But since we may replace a differential with regard to a coefficient of correlation by a double differential with regard to the corresponding organs, the coefficients of correlation may be put zero *before* instead of after the differentiation. In other words, we obtain a symbolic operator which, applied to a normal surface of frequency for n-uncorrelated organs, converts it into a correlated surface of frequency with $\frac{1}{2}n(n-1)$ coefficients of correlation of arbitrary values. This operator gives us by aid of certain symbolic equations the expansion of the n-fold integral

$$\int_{h_1}^{\infty}\int_{h_2}^{\infty}\int_{h_3}^{\infty} \ldots\ldots \int_{h_n}^{\infty} z\,dx_1 dx_2 dx_3 \ldots\ldots dx_n$$

in terms of the $\frac{1}{2}n(n-1)$ coefficients of correlation, and a series of new functions which we term the v-functions. These satisfy the difference equation:

$$v_n = xv_{n-1} - (n-1)v_{n-2}$$

and the differential equation

$$\frac{dv_n}{dx} = nv_{n-1}.$$

The calculation of these functions is shown to be easy, and their properties are investigated. In this manner the volume of a frequency surface of the nth order cut off by n planes parallel to the n co-ordinate planes is shown to be capable of calculation, and its value is determined in the numerical illustrations given for example of 1, 2, 3 up to 6-fold correlation. It may be noted that by putting $h_1 = h_2 = h_3 = \ldots\ldots = h_n = 0$, we have really obtained a result which enables us to find the "area" of a "spherical triangle" in n-fold hyperspace in terms of a series ascending by powers and products of the cosines of the angles between its faces.

The application of these results to the correlation of characters not quantitatively measurable, arises from the fact that the n-fold integral above given, and which we have shown how to evaluate, measures the total frequency beyond certain boundaries. We can observe, for example, whether horses' coats are bay and darker (or chestnut and lighter), whether eyes are grey and lighter (or, dark grey and darker). Thus by forming mass frequencies instead of frequency distributions for small changes of character, we can find equations to determine the correlation. The probable error of such correlation, the convergency of the series, and other points are investigated.

A number of illustrations of the new method are given from heredity in horses, dogs and man, and it is shown how normality of frequency must even for such a character as stature[1] only be looked upon as a first approximation.

An investigation is also made into the influence of superior stock in producing superior offspring. It is shown, for example, that if an individual who possesses a degree of character only found in one in twenty be considered "exceptional," then eighteen times as many exceptional men will be born of non-exceptional parents as of exceptional parents; but, on the other hand, exceptional parents produce exceptional offspring at a rate ten times as great as non-exceptional parents, the greater gross product of the latter being due to their much greater numbers. In other words, distinguished parents are more likely to have distinguished offspring than undistinguished—ten times as likely—and yet only one distinguished man in nineteen will be born of distinguished parents. The importance of such conceptions for both natural and artificial breeding can hardly be over-estimated.

Chemical Society, March 1.—Prof. Thorpe, President, in the chair.—The following papers were read:—On pilocarpine and the alkaloids of jaborandi leaves, by H. A. D. Jowett. The jaborine of commerce is shown to be a mixture of isopilocarpine, pilocarpidine and a trace of pilocarpine with colouring matter; no evidence has been obtained of the existence of the alkaloid previously described as jaborine.—Isomeric partially racemic salts containing quinquevalent nitrogen. Hydrindamine bromocamphorsulphonates, chlorocamphorsulphonates and *cis* π-camphanates, by F. S. Kipping. The author explains the formation of two isomeric salts of externally compensated hydrindamine with bromocamphorsulphonic, chlorocamphorsulphonic or *cis*-π-camphanic acid as due to partial racemism.—New syntheses of indene, by F. S. Kipping and H. Hall. Hydrindamine hydrochloride decomposes almost quantitatively into indene and ammonium chloride when heated.—Potassium nitritohydroximidosulphates and the non-existence of dihydroxylamine derivatives, by E. Divers and T. Haga. Raschig's dihydroxylamine derivatives are merely crystalline compounds of potassium nitrite with the 2/3 and 5/6 normal potassium hydroximidosulphates. — Identification and constitution of Fremy's sulphazotised salts of potassium, by E. Divers and T. Haga.—Some acids obtained from α-dibromocamphor, by A. Lapworth and E. M. Chapman. Camphonic acid, $C_{10}H_{16}O_3$, obtained by hydrolysing α-monobromocampholid, is a ketonic acid yielding an oxime, a semicarbazone and phenylhydrazones; it may be converted into tribromocamphonolactone, which fact indicates that bromocamphorenic acid has the constitution

$$CH\begin{cases} CH_2.CMe_2 \\ CBr\,.\,CH_2 \end{cases}CMe.COOH.$$

—Spectrographic studies in tautomerism. The absorption curves of the ethyl esters of dibenzoylsuccinic acid, by W. N. Hartley and J. J. Dobbie.—The curves of molecular vibrations of benzantialdoxime and benzsynaldoxime, by W. N. Hartley and J. J. Dobbie.—On campholytic and isolauronolic acids, by J. Walker and W. Cormack. As a result of further work, the authors consider that campholytic and isolauronolic acids are stereoisomeric, their structure being best represented by the formula

$$\begin{matrix} C(CO_2H):CMe \\ | \\ CH_2 \text{———} CH_2 \end{matrix}\Big\rangle CMe_2.$$

—The configuration of the camphoric acids, by J. Walker and J. K. Wood.—The constitution of camphoric acid, by J. Walker. The author considers the Perkin-Bouveault formula for camphoric acid to be the most satisfactory hitherto proposed.

[1] Cited by so many as an example of "normality."

—On the presence of invertase in plants of the Gramineæ (I.), by J. O'Sullivan.—Iodonium compounds of the type IR′R″R‴ and the configuration of the iodine atom, by F. S. Kipping and H. Peters. The authors have prepared phenylparatolyl-iodonium hydroxide

$$\begin{matrix} C_6H_5 \\ C_6H_4Me \end{matrix} \Big> I.OH,$$

and, since they could not resolve it into enantiomorphous components, they conclude provisionally that the three iodine valencies are arranged in one plane.—Note on the decomposition of semicarbazones, by F. S. Kipping. On heating benzaldehyde semicarbazone it yields the azine

$$C_6H_5.CH : N.N : CH.C_6H_5 ;$$

the formation of azines from aromatic semicarbazones is a fairly general reaction.

Geological Society, February 16.—Annual General Meeting.—W. Whitaker, F.R.S., President, in the chair.—The reports of the Council and of the Library and Museum Committee having been adopted, the medals and other awards already announced (p. 279) were presented. The President then proceeded to read his Anniversary Address, in which he first gave obituary notices of several foreign members, foreign correspondents, and fellows deceased since the last annual meeting. He then referred to the great advance in geological science in his own time, an advance that consisted largely of the arising of new lines of work and not merely of progress in old ones: thus petrology was a new branch of the science. Palæontology had been affected by the growth of the theory of evolution. In physical geology, such subjects as metamorphism, mountain-structure, and erosion had entered into new phases. In stratigraphy the geological series had been extended downward below the Cambrian, and, at the other end of the scale, our knowledge of the Drift had greatly developed, largely owing probably to geological discoveries connected with the antiquity of man. He then treated of the advance in our knowledge of underground geology, especially in the south-east of England, a subject in which comparatively little was known forty-five years ago; and he described in some detail the underground extension and thickness of various formations, particularly of those below the Chalk, under the heads Upper Greensand, Gault, Lower Greensand, Wealden and Purbeck, Jurassic, Lias and Trias, and Older Rocks, referring to the amount of knowledge which we possess in the London Basin, and its southern border in the Wealden district, as compared with the Hampshire Basin.

February 26.—J. J. H. Teall, F.R.S., President, in the chair.—"The Bunter Pebble-Beds of the Midlands and the Source of their Materials," by Prof. T. G. Bonney, F.R.S. The author states the results of occasional work in the Bunter Conglomerate of Staffordshire. After a sketch of matter already published, he gives additional particulars of the lithology of the pebbles, more especially of the felstones and of some rather compact dark rocks. The mode of transport and source of the pebbles are next considered. The reasons, already published, for a fluviatile, as opposed to a marine, origin are briefly summarised.—"Further Evidence of the Skeleton of *Eurycarpus Oweni*," by Prof. H. G. Seeley, F.R.S. The original specimen from which this species was named was obtained from the Sneewberg (South Africa) in 1876, and after being doubtfully referred to *Dicynodon* was described and figured in 1889. From a sketch the author is able to give some account of the skull, including its dimensions. From other material he gives new facts with regard to the vertebral column, the ribs, the shoulder-girdle, the fore-limb, the hind-limb, and the armour, which was present upon the limbs and the fore part of the body. The locality from which the animal was obtained appears to be one of the chief localities for the Lycosaurian types of Theriodontia, and to be on the horizon of the *Dicynodon*-beds. The recovery of the missing half of the Murray slab, with the evidence of the skull and pelvis which it would give, is to be desired in completion of our knowledge of this fossil animal.

Royal Microscopical Society, February 21.—Mr. Wm. Carruthers, F.R.S., the President, in the chair.—Mr. E. M. Nelson, in presenting a "'Jones' most improved combined microscope and apparatus," said the Society had not hitherto possessed an example of this instrument in its collection. The exact date of the instrument was a little uncertain, but he believed it to be about the last improvement in the non-achromatic microscope. The first published description of this microscope with a figure is to be found in Adams' "Essays on the Microscope," 1798.—Dr. J. W. Measures exhibited the photo-micrographic and projection apparatus made by Carl Zeiss, of Jena. The apparatus was very complete, sufficing both for photo-micrography and for projection. The camera was fitted with a bellows divided into two parts, and though carried upon a stand separate from that which carried the microscope and illuminating apparatus no inconvenience had been found to arise from vibration. An arc light was used supplied by a continuous current of 65 volts and 30 amperes. The condenser, water-chamber, iris diaphragm, and other parts required for illumination were fitted upon saddles sliding upon a Λ-shaped rail in front of the lamp, so that when once they had been accurately centred they could be moved along the rail to any required position without getting out of the centre. The first part of the exhibition illustrated the use of the arrangements for projecting the images of opaque objects upon the screen. This was followed by the exhibition of microscopic slides, comprising insects, plant sections, marine polyps, and preparation of animal tissues chiefly by means of the Zeiss microplanar objectives. The last portion of the exhibition consisted of lantern-slides of plants, animals and landscapes, and some fine photo-micrographs of diatoms, lent for the occasion by Dr. Spitta. The apparatus is constructed so as to render the transition from *micro* to *macro* projection, and the reverse, rapid and easy, the rearrangement of parts being effected in from one to three minutes.

Linnean Society, March 1.—Dr. A. Günther, F.R.S., President, in the chair.—Mr. W. Saville Kent exhibited lantern-slides of several British flowering plants to show the remarkable advances which have been recently made in colour photography.—Mr. C. B. Clarke, F.R.S., read a paper on botanic nomenclature. He showed that the new rule adopted at Berlin—not to disturb names that had fifty years' user on the ground of priority alone—resulted in a practical uniformity with the system of naming adopted by Mr. Bentham and Sir J. D. Hooker. The Old World, he said, had thus reached a fair general agreement in nomenclature. The American botanists follow a new system which aims at finality on a so-called "non-shifting basis" in which the genus or species, as the case may be, is established on a type-specimen. Mr. Clarke's paper was devoted mainly to showing by selected instances that this system did not ensure finality; that the errors in determining what should be ranked as the type are enough to discredit the system; and the author commented on the disputed question whether a plant should be given the oldest specific name bestowed upon it, or the oldest specific name it bears in the genus in which it is now placed.—Mr. F. Chapman read a paper on some foraminifera of Tithonian age from the limestone of Nesseldorf.

Entomological Society, March 7.—Mr. G. H. Verrall, President, in the chair.—Mr. H. Rowland-Brown was elected into the Council and as joint-Secretary in the place of Mr. J. J. Walker, R.N., who had resigned.—Mr. C. G. Barrett exhibited a series of varieties of *Spilosoma dorsalis* from South Africa, showing variation in some degree parallel with that of *S. lubricipeda* in Great Britain.—G. W. Kirkaldy exhibited several Rhynchota of economic interest, among them *Aegaleus bechuana*, Kirk., from Africa, which attacks coffee, and *Parlatoria victrix*, Ckll., from Phœnix, Arizona, found on date palms. The last-named Coccid was originally introduced from Egypt, and all attempts at eradication had hitherto failed. He also showed a series of thirteen colour-varieties of the oriental Scutellerine *Cantao ocellatus* (Thunb.), and examples of *Distantidea vedda* from Ceylon, in which the rostrum was very long, extending as far as to the apex of the abdomen.—Papers were communicated by Mr. W. L. Distant on "Undescribed genera and species belonging to the Rhynchotal family *Pentatomidae*," and by Mr. G. J. Arrow "On Pleurostict Lamellicorns from Grenada and St. Vincent (West Indies)." Mr. C. J. Gahan read a paper on "Stridulating organs in Coleoptera," in which he remarked that one of the best accounts of them was to be found in "The Descent of Man," but since that work was written several additional instances of their occurrence had been made known, showing that these organs were less uniform in structure and even more wonderfully diversified in position than Darwin considered them to be; while their discovery in the larvæ of certain forms would lead to some modification of the view that they have originated in connection with sex and primarily serve the purpose of attracting the sexes to one another.

Mathematical Society, March 8.—Prof. Elliott, F.R.S., Vice-President, in the chair.—The chairman announced that in accordance with a resolution passed at the Council meeting, the meetings of the Society would in future be held at 5.30 p.m. instead of at 8 p.m. as heretofore. The days of meeting will remain unaltered.—Prof. Elliott then dwelt upon the losses to mathematics which had resulted from the recent decease of Prof. E. Beltrami (Hon. Foreign Member), and of Mr. J. J. Walker, F.R.S. The latter gentleman was almost an original member of the Society, had served on the Council some twenty years, had been a most regular attendant at its meetings, and had contributed about twenty papers to its *Proceedings*. He had served as Vice-President four years, and President two years. Votes of condolence were unanimously passed in silence, and the senior secretary was directed to communicate to the relatives of the deceased the sympathy of the Society.—Prof. Lamb, F.R.S., read a paper, "Problems relating to the impact of waves on a spherical obstacle in an elastic medium."—Mr. W. F. Sheppard (Prof. Lamb, Vice-President, in the chair), spoke on the use of auxiliary curves in statistics, with tables for the curve of error.—Major Macmahon, F.R.S., Prof. Lamb and Mr. R. Hargreaves, discussed points which arose out of the communication.—A supplementary note on the theory of automorphic functions, by Prof. A. C. Dixon, was taken as read.

CAMBRIDGE.

Philosophical Society, March 5.—Mr. J. Larmor, President, in the chair.—Considerations regarding the Zeemann effect, by J. Larmor.—On the simplest algebraic minimal curves and the derived real minimal surfaces, by H. W. Richmond. The discovery of real algebraic minimal surfaces of the lowest degrees forms a part of the first of the two classical memoirs on the subject of minimal surfaces contributed by Sophus Lie to *Math. Annalen* xiv. and xv. When Lie's work is examined in the light of the fuller knowledge we now possess concerning space-curves of orders three or four, it appears that it is possible in most cases to write down the equations of the curves and surfaces found by him in a fairly simple form; but that one of the surfaces that he quotes is non-existent.—On Diophantine inequalities, by G. B. Mathews. This is a continuation of a recent paper of Major Macmahon's (*Camb. Trans.* vol. xviii).—Experiments on impact, by J. H. Vincent. When inflated india-rubber balls are allowed to fall on a stone floor the coefficient of restitution, e, is found to be a linear function of the velocity just before impact. This law holds also for a steel ball impinging on a block of india-rubber; but it does not hold for a steel ball impinging on the plane surfaces of blocks of paraffin wax, lead, brass and cast-iron. In these cases the curve obtained by plotting e against v the velocity of approach is convex towards the origin of co-ordinates and all the four curves are very similar; the value of e rises rapidly as v decreases. The permanent deformation produced by the impact was studied in these cases and was found to obey remarkably simple laws.—On the distance between the striæ and on other phenomena connected with the discharge of electricity, by R. S. Willows.—The teaching of mechanics by experiment, by Prof. Ewing. Prof. Ewing pointed out how by a course of suitable experiments students could not only be rendered familiar with the general principles of mechanics but could at the same time learn how to apply these principles to practical questions, and how to detect and allow for the causes which produce aberrations from what may be called the theoretical result. He exhibited in illustration of his remarks a number of self-contained pieces of apparatus for experiments in statics, dynamics and elasticity.

MANCHESTER.

Literary and Philosophical Society, March 6.—Prof. Horace Lamb, F.R.S., President, in the chair.—Dr. F. H. Bowman brought to the notice of the members the results of a series of experiments recently made in regard to the preservation of milk or cream by aeration. He explained that sterilised air is aspirated through the milk or cream in suitable vessels; and, after aeration for about twenty minutes in the sterilised air at ordinary temperature, it is found that the milk or cream so treated will keep sweet for from eight to ten days, though absolutely unchanged in composition in any way; the same milk or cream unaerated will become sour in two or three days. This discovery renders it possible for milk or cream to be kept or distributed in a perfectly pure and natural condition without the use of any preservatives or antiseptics.—On the production of nitric acid from air by means of the electric flame, by A. McDougall and F. Howles. The experiments were carried out with the view of obtaining the best conditions under which the oxidation of the nitrogen took place. The effect of varying the current in the flame was fully entered into, and the results clearly showed that for a maximum oxidation to take place the temperature of the flame must be as low as is consistent with steady working. The mode of obtaining the electric flames in parallel was described, and particulars were given relating to the drop in volts observed at the electrodes when the discharge is running. Various pieces of the apparatus used in the experiments were exhibited, photographs of the larger parts being thrown upon the lantern screen.

EDINBURGH.

Mathematical Society, March 9.—Mr. R. F. Muirhead, President, in the chair.—The following papers were read:—A note on change of co-ordinate axes, by Prof. Steggall.—The conditions for multiple roots of the equation in λ $(a-\lambda, b-\lambda, \ldots\ldots) = 0$, by Chas. Tweedie.—The analytical representation of a potential function by means of cylindrical and spherical harmonics, with applications to Green's problem, by John Dougall.

DUBLIN.

Royal Irish Academy, February 26.—Mr. John Ribton Garstin, F.S.A., Vice-President, in the chair.—Prof. D. J. Cunningham, F.R.S., read, for Prof. W. H. Thompson, a paper by the latter on degenerations resulting from cortical lesions of the temporal lobe.

PARIS.

Academy of Sciences, March 12.—M. Maurice Levy in the chair.—Notice on the works of M. Eugène Beltrami.—On the sexual apparatus and double fertilisation in tulips, by M. L. Guignard. The author has extended his researches on the double fertilisation in the genus *Lilium*. Similar phenomena were observed to take place in *Lilium candidum* to those previously studied in *L. Martagon* and *L. pyrenaicum*, although the work was more difficult in the case of the cultivated species. In *Endymion*, however, there are differences in the female sexual apparatus, since the two polar nuclei, the union of which produces the secondary nucleus of the embryonic sac, approach and touch each other long before the penetration of the pollen tube into the ovule. But although flattened at the surface of contact, they do not fuse, their contours remaining quite distinct.—On survey work carried out by Russian engineers by the photographic method, by M. Laussedat. An account of the survey operations for the Transcaucasian railway. The photographic method is very expeditious, and costs only about one-third of the usual survey.—On a new reaction between certain aromatic aldehydes and the sodium derivative of borneol, by M. A. Haller. The sodium derivatives of three borneols, ordinary dextrorotatory and lævorotatory borneol and lævorotatory isoborneol treated with benzaldehyde in petroleum solution all gave the same benzylidene-camphor. Derivatives are also described in which methylsalicylic aldehyde and the corresponding para-compound are substituted for the benzaldehyde.—On an application of the method of successive approximations, by M. A. Davidoglou.—On the integration of linear equations when the discriminant is not zero, by M. J. Le Roux.—On the extension of the properties of a reduced function to the fractions of interpolation of Cauchy, by M. H. Padé.—The determination of standard points in the spectrum, by M. Maurice Hamy. The author combats the view put forward recently by MM. Perot and Fabry, that the ray $\lambda 508$ of cadmium may vary slightly in wave-length with the form of vacuum tube employed. The cadmium tube without electrodes has shown no sign of variation in the constitution of the rays emitted by it even after working for fifty hours.—Theory of propulsive helices, by M. Rateau.—On gas motors, by M. L. Marchis. An analysis and criticism of the usual treatment of the cycle in gas engines. The usual assumptions lead to the absurd conclusion that the explosion produces no increase of the pressure.—On the experimental study of the Hertz exciter, by M. R. Swyngedauw. According to the theory of Poincaré and Bjerknes, the Hertz exciter emits a deadened vibration, for which the intervals between consecutive zeros of intensity are equal; the authors' views lead to the contrary result, that the intervals between two consecutive zeros should be unequal. The experiments here described show that the minima are not equidistant, and hence confirm the latter theory.—On the capacity of symmetrical conductors submitted to polyphase tensions, by M. Ch. Eug. Guye.—On the minimum volume of fluids, by M. Daniel Berthelot. A discussion of the limiting value of the co-volume.—Action of hydrogen peroxide upon baryta, by M. de Forcrand. A thermo-chemical study of the formation of barium peroxide in aqueous solution. The precipitate formed by mixing dilute solutions of baryta and hydrogen peroxide is regarded as $Ba.[O(OH)]_2$, which on further treatment with baryta gives $Ba[O.O]_2Ba$.—Reply to the remarks of M. D. Tommasi on the electrolysis of distilled water, by M. Th. Tommasina. A question of priority.—On the electrolysis of potassium chloride, by H. André Brochet. As the amount of free alkali present in the solution increases, the formation of hypochlorite diminishes.—Solubility of benzophenone, by M. E. Derrien. Determination of the solubility of benzophenone in twenty-four solvents. The measurements were not carried out at any fixed temperature (9°·6 to 17°·6 C.), and only one figure is given for each solvent.—Dichlordimethylamido-benzoylbenzoic acid, by M. Émile Severin.—The acetals of the phenols, by M. R. Fosse. The method employed is to heat the sodium derivative of the phenol, or a mixture of the phenol, with potash, with ethylidene dichloride in sealed tubes at 120° C. The preparation and properties of the acetals $CH_3.CH(O.C_6H_5)_2$ and $CH_3.CH.(OC_{10}H_7)_2$ are described.—Remarks on the transformation of organic material taking place during germination, by M. G. André. A series of proximate analyses of the Spanish haricot during different stages of germination.—The stores of carbohydrates in the seeds of lucerne, by MM. Em. Bourquelot and H. Hérissey.—Localisation of myrosin and gum in the *Moringa*, by M. F. Jadin.—On the origin and connections of the Arthropods with the class of Onychophores, by M. E. L. Bouvier.—Anatomical study of the male generative organs of the Coleoptera with compound testicles, by M. L. Bordas.—On some new bacteria in coal, by M. B. Renault. In addition to the bacilli and micrococci already described, a new species has been found, named *B. colletus*, and another, badly preserved, resembling the *Streptothrix chromogenes* of Gasperini.—On the regional types of metalliferous layers, by M. L. de Launay.—Synthesis of the vowels, by M. Marage. Two causes have been indicated by M. Marey as being concerned with the formation of vowels, the vibration of the air, and the transport of air in the supra-laryngeal cavities. According to the experiments of the author only the first of these is indispensable.—A new method of stereometry, allowing the stereoscopic determination of the three rectangular coordinates of any point whatever of a radiographic object, by MM. T. Marie and H. Ribaut.—Anodic influence on nervous conductibility in man, by M. S. Leduc.—Contribution to the study of the relations between the chemical constitution and the physiological action of the alkyl derivatives of the alka loids, by M. W. Rosenstein.

DIARY OF SOCIETIES.

THURSDAY, MARCH 22.

ROYAL SOCIETY, at 4.30.—The Croonian Lecture: On Immunity, with Special Reference to Cell Life: Prof. Paul Ehrlich (of Frankfort-on-Main).

ROYAL INSTITUTION, at 3.—Equatorial East Africa and Mount Kenya: H. J. Mackinder.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Storage Battery Problems: E. J. Wade.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Adjourned Discussion on Improvements in the Longworth Power-Hammer, and Portable Pneumatic Tools.—*Paper to be read:* Observations on an Improved Glass Revealer, for Studying Condensation in Steam-Engine Cylinders and rendering the Effects Visible: Bryan Donkin.

FRIDAY, MARCH 23.

ROYAL INSTITUTION, at 9.—Some Modern Explosives: Sir Andrew Noble.

PHYSICAL SOCIETY, at 5.—An Electromagnetic Experiment: Prof. S. P. Thompson, F.R.S.—(1) Some Experiments illustrating Syntony; (2) An Electrical Micrometer: P. E. Shaw.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Development of the Modern Locomotive Engine: J. W. Cross.

SATURDAY, MARCH 24.

ROYAL INSTITUTION, at 3.—Polarised Light: Lord Rayleigh.

MONDAY, MARCH 26.

SOCIETY OF ARTS, at 8.—The Photography of Colour: E. Sanger Shepherd.

INSTITUTE OF ACTUARIES, at 5.30.—The Methods of Analysing and Presenting the Mortality, Sickness, and Secession Experience of Friendly Societies, with Examples drawn from the Experience of the Manchester Unity of Oddfellows: Alfred W. Watson.

TUESDAY, MARCH 27.

ROYAL INSTITUTION, at 3.—Structure and Classification of Fishes: Prof. E. Ray Lankester, F.R.S.

ROYAL GEOGRAPHICAL SOCIETY, at 4.—Methods adopted in Surveying the Cordilleras of the Andes: Prof. Bertrand.

ANTHROPOLOGICAL INSTITUTE, at 8.30.—Native Life and Customs in Sarawak: Lantern Demonstration by Prof. A. C. Haddon, F.R.S.—Discussion by C. Hose, Resident of Baram, Sarawak; Dr. W. H. R. Rivers, and others.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Papers to be discussed:* The Great Central Railway Extension—Northern Division: F. W. Bidder; and The Great Central Railway Extension—Southern Division: F. Douglas Fox.

WEDNESDAY, MARCH 28.

SOCIETY OF ARTS, at 8.—Leather for Bookbinding: Douglas Cockerell.

THURSDAY, MARCH 29.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* On the Retinal Currents of the Frog's Eye, excited by Light and excited Electrically: Dr. A. D. Waller, F.R.S.—Observations on the Electromotive Phenomena of Non-medullated Nerve: Miss Sowton.—Variation: Prof. J. C. Ewart, F.R.S.—Mathematical Contributions to the Theory of Evolution: On the Inheritance of Characters not capable of Exact Quantitative Measurement: Prof. K. Pearson, F.R.S.

ROYAL INSTITUTION, at 3.—Mountain Exploration in the Andes: E. A. Fitzgerald.

CHEMICAL SOCIETY, at 3.—Annual General Meeting.—At 8.30.—Bunsen Memorial Lecture: Sir Henry Roscoe, F.R.S.

SOCIETY OF ARTS (Indian Section), at 4.30.—The Manufacture and Use of Indigo: Christopher Rawson.

FRIDAY, MARCH 30.

ROYAL INSTITUTION, at 9.—Facts of Inheritance: Prof. J. A. Thomson.

SATURDAY, MARCH 31.

ROYAL INSTITUTION, at 3.—Polarised Light: Lord Rayleigh.

CONTENTS.

THURSDAY, MARCH 29, 1900.

CELESTIAL PHOTOMETRY.

Die Photometrie der Gestirne. Von Prof. Dr. G. Müller, Observator am Königlichen astrophysikalischen Observatorium zu Potsdam. Pp. x + 556. Mit 81 Figuren im Text. (Leipzig: W. Engelmann, 1897.)

IN addition to the issue from time to time of the results of original research, the staff of the Potsdam Observatory displays its activity and manifests its usefulness by the publication of text-books, remarkable alike for their thoroughness and for the mastery of the subjects of which they treat. We recently called attention to Prof. Scheiner's work on celestial photography, and we have now to notice a book published about the same time, by his colleague, Dr. Müller, on photometry, a subject which he has made peculiarly his own, especially in researches permitting the application of the Zollner form of photometer. But if in practice he has limited himself to the use of this particular apparatus, his familiarity with the history and literature of the subject, his knowledge of the use and construction of other forms, and his intimate acquaintance with all that has been accomplished in this comparatively recent branch of astrophysics, mark him out as the proper authority for the production of a book on photometry, and constitute him a safe guide and able instructor in an inquiry that is not without its difficulties.

Dr. Müller divides his book into three main sections; the first treats of the elementary principles on which photometry is based, the second deals with photometric apparatus and methods, while the third is devoted to the detailed consideration of the results of photometry applied to celestial objects. In the first section, various elementary problems are discussed, which have been treated by numerous authors, from Lambert downwards. Over these one can rapidly pass, since they occupy, to some extent, a ground common to all photometric inquiries, and have extensive application outside astronomical research. The so-called Purkinge phenomenon and Fechner's psychophysical law are discussed at sufficient length, and may be found attractive since recent controversy has invested these subjects with considerable interest. Of more direct bearing on celestial photometry are the albedo of the planets, the distribution of light over planetary discs, the effects of phase, &c. The latest views of physicists, naturally of German physicists, on these questions are set out in great detail, and various problems which have been discussed in periodical literature are here collected into a convenient and accurate summary. In the third and concluding chapter of the first section we have presented to us a full discussion of the important, but rather thorny, inquiry into the amount of light lost in passing through our atmosphere. The theoretical treatment that this problem has received at the hands of Lambert, Bouguer, Laplace and Maurer (the last better known in this country in connection with the names of Dale and Gladstone) is copiously examined, and not only is justice done to the eminent mathematicians by whom the inquiry has been elaborated, but we have also a comparison between the results of theory and the amount actually deduced from observation by empirical methods, or, at least, by methods in which no theoretical assumptions are made. On the side of practical observation, Dr. Müller has himself worked with vigour and marked success. His table of values, which express the average amount of light extinguished by the atmosphere, as determined for the Potsdam Observatory, probably holds the most authoritative position of all the inquiries that have been instituted. In saying this, we do not leave out of sight, as Dr. Müller has apparently done in his table on p. 138, the work of Profs. Pickering and Bailey in this department of photometric inquiry. It is difficult to understand the reason for this omission. Prof. Pickering's method of observing the brilliancy of a circumpolar star at its upper and lower culmination seems to be free from objection, and has the certain advantage of confining the observations to the plane of the meridian, the plane in which all the observations are made. The amount of his material was so large that some roughness and inaccuracy in his observations would disappear in the results, and his simple formula of $-0{\cdot}25$ mag. sect. Z, applied to the observed magnitude, appears to us quite as deserving of mention as some of the results here collected. Some exception might be taken to Dr. Müller's own value given in the table (p. 138). He has himself made two determinations of the value of the coefficient of transmission of light through the atmosphere; one conducted in the presumably clearer and drier air of the Santis summit, the other at Potsdam, where the results are affected by the dust and vapour due to the proximity to a busy town, but which probably fairly represent the meteorological conditions that prevail in the neighbourhood of most observatories. To the results of the Santis investigation no exception can be taken; but, notwithstanding the general favour in which the Potsdam table is held and accepted, it has the disadvantage of containing implicitly two values of the transmission coefficient. This curious result is due to a change in the manner of observation when dealing with objects at small altitudes. Practically no difficulty will arise in the use of Dr. Müller's table of observed extinction, but we decline to follow the author in his assertion that this peculiarity is an advantage. In the first part of the table, the amount of light extinguished indicates that 81 per cent. of the incident light falling on the atmosphere is effective; while the latter part would show that 85 per cent. emerges. Both of these values cannot be correct; but the coefficient 0·835, suggested by Dr. Müller, represents not only the mean of his own observations, but accords very satisfactorily with the average of all the determinations that have been made. From the theoretical side, it is safe to say that the theory of Laplace represents the actual observations within the accuracy at present attainable.

This agreement between theory and observation leaves untouched Prof. Langley's contention concerning the total loss of radiant energy in a ray of light passing vertically through the atmosphere. While there is no question as to the legitimacy of the objection that Prof. Langley has raised, Dr. Müller is not inclined to accept the high percentage of loss demanded by the American physicist. Dr. Seeliger is quoted as an authority of equal weight, to show that the probable loss of light is only about one-third that suggested by Prof. Langley. With the view of obtaining a more correct determination, Prof. Müller has proposed, in connection with Dr. Kempf, to observe the brilliancy of a star simultaneously, as seen at sea-level and on the top of a neighbouring mountain, thus getting different lengths of atmospheric path; but the few observations that have hitherto been made with this object do not point to any trustworthy conclusion.

In the section devoted to the description of photometric apparatus, one looks for completeness rather than originality, and though Dr. Müller may have omitted some of the forms that have been recommended, yet so many examples have been illustrated and described, one would willingly hope that he has exhausted the entire catalogue. Practically there are only two principles which underlie every form of photometric measurement—extinction, and equalisation of light—but ingenuity has applied these two principles in every variety of method. This variety suggests great dissatisfaction with existing apparatus, and insinuates that a simple, convenient photometer, that would inspire confidence and ensure accuracy, has yet to be invented. After all, the eye is the real photometer; and it may be that here the inherent difficulty, physiological rather than mechanical, exists, though attempts to displace the eye, and to substitute the photographic film, have not as yet led to more satisfactory results. We cannot follow Dr. Müller through the various arrangements of diaphragms and the employment of absorbing media, by which the problem has been sought to be solved on the principle of extinction. Neither can we mention the many advocates of the method of equalisation, who have pressed into the service of photometry rotating discs, reflecting spheres, and other ingenious devices, while the applications of polarised light in various forms are legion. The special department of spectral photometry receives new additions to its apparatus every month; but if any one imagines that he has a new scheme to add to the many already proposed, we advise him to study the critical remarks of our author before venturing on a ground which is already strewn with failures, or, at least, doubtful successes.

The third and concluding section is not the least interesting. Here it is the author's purpose to show what has been accomplished by the application of photometrical methods to the planets and satellites, to the comets and stars. We not only get an historical account of what has been effected, and are thus reminded of the energy that astronomers of this century mainly have devoted to this subject, but are able to appreciate the degree of success that has attended their efforts, and see in what direction future enterprise is possible. From an observer of Dr. Müller's experience we get many critical remarks of great value, and are able to see the exact position in which celestial photometry stands. Perhaps, in the single direction of the application of photography, something more might have been added; but it must be remembered that the author's colleague, Dr. Scheiner, has already fairly occupied this ground, and some large catalogues, like the "Southern Durchmusterung" of Dr. Kapteyn, had not appeared at the time of publication. In this section, where so much is important, it is difficult to select any one topic for comment; but special mention should be made of the references to the observation of variable stars, and the relations existing between eye-estimations of star magnitude and photometric measurement. With this last subject is necessarily connected the difficult question of standards and units of measurement. Over such subjects, to which may be added the desirability of attaining uniformity of scale, some little controversy has hitherto ruled, and perhaps is not yet definitely settled, owing to the diversity in the instruments employed, and the systematic errors introduced, it may be, by abnormal vision. On the whole, Dr. Müller preserves a judicial dignity and impartiality, but some of the strictures concerning the Southern Catalogues produced under Harvard methods and auspices are, we think, undeserved. The lower altitude of the Pole at Arequipa did undoubtedly give rise to great difficulties, but any want of continuity, supposing it to exist, between the Northern and Southern Catalogues can hardly be ascribed to the method of observation. Dr. Müller's own method of establishing numerous points of reference, scattered over the sky, to serve as standard comparison stars, has much to recommend it, but it is a plan that involves long preparation before the work of real cataloguing can begin. How far the increased accuracy of the work repays for this preliminary labour, and to what extent other astronomers will avail themselves of these scattered standards, rather than to trust to a single star, are points that can hardly be decided yet; but every attempt that aims at additional accuracy must be welcomed, and on the side of accuracy we believe that the Potsdam photometric measures stand unrivalled.

AN ILLUSTRATED HISTORY OF MATHEMATICS.

Histoire des Mathématiques. Par J. Boyer. Pp. xii + 260. (Paris: G. Carré et C. Naud, 1900.)

To write within the compass of less than 240 octavo pages an intelligible outline of the history of mathematics from the earliest times to the present day is a task so difficult that its accomplishment might reasonably be thought impossible. Yet by adopting a consistent, if modest, programme, and frankly accepting its necessary limitations, M. Boyer has achieved a considerable measure of success; possibly as much as the scope of his essay could allow. A reader whose mathematical knowledge is only moderate, or even elementary, will obtain from this book some idea, trustworthy so far as it goes, of the contributions made to the science of mathematics by the ancient Babylonians, Egyptians, Indians and Greeks; he will be able to follow the feeble course of geometry and analysis through the Middle Ages, and appreciate to some extent the glorious renascence of the sixteenth and seventeenth centuries; and he will acquire some conception of the work of the giants, from Newton to Laplace, who established the primary landmarks of modern mathematics.

Perhaps the most satisfactory chapters in the book are xiv.–xvii., which cover the period from Descartes to Laplace. It deserves to be specially remarked that M. Boyer discusses the invention of the infinitesimal calculus in an impartial and charitable spirit, and that he does substantial justice to the merits of Cauchy and Monge, who are not always appreciated as they deserve, even by their own countrymen.

As might be expected, the chapter on contemporary mathematics and mathematicians is meagre, and lacking in proportion; but it has the merit of emphasising some, at least, of the most important lines of inquiry, and it is not disfigured by any of those erroneous statements which so often appear in summaries of this kind.

One feature of the book, which will make it attractive to all classes of readers, consists in the illustrations. They comprise four facsimiles of manuscripts, one of the title-page of the "Acta Eruditorum," two plates showing the form of mathematical instruments in the seventeenth century, and nineteen portraits. The portraits are fairly representative, and are derived from authentic originals; one would gladly have dispensed with Mme. du Chatelet and Saunderson in exchange for Gauss and Abel, who are unaccountably omitted.

The appearance of so many popular histories of mathematics lately suggests a few remarks upon the purpose which they are, or should be, designed to fulfil. Their proper object is that of supplying stimulus; and there is no doubt that the interest of a mathematical student is greatly encouraged by historical notes on the subject of his reading. To the teacher, the history of mathematics is a subject not merely of interest, but of vital importance, because the psychological history of a race tends to repeat itself, in little, in the mind of the individual; hence the proper order of teaching a subject is not necessarily the most logical one; and indeed the best compromise between logical sequence and what we may call "historical sequence" is precisely the golden mean at which the teacher must do his best to aim. A popular history does good if it awakens the teacher to some idea of this: the great risk is that he may imagine that the popular history contains all the information that he requires. This is so far from being the case that he may be actually in a worse position after reading his "History" than before. Points of the highest importance are necessarily ignored in a popular treatise, either from want of space, or because the author is afraid of frightening his readers with technicalities. For instance, it is comparatively easy to ascertain the net results of Greek geometry, expressed in modern terminology; but without some acquaintance with the actual works of Euclid, Archimedes and Apollonius, *as they wrote them*, it is simply impossible to have any correct ideas of the aims and methods of Greek mathematicians. If our teachers of mathematics were really familiar even with the "Elements" of Euclid, instead of with a garbled version of a part of it, they would be far better able to discuss intelligently the question of "Euclid and his Modern Rivals."

Again, the real interest of the ante-Descartes period in Europe consists in the gradual improvement of algebraic notation, and of methods of arithmetical computation. This question of notation is of the greatest interest from every point of view. What we have now is simply the survival of the fittest, and may have to submit to modifications more drastic than any of us at present imagine; still it is far ahead of its predecessors, and our admiration of Archimedes and Fermat is greatly enhanced when we realise the wretchedly inadequate notation which they had to employ. To have traced, even in a general way, this advance of notation and method, is far more instructive and important than to know, for instance, that logarithms were invented by Napier of Merchiston, or that Newton discovered the Binomial Theorem; yet very little help in this direction is afforded by the popular history.

A really good history of mathematics in the nineteenth century has yet to be written; it would probably require the combined labour of an organised body of experts, such as those engaged on that invaluable work, the "Encyclopädie der mathematische Wissenschaften." Until such a scientific history has been composed, it is idle to expect anything worth reading in a popular treatise. It may even be questioned whether a popular writer, however competent, could profitably deal with the subject at all, unless our methods of school teaching are greatly modified. For the history of modern mathematics is not mainly that of individual discoveries, however brilliant; but that of the systematic investigation of mathematical notions, such as "number," "continuity," "function," "limit," and the like. If these technical terms are ignored, even a popular sketch of the subject becomes impossible; yet how many of these terms are even approximately understood by any but mathematical specialists? And what is the use of trying to explain the theory of doubly periodic functions to readers who are unaware that, in learning trigonometry, they were studying singly periodic functions without knowing it?

G. B. M.

SCIENTIFIC LENS-MAKING.

Theorie und Geschichte des photographischen Objectivs. Von Moritz von Rohr. Pp. xx + 435. (Berlin: Springer, 1899.)

DR. VON ROHR'S book contains much to attract students interested in the theory and development of photographic lenses. The author is one of the scientific workers attached to Zeiss' manufactory in Jena, and has a practical acquaintance with his subject.

The book is most instructive to an English reader, specially for the reason that while the debt due to the great English opticians of the present day, as well as to those of the past, is freely owned, and the author's appreciation of the value of their work is warm and cordial, yet the contrast between the methods of the English school and those of the pupils of Abbé and Schott is sharply drawn, and it is clear that in the opinion of the author the future is with the latter. Schott and Abbé began in 1881 "to study carefully, as far as possible, all chemical elements, which in any form can become constituents of amorphous compounds produced by fusion, with regard to their influence on the refraction and dispersion of the compounds." On this secure basis is raised the great Jena glass factory, to whose work the scientific world is already so deeply indebted.

We doubt if any English manufacturer would have attempted thus to improve his products; the new methods, the methods which Englishmen must adopt if England is to retain her place among the manufacturing peoples of the world, have not yet found a home among us, and unless a change is made, England must cede the place of honour, not merely in lens-making, but in every branch of manufacture.

But to return to Dr. von Rohr's book. It is divided into two parts, theoretical and historical respectively; the first, occupying about 80 pages of the whole 400 in the book, is clear and interesting so far as it goes, but it is hardly satisfying. The author has abstained, no doubt wisely from some points of view, from attempting to give the mathematical proof of most of his propositions; the result is that the reader is often brought to a standstill with the question—But how does this follow? Without a much greater acquaintance with optics than can be gained from the book, he would find much of it difficult to read with profit. It is all very well to be told, to take at random a very simple example, that the correction for chromatic aberration for two colours depends, for a "thin" lens, only on the focal lengths and refractive indices of the two lenses concerned, and not on the curvature of their faces—so long as the focal length is not altered by change of curvature—but an intelligent reader would like a proof of this.

The author starts from Gauss' theory of lenses, which is only applicable to small pencils centrically incident and inclined at a small angle to the axis; he extends this practically by the assumption that lenses can be constructed for which Gauss' theory, freed from the restriction of nearly direct incidence, would hold strictly; and then he examines the points in which actual lenses differ from this ideal system.

Each error is discussed in turn, the method of correcting it is described, and the possibility of combining the corrections for various errors is considered. Admitting the difficulty of inserting the mathematical proofs, and the probability that if they had been inserted the book would have been useless to many for whom it was intended, it may be said that all this part is well done. The result of the discussion is summed up on page 56, in the section on Seidel's five spherical errors, and the impossibility of completely removing them from a photographic object-glass. A complete freedom from spherical aberration cannot be combined with absence of distortion for all positions of his object.

A further section of this part deals with chromatic aberration; the relations between the conditions for freedom from both spherical and chromatic aberration in a thick lens are specially well treated.

The second, and by far the larger, part of the book is an historical account of the development of a photographic objective, and this is written with great insight and judgment.

It may be felt by some that a too marked prominence is given, in the account of recent years, to the work of the Jena school; such prominence is only natural considering the circumstances of the author, and it is certainly true that he shows a high appreciation of the work of the distinguished English opticians, to whom so much of the advance in photographic lenses is due.

The work is very complete; it begins with the first camera obscura made by Giambattista della Porta in 1589, and carries us down to a lens patented by E. von Hoegh in 1899. The cuts illustrating the various lenses are carefully drawn—as far as possible to scale—reduced to a common focal length of 100 mm., and the nature of the glass used is indicated by special shading. Altogether the book deserves careful study.

EXPERIMENTS ON ANIMALS.

Experiments on Animals. By Stephen Paget, with an Introduction by Lord Lister. Pp. 269; 3 illustrations. (London: Fisher Unwin, 1900.)

THERE are many people who write about experiments upon animals, but only very few who have under their constant notice the actual facts relevant to the subject. In this connection, not merely is a knowledge of fact required, but an intellectuality capable of appreciating the significance of fact. The person most competent from this standpoint is one of the Inspectors under the Act. These Inspectors are most carefully chosen by the Home Office on account of special qualifications which they possess. It must not, however, be assumed that because they are the only officers paid by the Crown they are the only men of science who serve it. Most zealous and somewhat thankless help is afforded to them by those authorities who, by virtue of their position and attainments, are regarded as competent to support the candidate in his application for a license or certificate. It would not, however, be comely for a person holding an official appointment to write a book upon the subject-matter of his office. Every vivisector, a terrible term by which to designate any one who merely pricks a guinea-pig, knows full well that no one, with the above exceptions, is more entitled to write upon the subject of animal experiments than Mr. Stephen Paget, who for twelve years was the active and long-suffering secretary of the Society for the Advancement of Medicine by Research. During this time most licensees under the Act were brought into contact with the author of the book before us.

The volume does not simply concern itself with the working of the Act, but must be regarded as a weighty contribution to the polemical literature of the subject. It shows not only that the Act is vigorously worked by the authorities, but also enters largely into the question of the justification of animal experiment.

The part of the book devoted to this subject will be of the greatest interest to the general reader, and it is sincerely to be hoped that he will take advantage of it, for, while the diatribes of those who oppose all animal experiment are thrust almost weekly into the hands of the public, the *altera pars* says but little. Mr. Paget classifies the experiments that have up to the present been performed upon animals according to the individual field of medical science enriched by their results. The most casual reader must gather from his pages how in almost every domain, medicine, using this term collectively, has learnt from animal experiment, and how the treatment of disease has by its means advanced from mediæval empiricism to its present condition. To twit workers in the medical sciences with the fact that certain discoveries in physiology, established by means of vivisection, have not so far led to the curability of apparently cognate diseases, shows a want of that intellectuality which is capable of appreciating the significance of scientific fact. We might as well deny the value of the discovery of Africa because some parts of it are uninhabitable. As hygienic science advances, and our knowledge concerning both the methods of extinction of pathogenic micro-organisms, and the neutralisation of their injurious products increases, no doubt some of the now malarial swamps will be converted into thriving colonies; and so is it with physiology, when by further experiment our knowledge of the *modus operandi* of the change from the physiological to the pathological is more complete, many facts now apparently barren will bear fruit a hundred-fold.

Those who apparently with such unctuous satisfaction point to the inability of even modern therapeutics to cope successfully with certain deadly diseases, are surely supplying an argument for more experimentation, and not for less. If medicine has not derived the full benefit possible from physiological discovery, it will do so later on. But what is regarded by the anti-vivisectors as a benefit? One of them asks quite recently, and apparently quite seriously, what benefit has accrued to medicine from a knowledge of cerebral localisation.

Mr. Paget deals with many points in detail which have formed the text of many of the more or less scurrilous essays of both varieties of antivivisectionists; he succeeds in showing that their case is only skin deep, and that when care and some erudition are applied to the elucidation of the individual instance, the facts appear in quite another light.

The last part of Mr. Paget's work is devoted to the Prevention of Cruelty to Animals Act itself. He argues, with some reason, that however efficacious the Act might have been in 1876, since then a new science, bacteriology, has practically arisen. This science for the elucidation of its problems requires a special kind of technique, simple enough, but for which the Act is ill adapted. At the conclusion of this chapter some interesting accounts are given of questions in the House of Commons concerning the working of the Act, and some interesting letters reproduced, emanating from antivivisectors, and threatening her Majesty's ministers with political destruction if they failed to use their influence against experiments on animals. The President of the Board of Agriculture seems especially to have incurred their wrath.

OUR BOOK SHELF.

Cyclopedia of Classified Dates. By Charles E. Little. Pp. vii + 1454. (New York and London: Funk and Wagnalls Co., 1900.)

IT may be doubted whether this bulky volume is of sufficient value to justify the immense amount of labour that must have been spent in its compilation. There are no less than 95,000 entries of important (and unimportant) historical events, classified geographically, chronologically, and according to their nature, so that the where, when and what of any event can be discovered. The volume is intended to be a universal history, a biographical dictionary, a geographical gazetteer and many other books combined; in short, an omniscient and international Domesday Book. The only parts with which we have any concern are the divisions of science and nature included among several other groups of events recorded for each of the seventy-nine geographical divisions, which are arranged in alphabetical order. Many of the entries appear vague and trivial, and some are misleading, if not actually incorrect. As instances of information which comes under one or other of these criticisms, the following may be cited:—1089, a widespread earthquake is felt; 1737, Dr. James Bradley discovers the variation (*sic*) of the earth's axis; 1783, Walker produces ice in summer by means of chemical mixtures; 1783, Herschel proves the binding (*sic*) rotary motion of the stars; 1787, quicksilver is frozen without the aid of snow or ice; 1827, the spectrum analysis is worked out by Herschel; 1848, William Lassell discovers the eight (*sic*) satellites of Saturn; 1852, Sir William Thompson (*sic*) discovers the dissipation of energy; 1861, Mr. Thompson, of Weymouth, photographs the bottom of the sea; 1867, nitrous oxide gas (laughing gas) is introduced; 1881, telephotography is invented by Shelford Bidwell; 1890, the bones of a hippopotamus are found imbedded in clay; and there are many others.

But the sins of commission are as nothing in comparison with those of omission. The only events recorded under science and nature in 1894 are the meeting of the British Association, and the departure of the Jackson-Harmsworth polar expedition; in 1893, an earthquake and a flood; in 1892, two earthquakes; and in 1891, the meeting of the international congress of hygiene and demography.

Judging from these facts, no serious attempt has been made to trace the progress of science in any of its branches in latter years. From our point of view, therefore, the book is of little value. In a charitable spirit we trust its merits in other sections help to make up its deficiencies in those referring to scientific matters.

Justus von Liebig und Christian Friedrich Schönbein. Briefwechsel, 1853–1868. By Georg W. A. Kahlbaum und Eduard Thon. Pp. xxi + 278. (Leipzig: Johann Ambrosius Barth, 1900.)

THE correspondence of Faraday and Schönbein, which was noticed in a former issue (Feb. 8), finds a companion volume in the work before us, which comprises 133 letters covering a period of fifteen years. Of these letters, eighty-four are from the pen of Schönbein. The same care as regards editing and annotation which was observable in the previous volume is a conspicuous feature of the present work.

The subjects dealt with by Schönbein are chiefly those which are referred to in his letters to Faraday, more especially ozone and the work arising from his investigations of that substance. Some of the letters are more or less personal and political, and will be found very interesting reading. Liebig's letters also are replete with topics of interest in the history of chemistry, and will repay detailed consideration.

Among the subjects dealt with are fermentation, food preservation, meat extract, and agricultural chemistry. It must be remembered that the views concerning fermentation, and the bearing of chemistry upon agriculture, were at that period in the polemical stage, and this imbues Liebig's statements with special interest. Both writers also from time to time soar from the commonplace recital of facts and discoveries into the higher regions of speculation and philosophy. Liebig's views on the place of Bacon in philosophy and science are referred to by Schönbein with approval (p. 166). Schönbein's views on theory as a stimulus to new discovery (p. 216) will also commend themselves to the majority of readers.

It will be gathered from this brief notice that the volume under consideration is as valuable a contribution to the history of science as its predecessor. R. M.

Cina e Giappone. By E. von Hesse Wartegg. Translated into Italian by Captain Manfredo Camperio. Pp. 536; illustrated by 168 woodblocks, 72 plates, *facsimiles* of manuscripts, and one map. (Milan: Ulrico Hoepli, 1900.)

THE opening up of China to foreign commerce has naturally created a demand for books dealing with the country and its inhabitants considered from every aspect; their religion, their treatment of missionaries, their laws their secret societies, their educational systems, their army, their monetary systems, postal arrangements, banks, theatres, and public institutions generally. This book is a traveller's account of the country, with no pretensions to be regarded as scientific; indeed, in reading the book with a view to matters of direct scientific interest, we have found nothing more noteworthy from this aspect than the description of the Chinese methods of performing calculations and of teaching arithmetic in schools. In connection with Japan, attention is called to the serious competition on the part of the Japanese, which threatens to undermine European commerce in the East; and the translator, as president of an Association for trading with the East, corroborates this view.

Europeans have been engaged by Japanese firms to teach them European methods of manufacture, and Japan is now sending out goods precisely similar to those of European make, and with the trade marks copied on them, and is able to sell them at lower prices than the Germans. It is particularly in the competition to supply the Chinese markets that Japan seems likely to outstrip Germany most effectually.

Practical Chemistry. Part i. By William French, M.A., F.I.C. Pp. xvi + 136. (London: Methuen and Co., 1900.)

An Introduction to Qualitative Analysis. By H. P. Highton, M.A. Pp. xii + 170. (London: Rivingtons, 1900.)

THE many excellent elementary text-books now available for students of chemistry ought to have a very distinct influence upon chemical teaching in schools. The two books under notice differ in several respects, but each is the work of a teacher who knows the capacity of a school curriculum for science, and the limitations as well as the capabilities of the human boy. Mr. French's book follows more or less closely the chemical subjects included in the syllabus of elementary physics and chemistry prescribed for Evening Continuation Schools. The syllabus is a reasonable one, and therefore it has been possible to describe a course of work which will meet with the approval of the advocates of rational methods of instruction in chemistry. Intelligent work in experimental science is now encouraged by the authorities of the University Local Examinations as well as the Education Department; and Mr. French's book provides a course of instruction which may be adopted with advantage, not only by teachers who have the requirements of examiners and inspectors in view, but who desire also to cultivate habits of observation and reasoning in their pupils.

Mr. Highton's book contains a carefully graduated course of practical chemistry which will serve as an introduction to simple qualitative analysis. It is not so distinctly a product of the "heuristic" movement as Mr. French's book, and is largely devoted to systematic analysis. The first part contains simple qualitative experiments and preparations leading up to analysis; while the second comprises all the metals and acid radicals not included in Part i., and met with in simple qualitative analysis. The third part deals with the separation and identification of the separate parts of a mixture of two or more simple salts. After a pupil has been taught to think, a course of practical chemistry such as this may be intelligently performed; but if he is introduced to chemistry by reagents and precipitates, the educational value of his work will be very small. Mr. Highton has succeeded in making a useful course of analytical work for boys preparing for examinations in practical chemistry.

Essai de Chronologie des Temps préhistoriques. By M. Roisel. Pp. 60. (Paris: Felix Alcan, 1900.)

AN essay in which evidence for three glacial epochs is made the basis of a division of the Quaternary period into seven distinct ages, extending from the year 88,000 B.C. to 6500 A.D.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Atmospheric Electricity.

FROM a paragraph in the "Notes" in NATURE of March 1 (vol. lxi. p. 422), it will be seen that the theory advanced by Mr. C. T. R. Wilson, of the Cavendish Laboratory, Cambridge, and recently supported by Elster and Geitel, of the origin of atmospheric electricity is gradually crystallising and becoming accepted, as might be expected when supported by such authorities. This theory is founded on the very beautiful and interesting experiments of these investigators, which show that there are ions in our atmosphere, and that these ions can form nuclei for the condensation of water vapour; and, further, that the negative ions become centres of condensation with a less degree of supersaturation than the positive ones, and consequently during condensation they will be the first to be carried down by precipitation, the positive ions being left in the atmosphere.

Before meteorologists accept this explanation of atmospheric electricity there are some points I would like to place before them for their consideration. These ions do not act as centres of condensation unless the air be highly supersaturated, whilst dust particles are active in saturated air, and some of them in air that is not quite saturated. So that before we can accept this theory of the electrification of the air we must be sure there is such a thing as dust-free air in our atmosphere; because if there is not there can be no such thing as the supersaturated air required to produce this separation of positive and negative ions.

Mr. Wilson is evidently conscious of this difficulty (*Phil. Trans.* vol. cxciii. pp. 289-308), as he adds a note to the end of his paper, in which he states that there is no evidence of supersaturation in the atmosphere; but he also says there is an equal lack of evidence against its existence; and whilst admitting it cannot exist in the lower dust-charged layers of the atmosphere, he is reluctant to give up the theory on that account, and supposes it may be possible that cloudy air may be purified of its dust as it ascends, by the dust particles becoming weighted by the vapour condensed on them, when they will fall, or the air may rise up through them and be dust-free when it escapes. Now any one who has been in clouds, or knows the slow rate at which cloud particles descend, will be aware that this process is an extremely slow one, and compared with movements of the cloud as a whole very insignificant. But suppose we give the cloud every chance to get free from its cloud particles: let it be kept quite still and free from eddies, and time allowed for all the water particles to fall out of it. Now what would be the condition of the air afterwards? Practically what it was before the cloud was formed. There would be a smaller number of dust particles in the air, but there would still be plenty to form a number of clouds in succession if the vapour supply was not exhausted. When a cloud forms in ordinary impure air, only a small proportion of the dust particles become active centres of condensation, whilst many receive no charge of vapour. On the Rigi Kulm (*Trans.* Roy. Soc. Edin. vol. xxxvii. Part iii. No. 28) I have counted as many as 3000 and 4000 dust particles per c c. in clouds, and on one occasion as many as 7700 in a dense cloud. Whilst in fog, which we may call a low-level cloud, I have observed as many as 50,000 dust particles per c.c. With thousands of dust particles in each cubic centimetre it is evident a cloud has dust nuclei sufficient for making a number of clouds should the first formed cloud particles be precipitated, as these dust particles will move with the air, whilst the cloud particles fall out.

No doubt clouds do not always have such large numbers of dust particles in them as the clouds above referred to, but cumulus clouds seem to be always pretty well supplied in that way, especially over continental areas. Then, as the quantity of water to be condensed is limited to the amount the cloud takes up with it from the surface of the earth—as it is not likely to have any vapour added to it unless it falls below the rain cloud level—there seems generally to be enough dust particles to condense all the water.

We must further remember that nature is economical in its use of these dust particles. If the cooling is taking place very rapidly, a large number of particles at once become active, but after a time a number of them lose their load of water by drying up, and only a sufficient number to do the work being retained on duty, the others going to the reserve (*Trans.* Roy. Soc. Edin. vol. xxxvii. Part ii. No. 20). It may be also as well to remember that even supposing all the dust to be precipitated out of the air, nature may be able to manufacture fresh supplies (*Trans.* Roy. Soc. Edin. vol. xxxix. Part i. No. 3). If there are any gaseous impurities in the air, such as ammonia, nitric acid, nitrous acid, peroxide of hydrogen, sulphurous acid, sulphuretted hydrogen, hydrochloric acid or chlorine, the sunshine will convert them into nuclei, which do not require a high degree of supersaturation to make them active centres of condensation.

There is another point in connection with condensation by means of ions which may be referred to here. It does not seem probable that ions could ever cause the formation of a cloud though they might give rise to rain. If the air becomes so supersaturated as to make them active centres of condensation, it will then be in an unstable condition. It will, in fact, be in an explosive state—explosive centripetally and not centrifugally as usual. Whenever any ion, in air in that condition, owing to any advantage of its constitution, or difference of temperature, pressure, or saturation in the air surrounding it becomes active before the others, it will grow extremely rapidly, and at once begin to fall; and as it will fall through highly supersaturated air, it will relieve the tension all along its path, and so grow rapidly, and soon become a rain-drop and fall to the earth. In Mr. Wilson's experiments cloudy condensation takes place with ions as nuclei, but in his apparatus the expansion is nearly instantaneous, and no particular ion has time to take advantage over the others, and many are thus formed at the same instant. There is still another point which requires consideration. What would the effect be in a rising column of air if it could not call on the reserve heat, latent in its vapour, till it had risen to a higher elevation than is necessary when dust is present.

So far as our knowledge goes, it can hardly be said there is such a thing as dust-free air in our atmosphere, and the cases in which low numbers have been observed are so extremely rare that they can hardly have any bearing on a phenomena of such widespread existence as atmospheric electricity, even though we suppose those few particles to be afterwards got rid of. We cannot suppose the positive ions will always remain in the atmosphere, because if the conditions are ever such as to cause the fall of the negative ions, the positive ones will also afterwards fall with only a slightly greater increase in supersaturation.

From what has been stated above, I think we must defer expressing an opinion on the value of this theory of the source of atmospheric electricity, and wait till some stronger evidence is produced that the air in our atmosphere is ever absolutely dust-free, so as to permit of the supersaturation becoming great enough to cause a separation of the negative and positive ions.

Ardenlea, Falkirk, March 17. JOHN AITKEN.

Escape of Gases from Planetary Atmospheres.

IN the "Astronomical Column" of last week's NATURE, on p. 501, you give an abstract of a paper by Mr. S. R. Cook, of the University of Nebraska, and quote the passage in which he points out that the present writer, when investigating the escape of gases from atmospheres, does not base his argument upon "the determination by the kinetic theory of the relative number of molecules which would have a velocity sufficient to enable them to escape from the earth or planet."

This is so: and the reason is that no such determination existed until that arrived at in the paper criticised by Mr. Cook, where data drawn from outside the kinetic theory are employed to supplement what the kinetic theory teaches. These auxiliary data are (1) that the moon has not retained an atmosphere; and (2) that the earth and Venus do retain the vapour of water in their atmospheres.

Mr. Cook supposes that Maxwell's law for the distribution of the speeds of the molecules when a gas exists under normal conditions may legitimately be employed to obtain the rate of the escape from an atmosphere. But in this he overlooks (1) the fact that the molecules that escape are emitted exclusively from that outermost layer of the atmosphere, throughout which the molecules are within striking distance of the void space beyond; and (2) the important circumstance that the molecules exist within this altogether special layer under conditions entirely remote from those which are assumed by Maxwell in the proof[1] of his law; so that Maxwell's law fails us just where we want its help, viz. in that part of the atmosphere from which the entire of the escape of molecules takes place.

This upper stratum of the atmosphere, which is probably some miles in depth, is limited on its inner side by a deeper-seated stratum of air, and on the outer side by a stratum of virtually empty space, that is, by a space tenanted only by molecules which seldom or never meet with encounters while within that space, and are therefore to be regarded as temporarily or permanently beyond the atmosphere. As to the stratum which is above spoken of as the outermost of the atmosphere, molecular encounters take place in it; and whenever an unusual speed is generated in any of the molecules which occupy it (as happens frequently to every molecule of a gas) these molecules have an opportunity of placing themselves beyond the reach of those subsequent encounters which, in gas under normal conditions, are what tone down the frequently recurring irregularities, and bring about an approximate conformity with Maxwell's law within a sufficient volume of gas of uniform density, and surrounded by gas of the same density.

Nevertheless, the numerical results obtained by Mr. Cook, though arrived at by a faulty process, are not useless. They have a certain value, inasmuch as it can be proved that the actual escape of gases from an atmosphere is more rapid than it would be if Maxwell's law governed that rate. Accordingly, Mr. Cook's numbers furnish a computed rate which we know that the actual rate must exceed, and may largely exceed. This in itself is valuable information; and would be important information, if we had no better way of investigating the problem.

Like Mr. Cook, the present writer, when he first entered on the investigation of the escape of gases from atmospheres in 1867 or 1868, hoped that Maxwell's law for the distribution of the speeds of the molecules under normal conditions would render aid; and it was only when he found that to conduct the inquiry in this way could not furnish correct results, that he cast about for some other way of approaching the problem, and finally adopted that which is developed in his memoir.[2]

G. JOHNSTONE STONEY.

8 Upper Hornsey Rise, N., March 25.

State of Practical Instruction in Physics.

WITH the view of obtaining comparative statistics of the organisation of practical instruction in physics, I have recently sent a list of questions, with table of different manipulations, to the directors of all the physical laboratories with the addresses of which I am acquainted.

Through the medium of your esteemed journal, may I ask the directors of the laboratories, who, by any reason whatever, have not received this list, kindly to inform me, so that I may at once forward the same. I should like to make the same appeal to the directors of the mechanical, electrical engineering, electro-chemical, physico-chemical, &c., laboratories where part of the practical work is of a purely physical character.

BORIS WEINBERG.

University of Odessa, Russia, March 17.

Indian Corn.

I HAVE just found in Nakamura's "Kimmō Dzui," first edition, 1666, Book xvi. fol. 7*b*, a Japanese wood-cut of Indian corn, with its Japanese and Chinese names as I gave in my previous letter (p. 392, *ante*). This figure proves that, though Kaempfer does not mention the plant in his "History of Japan," 1727, yet, through his seeing to it, he must have recognised as a fact the introduction of maize to Japan before the time of his sojourn in it; for most illustrations of the biological objects in his noted "History" (vol. i. tab. ix.–xiv.) are actually found to have been reproduced from the above-mentioned, once very popular, Japanese cyclopædia (Books xii.–xv.).

KUMAGUSU MINAKATA.

1 Crescent Place, South Kensington, S.W., March 9.

The Bacteriology of the Soil.

I SHOULD be much obliged if, through the columns of NATURE, you would give me the names of the best books in English or German which deal with soil (agricultural) bacteria.

THOS. T. WATSON.

Rosely Cottage, Collier Street, Carnoustie, March 26.

[1] See *Phil. Mag.* for January 1860, p. 22; or vol. i. of his "Collected Papers," p. 380.

[2] See *Scientific Transactions* of the Royal Dublin Society, vol. vi. Part 13; or *Astrophysical Journal* for January 1898.

THE BIRDS OF AFRICA.[1]

THE appearance of the first volume of the history of its fauna at a time when all our attention is concentrated on South Africa is doubtless in a great degree accidental, although nevertheless opportune, if only as a reminder that, when the present period of stress and anxiety has passed away, there are matters other than war and armaments demanding our attention in that part of the globe. It was a fortunate circumstance that the editor of the series—Mr. W. L. Sclater—was able to secure for his first volume the valuable services of a local ornithologist, well acquainted, not only with the birds themselves, but likewise with their habits and the localities they frequent. Unhappily, the labours in this world of Mr. Stark are ended for ever, his career having been terminated, as he stood at the door of his own house in Ladysmith, by the fragment of a shell which struck him dead almost on the spot. It is said that his last words were "Take care of my Cat.," doubtless referring to the present volume and its successor, of which latter we believe we are right in saying that the MS. was complete at the time of the author's death.

The fact that Mr. Stark's last thoughts were for the safety of the scientific labours on which he had expended so much time and care confers a pathetic interest on the appearance of the volume before us, and should go far to disarm hostile criticism, were such otherwise called for. Fortunately, however, under no circumstance would there apparently be much, if any, room for unfavourable comments, as the execution of the work seems, from all points of view, excellent and praiseworthy.

As stated in the editorial preface, the series, of which the present volume forms the first instalment, is intended to deal with the fauna of that portion of Africa lying to the southward of the Zambesi and Cunene Rivers; and therefore includes, not only the very peculiar and restricted assemblage of animals characteristic of Cape Colony and the other districts south of the Orange River, but likewise embraces a large stretch of country whose animals have a wider geographical range. The present volume treats of about one-half the total number of Passerine birds met with in the area under consideration. It is satisfactory to find that in the treatment of his subject the author has seen fit to follow, so far as practicable, the plan of arrangement and description adopted by Mr. Oates in his contribution to the "Fauna of British India," under the editorship of Mr. Blanford.

Accordingly we have, so far as the present volume and its successor are concerned, the great advantage of having the faunas of the two great old-world dependencies of the British Empire described on a similar plan, so that they are readily comparable with one another. And how extraordinarily different is the avian fauna of South Africa—especially as regards its host of peculiar generic types—from that of Peninsular India, can be ascertained at a glance by comparing the systematic index in Mr. Oates' volumes with that in the one now before us.

And yet, in spite of this great general faunistic difference, there are in birds, as in mammals, a certain number not only of generic, but likewise of specific types common to the two areas. A case in point is afforded by the Spotted Creeper (*Salpornis spilonotus*), the African and Indian forms of which are regarded by the author as worthy only of subspecific distinction. And we are glad to notice that, not only does the author give an unqualified adherence to the manifold advantages offered by trinomial nomenclature, but that he has not been frightened by the bugbear of "absence of connecting links" out of regarding closely allied, but widely separated, forms as local races. Consequently we have the African representative of the Spotted Creeper appearing as *Salpornis spilonatus salvadorii*, while the Indian form would be distinguished as *typicus*.

As regards the general scheme of classification for the "orders," the author adopts the one proposed by Dr. P. L. Sclater in 1880; and although there are doubtless some respects in which this scheme is susceptible of emendation, it is a very workable one, and has the great merit of simplicity.

A somewhat instructive parallel may be drawn between the avian and mammalian faunas of South Africa. Attention has been already drawn to the large number of genera of birds peculiar to Africa, notable examples occurring in the families of the Starlings (*Sturnidae*) and Weaver-Birds (*Ploceidae*); and these may be regarded as the analogues of the many genera of Antelopes likewise characteristic of the country. But the parallelism by no means stops here. Many of the species of the Antelopes (as well as other mammals) are restricted to the area south of the Orange River, but are represented by kindred types in the districts to the northward of that river. Among the Passerines we may notice the Red-shouldered Glossy Starling (*Lamprocolius phaenicopterus*), the Cape Weaver-Bird (*Sitagra capensis*), the Cape Long-tailed Sugar-Bird (*Promerops cafer*), and the Cape Sun-Bird (*Cinnyris chalybeus*), as well-known species exclusively confined to the Cape, but represented in Natal or in districts still further north by allied species or subspecies, precisely in the same manner as are Antelopes. Evidently, therefore, we have to deal with some deep-seated cause which has modified a large portion of the Cape fauna; but the exact nature of this cause has yet to be worked out.

So far as we have had an opportunity of testing them, Mr. Stark's diagnoses and "keys" to the various genera and species he describes are all that the most exacting ornithologist can desire. But the work is very imperfectly described, as in the lamented author's last words, as a mere "Catalogue." On the contrary, it contains some delightful and interesting descriptions of the habits and mode of life of African birds, of which we know far too little. Witness, for instance, the author's description of the "showing-off" of the male of the Cape Long-tailed Sugar-Bird,[1] the illustration of which we are enabled by the courtesy of the publisher to reproduce. "Towards the end of April or beginning of May," he writes, "the males, when not feeding, fighting, or chasing one another with shrill cries, may be usually seen perched on the summit of some prominent bush or young pine-tree, their long, flexible and curved central tail-feathers blowing about in the wind, often in a reversed curve over the bird's head. At intervals one of them will mount twenty or thirty feet in the air, incline his body backwards, violently jerk his tail up and down, and at the same time rustle the feathers together, and bring his wings with sharp, resounding 'claps' against his sides, before returning to his perch to indulge in an outburst of song. Occasionally a male may be seen to throw the longer tail-feathers into a double curve. At the same season the hens amuse themselves by flying round and round in a small circle."

Special attention has been devoted to nidification, and the illustration on page 76, in which the nests of three species of Weaver-Birds are shown in a single tree, is highly noteworthy. Still more remarkable are the three enormous dome-shaped nests of the Sociable Weaver-Bird depicted in the photogravure on page 117. Before dismissing the subject of illustrations, it may be mentioned that these are in the main restricted to the head and wing, which afford the best diagnostic features of the species described. The mere fact that they were drawn by Mr. Grönvold is a sufficient guarantee of the excellence of their execution.

[1] "The Fauna of South Africa. Birds." Vol. i. By A. C. Stark, M.B. Pp. xxx + 322, illustrated. (London: R. H. Porter, 1900.)
"The Birds of Africa, comprising all the Species which occur in the Ethiopian Region." By G. E. Shelley. Vol. i. 1896. Vol. ii. Part i. (London: R. H. Porter, 1900.)

[1] The only error we have hitherto noticed in the book is that this illustration is lettered *Promerops capensis* instead of *P. cafer*.

In conclusion, we can scarcely bestow a higher meed of praise on the labours of the late Mr. Stark than the expression of the hope that the subsequent volumes of this valuable series will be equal in merit to the one before us.

Captain Shelley's work covers a much wider field than that of Mr. Stark, embracing all the birds of Africa south of the Tropic of Cancer, together with those of Madagascar and other islands off the African coast. In other words, it describes the avi-fauna of the Ethiopian region in its more extended sense. A notable feature of the second part is the beautiful series of coloured plates with which it is illustrated; the portraits of the birds, as in all Mr. Grönvold's work, being remarkably true to nature, and at the same time forming artistic pictures.

The first volume, which made its appearance four years ago, consists of a classified list of the genera and species of African birds, with references to the works in which the names first appeared. With the second volume commences the descriptive portion of the work; the first part, in addition to containing the Angola Pitta and the two other Ethiopian representatives of the "Oligomyodæ," being devoted to the beautiful Sun-Birds, or *Nectariniidae*.

With reference to the plan of the work, it is stated in the Introduction that it will "consist of a series of handy volumes complete in themselves," and that the second volume "will be an acceptable work to the Field Naturalist, for whom many of the notes will be specially intended." From these statements, we venture to think, it may be inferred that the work is intended to supply all the needs of the African ornithologist when working alone in the wilds, far away from a library. But, on examination, we doubt whether this is altogether the case. For example, when the genus of a bird has been changed, there is in most cases no possibility of finding out the name under which it was originally described; the references in the first volume merely giving the name of the author of the species, and the place and date of publication, without mention of the genus. Neither can we approve of the mode of arrangement of the references themselves. We have, for instance, on page 89, the following, viz.:—*Chalcomitra senegalensis* (Linn.), Shelley, B. Afr. i. No. 47 (1896); *Cinnyris senegalensis*, Shelley, Mon. Nect. p. 267 (1878); *Nectarinia senegalensis*, Bocage, J. f. O. 1876, p. 435. Apart from the omission of the references to the Linnean genus and place of publication, the arrangement of these references is, we venture to submit, totally unjustifiable, and they should have been put in just the reverse order, when they would accord with their chronology. As a matter of fact, references to the author's previous works are, we think, a great deal too prominent. Moreover, the complicated system on which the author makes his references is liable to lead to great confusion in the event of any typographical error. For example, the omission of a couple of brackets on page 95 of the first volume would lead the reader to believe that a certain bird was described as *Newtonia brunneicauda* three years before the date of publication of the generic name!

In regard to the arrangement of the families of Passeres, it is a matter for regret that there is much divergence between the present work and that of Mr. Stark. In the latter the arrangement is from the highest to the lowest, commencing with the *Corvidae*, and concluding with the "Oligomyodæ." Captain Shelley, on the other hand, adopts the opposite plan, commencing with the "Oligomyodæ"; and in this he is no doubt perfectly justified, although we are at a loss to ascertain why he follows on immediately with the *Nectariniidae*, which are usually placed near the middle of the series. Apart from this, we have no hesitation in saying that, in a matter which is really of no importance at all, it would be a great convenience if ornithologists could agree to follow the same method of arrangement of the families. And this reminds us that there is another difference between Captain Shelley and

FIG. 1.—Male of the Cape Long-tailed Sugar-Bird "showing-off." From Stark's "Birds of South Africa."

Mr. Stark; the former adding the termination "formes" to the names of the orders. Here again, although we regard the addition of the termination in question as totally superfluous, and at the same time ugly, we should be quite prepared to sacrifice our personal prejudices for the sake of uniformity.

The descriptive portion of the work appears to be carefully executed, and the "keys" seem to be well drawn up. While quoting from the publications of the numerous field-naturalists who have written on African ornithology, Captain Shelley is by no means dependent altogether on the observations of others for his accounts of the habits of many of the birds he describes, since he himself has twice visited Egypt, and has likewise travelled in Cape Colony and Natal, where he had the advantage of meeting such well-known local ornithologists as the Messrs. Ayres. As a "bird-country" Captain Shelley speaks very enthusiastically of Africa, observing that it "may fairly claim to be the metropolis of the song-birds, for the bush resounds with their melody; it is the winter home of a large proportion of our most attractive small birds, such as the nightingale and the many warblers which enliven our English gardens and surrounding country in summer, as well as the swallow, our well-known harbinger of spring."

Mention has already been made of the beauty of the plates illustrating the second part, and it may be added that the typography and general "get-up" of the work are beyond praise. If the same high standard be maintained in the succeeding issues, the complete work cannot fail of proving highly attractive to all bird-lovers.

R. L.

NOTES.

PROF. W. C. BRÖGGER, of the University of Christiania, the distinguished Norwegian geologist, will deliver the second course of the George Huntington Williams memorial lectures at the Johns Hopkins University during next month. Prof. Brögger is the most prominent Scandinavian geologist, and has published a series of memoirs upon the geology of Southern Norway that have given him rank among the leading investigators of his time. As the Williams lecturer, he follows Sir Archibald Geikie, who opened the lectureship two years ago with a course upon the founders of geology. Prof. Brögger will lecture upon modern deductions regarding the origin of igneous rocks, a subject that has commanded the attention of many geologists in recent years.

THE Royal Meteorological Society will attain its jubilee on Tuesday next, April 3, having been founded on April 3, 1850. The celebration of this fiftieth anniversary will be commenced at a commemoration meeting to be held on Tuesday afternoon, when the President, Dr. C. Theodore Williams, will deliver an address, and delegates from other societies will be received. A conversazione will be held at the Royal Institute of Painters in Water Colours in the evening. In addition to the pictures in the galleries, there will also be an exhibition of meteorological instruments, models and photographs, and lantern demonstrations will be given by Colonel H. M. Saunders, Mr. T. C. Porter and Mr. W. Marriott. On Wednesday, April 4, there will be an excursion to the Royal Observatory, Greenwich, and a dinner at the Westminster Palace Hotel. As a memento of the jubilee of the Society, a bronze commemoration medal, bearing on the obverse a portrait of Luke Howard, F.R.S., has been struck.

THE New York *Electrical Review* states that the North German Lloyd has decided to equip all its swift steamships with wireless telegraphy apparatus to announce their proximity to the German coast. The *Kaiser Wilhelm der Grosse* has been equipped with the necessary instruments, and a similar outfit has been installed on an island near the mouth of the Ems in the North Sea. The ship will thus be able to exchange signals with the mainland long before she is sighted, or has passed out of view when outward bound. The question of installing wireless telegraphy apparatus on the Nantucket Shoals Lightship, off the Massachusetts coast, is under consideration by the Lighthouse Board. Incoming steamships, similarly equipped, could thus be reported many hours before they could be sighted at Fire Island.

M. CREVAT-DURAND, who recently died at Fontainebleau, bequeathed to the Pasteur Institute the sum of 100,000 francs.

DR. PATRICK MANSON, professor of medical pathology at the English Colonial School of Medicine, has been elected an associate of the Paris Academy of Medicine.

IT is stated that Dr. Edward Ehlers, of Copenhagen, is about to proceed to Crete to make arrangements for the segregation of the lepers on the island. There are about 2000 of these, and they will be placed on a small island off the north coast.

THE death is announced, at New York, of Dr. Oliver P. Hubbard, formerly professor of chemistry and geology in Dartmouth College, and one of the founders of the American Association for the Advancement of Science.

IT is reported that the Lemaire scientific expedition has reached Tenka, after a successful and peaceful journey of 3000 kilometres along the border of the Congo State. Three days east of Lualaba Mission the expedition met Major Gibbons, who was on his way to Tanganyika, *via* Lafoi, and thence to the Nile.

WE learn from *Science* that under the direction of Prof. A. A. Wright, of Oberlin College, systematic excavation has been commenced in Brownhelm, Ohio, near Lake Erie, and about twelve miles from Oberlin, to recover mastodon remains, the first of which were discovered several years ago. The jaws and head, both tusks, together with a number of ribs and vertebræ, have been obtained in a good state of preservation.

THE Royal Scottish Geographical Society proposes to organise a purely Scottish expedition to the South Pole to work in conjunction with the British and German expeditions. The sphere of the expedition will be the Weddell sea quadrant, south of the Atlantic Ocean, while the British expedition will explore to the south of the Pacific Ocean and the Germans to the south of the Indian Ocean. The leader will be Mr. William S. Bruce, who visited the Antarctic regions in 1892 and 1893.

AT the last meeting of the Paris Société d'Encouragement, the president, M. Carnot, referred to the death of Prof. S. Jordan, a member of the council of the society. Prof. Jordan was professor of metallurgy at the École centrale for many years, and was widely known among metallurgists and engineers. He was a member of the Comité des Arts chemiques, and represented more particularly the metallurgy of iron and steel. It was upon his report that the society awarded the Lavoisier medal to M. Osmond in 1897, for his excellent researches on the microstructure of steel.

IT was mentioned last week (p 498) that a gentleman had given the Scottish Meteorological Society a donation of 300*l.* to be spent during the next two years in the discussion of the results of the observations made on Ben Nevis and at Fort William since 1881. By the patriotic generosity of Mr. Mackay Bernard, of Dunsinane, whose three donations amount to 1500*l.*, the observations will be carried on to the end of next year. By the 1000*l.* presented by the Royal Societies of London and Edinburgh, the hourly and other observations will be printed *in extenso*, filling three volumes of the *Transactions* of the Royal Society of Edinburgh; and by the gift of 300*l.* just received, the necessary clerical assistants will be engaged to enable Dr. Buchan and Mr. Omond to lay before the scientific world the results of the great experiment in meteorology undertaken by the Directors of the Ben Nevis Observatories in 1881.

THE Society for the Protection of Birds had a year of active work to report upon at the annual meeting held a few days ago. Several new publications were issued during 1899, fifty-nine lectures were delivered, and petitions were sent to various responsible officials and authorities asking for their sympathy and assistance. Steps have been taken to prevent the exportation of Birds of Paradise and others from British New Guinea; the wearing of osprey plumes by the officers of the Hussar and Rifle Regiments, and of the Royal Horse Artillery has been discontinued; and turbans have been substituted for the caps with birds' plumes formerly worn by the body-guard of the Viceroy of India. Orders for the protection of rare birds are in force in many parts of the British Isles, but they are numerous and complicated instead of being few and simple. Efforts are now being made to obtain Parliamentary approval of a Bill designed to simplify and consolidate the present law relating to the protection of wild birds, and practically introducing but one change, viz. to extend protection during a close time to all species and their eggs, leaving it to the various county councils to obtain orders exempting from protection within their administrative areas those species which are destructive or too numerous. Such a law would be far easier to understand and administer than the present intricate and varying regulations.

AN admirable summary of the methods used to preserve food in ancient as well as in modern times was given by Dr. S. Rideal in a paper read before the Society of Arts on March 21, and published in the current number of the Society's *Journal*. There are only a few early allusions to the use of salt, vinegar, nd allied substances, to keep food from putrifying, and none of much importance. After either smoking, salting or drying, the characters of fresh food cannot be restored. It was not till the middle of the nineteenth century that it was discovered that small quantities of certain antiseptics would enable the original qualities to be retained, and prevent decay for a considerable period, with less influence on digestion than the old curing processes. Utilising the fact that fermented liquids remain stable for long periods, Bethell, in 1848, patented a process for preserving milk, which consisted in first boiling the milk to expel all the air contained in it, and then saturating with carbon dioxide; when so treated, the liquid remains fresh for a long time after being opened. More recently, compressed oxygen and sterilised air have been tried for preserving milk. Butter, when kept in carbonic acid, at a pressure of six atmospheres, often remains unchanged for four or five weeks. But experiments have shown that carbonic acid, though generally effective for mineral waters, will not of itself prevent changes in milk or meat. Moreover, with regard to the sterilising effect of carbonic acid in mineral waters, Dr. Otto Hehner has examined many such waters and found them swarming with germ life. A great variety of substances containing boric acid are used as preservatives at the present time, especially for the preservation of milk, cream and butter. There is, however, a wide difference of opinion as to the effects of preservatives upon the consumer of the food containing them, and the whole matter is being inquired into by a Departmental Committee.

THOUGH we have as yet no agricultural experiment stations comparable with those of the United States, Canada, and elsewhere, a large amount of valuable work is being done in connection with the agricultural departments of some of our colleges, and by other organisations. Two reports upon work of this kind are before us—one containing the results of experiments made by the agricultural department of the Yorkshire College, Leeds, and the other the *Proceedings* of the Agricultural Research Association, N.B. One of the papers in the former describes the effect of various fertilisers upon the production of meadow hay, which is one of the chief objects of farmers in the West Riding. Among the conclusions arrived at as the result of experiments on clover are:—"Nitragin, a preparation used for inoculating soil with the bacteria that are found in the nodules of clover roots, did not increase the crop."

THE work of the Agricultural Research Association covers a very wide ground. Among the useful results of the investigations carried on under its auspices are the following:—The demonstration that insoluble finely ground mineral phosphate is as effective as soluble phosphate. This led to the use of coprolite and phosphatic slag instead of soluble phosphate, and thereby reduced the cost of phosphate to the farmer; discovery of aperture in root hairs, giving explanation of the absorption into the plant of insoluble matter; determination of the relative values of different forms of nitrogenous, phosphatic and potash manures—leading to economy in the selection of manures for turnip, grain and grass crops; the cause of finger and toe disease in turnips, and means for its prevention. Inquiries on grasses and clovers which indicated the most economical grass mixtures to use, explained the poorness of rye grass pastures and showed the remedy, and led to the suggestion of a ten-year rotation. This rotation is being gradually adopted in practice. The chief subject of investigation at present on hand is an inquiry into the natural cross-fertilisation of oats. Most satisfactory confirmation has been got, during the past season, that an increase is attainable in the yield of the oat crop by means of such natural cross-fertilisation. It now appears that the increase that may be expected by this method is substantial, and it is one which does not involve any outlay. Experiments are now being made to discover the cross which gives the best crop. Several other inquiries are being proceeded with, but they have not reached the stage for being reported upon. We regret to see that certain of these inquiries have had to be stopped for want of funds, but it is hoped that an opportunity may soon arise to admit of their being taken up again.

WE have received from Mr. R. C. Mossman a paper on the price of wheat at Haddington from 1627 to 1897, read before the Scottish Society of Economists. It is a rather laborious compilation, for, although dealing with local wheat prices, it necessarily has to take into consideration many conflicting interests outside the district under discussion. The results are clearly shown in a diagram, in which the mean annual temperature of the air in Edinburgh since 1764 is also given. Previous to this date the observations were non-instrumental, and have been extracted from such works as Lowe's "Natural Phenomena." The relation between temperature and prices during most of the period for which the information is available is clearly seen on looking at the two curves. The most extraordinary prices occurred in 1800 and 1812 (134*s.* 9*d.* per quarter). In the first case heavy rains and a low temperature in August were the chief causes. In the second case the high price was due to the deficiency of the 1811 crop, without the means of obtaining any from abroad. Since 1873, when the price was 64*s.* 8*d.* per quarter, there has been a rapid and almost uninterrupted fall in price, the most potent factor being the great increase in the wheat area of the United States, the lowest figure being 26*s.* 6*d.* in 1894. The rise in 1879 (53*s.* 6*d.*) was due to the unparalleled severity of the weather, and the rise in 1891 (46*s.* 7*d.*), although the wheat harvest of the world was much above the average, was due to a severe and extensive rye famine in Russia, and to the supply in two preceding years being inadequate to meet the demand.

FROM a lengthy "note" on the food supply of the United Kingdom, Belgium, France and Germany, by Mr. R. F. Crawford, published in the *Journal* of the Royal Statistical Society, we learn that the average dietary of an inhabitant of the United Kingdom contains a much larger quantity of meat than that of a Belgian, Frenchman or German, but a smaller proportion of bread and potatoes. In Belgium more bread and less meat are consumed than in any of the other countries named, while in France a noteworthy feature is the apparently small consumption of milk. In the case of potatoes, the consumption per head in Belgium and Germany is about three times that in Great Britain, but the considerable requirements are largely accounted for by their use in the manufacture of starch and spirits.

A FRESHWATER chert from Asia Minor is the text of Mr. W. T. Haydon's presidential address to the Liverpool Microscopical Society, published in the thirty-first annual report of the society. The investigation was based on the examination of some "worked flints" from Hermanjik imported in cargoes of horse beans, which flints were doubtless used as teeth in threshing boards. Thin sections of the flints were remarkably rich in organic remains, chiefly vegetable, including mosses, hepaticæ, pine pollen grains, ferns and grasses; while remains of mollusca, diptera, spiders, &c., were also found. In endeavouring to explain the origin of the silica forming this deposit, an examination was made of some chalk-rock from the same neighbourhood, and this was found to contain great numbers of unmistakable remains of *diatoms*, but all traces of these disappeared in hydrochloric acid. Mr. Haydon's conclusion is that the flint deposits derived their silica from the diatoms, and that the forms of the latter, as represented in the calcareous rocks, were "pseudomorphs" whose silica was replaced by calcite.

A NOTE on the use of formalin as a preventive of silkworm disease is given by Prof. G. Gianoli and Dr. E. Zappa in the *Rendiconti del R. Istituto Lombardo* (xxxiii. 2, 3). From experiments, it appears that the diffusion of formic aldehyde in the form of vapour through the breeding chambers containing the silkworms is not a certain preventive of *Botrytis bassiana*, a fact which the authors attribute in some degree to its high chemical activity, which causes it to be absorbed by various objects, such as the leaves on which the silkworms feed. On the other hand, the presence of this vapour produces a diminution in the weight of the cocoons, and a deterioration in the quality of the silk.

IN the March number of the *Zoologist* Mr. J. H. Gurney gives a plate of one of the so-called "Chestnut Partridges" which have recently excited so much interest in Norfolk. It is stated that a local race of these abnormally coloured birds has now been established; the figured specimen being the twelfth example.—The same number contains the conclusion of Mr. Distant's article on "Mimicry," to which allusion has been previously made in these columns. "The theory of mimicry," writes the author in his concluding paragraph, "is probably the still imperfect recognition of a great truth which is struggling to survive a mass of more or less irrelevant evidence too frequently offered in its support. . . . Whatever view be held, this alone is certain, that the theory in either its demonstrated or suggestive enunciation has been the means of a vast record of facts pertaining to the life-histories of animals and plants which would otherwise have remained either unobserved or disregarded." Can more be demanded in favour of any working hypothesis?

MISS ELEANOR ORMEROD'S Twenty-third Report on Injurious Insects and Common Farm-Pests has just been issued. From this it appears that during 1899, in addition to the ordinary insect infestations, there occurred developments of species which had hitherto been but little noticed. None of the infestations were of a very serious nature, with the exception of the so-called Turnip-Fly, which was very prevalent in some parts of the country. A feature of the year was the marked absence of injury to root-crops by visitations of Caterpillars and Mangold-leaf Fly; while orchard-haunting Caterpillars, as well as those of the Gooseberry and Currant Moth, were likewise conspicuous by their absence. Hessian Fly was recorded from one district; and in this connection the author draws the attention of farmers to the extreme importance of destroying wheat-screenings containing the pupæ of this noxious insect, in the form of the so-called "flax-seeds." A section of the Report is devoted to the Grouse-Fly, which appears to be more interesting to the entomologist than harmful to the prospects of the sportsman, as there is no evidence that it does any appreciable injury to the birds it infests. The remarkable structure of the foot of this insect is illustrated by a tinted plate.

A *Bulletin* of the U.S. Department of Agriculture, by Dr. L. O. Howard, on "Some Results of the Work of the Division of Entomology," bears testimony to the attention bestowed on the mitigation of insect ravages to crops and trees on the other side of the Atlantic. A large portion of this *Bulletin* is devoted to the life-history of two scale-insects of the genus Pulvinaria, which infest maples, and occasionally do much harm to these valuable shade-trees in various parts of the Eastern United States. The second article treats of the insects which (together with the newspapers, as it is significantly remarked) were responsible for the so-called "kissing-bug scare" of the past summer; the account being published mainly to satisfy a shoal of inquirers as to the truth of the newspaper stories. Reports on the devastation caused by locusts in the Western Territories during 1899 are of especial interest at the present time on account of the recent arrival of flights of the true Rocky Mountain Locust (*Melanoplus spretus*) in certain districts of the North-west. Housekeepers in many parts of the world will be interested to hear of a simple Australian remedy for cockroaches, consisting of a mixture of flour and plaster of Paris, which is greedily eaten by the insects and rapidly sets in their stomachs.

YET another serial dealing, in part, with insect pests is to hand, in the form of the February number of the *Agricultural Gazette of New South Wales*. The contents of this number are varied and interesting, ranging from such subjects as the proper mode of stretching barbed wire and the pruning of plants, to the incubation of eggs and the bacteria found in milk and butter. It is undoubtedly a healthy sign when it is considered advisable to teach poultry-raisers the changes which take place in eggs during incubation; and the excellent figures with which these changes are illustrated, as also those displaying milk and butter bacteria, are worthy of the highest commendation.

M. E. LAURENT has an interesting note, in the *Bulletin* of the Royal Botanical Society of Belgium, on the distribution of the mistletoe in that country. While almost entirely absent from Holland, its distribution in Belgium is local, and appears to have some connection with the nature of the soil, preferring that of a calcareous character. The trees on which it either grows naturally, or has been artificially inoculated, are *Salix viminalis* and *grandiflora* (?), the fig, the olive, *Eucalyptus globulus*, the oleander, the hawthorn, the apple, the pear, the medlar, the quince, and *Malus spectabilis*. On *Ficus elastica*, *Spartium junceum*, and some varieties of the pear, the berries of the mistletoe appeared to produce a poisonous effect. Somewhat similar results as to the influence of the nature of the soil on distribution were obtained with the dodder.

UNDER the title of "The Temple Cyclopædic Primers," Messrs. Dent and Co. have commenced the publication of a series of little volumes on scientific and other subjects. "An Introduction to Science" is written by Dr. Alex Hill; and an "Ethnology" has been translated by Mr. J. H. Loewe from the German of Dr. Michael Haberlandt. The books are both attractive in appearance and instructive in contents; and they should bring a large public in touch with scientific work and thought. Students of science as well as general readers will find the volumes well worthy of consideration.

THE advantages of quartz as a thermometric substance as compared with glass are well known, and since the well-known experiments of Mr. Boys on the behaviour of quartz near its melting point, numerous attempts have been made to produce quartz tubes. M. Dufour, who describes his experiments in the current number of the *Comptes rendus*, has been able to constructs quartz thermometers, two of which are described, one carrying tin as the thermometric liquid, and hence suitable for temperatures from 240° C. upwards. The second instrument contained mercury, and was constructed with the view of comparing its zero residues with those of a glass thermometer.

THE limiting value for the molecular depression of the freezing point in solutions of non-electrolytes, when these solutions become infinitely dilute, is a constant of great importance in the van 't Hoff theory of solution. Raoult, Abegg and Loomis are among the best known workers in this field, and in the current number of the *Zeitschrift für physikalische Chemie* is a contribution by the last named in which the numerous difficulties surrounding the apparently simple operation of taking a freezing point are discussed. The limiting value in extreme dilution for the molecular depression of a considerable number of non-electrolytes of different constitution is the same, 1·86. This is exactly the figure which is obtained from van 't Hoff's well-known formula, if the latent heat of fusion of ice be taken as 79·3 thermal units.

THE additions to the Zoological Society's Gardens during the past week include a Sooty Mangabey (*Cercocebus fuliginosus*, ♀) from West Africa, presented by the Rev. A. Christopher; a Jaguar (*Felis onca*) from Brazil, presented by Mr. Rodriques; two Martinican Doves (*Zenaida aurita*) from the West Indies, presented by Mr. G. R. Phillipps; a Great Bustard (*Otis tarda*, ♂), European, presented by Mr. E. G. B. Meade-Waldo; a Pine Marten (*Mustela martes*) from the Spanish Pyrenees, a Snowy Owl (*Nyctea scandiaca*), European; a Pin-tailed Sand Grouse (*Pterocles alchata*), a Slender-billed Gull (*Larus gelastes*) from Southern Europe, deposited.

OUR ASTRONOMICAL COLUMN

ASTRONOMICAL OCCURRENCES IN APRIL.

April 2. 13h. Venus in conjunction with the moon. Venus 0° 46′ N.
2. 13h. 2m. Jupiter's Sat. IV. in conjunction with N. pole of planet.
3. 8h. 47m. to 9h. 44m. Moon occults B.A.C. 1373 mag. 5·7).
3. Venus 2° S. of the Pleiades.
4. 9h. 30m. to 10h. 22m. Moon occults *o* Tauri (mag. 4·8).
8. 11h. 46m. to 12h. 45m. Moon occults *α* Cancri (mag. 4·3).
15. Illuminated portion of disc, Venus = 0·576; Mars, 0·985.
17. 12h. 56m. Minimum of Algol (*β* Persei).
18. 10h. 36m. to 11h. 42m. Moon occults 24 Ophiuchi (mag. 5·6).
19. 15h. 9m. to 16h. 28m. Moon occults B.A.C. 6088 (mag. 6·0).
20. 9h. 45m. Minimum of Algol (*β* Persei).
20. 12h. 37m. to 13h. 30m. Moon occults 33 Sagittarii (mag. 6·0).
20. 14h 27m. to 15h. 42m. Moon occults ξ^2 Sagittarii (mag. 3·5).
20. Epoch of the April meteoric shower (Lyrids, radiant 271° + 33°).
20. Saturn. Outer major axis of outer ring, 40″·18.
20. Saturn. Outer minor axis of outer ring, 17″·52.
22. 12h. 12m. to 13h. 49m. Transit of Jupiter's Sat. III.
23. 15h. 23m. to 15h. 57m. Moon occults c^1 Capricornii (mag. 5·2).
24. 14h. 20m. to 15h. 12m. Moon occults *κ* Aquarii (mag. 5·5).
28. 12h. Venus at greatest elongation, 45° 30′ E
28. Perihelion passage of Giacobini's comet (1900*a*).
29. 15h. 37m. to 17h. 14m. Transit of Jupiter's Sat. III.

COMET 1899 V.—Herr S. K. Winther continues his ephemeris of this comet in the current issue of the *Astronomische Nachrichten* (Bd. 152. No. 3631).

Ephemeris for 12h. Berlin Mean Time.

1900.		R.A. h. m. s.		Decl. ° ′
April 2	...	21 59 40	...	+55 38·0
4	...	22 3 59	...	56 20·9
6	...	8 18	...	57 3·4
8	...	12 40	...	57 45·5
10	...	17 3	...	58 27·2
12	...	22 21 28	...	+59 8·5

NEW SYSTEM OF SPECTRUM PHOTOMETRY.—In the *Astrophysical Journal*, vol. xi. pp. 6–24, January 1900, Prof. D. B. Brace, of Nebraska University, describes a new system of spectral photometric work, the foundation of which depends on a novel method of bringing into juxtaposition the two illuminated areas, the intensities of which are to be compared. This is done by using for the dispersion-piece of the spectro-photometer a compound prism, one-half of which has been silvered along a narrow strip of its face before being cemented to the other. Two collimators are then used, one sending light through the prism in the customary manner, the other so arranged that after internal reflection from the silvered strip and subsequent refraction, the resulting spectrum is received in the same telescope as that from the first source. The two spectra will thus be seen in absolute juxtaposition, and perfect equality will be denoted by the disappearance of the junction line between them. The instrument is stated to be so sensitive that good comparisons could be made on the star Capella, using a 4-inch telescope, so that with larger telescopes the spectra of all the brighter stars could be accurately compared.

VARIABLE STARS OF THE ALGOL TYPE.—In *Popular Astronomy* for March 1900, Mr. H. C. Wilson, of Goodsell Observatory, Minnesota, U.S.A., gives a very complete synopsis of the eclipse theory of the Algol type of variables. In the computations of the possible light curves due to eclipses, formulæ are given for both circular and elliptic orbits, and for direct and oblique line of sight. Using Vogel's values for the radial velocity of the star during the period, there is some little disagreement in the resultant curves, which is too systematic to be put down to errors of observation. Dr. Vogel considering that part of this might be due to the possibly existing atmospheres surrounding the stars having been neglected, Dr. Wilsing calculated anew the resultant light curve, which is so nearly in accordance with the actual one observed as to leave little doubt of the accuracy of the assumption. In this particular Mr. Wilson makes an interesting suggestion with respect to the light curve of the class of variables represented by *β* Lyræ, showing how, by considering certain values of distance, intensity, and extent of atmosphere of two bodies, a curve of light variation may be found very closely agreeing with that deduced spectroscopically.

COMPUTATION OF ORBITS OF SPECTROSCOPIC DOUBLES.—Dr. K. Schwarzschild, of Munich, contributes to the *Astrono-*

mische Nachrichten (Bd. 152, No. 3629) an extension of the method put forward by Lehmann-Fildes (*Astr. Nach.* No. 3242) for the determination of the orbit of a spectroscopic double from the observation of the velocities in the line of sight. The chief characteristic of the present method is that the solution by mechanical quadratures formerly necessary is here dispensed with, thus somewhat simplifying the problem.

MALARIA AND MOSQUITOES.[1]

OUR knowledge of the disease called malarial fever first emerges from chaos in the seventeenth century, when, owing to the recent discovery of quinine, the great Italian physician, Torti, was able to differentiate this malady from other fevers, and to describe its symptoms with accuracy. Next century Morton, Lancisi, Pringle and others observed the connection of the disease with stagnant water and low-lying ground, and first emitted the theory—which in one form or another has found general acceptance up to the present date—that the fever is due to a miasm which rises from the soil or water of malarious localities. The next great advance was made in the middle of the nineteenth century by Meckel, Virchow and Frerichs, who ascertained that the distinguishing pathological product of the disease is a black substance, which is distributed in collections of minute coal-black or brown granules in the blood and organs of patients, and which is called the *malarial pigment* or *melanin*. This line of research culminated in the great discovery of Laveran in 1880—to the effect that the melanin is produced within the bodies of vast numbers of minute parasites which live in the red blood-corpuscles of the patient.

Ray Lankester had already opened the science of the parasitology of the blood by his discovery of *Drepanidium ranarum* in frogs; and it was at once apparent that the parasites found by these two observers are somewhat nearly allied—that is, that Laveran's parasite is a *Protozoal* organism, and not a vegetable one like the pathogenetic organisms recently discovered by Pasteur, Lister, Koch and many others. And our knowledge of the subject was quickly increased by the discovery of similar hæmatozoa in certain species of reptiles, birds, monkeys and bats, and in cattle, by Danilewsky, Kruse, Labbé, Koch, Dionisi, Smith and Kilborne. In 1885 a further advance was made by Golgi, who ascertained that the human parasites propagate within the body of the host by means of ordinary asexual spore-formation; that the exacerbations of fever in a patient are coincident with the disruption of the clusters of spores produced by the organisms; and that there are at least three varieties of the parasites in man in Italy. These observations were confirmed and extended by a large number of persons working in various parts of the world—most prominent among whom are Marchiafava, Celli, Vandyke Carter, Grassi, Osler, Bignami, Antolisei, Councilman, Mannaberg, Romanowsky, Labbé, Koch, Manson, Thayer and MacCallum. In short, the work of all these observers, and of many others scarcely less meritorious, has not only absolutely established the fact that the parasites are the cause of malarial fever, but has given us a very thorough knowledge both of the parasites themselves and of their pathological effects, direct and indirect; until the science of malaria —for it may almost be described as a science in itself—has become a brilliant exemplar of the modern methods of research as regards the science of disease in general.

But I am not here concerned with questions of pathology in malarial fever. At the conclusion of the labours to which I have just referred, we had, it is true, grasped the nature of the disease itself; but a question of the greatest moment still required an answer. We had studied side by side the morbid process and the parasites which cause it; but we had still to find out how infection is caused, how these parasites effect an entry. We had ascertained the life-history of the parasites within man, and of the kindred parasites within other animals; but, even after all these investigations, the life-history of the parasites *outside* man and *outside* other vertebrate hosts remained to be discovered. Until this was done our knowledge was not complete. It is now my privilege to describe the interesting theories and investigations which led to the solution of this great and difficult problem.

The *importance* of the problem need not be enlarged upon. In the British army in India during the year 1897, out of a total strength of 178,197 men, no less than 75,821 were admitted into hospital for malarial fever! Fortunately the death-rate of the disease is low in most places; but on the other hand the cases are so numerous that in the aggregate the mortality from malarial fever is very large indeed. For instance, in India alone, among the civil population (who do not take adequate treatment) the mortality from "fevers" during the single year 1897 amounted to the enormous total of 5,026,725—over five million deaths—being nearly ten times that due to any other disease. Although undoubtedly thousands of deaths are wrongly attributed to fever in these statistics, such figures can point only to a very great mortality due to malaria. Yet India on the whole is not nearly so malarious as many localities—such, for instance, as places on the coasts of Africa. In short, next perhaps to tuberculosis, malarial fever is admittedly the most important of human diseases.

But if the problem to which I refer was an important one, its solution presented difficulties which I, for one, formerly thought to be insuperable. It has been mentioned that Lancisi and Pringle connected the disease with stagnant water; and their views have been generally endorsed by innumerable observations made since their time—by the general experience of mankind, by statistics, and by the fact that malaria can often be actually banished by means of drainage of the soil. But Laveran had now shown the disease to be due to a parasite of the blood. How reconcile these facts? There appeared to be but one way of doing so—namely, by supposing that the organism lives a free life in the water or soil of malarious places, from which it enters man by the respiratory or digestive tracts. To prove this it was necessary to discover it in the water or soil of malarious places. But how make this discovery? The organism is not a bacterium, but an animal parasite. It cannot be taken from the living blood and sown on the surface of a gelatine film. Experiments have proved that it can be inoculated from man to man by the intravenous injection of fresh infected blood; but this is a very different thing to cultivating it in an artificial medium. At all events, experiments in this line have always failed and are not in the least likely to succeed. The parasites simply perish when taken from their natural habitation, the blood. It was therefore extremely unlikely that we should ever be able to follow up their life-history by this means—which has proved so successful as regards the bacteria. It remained only to find them in the soil or water by direct search. But how identify them among the host of Protozoa which live in these elements? Certainly not by their form or appearance. As known to us at that time, they were simply minute amœbæ ensconced in the red corpuscles and accurately adapted for such a life. Now red corpuscles do not exist in soil and water; if the parasites live in the latter, they must possess some other form to that which they possess in the blood, and the clue afforded by identity of appearance fails us. The only remaining method open to us would have been to attempt to produce infection by each one in turn of the numerous species of Protozoa found in the water and soil of malarious places—a task of great magnitude, and one which we now know would have failed. Indeed, it was actually attempted by several observers, and actually did fail.

Such was the state of things up to the end of the year 1894. Speaking for myself, I can well remember the hopeless feelings with which I then regarded the problem. Fortune, however, was to be kinder to us than I had dared believe. At this very moment the key to the solution of the problem had already been indicated by Dr. Patrick Manson.

I have said that since the original discovery of Ray Lankester numerous hæmatozoa—or rather hæmocytozoa—have been found in man and various animals. All these are generally classed by zoologists in Leuckart's order of the Sporozoa, and are usually divided into three groups—groups which are not very closely related, except for the fact that all the organisms concerned are parasites of the red corpuscles of the blood. One group—found in reptiles—consists of parasites closely allied to the Gregarinidæ; another is found in oxen, and is the cause of Texas cattle-fever; the third—for which I adopt the name of Hæmamœbidæ, Wassielewski—is found in man, monkeys, bats and birds. It is to this third group—the Hæmamœbidæ—to which we must now direct our attention, because it includes the parasites of malarial fever. There are, at least, two known species found in birds, two in bats, one in monkeys, and three in man. The human parasites are those which respectively

[1] A lecture delivered at the Royal Institution of Great Britain on March 2, by Major Ronald Ross, D.P.H., M.R.C.S., Lecturer in Tropical Medicine, University College, Liverpool.

cause the three varieties of malarial fever—quartan, tertian, and remittent or pernicious fever. For these three species I adopt the names *Haemamoeba malariae* (quartan), *Haemamoeba vivax* (tertian), and *Haemomenas praecox* (remittent fever).[1] According to Metchnikoff the group belongs, or is allied, to the Coccidiidæ. All the species have a close resemblance to each other, and all contain the typical melanin of malarial fever. The youngest parasites are found as minute *amoebulae* living within the red corpuscle and generally containing granules of this melanin (which, indeed, is derived by the parasite from the hæmoglobin of the corpuscle within which it makes its abode). The amœbulæ grow rapidly in size, until, after one or more days (according to the species), they reach maturity. At this point many of them become *sporocytes*—that is, give rise to ordinary spores by vegetative reproduction. These spores presently attach themselves to fresh corpuscles, become fresh amœbulæ, and so continue the life of the parasites indefinitely within the vertebrate host. Others of the amœbulæ, however, instead of becoming sporocytes like the rest, become *gametocytes*.

Now it is to these gametocytes that an extreme interest attaches, because it is to them, and to Manson's study of them, that we owe the solution of the malaria problem. Numerous observers had examined them before Manson's time, but all had failed in arriving at a correct idea as to their function It had been often observed that they circulate in the blood of the vertebrate hosts without, apparently, performing any function at all. As soon, however, as they are drawn from the circulation—as when the blood containing them is made into a fresh specimen for microscopic examination—they undergo the most remarkable changes. They swell up and liberate themselves from the enclosing corpuscle; and then some of them are suddenly seen to emit a number of long *motile filaments*. These filaments can easily be watched struggling violently, and may sometimes be seen to break from the parent cell and to dart away among the corpuscles, leaving the residue of the gametocyte, with its melanin, an inert and apparently dead mass.

Now it is not to be supposed that such an extraordinary phenomenon as this—which was observed by Laveran during his first investigations—could be witnessed without exciting the liveliest curiosity. As a matter of fact a hot controversy rose regarding it. Laveran, Danilewsky and Mannaberg maintained that the phenomenon is a vital one—that the motile filaments are living organisms, and constitute a stage in the history of the parasite. Antolisei, Grassi, Bignami and others of the Italian school fell back upon the old theory—which we always like to employ when we cannot explain a phenomenon—that it is a regressive phenomenon, a disintegration of the parasite due to its death *in vitro*. Here, however, the controversy practically stayed. While the Italians, in conformity with their views, attached no signification to the motile filaments, Laveran, Danilewsky and Mannaberg, who held an opposite opinion, did not expressly or exactly state what their signification is. Mannaberg, indeed, held that they are meant to lead a saprophytic existence, but did not explain how they could escape from the body in order to do so.

It was reserved for Manson to detect the ultimate (though not the immediate) function of these bodies. He asked why the escape of the motile filaments occurs only after the blood is abstracted from the host (a fact agreed upon by many observers). From his study of these filaments, of their form and their characteristic movements, he rejected the Italian view that they are regressive forms; he was convinced that they are living elements. Hence he felt that the fact of their appearance only *after* abstraction of the blood (about fifteen minutes afterwards) must have some definite purpose in the life-scheme of the parasites. What is that purpose? It is evident that these parasites like all others must pass from host to host; all known parasites are capable not only of entering the host, but, either in themselves or their progeny, of leaving him. Manson himself had already pushed such methods of inductive reasoning to a brilliantly successful issue in discovering by their means the development of *Filaria nocturna* in the gnat. He now applied the same methods to the study of the parasites of malaria. Why should the motile filaments appear only after abstraction of the blood? There could be only one explanation. The phenomenon, though it is usually observed in a preparation for the microscope, is really meant to occur *within the stomach cavity of some suctorial insect, and constitutes the first step in the life-history of the parasite outside the vertebrate host.*

[1] NATURE, August 3, 1899.

It is perhaps impossible for any one, except one who has spent years in revolving this subject, to understand the full value and force of this remarkable induction. To my mind the reasoning is complete and exigent. It was from the first impossible to consider the subject in the light in which Manson placed it without feeling convinced that the parasite requires a suctorial insect for its further development. And subsequent events have proved Manson to have been right.

The most evident reasoning—the connection between malarial fever and low-lying water-logged areas in warm countries—suggested at once that the suctorial insect must be the *gnat* (called *mosquito* in the tropics); and this view was fortified by numerous analogies which must occur at once to any one who considers the subject at all, and which it is not necessary to discuss in this place.

Needless to say, since Manson's theory was proved to be right it has been shown to be not entirely original. Nuttall, in his admirable history of the mosquito theory, demonstrates its antiquity. Eleven years before Manson wrote, King had already accumulated much evidence, based on epidemiological data, in favour of the theory. A year later (1884), Laveran himself briefly enunciated the same views, on the analogy with *Filaria nocturna*. Koch, and later, Bignami and Mendini, were also advocates of the theory—partly on epidemiological grounds and partly because of a possible analogy with the protozoal parasites of Texas cattle-fever which Smith and Kilborne had shown to be carried by a *tick*. Hence many observers had independently arrived at the same theory by different routes. But I feel it most necessary to point out here that there is a difference between a fortunate guess and a true scientific theory. Interesting and suggestive as were many of the hypotheses to which I have just referred, they were to my mind far from convincing. *Filaria nocturna*, and even *Apiosoma bigeminum*, are not in close enough relationship with the Hæmamœbidæ to admit of very forcible analogies in regard to the respective life-histories. The epidemiological arguments of King and Bignami (some of which were also used by Manson) were scarcely solid enough to support by themselves a theory of any weight. All these were hypotheses—little more: I can scarcely conceive a practical man sitting down to laborious researches on the strength of arguments like these. On the other hand, Manson's theory was what I have called it—an *induction*—a chain of reasoning from which it was impossible to escape.

I have wished to defend this work of Manson's because it has been much misunderstood and much misrepresented, and even (in a somewhat amusing manner) completely ignored by some who, though they once strongly opposed his theory, now, as soon as it has done its work, wish to forget it. It is true that he endeavoured to predict the history of the parasites a little too far, and that he was in error (as will presently appear) regarding the immediate nature of the motile filaments; but the centre of his theory was invaluable. I have no hesitation in saying that it was Manson's theory, and no other, which actually solved the problem; and, to be frank, I am equally certain that but for Manson's theory the problem would have remained unsolved at the present day.

To leave these interesting theories and to return to actual observations—I should begin by remarking that Manson thought the motile filaments to be of the nature of zoospores—that is, motile spores which escape from the gametocytes in the stomach cavity of the gnat, and then occupy and infect the tissues of the insect. In this he was proved, two years later, to have been wrong. The motile filaments are not spores, but *microgametes*—that is, bodies of the nature of spermatozoa. I have said that some of the amœbulæ in the blood-corpuscles of the host become sporocytes, which produce asexual spores (nomospores); while other amœbulæ become gametocytes, which have no function within the vertebrate host. As soon, however, as these gametocytes are ingested by a suctorial insect they commence their proper functions. As their name indicates, they are sexual cells—male and female. About fifteen minutes after ingestion (in some species) the male gametocyte emits a variable number of microgametes—the motile filaments—which presently escape and wander in search of the female gametocytes. These contain a single *macrogamete* or ovum, which is now fertilised by one of the microgametes, and becomes a *zygote*. We owe this beautiful discovery to the direct observation of MacCallum (1897), confirmed by Koch and Marchoux, and indirectly by Bignami. Metchnikoff, Simond, Schaudinn and Siedlecki have also demonstrated what are practically sexual elements in some of the Coccidiidæ. Directly MacCallum's discovery was announced Manson saw the important bearing of it on the mosquito theory. Admitting that the motile filaments themselves do not infect the gnat, he at once observed that it was probably the function of the zygote to do so—and this time he was perfectly right.

I must now turn to my own researches. Dr. Manson told me of his theory at the end of 1894, and I then undertook to investigate the subject as far as possible. I began work in Secunderabad, India, in April 1895; and should take the present opportunity for acknowledging the continuous assistance and advice which I received both from Dr. Manson and from Dr. Laveran, and later from the Government of India. Even with the aid of the induction, the task so lightly commenced was, as a matter of fact, one of so arduous a nature that we must attribute its accomplishment largely to good fortune. The method adopted—the only method which could be adopted—was to feed gnats of various species on persons whose blood contained the gametocytes, and then to examine the insects carefully for the parasites which by hypothesis the gametocytes were expected to develop into. This required not only familiarity with the histology of gnats, but a laborious search for a minute organism throughout the whole tissues of each individual insect examined—a work of at least two or three hours for each gnat. But the actual labour involved was the smallest part of the difficulty. Both the form and appearance of the object which I was in search of, and the species of the gnat in which I might expect to find it, were absolutely unknown quantities. We could make no attempt to predict the appearance which the parasite would assume in the gnat; while owing to the general distribution of malarial fever in India, the species of insect concerned in the propagation of the disease could scarcely be determined by a comparison of the prevalence of different kinds of gnat at different spots with the prevalence of fever at those spots. In short, I was forced to rely simply on the careful examination of hundreds of gnats, first of one species and then of another, all fed on patients suffering from malarial fever—in the hope of one day finding the clue I was in search of. Needless to say, nothing but the most convincing theory, such as Manson's theory was, would have supported or justified so difficult an enterprise.

As a matter of fact, for nearly two and a half years my results were almost entirely negative. I could not obtain the correct scientific names of the various species of gnats employed by me in these researches, and consequently used names of my own. Gnats of the genus *Culex* (which abound almost everywhere in India) I called "grey" and "brindled" mosquitoes; and it was these insects which I studied during the period I refer to. At last, the persistently nugatory results which had been obtained with gnats of this genus determined me to try other methods. I went to a very malarious locality, called the Sigur Ghat, near Ootacamund, and examined the mosquitoes there in the hope of finding within them parasites like those of malaria in man. The results were practically worthless (except that I observed a new kind of mosquito with spotted wings); and I saw that I must return to the exact method laid down by Manson. The experiments with the two commonest kinds of Culex were once more repeated—only to prove once more negative. The insects, fed mostly on cases containing the crescentic gametocytes of *Haemomenas praecox*, were examined cell by cell—not even their excrement being neglected. Although they were known to have swallowed living Hæmamœbidæ, no living parasites like these could be detected in their tissues—the ingested Hæmamœbidæ had in fact perished in the stomach cavity of the insects. I began to ask whether after all there was not some flaw in Manson's induction; but no—I still felt his conclusion to be an inevitable one.. And it was at this very moment that good fortune gave me what I was in search of.

In a collecting bottle full of larvæ brought by a native from an unknown source I found a number of newly-hatched mosquitoes like those first observed by me in the Sigur Ghat—namely, mosquitoes with *spotted wings* and *boat-shaped eggs*. Eight of these were fed on a patient whose blood contained crescentic gametocytes. Unfortunately I dissected six of them either prematurely or otherwise unsatisfactorily. The seventh was examined, on August 20, cell by cell; the tissues of the stomach (which was now empty owing to the meal of malarial blood taken by the insect four days previously being digested) were reserved to the last. On turning to this organ I was struck by observing, scattered on its outer surface, certain oval or round cells of about two to three times the diameter of a red blood-corpuscle—cells which I had never before seen in any of the hundreds of mosquitoes examined by me. My surprise was complete when I next detected within each of these cells *a few granules of the characteristic coal-black melanin of malarial fever*—a substance quite unlike anything usually found in mosquitoes. Next day the last of the remaining spotted-winged mosquitoes was dissected. It contained precisely similar cells, each of which possessed the same melanin; only the cells in the second mosquito *were somewhat larger than those in the first.*

These fortunate observations practically solved the malaria problem. As a matter of fact, the cells were the *zygotes of the parasite of remittent fever growing in the tissues of the gnat*; and the gnat with spotted wings and boat-shaped eggs in which I had found them belonged (as I subsequently ascertained) to the genus *Anopheles*. Of course it was impossible absolutely to prove at the time, on the strength of these two observations alone, that the cells found by me in the gnats were indeed derived from Hæmamœbidæ sucked up by the insects in the blood of the patients on whom they had been fed—this proof was obtained by subsequent investigations of mine; but, guided by the presence of the typical and almost unique melanin in the cells, and by numerous other circumstances, I myself had no doubt of the fact. The clue was obtained; it was necessary only to follow it up—an easy matter.

The preparations of the stomachs of the two *Anopheles* were sealed, and were afterwards examined by Drs. Smyth, Manson, Thin and Bland-Sutton; and an account of the work and of the observations of these gentlemen was published a little later. Unfortunately, my labours now met with a serious interruption; but not before I had succeeded again in finding the zygotes in two other mosquitoes—one, another species of *Anopheles*, also bred from the larva, and also fed on a case containing crescentic gametocytes; the other, a "grey mosquito" (*Culex pipiens* type), which had been caught feeding on a case of tertian fever, and which I now think had become previously infected from a bird with *Haemamoeba relicta*.

Early in 1898, mainly through the influence of Dr. Manson, Sir H. W. Bliss and the United Planters' Association of Southern India, I was placed by the Government of India on special duty in Calcutta to continue my investigations. Unable to work with human malaria—chiefly on account of the plague-scare in Calcutta—I turned my attention to the Hæmamœbidæ of birds. Birds have at least two species of Hæmamœbidæ. I subjected a number of birds containing one or the other of these parasites to the bites of various species of mosquitoes. The result was a repetition of that previously obtained with the human parasites. Pigmented cells precisely similar to those seen in the *Anopheles* were found to appear in gnats of the species called *Culex fatigans*, Wiedemann, when these had been fed on sparrows and larks containing *Haemamoeba relicta*. On the other hand, these cells were never found in insects of the same species when fed on healthy birds or on birds containing the other parasite, called *Haemamoeba danilewskii*.

It will be evident that this fact was the crucial test both as regards the parasitic nature of these cells and as regards their development from the hæmocytozoa of the birds; and it was not accepted by me without very close and laborious experiment. The actual results obtained were as follows:—

Out of 245 *Culex fatigans* fed on birds containing *H. relicta*, 178, or 72 per cent., contained "pigmented cells." But, out of 41 *Culex fatigans* fed on a man containing crescentic gametocytes, 5 on a man containing immature tertian parasites, 154 on birds containing *H. danilewskii*, 25 on healthy sparrows, and 24 on birds with immature *H. relicta*—or a total of 249 insects, all carefully examined—not one contained a single "pigmented cell."

Another experiment was as follows:—Three sparrows, one containing no parasites, another containing a moderate number of *H. relicta*, and the third containing numerous *H. relicta*, were placed in separate cages within three separate mosquito-curtains. A number of *Culex fatigans*, all bred simultaneously from larvæ in the same breeding bottle, were now liberated on the same evening partly within the first mosquito-netting, partly within the second, and partly within the third. Next morning many of these gnats were found to have fed themselves on the birds during the night. Ten of each lot of gnats were dissected after a few days, with the following result:—

The ten gnats fed on the healthy sparrow contained no "pigmented cells." The ten gnats fed on the sparrow with a moderate number of parasites were found to contain altogether 292 "pigmented cells"; or an average of 29 in each gnat. The ten gnats fed on the sparrow with numerous parasites contained 1009 "pigmented cells"; or an average of 100 cells in each gnat. These thirty specimens were sent to Manson in England, who made a similar count of the cells.

I may mention one more out of several experiments of the same kind. A stock of *Culex fatigans*, all bred from the larva, were fed on the same night partly on two sparrows containing *H. relicta*, and partly on a crow containing *H. danilewskii* (placed, of course, under separate mosquito-nettings). Out of 23 of the former lot, 22 were found to have pigmented cells; while out of 16 of the latter, none had them.

Hence no doubt remained that the "pigmented cells" really constitute a developmental stage in the mosquito of these parasites; and this view was accepted both by Laveran and Manson, to whom specimens had been sent. In June 1898, Manson published an illustrated paper concerning my researches, and showed that the pigmented cells must in fact be the zygotes resulting from the process of fertilisation discovered by MacCullum.

It remained to follow out the life-history of the zygotes. For this purpose it was immaterial whether I worked with the avian or the human parasites, since these are so extremely like each other. I elected to work with the avian species, chiefly because the plague-scare in Bengal still rendered observations with the human species almost impossible. By feeding *Culex fatigans* on birds with *H. relicta* and then examining the insects one, two, three and more days afterwards, it was easy to trace the gradual growth of the zygotes. Their development briefly is as follows:—After the fertilisation of the macrogamete has taken place in the stomach-cavity of the gnat, the fertilised parasite or zygote has the power of working its way through the mass of blood contained in the stomach, of penetrating the wall of the organ, and of affixing itself on, or just under its *outer coat*. Here it first appears about thirty-six hours after the insect was fed, and is found as a "pigmented cell"—that is, a little oval body, about the size of a large red corpuscle, and containing the granules of melanin possessed by the parent gametocyte from which the macrogamete originally proceeded. In this position it shows no sign of movement, but begins to grow rapidly, to acquire a thickened capsule, and to project from the outer wall of the stomach, to which it is attached, into the *body-cavity* of the insect host. At the end of six days, if the temperature of the air be sufficiently high (about 80° F.), the diameter of the zygote has increased to about eight times what it was at first; that is, to about 60 μ. If the stomach of an infected insect be extracted at this stage, it can be seen, by a low power of the microscope, to be studded with a number of attached spheres, which have something of the appearance of warts on a finger. These are the large zygotes, which have now reached maturity and which project prominently into the mosquito's body-cavity.

All this could be ascertained with facility by the method I have mentioned; and it should be understood that gnats can be kept alive for weeks or even months by feeding them every few days on blood—or, as Bancroft does, on bananas. But a most important point still required study. What happens after the zygotes reach maturity? I found that each zygote as it increases in size divides into *meres*, each of which next becomes a *blastophore* carrying a number of *blasts* attached to its surface. Finally, the blastophore vanishes, leaving the thick capsule of the zygote packed with thousands of the blasts. The capsule now *ruptures*, and allows the blasts to escape into the body-fluids of the insect.

These blasts, when mature, are seen to be minute filamentous bodies, about 12–16μ in length, of extreme delicacy, and somewhat spindle-shaped—that is, tapering at each extremity. Just as the zygotes recall the shape of the Coccidiidæ, so do these blasts recall the "falciform bodies." Prof. Herdman and I have adopted this word "blast" for these bodies after careful consideration—but others prefer other names. They are, of course, *spores*; but spores which have been produced by a previous sexual process—and are in fact the result of a kind of *polyembryony*. Just as a fertilised ovum gives rise to blasts, which produce the cluster of cells constituting a multicellular animal, so, in this case, the fertilised ovum, or zygote, gives rise to blasts, each of which, however, becomes a separate animal. Prof. Ray Lankester suggests for the blasts of the Hæmamœbidæ the simple term "filiform young."

At this point the investigations took a turn of extreme interest and importance, scarcely second even to what attached to the first study of the zygotes. Since the blasts are evidently the progeny of the zygotes, they must carry on the life-history of the parasites to a further stage. How do they do so? What is their function? Do they escape from the mosquito, and in some manner, direct or indirect, set up infection in healthy men and birds? Or, if not, what other purpose do they subserve? It was evident that our knowledge of the mode of infection in malarial fever—and perhaps even the prevention of the disease—depended on a reply to these questions.

As I have said, the zygotes become ripe and rupture about a week after the insect was first infected—scattering the blasts into the body-cavity of the host. What happens next? It was next seen that by some process, apparently owing to the circulation of the insect's body-fluids (for the blasts themselves appear to be almost without movement), these little bodies find their way into every part of the mosquito—into the juices of its head, thorax, and even legs. Beyond this it was difficult to go. All theory—at least all theory which I felt I could depend upon—had been long left behind, and I could rely only on direct observation. Gnat after gnat was sacrificed in the attempt to follow these bodies. At last, while examining the head and thorax of one insect, I found a large gland consisting of a central duct surrounded by large grape like cells. My astonishment was great when I found that many of these cells were closely packed with the blasts (which I may add are not in the least like any normal structures in the mosquito). Now I did not know at that time what this gland is. It was speedily found, however, to be a large racemose gland consisting of six lobes, three lying in each side of the insect's neck. The ducts of the lobes finally unite in a common channel which runs along the under surface of the head and *enters the middle stylet, or lancet, of the insect's proboscis.*

It was impossible to avoid the obvious conclusion. Observation after observation always showed that the blasts invariably collect within the cells of this gland. It is the *salivary* or *poison* gland of the insect, similar to the salivary gland found in many insects, the function of which, in the gnat, had already been discovered—although I was not aware of the fact. That function is to *secrete the fluid which is injected by the insect when it punctures the skin*—the fluid which causes the well-known irritation of the puncture, and which is probably meant either to prevent the contraction of the torn capillaries or the coagulation of the ingested blood. The position of the blasts in the cells of this gland could have only one interpretation—wonderful as that interpretation is. The blasts must evidently pass down the ducts of the salivary gland into the wound made by the proboscis of the insect, and *thus cause infection in a fresh vertebrate host.*

That this actually happens could, fortunately, be proved without any difficulty. As I had now been studying the parasites of birds for some months, I possessed a number of birds of different species, the blood of which I had examined from time to time (by pricking the toes with a fine needle). Some of them were infected, and some, of course, were not. Out of 111 wild sparrows examined by me in Calcutta, I had found *H. relicta*—the parasite which I had just cultivated in *Culex fatigans*—in 15, or 13·5 per cent. As a rule, non-infected birds were released; but I generally kept a few to use for the control experiments mentioned above, and the blood of these birds had consequently been examined on several occasions, and had always been found free from parasites. At the end of June I possessed five of these healthy control birds—four sparrows and one weaver-bird. All of them were now carefully examined again and found to be healthy. They were placed in their cages within mosquito-nets, and at the same time a large stock of old infected mosquitoes were released within the same nets. By "old infected mosquitoes" I mean mosquitoes which had been previously fed repeatedly on infected birds, and many of which on dissection had been shown to have very large numbers of blasts in their salivary glands. Next morning, numbers of these infected gnats were found gorged with blood, proving that they had indeed bitten the healthy birds during the night. The operation was repeated on several succeeding nights, until each bird had probably been bitten by at least a dozen of the mosquitoes. On July 9, the blood of the birds was examined again. I scarcely expected any result so complete and decisive. Every one of the five birds was now found to contain parasites—and not merely to contain them, but to possess such immense numbers of them as I had never before seen in any bird (with *H. relicta*) in India. While wild sparrows in Calcutta seldom contain more than one parasite in every field of the microscope, those which I had just succeeded in infecting contained ten, fifteen, twenty and even more in each field—a fact due probably to the infecting gnats having been previously fed over and over again on infected birds, a thing which can rarely happen in nature.

The experiment was repeated many times—generally on two or three healthy birds put together. But I now improved on the original experiment by also employing controls in the following manner. A stock of wild sparrows would be examined, and the infected birds eliminated. The remainder would then be kept apart, and at night would be carefully secluded from the bites of gnats by being placed within mosquito nets. These constituted my stock of healthy birds. From time to time two or three of these would be separated, examined again to ensure their being absolutely free from parasites, and then subjected to the bites of "old infected mosquitoes," and, of course, kept apart afterwards for daily study. Thus my stock of healthy birds was also my stock of control birds. Until they were bitten by gnats, I found that they never became infected (except in a single case in which I think I had overlooked the parasites on the first occasion), although large numbers of healthy birds were kept in this manner. The result in the case of the sparrows which were subjected to the bites of the infected gnats was different indeed. Out of 28 of these, dealt with from time to time, no less than 22, or 79 per cent., became infected in from five to eight days. And, as in the first experiment, all the infected birds finally contained very numerous parasites.

It was most interesting to watch the gradual development of the parasitic invasion in these birds; and this development presented such constant characters that, apart from other reasons, it was quite impossible to doubt that the infection was really caused by the mosquitoes. The course of events was always as follows. The blood would remain entirely free from parasites for four, five, six or even seven days. Next day one or perhaps two parasites would be found in a whole specimen. The following day it was invariably observed that the number of the organisms had largely increased; and this increase continued until in a few days immense numbers were present—so that, finally, I often observed as many as seven distinct parasites contained within a single corpuscle! Later on, many of the birds died; and their organs were then found to be loaded with the characteristic melanin of malarial fever.

I also succeeded in infecting on a second trial one of the six sparrows which had escaped the first experiment; and also a crow and four weaver-birds; and, lastly, gave a new and more copious infection to four sparrows which had previously contained only a few parasites.

These experiments completed the original and fundamental observations on the life-history of the Hæmamœbidæ in mosquitoes. The parasites had been carried from the vertebrate host into the gnat; had been followed in their development in the gnat; and had finally been carried back from the gnat to the vertebrate host. The theories of King, Laveran, Koch and Bignami, and the great induction of Manson, were justified by the event: and I have given a detailed historical and critical account of these theories, and of my own difficulties and experiences, in the hope of bringing conviction to those who might, perhaps, otherwise think the story to be too wonderful for credence.

But work of great importance remained to be done. I had intended, immediately after making this study of one of the parasites of birds, to extend the investigation more fully to those of man—a work which now presented no difficulty, since both the kind of mosquito hospitable to them (*Anopheles*) and the form of the parasites in the mosquito were well known to me. Unfortunately I was obliged to attend to other and less important duties, which kept me fully occupied for several months—an interruption which practically put an end to my own study of the mosquito-theory at a very interesting point. No time, however, was really lost. In December 1898, Dr. Daniels, of the Malaria Commission of the Royal Society and the Colonial Office, arrived in Calcutta to examine and report upon my results. After carefully repeating the various experiments, he fully confirmed the statements made by me.[1] At the same moment, the work was taken up with great brilliance and success by Dr. Koch and by Prof. Grassi and Drs. Bignami and Bastianelli, in Italy. I must now describe the investigations of these observers—though I have scarcely space to do so at the length they deserve.

Ever since the discoveries of Laveran and Golgi, the Italian observers of the Roman school had done much important work on malaria, facilitated by the well-known prevalence of the disease near Rome—work, if not of much originality, yet full of careful detail. More recently, however, this work had been practically arrested by their theory—wholly gratuitous, but which they accepted as a dogma—that the motile filaments are forms of disintegration *in vitro*. When Manson propounded his theory, Bignami, for instance, rejected it on this ground. But at the same time he evolved a gnat-theory of his own—a theory that malarial fever is inoculated by gnats which carry the parasite from marshy areas. The arguments he used were the epidemiological ones already advanced by King, and which can scarcely be said to amount to more than a plausible hypothesis: the only solid basis for the theory—that of Manson—was opposed by him. Later, however, the work of Simond, Schaudinn, Siedlecki, MacCallum and myself, explained by Manson, rendered the Italian position concerning the motile filaments quite untenable; and Bastianelli, Bignami and Grassi now undertook a study of the mosquito-theory on sound principles. My own results, with descriptions of the technique employed and with illustrations of the zygotes, had been published from time to time; a summary of them had been given by Manson in June 1898, and another, including the infection of healthy birds, before the British Medical Association, early in August; and there could therefore be no difficulty in following up the observations therein recorded. In September, Grassi published a paper in which he described certain investigations made in Italy with a view to ascertaining the species of gnats which are associated with the prevalence of malaria in that country. Such investigations are not, I think, trustworthy; and as a matter of fact two out of the three species of gnat then selected by Grassi as being malaria-bearing ones have now been rejected by him. The third species was an *Anopheles*, namely *A. claviger*, Fabr.

At the same time Bignami resumed his study of the subject. Some years previously, following his theory, he had endeavoured to infect healthy persons by the bites of gnats brought from malarious places. He had failed, and abandoned his efforts—and I believe that his method would of itself never have led to a solution of the problem. In the autumn of 1898, however, he renewed his efforts; but was again unsuccessful until he used a number of *Anopheles claviger*, brought from a house containing infected persons. The result was successful, the subject of the experiment becoming infected after some time. This important experiment gave the first confirmation with human malaria of my previous inoculation experiments with the malaria of birds; but since other species of gnats as well as *A. claviger* had been employed, it failed to fix suspicion entirely on the latter. In order to obtain this result, these observers were finally obliged to resort to the correct method of Manson and myself—namely that of direct cultivation of the parasites in the gnat. Success was now immediate. The zygotes and blasts of the parasites were found, exactly as previously described by me, in the tissues of *A. claviger*; and, lastly, healthy persons were infected by the bites of these insects. Pushing forward with admirable rapidity, the Italian observers next found that all three species of the human Hæmamœbidæ are cultivable in *A. claviger*; and not only in this, but in other Italian species of *Anopheles*; while, like me, they failed in cultivating the parasites in *Culex*.

Almost simultaneously Koch repeated and confirmed with the weight of his authority most of the results which had been obtained as regards both the human and avian parasites. In August 1899, the malaria expedition sent to Sierra Leone by the Liverpool School of Tropical Medicine (of which expedition I was a member) found the human parasites in two species of *Anopheles* in that colony, namely *A. costalis*, Loew, and *A. funestus*, Giles. I hear also that the same result has been obtained with *Anopheles* in two other parts of the world; so that it would appear that something like nine species of *Anopheles* have now been inculpated—while as yet every species of Culex which has been tried has failed to give positive results.

From this point it becomes impossible to follow in detail the researches carried out in connection with the mosquito-theory

[1] NATURE, August 3, 1899.

in various parts of the world. The facts already collected would fill a small volume; and every month witnesses additional publications on the subject. I shall therefore, in conclusion, content myself with a brief reference to three points of leading importance.

I shall first try to indicate how completely the recent discoveries explain the well-known laws regarding the diffusion of malaria. As mentioned at the beginning of this lecture, malarial fever has long been known to be connected with the presence of stagnant water. That is to say, we generally, though not invariably, find that the disease is associated with low-lying flat areas, where water tends to collect to a considerable extent. It was indeed the general appreciation of this law which led to the old miasma-theory of the disease—the theory on which the word "malaria" was based. We assumed that the poison is one which rises from marshy areas in the form of a mist, and which thence infects all living within a given distance. Later, when the pathogenetic parasite was discovered in the blood of febricitants, many observers, still clinging to this conception, thought that the parasite is an organism which in its free state dwells in such places, and diffuses itself in such mists. It is interesting to note how near to the truth this almost instinctive conception took us. It is right in idea, wrong in fact. It is not the parasite itself which springs from the marshy ground, *but the carrier of the parasite.*

This was one of the many interesting points made by King in his mosquito-theory of seventeen years ago. But King fell into an error which could have been used as a powerful argument against his hypothesis. He seemed to have assumed that all mosquitoes rise from marshes. Hence, he said, malaria exists in the presence of marshes; hence it is a disease of the country rather than of towns, and so on. As a matter of fact, mosquitoes as a rule do not rise from marshes at all; they do not all even rise from pools of water on the ground; the commonest species, at least of those which habitually annoy human beings, spring from tubs and pots of water in the vicinity of houses, and are indeed more common in cities than in country places, at any rate in the tropics. Now it is not the least interesting feature of recent researches that they have shown where the error lay. As soon as I had succeeded in cultivating the human parasites in my "dappled-winged mosquitoes," which were really gnats of the genus *Anopheles*, I began to study the habits of these insects, and soon ascertained the remarkable fact that while gnats of genus *Culex* generally breed, in India, in vessels of water round houses, gnats of genus *Anopheles*, which I had just connected with malaria, breed in *small pools of water on the ground.* This point was made the subject of a special investigation by the recent expedition to Sierra Leone; and we found that the law holds good there as in India. While *Culex* larvæ were to be seen in almost every vessel of water, or empty gourd or flower-pot in which a little rain-water collected, in only one case did we find *Anopheles* larvæ in such. On the other hand, *Anopheles* larvæ occurred in about a hundred small puddles scattered through the city of Freetown—puddles mostly of a fairly permanent description, kept filled by the rain, and not liable to scouring out during heavy showers. What was almost equally significant, the larvæ seemed to live chiefly on green water-weed. Hence it follows that while *Culex*, the apparently innocuous genus of gnats, are essentially, or at least often, domestic insects, *Anopheles*, the malaria-bearing genus, are essentially gnats which spring from stagnant water on the ground. And numerous other facts in the history of malaria can be explained by the same discovery. It is supposed, for instance, that malaria originates from freshly-turned earth; now we actually noted examples where railway embankments and the like had produced *Anopheles* pools; and it is easy to see that disturbance of the soil may often produce depressions in the ground capable of holding a little rain-water suitable for the larvæ of these insects. Again, malarial fever often appears on board vessels which have touched at malarious ports; as an explanation of this we ascertained that *Anopheles* visit ships from the shore. In short, on studying the matter from every point of view, I must confess to being ignorant of any well-established fact about malarial fever which is not explained by the mosquito-theory.

This brings me to the subject of *objections* to the mosquito-theory. In view of the exact and copious microscopical and experimental evidence which has now been collected in proof of the theory, it is no longer permissible to doubt the main facts; and the objections which one still finds, both in the lay and the medical press, are generally based on a complete ignorance of these facts, and need not be discussed here. But there is one objection—frequently made, in spite of corrections as frequent, by persons who reside in malarious places—which deserves comment. This is, that malaria exists where there are no mosquitoes, and that so-and-so has had fever without being bitten by gnats at all. Generally speaking, we must always remember that malarial fever is a disease in which relapses occur perhaps for years after the first infection, and that it is this first infection and not the relapses which are due to the bite of *Anopheles*. It is thus possible to suffer from any number of attacks of fever without being bitten by *Anopheles* (except on one occasion), and without invalidating the theory—a fact of which those who argue in this manner are generally ignorant. Again, it is well known that one may be bitten without perceiving it; that some persons are singularly callous to the punctures of these insects; and, lastly, that many others have very limited powers of observation. I may say at once that, personally, I cannot accept any statement to the effect that gnats are absent in any locality in the tropics, until such a statement is made by a competent observer after direct search; because I have never been in any place in the tropics—and I have been in a large number—where there were no gnats. On the other hand, I have often found numerous gnats in localities where I was previously told there were none. I was once actually informed that there are no mosquitoes in Sierra Leone! The fact is that those who will trust the statements of the general public on such matters must be very credulous.

I turn lastly to the all-important subject of *prevention*, but can do no more than touch upon it here. Two methods suggest themselves at once. I need not refer to that of guarding against the bites of these insects by the use of mosquito-nets and so on—an obvious and, I believe, an exceedingly useful measure, which may reduce the chances of infection to a small fraction. Unfortunately such methods will never be employed on a large scale in the majority of malarious localities; and we must resort to the *destruction of malaria-bearing species of gnats*. Early in 1892 I reported to the Government of India that it may be possible to exterminate *Anopheles* in *some* localities—especially some towns, cantonments and plantations—owing to the habit the insects have (in some places) of breeding only in selected pools. Since then, a considerable literature has already grown up round the subject. Reviewing this literature, it seems probable that we may be able to exterminate *Anopheles*, or at least largely reduce their numbers, in towns where, owing to the conformation of the ground, the low level of the subsoil water or the small rainfall, surface pools suitable for the insects are comparatively few. The methods which can be adopted against the larvæ are numerous—such as brushing out the pools with a broom, draining them away, filling them up, or treatiug them with various *culicides*, such as paraffin and numerous other substances (recently investigated by Celli and Casagrandi). On the whole, the most promising method which suggests itself is the employment of some cheap solid material or powder which dissolves slowly, which kills the larvæ without injuring higher animals, and which renders small pools uninhabitable for the larvæ for some months. If, for instance, a cartload of such a material would suffice to extirpate the larvæ from a square mile of a malarious town, the result would be a large gain to its healthiness. Dr. Fielding-Ould has lately reported favourably on *tar*. Grillet recently reports a case in France where a large district was rendered free of malaria by the extensive use of *lime* for agricultural purposes. *Gas-lime*, or even common *salt*, may be suggested. In short, though the question of the possibility of attacking these insects with success is still entirely in the experimental stage, we may reasonably hope that the mosquito-theory of malaria may some day prove to be as useful to humanity as it certainly has proved interesting to the student of science.

In conclusion, however, I should add that this result is not likely to be attained unless we, as a nation, determine to pay more attention to scientific discoveries in the field of tropical medicine than hitherto we have done. During the last fifty years discovery after discovery in this field has been made without finding any adequate reflex in medical and sanitary practice in our tropical possessions. The discoveries, for instance, of Lösch, Davaine, Dubini, Bilharz, Bancroft, Koch, Laveran, Manson, Carter and Giles, though nearly concerned with the lives of thousands of human beings, have been generally treated either with scepticism or neglect—have been neither sufficiently followed in the laboratory nor sufficiently acted upon in the region of practical sanitation.

AUSTRALIAN EXPERIMENTAL FARMS.

THE importance attached by the various Australian Governments to the encouragement of agriculture is shown in the fact that in most of the colonies a department of agriculture has been established, the official head of which is a member of the colonial ministry. In New South Wales a site suitable for a central establishment was selected at Ham Common, near the town of Richmond, in the Hawkesbury district, about 39 miles from Sydney, where an area of about 4000 acres was resumed for the purpose. The college and farm are now in their seventh year of existence. Accommodation is provided for ninety-six resident students, and during 1898 there was a full roll. Theoretical as well as practical instruction is imparted by experts in every branch of agriculture, and experimental work is carried on with cereal and other crops. There is an orchard, 30 acres in extent, and a vineyard, 10 acres in extent, and the cultivation of plants for the production of scent has also been begun. There are also experimental farms at Bomen, 304 miles from Sydney, in the Murrumbidgee district; and at Wollongbar, 366 miles from Sydney, in the Richmond River district. The former is near the town of Wagga Wagga, and embraces an area of 2460 acres, of which 1200 acres are in cultivation, 1000 acres being devoted to growing cereals, of which 500 acres are for seed wheat; 85 acres to fruit trees and grape-vines, and 80 acres to forage plants; while 8 acres are under olive trees; the remaining portion being taken up by irrigation plots, nursery and experimental plots. Quarters have been provided for twenty-five students. At the Wollongbar Farm experiments have been made with sugar-canes obtained from New Guinea, sugar cultivation being a staple industry on the Clarence, Richmond, and other northern rivers. Experiments with grasses for the grazing of dairy cattle have been carried on, and steps taken to assist the dairying industry, which is greatly on the increase in the northern parts of the colony. Other trials are being made with citrus fruits, pineapples, bananas, and various other tropical and semi-tropical fruits. The total area of the farm is 263 acres. The experimental farm at Bathurst, 145 miles from Sydney, is largely devoted to the cross-breeding of sheep, irrigation, fruit-growing, cereal culture, and general mixed farming. The area of the farm is 596 acres, to which leased areas of 176 acres have been added. The area under cultivation is 370 acres. There are 1000 sheep and lambs on the farm; and nine students have been enrolled. Another farm is situate at Coolabah, in the dry country, about 424 miles from Sydney, where there are about 200 acres in cultivation, trials being systematically made with various kinds of wheat, maize, sorghum, cow-peas, grasses, fodders, and so on. There is also a travelling instructor, whose duty it is to visit the rural districts and give personal advice and practical demonstration in all matters connected with agriculture. Under the direction of the Government pathologist, investigations are carried out at the laboratories at the Sydney, Bathurst, and Wagga Wagga farms. At a laboratory at Pymble, a few miles from Sydney, the diseases of citrus plants have formed the subject of special inquiry. Operations at Bathurst are not specially directed to agriculture, but are confined more to the diseases of stock; but at Wagga Wagga the work of the laboratory is mainly in connection with wheat and other farm crops.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

A SCHOOL of forestry is to be established at Yale University. The large estate bequeathed by the late Prof. O. C. Marsh will be used as a school of botany, and will also be used for the present as a school of instruction in forestry.

BESIDES the degrees recognised by the State, the universities of France can grant degrees exclusively scientific, but which confer none of the rights or privileges belonging to the State degrees, and which must in no case be declared as equivalent to them. We learn from the *Lancet* that the Nancy faculty of medicine is not content with its power to present candidates for the university doctorate as regards medicine, but desires the right to present for a degree persons who have shown their especial knowledge in biological science. The council of the University of Nancy has agreed to this proposition, and accepted it at a special meeting. The resolution has just been approved by the Minister of Public Instruction, and so, starting during the current scholastic year, the faculty of medicine at Nancy is authorised to present candidates for the new degree, which is the first of the kind to exist in France.

THE unsatisfactory condition of the teaching of geography in this country should afford plenty of scope for the work of the Geographical Association, which aims "to improve the teaching of geography by spreading the knowledge of all such methods as call out the pupil's intelligence and reasoning powers and make geography a real educational discipline, instead of merely loading the memory with names and isolated facts." The membership of the Association has hitherto been limited to teachers in secondary schools and others interested in public school education. At the recent annual meeting, its boundaries were extended, and the Association is now open to all teachers of geography, and to other persons desirous of encouraging improved methods of geographical instruction. Geography as it is usually taught ought to be banished from our schools, for it is of no scientific value whatever, and benumbs a child's intellect instead of developing it. When the authorities which supervise and examine the work done in primary and secondary schools take a wider view of geography than at present exists, when, in fact, they make geography mean physiography, there will be hope for the rational methods of teaching which the Geographical Association seeks to encourage.

A SHORT time ago it was proposed to form a Bureau or School of Research in Washington, under the supervision of the Smithsonian Institution. The Regents of the Institution are in sympathy with the scheme, but they consider that their present powers are scarcely broad enough to embrace the work proposed. They may, however, decide to ask Congress to provide the means for organising the scientific work of the various Government departments, and for co-operating with the universities and colleges of the United States in systematic research work. The Bureau would be in connection with the proposed National University, upon which subject a sub-committee of the National Educational Association has just presented a report. The committee suggests that if the Smithsonian Institution is unable to take the initiative in the matter, the Bureau of Education shall become the administrative centre of the Bureau of Research. Under the terms of either of the plans proposed, it is assumed that the persons admitted to carry on research will be graduates of a college or university in good standing, or will have had an equivalent training. The committee point out that such a bureau of research, whether it be placed under the care of the Smithsonian Institution or under that of the Department of Education—which would supersede the existing Bureau of Education—would be a source of strength to the higher education of the United States and a great advantage to the Government in its work of promoting the progress of science and the useful arts, and in applying the result of scientific investigation to the development of the natural resources of the country, of agriculture, of manufactures, and of commerce.

SCIENTIFIC SERIALS.

American Journal of Science, March.—Hot water and soft glass in their thermodynamic relations, by C. Barus. Glass shares the property of colloids, of being soluble in a liquid when the latter is hot enough. Glass is dissolved in water heated under pressure to 210°. Every glass at a sufficiently high temperature must eventually show complete solubility in water. Such solutions are, however, unstable at ordinary temperatures. The solubility of silicates in very hot water has an important bearing upon natural phenomena. Sea-water more than 200 metres below the surface of the ocean will remain liquid at 200°. If, therefore, water from anywhere below that depth penetrates into the earth as far as the isotherm for 200°, the rock there, if of the character of glass, will become liquefied, apart from pressure. The hydrated silicate is thus virtually fluid 8 kilometres below the surface, and the level of aqueous fusion is five times as near the surface as that of igneous fusion.—An electrical thermostat, by W. Duane and C. A. Lory. The thermostat, which is of very high efficiency, consists of a wooden trough containing an ordinary salt solution, which is heated by an electric light current introduced through zinc plates at the ends of the trough. The regulating device is a set of brass tubes filled with alcohol, whose expansion depresses a thread of mercury in one arm of a U-tube, and thus makes contact in the other arm. The circuit thus established works a relay which inserts a resistance in the heating circuit, and thus automatically reduces the temperature. The action is remarkably prompt, the regulating circuit being made and broken two or three times per second. The temperature of the thermostat remains constant to within $\frac{1}{3000}$th of a degree C., even when the surrounding temperature changes suddenly by some 12 degrees.—Explorations of the *Albatross* in the Pacific, (iii.), by A. Agassiz. The deepest trawl haul yet made was made about 75 miles east of Tonga-Tabu. It was at 4173 fathoms. The bag brought up a number of large fragments of silicious sponge, belonging probably to the genus Crateromorpha, which had been obtained by the *Challenger* at depths of only 500 fathoms. The bottom consisted of light brown volcanic mud mixed with radiolarians.—Illinois Gulch meteorite, by H. L. Preston. This siderite was found in Montana last year, on the bed rock about four feet below the surface. It weighs $2\frac{1}{2}$ kilograms, and consists of 92 5 per cent. iron, 6·7 per cent. nickel, and traces of cobalt, silicon, phosphorus and carbon. It shows no figures on etching, but greatly resembles the Morrodal siderite of Norway.—The Silurian-Devonian boundary in North America, by H. S. Williams. This first article deals with the Chapman sandstone fauna. It must be regarded as the equivalent of the topmost fauna of the Welsh Silurian system. This classifies the Lower Helderberg formation in the Silurian system.

THE *Physical Review* for January contains the first part of a paper, by Prof. R. A. Fessenden, bearing the title of "A determination of the nature of the electric and magnetic quantities, and of the density and elasticity of the ether."—Mr. B. E Moore, in the same number, deals with electrolytic polarisation; and Mr. H. V. Carpenter with the comparison of two self-inductances.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 1.—"On the Influence of the Temperature of Liquid Air on Bacteria." By Allan Macfadyen, M D.

The experiments of Dr. Horace T. Brown and Mr. Escombe (*Roy. Soc. Proc.* vol. 62, 1898, p. 160) have shown that no appreciable influence is exerted upon the germinative power of seeds when exposed for 110 hours to the temperature of liquid air (–183° C. to –192° C.). The results were equally negative in the recent experiments of Sir W. Thiselton-Dyer (*ibid.* vol. 65, 1899, p. 361), in which seeds survived exposure for upwards of six hours to the temperature of liquid hydrogen (–250° C. to –252° C.).

The following investigation on the influence of the temperature of liquid air on bacteria was carried out at the suggestion of Sir James Crichton Browne and Prof. Dewar. The necessary facilities were most kindly given at the Royal Institution. The experiments were conducted under the personal supervision of Professor Dewar, and he has asked me to put the results on record, although it must be acknowledged that the essential features of the investigation are due to him.

Ten organisms were used for the experiments, viz.:—*B. typhosus*, *B. coli communis*, *B. diptheriae*, *Spirillum cholerae Asiaticae*, *B. proteus vulgaris*, *B. acidi lactici*, *B. anthracis* (sporing culture), *Staphylococcus pyogenes aureus*, *B. phosphorescens* and *Photobacterium balticum*.

The cultures were simultaneously exposed to the temperature of liquid air for twenty hours (–182° C. to –190° C.). They were then carefully thawed and examined. The results may be briefly stated. In no instance, whether on solid or in liquid media, could any impairment of the vitality of the micro-organisms be detected. The fresh growths obtained from the exposed tubes were normal in every respect, and the functional activities of the bacteria were equally unaffected. The colon bacillus produced its typical effects—such as the curdling of milk, the fermentation of sugar and the production of indol; the *Staphylococcus pyogenes aureus* retained its pigment-producing properties, and the anthrax spores their pathogenic action, on animals. The photogenic bacteria preserved their normal luminous properties. These photogenic properties are intimately connected with the functional activities of the cells. The cells emit light which is apparently produced by a chemical process of intracellular oxidation, and the phenomenon ceases with the cessation of their activity. These organisms therefore furnished a very happy test of the influence of low temperatures on vital phenomena. Their cultures, when cooled down in the liquid air for twenty hours, became non-luminous, but on rethawing the luminosity returned with unimpaired vigour as the cells renewed their activity. Watery emulsions of the photogenic bacteria, on immersion in liquid air for a few minutes, ceased to emit light, but on withdrawal the luminosity reappeared in a very short time. Strips of filter paper soaked in the watery emulsions and brightly luminous were immersed directly in the liquid air with similar results. The sudden cessation and rapid renewal of the photogenic properties of the cells, despite the extreme changes of temperature, was remarkable and striking.

The above experiments show that bacteria may be cooled down to –190 C. for a period of twenty hours without losing any of their vital properties.

Further experiments are in progress with the above-mentioned, and with other micro-organisms exposed to the temperature of liquid air for still longer periods of time, as well as to that of liquid hydrogen. These experiments will form the subject of a future communication.

March 15.—"The Theory of the Double Gamma Function.' By E. W. Barnes, B.A., Fellow of Trinity College, Cambridge. Communicated by Prof. A. R. Forsyth, Sc.D., F.R.S.

Physical Society, March 23.—Prof. W. E. Ayrton, F.R.S., Vice-President, in the chair.—A paper on some experiments illustrating syntony was read by Mr. P. E. Shaw. The experiments described in this paper have been devised for the purpose of showing in a lecture-room the principles of magnetic space telegraphy, the distance between the sending and receiving circuits being about fifteen yards. A current flowing in a main circuit was interrupted by a tuning-fork of 100 vibrations per second, and a fraction of the current was passed through the sending coil. The sending coil was placed in series with a coil of adjustable self-induction, and the two coils were shunted with a condenser of variable capacity. By suitable adjustments an oscillation of frequency 400 could be maintained in the sending circuit. The receiving coil was in series with a variable self-induction and a variable capacity, and was tuned to respond to the waves given out by the primary. The current induced in the secondary coil was passed round a light drum fastened to a wire tuned to 400 vibrations per second. The drum was placed in a strong magnetic field, and the electrical oscillations caused mechanical vibrations of the drum. On to the drum was attached one carbon of a microphone, and the induced oscillations were thereby considerably magnified in the microphone circuit. This circuit was also arranged in the same way as the former, and by means of another microphone the vibrations were transferred to another circuit where their intensity was sufficient to actuate the diaphragm of an ordinary telephone receiver to such an extent as to render the sound perfectly audible. Mr. Watson described some experiments which he had shown to illustrate syntony, both by obtaining galvanometer deflections and sparks in the secondary circuit. Dr. Lehfeldt asked how the circuit was tuned when it contained both a variable capacity and a variable self-induction. Mr. Shaw said that the values of the capacity and self-induction were connected with the vibration frequency by a formula given by Dr. Lodge. Starting with a known capacity, the necessary self-induction was calculated and small alterations produced by means of an iron core.—Mr. Shaw then read a paper on an electrical micrometer. In this paper the motion of the centre of a telephone diaphragm was measured by means of a system of levers and a spherometer screw. The screw, which had a pitch of 0·5 mm. and a head divided into 500 parts, pressed against the long arm of an aluminium lever. The short arm of this lever pressed against the long arm of another, and so on through three levers. In this way any motion of the spherometer screw was transmitted to a fine platino-iridium point close to a small platino-iridium disc fastened to the centre of the telephone diaphragm. Since the head of the spherometer could be accurately read to 0·1 of a division by means of a telescope, and since the system of levers minified any motion a hundred-fold, it follows that an accurately observable twist of the spherometer head corresponds to a movement of a millionth of a millimetre or 1 $\mu\mu$ of the fine point. To test the action of the levers, the point was removed and a convex lens substituted. This lens formed one of a system by means of which Newton's rings were produced and observed. By means of an optical experiment, the author has found that 0·1 of a division on the graduated head equals 1·033 $\mu\mu$ at the platino-iridium point. The point and the diaphragm then formed part of a circuit containing an ordinary telephone, and the levers were so adjusted that the point just touched the diaphragm. A sharp click was then heard in the telephone. A small current was then sent through the electromagnets of the original telephone, and the displacement of the diaphragm measured by turning the spherometer screw until the point just touched it and a second click was heard. By carrying out a series of experiments of this description, a curve has been drawn showing the relation between current strength and diaphragm displacement. It is then interesting, by exterpolation from the curve, to find the movement which corresponds to the least audible sound. The author has done this, and finds that he cannot hear sounds if the amplitude is less than 0·37 $\mu\mu$. A motion of 50 $\mu\mu$ gives comfortable sounds, 1000 $\mu\mu$ uncomfortable sounds, and 5000 $\mu\mu$ sounds unbearably loud. Throughout the experiments it was necessary to get rid of extraneous vibration by means of indiarubber balls and door-spring suspensions, and by working at night. Prof. Everett expressed his interest in the delicacy of the system of measurement, and asked if the micrometer had been used to determine the form of the plate when vibrating. Mr. Phillips asked if experiments on the smallest sound audible had been made on different people, as it would be physiologically interesting to know if this minimum value were constant. Mr. Campbell asked if the sound was expected when heard. Mr. Shaw said he had not conducted experiments on the form of the plate when vibrating, although he had investigated its law of damping. He said the small sounds were expected and the limit varied. The chairman said he found it easy to rid galvanometers and electrometers from extraneous disturbance by placing them on a block of stone resting on a thickness of three or four feet of slag wool contained in a hollow brick pillar.—The Society then adjourned until April 27, when the meeting will be held at eight o'clock in the Solar Physics Observatory of the Royal College of Science.

Chemical Society, March 8.—Prof. Thorpe, President, in the chair.—Prof. Warington delivered a lecture on recent researches on nitrification.

March 15.—Prof. Thorpe, President, in the chair.—The following papers were read:—The vapour densities of dried mercury and mercurous chloride, by H. B. Baker. Carefully dried mercurous chloride seems to have the molecular composition Hg_2Cl_2 at 448°, thus differing from the undried material, which is known to dissociate at this temperature. Carefully purified and dried mercury is monatomic at 448°.—The preparation of pure hydrobromic acid, by A. Scott. Pure hydrobromic acid is very conveniently prepared by the action of sulphurous acid upon bromine, the product being easily separated, by two or three distillations, from the sulphuric acid simultaneously formed.—A new sulphide of arsenic, by A. Scott. On allowing an arsenate to react with phosphorus trichloride and sulphurous acid at ordinary temperatures a dark brown precipitate is formed, which consists of a new arsenic sulphide having the composition As_3S.—The action of iodine on alkalis, by R. L. Taylor. The author shows that the action of iodine upon alkalis in the cold is always the same in the first instance, and consists in the formation of hypoiodite and iodide; the hypoiodite, however, decomposes more or less rapidly, according as the solution is more or less concentrated, into iodate and iodide.—The interaction between sulphites and nitrites, by E. Divers and T. Haga.—The sym-dipropyl, sym-diisopropyl- and $\alpha\alpha'$-propylisopropyl-succinic acids, by W. A. Bone and C. H. G. Sprankling. The authors show that, contrary to the received view, each of the above alkyl-substituted succinic acids exists in two stereoisomerides; both *cis*- and *trans*-isomerides yield their own anhydrides with acetic chloride, and the anhydrides give characteristic anilinic acids with aniline.—Manno-galactan and lævulo-mannan; two new polysaccharides, by J. L. Baker and T. H. Pope. The Indian clearing nut (*Strychnos potatorum*) yields an amorphous manno-galactan on extraction with hot dilute alkali; the new substance gives a mixture of two parts of galactose to one of mannose on hydrolysis. The ivory nut (*Phytelephas macrocarpa*) similarly yields a lævulo-mannan which on hydrolysis gives a mixture of twenty parts of mannose with one of lævulose.—Hydrolysis of semicarbazones, by G. Young and E. Witham.—The dissociation constant of azoimide, by C. A. West. Determinations of the electrical conductivity of aqueous solutions of azoimide show that this substance resembles acetic acid in acid character.—Racemisation occurring during the formation of benzylidene, benzoyl- and acetyl derivatives of dextro-ac-tetrahydro-β-naphthylamine, by W. J. Pope and A. W. Harvey. During the formation of the benzylidene, benzoyl and acetyl derivatives of dectrotetrahydro-β-naphthylamine nearly, but not quite, all of the material undergoes racemisation.

Geological Society, March 7.—J. J. H. Teall, F.R.S., President, in the chair.—Notes on the geology of Gilgit, by Lieut.-General C. A. McMahon, F.R.S. Briefly stated, the author's conclusions are as follows:—That at one period in the elevation of the Hindu Kush the strata were thrown into a series of folds and compressed into a series of uniclinal beds with a vertical dip. That the direction of the main drainage of the area was determined before, or at the commencement, of the last series of earth-movements that crumpled up the strata. The sedimentary rocks were profusely invaded by granite and diorite, and profoundly metamorphosed by contact-action. As regards the age of the rocks, the author gives his reasons for identifying the Gilgit limestones with the conformable Carbo-Triassic series of the Himalaya.—The rocks of the south-eastern coast of Jersey, by John Parkinson. In this paper the author has continued the study of the deep-seated rocks of Jersey, begun in a communication presented to the Society last session, entitled, "On an intrusion of granite into diabase at Sorel Point (Northern Jersey)." A great resemblance exists between these rocks in the north and south of the island, and it is concluded that they represent parts of the same magma; but in the south-east additional complications arise, owing to the intrusion of another rock before the invasion of the granite.—The rocks of La Saline (Northern Jersey), by John Parkinson.

Anthropological Institute, March 13.—Mr. C. H. Read, President, in the Chair.—A photographic slide, presented by Mr. Sidney Hartland, was exhibited, representing the figure of a War God from Boma, in the Congo State (now in the museum of Leyden), into which numerous nails have been driven, probably in registration of the prayers or vows of worshippers. The President compared a similar figure in the possession of Miss M. H. Kingsley, in which the nails were explained as records of lives taken through the magic power of the God.—Mr. A. L. Lewis read a paper on "Stone Circles in Scotland," which he classified according to local types as follows: (1) the Western type, consisting of a single ring of stones with a cist or grave within the enclosure; (2) the Inverness type (found also locally along the east coast, north of Inverness, and easily accessible thence by sea) with two concentric rings, of which the inner formed the retaining wall of a cairn, under which was a stone lined sepulchral chamber accessible by a stone lined passage; (3) the Aberdeen type, which differs mainly from that of Inverness in the presence of a large slab set vertically between the two largest stones of the outer ring at a point opposite to the passage leading to the chamber. The more irregular circles and alignments, such as Callernish and Brogars, which the author regarded as not primarily sepulchral, and explained as "sun and star" circles, on the ground of their aspect, and of certain proportions which were found to exist among their dimensions. He insisted upon the ethnological value of the various local types, and upon the importance of testing this by applying a similar classification to the stone circles of England. In discussion, Mr. W. Gowland pointed out that failure to find traces of an interment within a circle did not prove that that circle was not a sepulchral monument originally; and emphasised the points of agreement between the Western, the Inverness, and the Aberdeen types of circle. Dr. J. G. Garson discussed the modes of determining the age of stone circles, in view of the work of the Stone Circles Committee of the British Association. Mr. G. L. Gomme protested against the premature adoption of an astronomical interpretation of individual monuments. Mr. Lewis briefly replied; and the President, in returning thanks, dwelt on the necessity of collecting the local traditions as to the original use of these monuments, and at the same time of distinguishing, as in the case of the Yorkshire "Danes Graves," between aboriginal and immigrant sources of tradition.—Mr. J. L. Myres exhibited and described a series of photographs of the megalithic buildings of Malta and Gozo, and pointed out the inapplicability of certain current theories of their origin.

EDINBURGH.

Royal Society, February 19.—Prof. McKendrick in the chair.—Sir John Sibbald read a paper on the statistics of suicide in Scotland. The various tables were arranged to bring out such features in the statistics of suicide as the influence of sex and age, of season, of locality, of town and country, and so on. The prevalent idea that statistics proved an increasing tendency in suicide was shown to be a too hasty deduction from the figures. When the statistics of suicide by hanging—the one method in which there was very little chance of mistake—were compared for the last fifteen years and for the preceding period of fifteen years, the number of suicides per million was exactly the same. Then a careful scrutiny of the returns for deaths by accident showed that the apparent increase in suicide by such methods as drowning, shooting, poisoning, &c., was balanced by a decrease in deaths by accident due to the same causes. It would, therefore, appear that the apparent increase in suicides in the last fifteen years was due, not to a real increase in suicide, but to improved methods of discriminating between suicide and accident. The statistics clearly established the fact that the suicidal rate was less in the western than in the eastern counties of Scotland, a fact which Dr. Clouston, in the after-discussion, explained as being in all probability due to difference of race, the greater Celtic element in the west producing, not necessarily a less suicidal disposition, but a less determined carrying out of the deed of self-destruction.

March 5.—Prof. Duns in the chair.—A paper, by Dr. Thomas Muir, on certain aggregates of determinant minors, was taken as read.—Mr. John Aitken, F.R.S., communicated a paper on the dynamics of cyclones. Attention was first drawn to the conditions under which cyclonic motion was developed both in air and in water; and the dynamic principles underlying the production of the phenomenon were illustrated by means of a neat arrangement of balls hung at the ends of two parallel wires, the whole being capable of rotation about a central vertical axis. When drawn together by pulls along threads which passed through the axis of rotation, the two balls were made to spin round one another with a rapidly increasing angular velocity, thus illustrating the important principle of the conservation of moment of momentum. By a simple modification, the apparatus could be made to illustrate the principle of the conservation of energy. Mr. Aitken emphasised the importance of giving increased attention to the anti-cyclonic distributions which in a sense may be regarded as playing, relatively to the accompanying cyclonic distributions, the same *rôle* as is played by the condenser relatively to the boiler of a steam engine. The direction and rate of movement of a cyclone was shown to be determined by the position and configuration of the region where the isobars were closest; a cyclone whose isobars form a set of concentric circles having little or no translatory motion. This characteristic was explained by the author as due to the direct influence of the anti-cyclonic vortex. Many of the features of cyclones were illustrated by means of an ingenious apparatus in which the necessary upward draught was produced in a tall chimney, the whirls of air developed beneath being made visible by the use of sal-ammoniac fumes. The crossing of currents at different heights was beautifully demonstrated. In conclusion, Mr. Aitken referred to the physiological effects observed in the front area of a cyclone, and thought that these might be explained as due to the impure air rising from the ground. In the after-discussion, Prof. Crum Brown drew attention to the experiments by which Prof. Hunter Stewart had established the fact that the soil breathed out a great deal of carbonic acid gas, and no doubt other emanations as well. Mr. Omond pointed out that the dissimilarity as regards relative dimensions between Mr. Aitken's model and the real cyclone should make us very cautious in applying the results obtained with the model to the explanation of cyclonic effects. Dr. Buchan said that, although most of the storms of the north-west of Europe travelled westwards and were characterised by high westerly and south-westerly winds, there were occasionally cyclones which travelled eastwards, and these were always characterised by high east winds. Dr. Knott took the opportunity of protesting against the tendency of speaking of a cyclone as something independent of the winds that really constituted it. Given a cyclonic condition moving through the air, it is obvious that the strongest winds will be on the whole in the direction of that movement, and consequently the isobars will be closest where the associated wind has this direction. It is merely expressing the same truth in different ways to say that a westward travelling cyclone in our latitudes has its isobars closest to the south and is characterised by high west winds, that a slow moving or motionless cyclone has a symmetrical arrangement of isobars, and that an eastward travelling cyclone has its isobars closest on the north and is characterised by high east winds.—Dr. W. G. Aitchison Robertson read a note on the activity of saliva in diseased conditions of the body, being a continuation of a previous paper. In many diseases the digestive activity of saliva on starchy foods underwent a great diminution. This was particularly the case in disorders of the stomach, and the importance of selecting a proper dietary in such cases was insisted on. In many instances a more thorough examination of the saliva than is customary would almost certainly lead to valuable conclusions, and an examination of this kind had the great merit of being extremely easy.

PARIS.

Academy of Sciences, March 19.—M. Maurice Lévy in the chair.—Forces related to the state of perfect elasticity that dynamic contraction creates in the muscle substance. The physiological work intimately constituted by this creation, by M. A. Chauveau.—On linear partial differential equations of the second order with constant coefficients, by M. J. Coulon.—On differential systems with fixed critical points, by M. Paul Painlevé.—On multiplex telegraphy, and a differential telemicrophonic relay, by M. E. Mercadier. A description of a new microphonic relay by means of which it is possible to send a large number of messages simultaneously over the same wire. Between the two end stations, intermediate stations working together with the extremes can be interposed without any difficulties arising.—Relations between the electrolytic conductivity and internal friction of saline solutions, by M. P. Massoulier. Solutions of sulphate of copper in solutions of glycerine and water of various strengths were employed. The resistances were measured both by the Lippmann electrometric method and by the telephone with alternating currents, the viscosity by Poiseuille's method. At 15° the rises of resistance and viscosity with increase of glycerine are proportional, but this does not appear to hold at 0° C.—On a quartz thermometer for high temperatures, by M. A. Dufour. Two quartz thermometers have been prepared, one containing tin, capable of measuring temperatures between 240° and 580° C., and another containing mercury. The study of the zero residues in the quartz-mercury thermometer is under consideration.—Fluorescence of certain metallic compounds when submitted to the Röntgen and Becquerel rays, by M. Paul Bary. Numerous salts of the metals of the alkalies and alkaline earths are divided into two groups according as they were found to be fluorescent or non-fluorescent in the X-rays. The substitution of a radio-active substance for the Crooke's tube showed that all bodies which fluoresce with the X-rays present the same phenomenon with the Becquerel rays. The division proved to be somewhat arbitrary, no general relation between the position of a salt and its chemical composition being apparent.—On the hydrated peroxides of barium, by M. de Forcrand. A calorimetric study of the action of solutions of hydrogen peroxide upon baryta.—On the separation of the rare earths, by M. R. Chavastilon. In the separation of thorium and cerium from lanthanum and didymium, the author reverses the method of M. Urbain and keeps the thorium in solution. Two methods are proposed; in the first the solution of the rare earths is poured into an excess of neutral sodium sulphite, the cerium, lanthanum and didymium being precipitated as sulphites, the thorium remaining in solution. In the second method, the solution of the rare earths is precipitated by adding ammonia and hydrogen peroxide, from which precipitate alkaline bicarbonates extract the thorium and ceriux oxides only.—Chemical reactions produced in a solution; vapour tension of the solvent, by M. A. Ponsot. A mathematical discussion of the conditions under which the vapour pressure of a liquid increases, when reactions occur between substances dissolved in it.—On the detection, estimation and variations in cystine in polluted water, by M. H. Causse. The reagent used is the chloro-mercurate of sodium *p*-diazobenzenesulphonate, which produces with cystine a yellow-orange coloration, the depth of which is proportional to the quantity of cystine present. The author has been able to trace a direct connection between the presence of cystine in a drinking water and an outbreak of typhoid fever.—On certain phenomena presented by nuclei under the action of cold, by MM. L.

Matruchot and M. Molliard. In the plant studied (*Narcissus Tazetta*) the action of cold produced nuclear deformations, which are evidently related to the respective positions of the nucleus and the cell fluid. The most obvious phenomenon is an orientation, generally bipolar, of the chromatic portion with a more or less complete condensation of the chromatin in the equatorial region.—On the toxicity of the compounds of the alkaline earths with respect to higher plants, by M. Henri Coupin. Of the salts tried, barium chlorate proved to be the most injurious. The iodine compounds of all three alkaline earths possess a much higher toxic effect than the other halogen compounds, and for a given acid the toxicity increases with the atomic weight of the metal.—On the pure culture of a green algæ: formation of chlorophyll in the dark, by M. Radais. Comparative experiments on the cultivation of *Chlorella vulgaris* in the daylight and in the dark showed that the multiplication of the cells was the same in both cases. After about a fortnight's growth at 25°, the green tint was also the same in both, the identity of the green colouring matter formed in the dark with chlorophyll being proved spectroscopically.—The andesitic volcano of Tifarouine (Algeria), by M. L. Gentil.—Specific heat of the blood, by M. H. Bordier. The measurements were made by the method of cooling, the upper starting temperature being 45°. Arterial blood, defibrinated blood and serum gave ·901, ·920 and ·932 respectively. The specific heat of arterial blood is greater than that of venous blood (·893). It follows from these figures that the specific heat of the organism taken as a whole must be nearer 0·7 or 0·8 than 1·0 as usually assumed.—Restoration of the functions of the heart and central nervous system after complete anemia, by M. Frédéric Batelli.—Method for the examination and measurement of taste, by MM. Ed. Toulouse and N. Vaschide. Four solutions were employed of salt, sugar, quinine bromhydrate and citric acid, which were systematically diluted. Special precautions as to temperature and mode of contact with the tongue were made, the start being made with a tasteless solution, the strength of which was gradually increased until the taste became perceptible.—Some considerations concerning the freezing of water, by M. F. Bordas.

DIARY OF SOCIETIES.

THURSDAY, March 29.

Royal Society, at 4.30.—On the Retinal Currents of the Frog's Eye, excited by Light and excited Electrically: Dr. Waller, F.R.S.—Observations on the Electromotive Phenomena of Non-medullated Nerve: Miss Sowton.—Variation: Prof. Ewart, F.R.S.—Certain Laws of Variation: Dr. H. M. Vernon.—(1) Data for the Problem of Evolution in Man. IV. Note on the Effect of Fertility depending on Homogamy. (2) Mathematical Contributions to the Theory of Evolution. VII. On the Inheritance of Characters not capable of Exact Quantitative Measurement: Prof. K. Pearson, F.R.S.
Royal Institution, at 3.—Equatorial East Africa and Mount Kenya: H. J. Mackinder.
Chemical Society, at 3.—Annual General Meeting.——At 8.30.—Bunsen Memorial Lecture: Sir Henry Roscoe, F.R.S.
Society of Arts (Indian Section), at 4.30.—The Manufacture and Use of Indigo: Christopher Rawson.

FRIDAY, March 30.

Royal Institution, at 9.—Facts of Inheritance: Prof. J. A. Thomson.

SATURDAY, March 31.

Royal Institution, at 3.—Polarised Light: Lord Rayleigh.

MONDAY, April 2.

Society of Arts (Foreign and Colonial Section), at 4.30.—The Century in our Colonies: Right Hon. Sir Charles Wentworth Dilke, Bart., M.P.
Royal Geographical Society, at 8.30.—Explorations in Central Asia: Captain H. H. P. Deasy.
Victoria Institute, at 4.30.—North Polar Thalassography: Cavaliere Jervis.

TUESDAY, April 3.

Royal Institution, at 3.—Structure and Classification of Fishes: Prof. E. Ray Lankester, F.R.S.
Society of Arts, at 8.—Process Engraving: Carl Hentschel.
Royal Meteorological Society, at 3.—Commemoration Meeting.—Address by Dr. C. Theodore Williams.
Zoological Society, at 8.30.—On *Mus sylvaticus* and its Allies, Subspecies, and Geographical Variations: G. E. H. Barrett-Hamilton.—Notes on the Mammals of Siam and the Malay Peninsula: Stanley S. Flower.—On a Remarkable New Piece of Skin from Cueva Eberhardt, Patagonia: Dr. Einar Lönnberg.
Institution of Civil Engineers, at 8.—Economical Railway Construction in New South Wales: Henry Deane.—The Tocopilla Railway: Robert Stirling.
Royal Photographic Society, at 8.—F. P. Ambrano will show Slides, Old and New.
Mineralogical Society, at 8.—Hamlinite, Florencite, Plumbogummite (Hitchcockite), Beudantite and Svanbergite as Members of an Isomorphous Group: G. T. Prior.—On the Optical Properties of Chalybite and Diallogite: Dr. A. Hutchinson.—Ægirine (and Riebeckite) Anorthoclase Rocks related to the "Grorudite-Tinguaite" Group from the Neighbourhood of Adoa and Axum, Abyssinia: G. T. Prior.—The Chemical Composition of the Mount Zomba Meteorite: L. Fletcher, F.R.S.

WEDNESDAY, April 4

Society of Arts, at 8.—Cotton Supplies: John A. Banister.
Geological Society, at 8.—Additional Notes on some Eruptive Rocks from New Zealand: F. Rutley.—On the Discovery and Occurrence of Minerals containing Rare Elements: Baron A. E. Nordenskiöld.
Entomological Society, at 8.
Society of Public Analysts, at 8.—Note on the Influence of Temperature and Concentration on the Saline Constituents of Boiler Waters: Cecil H. Cribb.—On an Improved Absorption Apparatus for Use in the Analysis of Essential Oils: Alfred C. Chapman and H. E. Burgess.—On the Composition of Danish Butters: H. Faber.—The Composition of Milk and Milk Products: H. Droo Richmond.

THURSDAY, April 5.

Royal Society, at 4.30.—*Probable Papers:* On the Weight of Hydrogen desiccated by Liquid Air: Lord Rayleigh, F.R.S.—Combinatorial Analysis: The Foundations of a New Theory: Major MacMahon, F.R.S.—Über Reihen auf der Convergenzgrenze: Dr. E. Lasker.—Extinct Mammalia from Madagascar. I. *Megaladapis insignis*, sp. n.: Dr. C. J. Forsyth Major.—The Kinetic Theory of Planetary Atmospheres, Part I.: Prof. E. H. Bryan, F.R.S.—Observations on the Effect of Desiccation of Albumin upon its Coagulability: Prof. J. B. Farmer.
Royal Institution, at 3.—Equatorial East Africa and Mount Kenya: H. J. Mackinder.
Mathematical Society, at 5.30.—The Orthoptic Loci of Curves of a Given Class: A. B. Basset, F.R.S.
Linnean Society, at 8.—*Sphenophyllum* and its Allies, an Extinct Division of the Vascular Cryptogams: Dr. D. H. Scott, F.R.S.
Chemical Society, at 8.—(1) The Liquefaction of a Gas by "Self-Cooling": A Lecture Experiment; (2) Note on Partially Miscible Aqueous Inorganic Solutions: G. S. Newth.—The Decomposition of Chlorates. II. Lead Chlorate: W. H. Sodeau.—The Interaction of Mesityl Oxide and Ethyl Sodiomethylmalonate: A. W. Crossley.—The Bromination of Benzeneazophenol: J. T. Hewitt and W. G. Aston.
Institution of Electrical Engineers, at 8.
Röntgen Society, at 8.—The Influence of the X Rays upon the Growth and Development of Micro organisms: Dr. Norris Wolfenden and Dr. Forbes Ross.

FRIDAY, April 6.

Royal Institution, at 9.—Solid Hydrogen: Prof. J. Dewar, F.R.S.
Geologists' Association, at 8.—Zonal Features of the Kentish Chalk-Pits between London and the Medway Valley: G. E. Dibley.
Institution of Civil Engineers, at 8.—Experiments on Struts with and without Lateral Loading: H. E. Wimperis.

SATURDAY, April 7.

Royal Institution, at 3.—Polarised Light: Lord Rayleigh.

CONTENTS.

THURSDAY, APRIL 5, 1900.

CELESTIAL PHOTOGRAPHS.

Photographs of Stars, Star-clusters and Nebulae, together with Records of Results obtained in the pursuit of Celestial Photography. By Isaac Roberts, D.Sc., F.R.S. Vol. ii. Pp. 178. Plates. (London: *Knowledge* Office, 1900.)

IT is now nearly six years ago since Dr. Roberts published his first volume on celestial photographs, which was noticed at some length in these columns (Vol. l. p. 447). It was there remarked that the volume was the result of a "remarkable example of what can be done single-handed in a new line of research," and we might echo the same statement as regards the contents of the present issue.

Every astronomical reader is familiar with the first publication; indeed, Dr. Roberts's celestial photographs of long exposure were, and still are, so remarkable that many of them have been reproduced in most of the more recent works on astronomy. It is interesting to remark that in commencing astronomical photography it was the author's original intention to make a photographic chart of the sky between the north pole and the equator, so that those who came after him could, by taking similar photographs and comparing them with his, detect any changes that might have taken place during the interval that had elapsed. After he had secured many photographs on a definite programme of work, the international scheme for making a photographic chart of the whole heavens was suggested and commenced under the direction of the late Admiral Mouchez. Dr. Roberts therefore discontinued his charting work, and began the important investigation of photographing, on a large scale and with long exposures, the various star-clusters and nebulæ with the object of securing exact pictures of them, so that any changes that might take place in them might be detected after the lapse of some years.

The first volume indicated to the astronomical world the great and well deserved success which rewarded the labours of Dr. Roberts in this, perhaps, the most interesting branch of astronomy, and he may be said to have continued with the photographic plate the work that the Herschels accomplished visually with their giant telescopes. Like these celebrated observers, he has photographed "double and treble nebulæ variously arranged: large ones, with small, seeming attendants; narrow, but much extended, lucid nebulæ and bright dashes; some of the shape of a fan, resembling an electric brush, issuing from a lucid point; others of a cometic shape, with a seeming nucleus in the centre, or like cloudy stars surrounded with a nebulous atmosphere; a different sort, again, contains a nebulosity of a different kind, ...; while others shine with a fainter, mottled kind of light, which denotes their being resolvable into stars."

Of the seventy-two objects enlarged from the original negatives, and here beautifully reproduced in collotype by the London Steroscopic Company, thirty-three are of spiral nebulæ, fifteen of clusters, fourteen of nebulæ, irregular and cloudlike in form, six of crowded star areas, and four of annular nebulæ. The original photographs, which are 15 centimetres square, were all obtained, as formerly, with the silver on glass reflector of 20 inches aperture and 98 inches focal length. It may be here mentioned that Dr. Roberts has added to his instrumental equipment a specially made Cooke triplet portrait lens of 5 inches aperture and 19·22 inches focal length, with a photographic field of 15 degrees diameter.

In the work before us, the arrangement of the plates differs from that adopted in the first volume. The photographs, instead of following each other in the order of right ascension, are here divided into classes or groups, each of which indicates apparent physical relationships, and the members of each group are arranged as far as practicable in the order of right ascension. The scale of enlargement is given in each case, as well as a table for converting the measured right ascensions of the stars shown on the photographs into intervals of time for each degree in declination. It may be remarked that the table of corrections to be applied to the scales of the photo-plates which appeared in the first volume has been dispensed with, owing no doubt to the improvement in the manufacture of photographic films. The coordinates of each of the fiducial stars are given for the epoch 1900, and on the plates these stars are marked with dots as formerly.

In the reproduction of such difficult objects as those here illustrated, it is well known that much fine detail is lost in the process. Reproductions, although approximating closely, yet never come up to the quality of the original negatives. The last mentioned, however, are subject to many vicissitudes. They can become broken, the films become discoloured after some time, images fade, and faint nebulosities disappear entirely. That such is the case is clearly proved by the experience of Dr. Roberts, which is related in his introduction.

To mention only one instance of many, he tells us how, shortly after a photograph of a certain region of the sky was taken (in February 1886), he counted 403 star images on the negative. On May 29, 1895, or after an interval of nine and a quarter years, no less than 131 stars had disappeared from the same plate, he being only able to count 272 images.

With such facts before us, it is therefore of great importance that as each negative is secured an impression of it should be made in permanent form, such as in printer's ink. If the work be done well, as is the case with the beautiful illustrations in this volume, future astronomers will have valuable data at their disposal for making direct comparisons.

In the introduction, Dr. Roberts refers to several points of great interest, which will be read generally with advantage, but especially by those who expose their plates to the sky for long intervals of time. He first gives us an account of his experiments regarding the effect of "atmospheric glare," which is due to starlight, causing a general fogging of the whole photographic plate. For exposures extending over several hours, Dr. Roberts is led to deduce that, at any rate for this country at least, by the time that the image of an eighteenth magnitude star is well impressed on the photographic plate, the whole plate has become so generally fogged that the density of a star of the nineteenth magnitude, or of even nebulosity of the same brightness, is not distinguishable. This glare, therefore, apparently places a limit on the photographic penetrative power of the instrument employed, and, as far as Dr. Roberts's conditions of observation are concerned, the limit for luminosity of the feebleness of about the eighteenth magnitude is reached. Perhaps for such a clear atmosphere as is experienced at Arequipa, in Peru, and like stations, and with instruments of larger aperture, even fainter stars might be reached. This is a subject, however, which requires considerable research before any very definite statement can be accurately made.

The next point dealt with is perhaps the most important of all. It is the general impression that if a photographic plate be exposed in a telescope for several hours, it will, on development, show more stellar images than if it had been exposed for one hour; indeed, the longer the exposure, the more detail will be impressed on the photographic plate, and one can quite imagine that if exposure were sufficiently long, the whole plate would be covered with images, indicating that we are practically surrounded by a wall of stars.

This, however, is not the case according to the investigations of Dr. Roberts, and he produces very strong evidence in his favour. If two exposures be made on one object, say, one lasting one and one-half hours, and another for twelve hours, and should the same amount of detail be depicted on each, the natural deduction would be that the longer exposure did not show any more detail than the shorter one, because there would be no more images to record. From a minute examination of photographs of the great nebula in Andromeda, in Orion, the group of the Pleiades, and the region of the Milky Way about Cygnus, Dr. Roberts finds that such is the case, and that lengthened exposure need not necessarily mean an increased number of stellar images. He is thus led to accept the fact as a demonstration "of the accuracy of the surmises of astronomers in the past, that the part of the starry universe visible from the earth is limited in extent, and that notwithstanding the enormous assistance afforded by the photographic method, we are again brought to a check because of the inadequacy of the powers we possess to enable us to peer beyond that part of space in the midst of which we are placed. . . ."

It would be interesting to inquire whether Dr. Roberts has examined other photographs of these regions taken by different observers who have also employed long exposures and other instruments, and, if so, whether his opinion as regards this point has been endorsed. Such an examination as here suggested might lend additional strength to the conclusion he has already drawn.

In directing attention to the evolution of stellar systems, the author places before his readers a series of beautiful illustrations of his plates showing rich fields of stars of various degrees of condensation; spiral nebulæ varying as regards symmetry; circular, annular and irregular nebulæ; and lastly, nebulæ of a cloud-like nature, which cover enormous areas and are conspicuous by their great irregularity. The wonderful groupings into lines and curves of many of the stars in these clusters and nebulæ, and the forms of the nebulous matter, leave, as Dr. Roberts points out, no room for doubt that they are the effects of physical causes, and, on account of their persistency on the plates, are very improbably due to coincidence only. The author further differentiates between those stars which are actually involved in nebulæ, and those which are situated simply in the line of sight, but do not conform with the trend of the spirals or with the curves of the nebulous stars involved in them.

Many other points of interest are referred to in these pages, among which we may mention the variability and motion of nebulæ; these and others, however, we must leave to those of our readers who have the good fortune to examine the volume for themselves.

In the publication of this work, Dr. Roberts has not only nobly enriched astronomical science, but has raised a monument to himself which will last as long as astronomy has any interest for mankind. This handsome book, besides being a most valuable mine of information, serves not only as a demonstration of the success that has rewarded his efforts after an infinite amount of most skilful instrumental adjustment and working, but as an excellent example of the valuable work that can be accomplished single-handed when one is endowed with both the love for and the means of studying the oldest of the sciences. William J. S. Lockyer.

TWO MONSTROUS REPTILES.

(1) *A Complete Mosasaur's Skeleton and* (2) *A Skeleton of Diplodocus.* Being Parts iv. and v. of vol. i. of "Memoirs" of the American Museum of Natural History. By H. F. Osborn. With 8 Plates and 28 Text Illustrations. (New York: The Knickerbocker Press, 1899.)

The memoirs above-mentioned are the latest of a series which, though not yet in their second volume, have already taken their place in the foremost rank of zoological publications. For this praiseworthy result the world is largely indebted to the author of the present memoirs, through his great monograph on "The Extinct Rhinoceroses"—the third in order of succession to appear. That came to those cognisant of his rich resources and familiar with his former doings as the fulfilment of a desire, and in itself set a high standard of excellence. In the memoirs under review this has been fully maintained, both as regards text and illustrations, which are alike highly finished works of art, worthy a pupil of Huxley. The two sets of remains dealt with are equally remarkable—one for the fact that parts usually lost by decomposition after death are here preserved; the other as furnishing us, for the first time in an undisturbed state, with well-nigh half the axial skeleton of a colossus, whose backbone was hitherto known only by some few isolated vertebræ.

The specimen of the Mosasaur is from the famous Kansas Chalk, which vies only with that of Mesvin in yielding the remains of the later aquatic reptiles, as evidenced by the grand series preserved in the Brussels Museum. The specimen under consideration measures some thirty feet in length, and is in detail noteworthy for the condition of its cervical vertebræ and limb skeleton, and for the preservation of the cartilaginous sternum, sternal ribs, and coracoids, and laryngo-tracheal supports. Of the cervical vertebræ there were indubitably seven, and the lesser parts of these are so well preserved that the author is able to give a detailed account of the "atlas complex" and individual relationships of the "intercentra," admitting of comparison with the corresponding parts of recent reptiles. But one sacral vertebra is present, and of the twenty-two so-called "dorsals" ten are proved to have entered into the composition of the sternum. The limbs are of the usual Mosasaurian type, except for a broadening and shortening of the fifth metapodial in both fore and hind members; while the phalanges of the fourth and fifth digits of the manus are estimated as nine in number. The caudal vertebræ come in for consideration, and there is given a restoration of the entire skeleton in outline, and an accompanying attempt at that of the animal in the flesh. For this the author expresses his indebtedness to Mr. C. Knight, who, on the whole, does not seem to have been so successful as with some of his earlier efforts of the kind. The introduction of a "nuchal fringe" by analogy to *Platecarpus* is risky, and the contour of head and jaws grotesque, if not erroneous.

Concerning the affinities of the Mosasaurs, the author is unable to decide; for while showing them to be possessed of varanoid characters beyond those already recognised, he points to differences between the two groups, which he considers irreconcilable with the view that they sprang from a common stem. Here, however, he does not appear to have sufficiently considered the Dolichosaurian kinship, so strongly urged by Boulenger, supported by Dollo, and accepted by Smith Woodward; and his assertion that the presence of but seven cervical vertebræ is against this is unfortunate, since there is reason to believe that in some members of that suborder the number was thus small. The great expansion and non-fenestration of the unossified portion of the coracoid is a feature in respect to which this Tylosaurus is on a closer structural equality with the Rhynchocephalia than with the higher Lacertilia; and if it be that the bone claimed by Baur as the quadrato-jugal in *Platecarpus* really represents that, in consideration of the condition and inter-relationships of the palatines, pterygoids, and vomers, so well known in certain Mosasaurs, there can be little doubt that these struck off from some reptilian type intermediate between the Rhynchocephalia and the higher Lacertilia as to-day represented, *i.e.* that they arose "at an early stage in the evolution of the Squamata, before the modern Lacertilia and Ophidia had become differentiated," as Smith Woodward has so aptly remarked. Our greatest desideratum in the osteology of these creatures is a fuller knowledge of the posterior portion of their maxillo-jugal arcade, and it is unfortunate that with the present specimen, in which the conditions for preservation have been so favourable, that has been crushed.

Diplodocus is a notorious member of the Jurassic quadrupedal Dinosaurs, believed to have been an aquatic vegetable feeder; and, as already remarked, a full acquaintance with its axial skeleton has been a desideratum. The present specimen was obtained from the Como Bluffs of Wyoming, by a prospecting party led by the author in 1897. Hopes of the recovery of the entire skeleton proved false, but there were obtained a complete set of caudal vertebræ, together with the greater portion of the sacrum, hip-girdle and femur, all in an undisturbed state, and also fragments of the rest of the vertebral column and the ribs. Passing over important details concerning the cervical and so-called "dorsal" and pre-sacral vertebræ, with which the memoir deals in detail, it is as concerning the posterior of the latter, together with the sacral and caudal, and the ilium, that interest is greatest. The overlapping, by forward extension of the ilium, of certain free lumbar ribs with accompanying co-ossification of parts furnishes an interesting feature of convergence towards the Ratite bird type. Passing on, the author remarks that *Diplodocus* "gives us a new . . . conception of the Cetiosaurs," as involving the following interesting facts. He points out that the tail—some thirty feet in length—constitutes one-half of that of the whole animal, that the sacral spines mark the highest point in the backbone, and that the sacrum and ilium "come as a centre of power and motion"—the whole set of parts being so disposed as to lead us to regard the tail (which undoubtedly served as a propeller) as a "lever to balance the weight of the dorsal vertebræ" and the anterior portion of the body. He further points to a "balance between the opisthocœlous pre-sacrals and the procœlous post-sacrals," and draws the conclusion that the dominating principle of this great backbone is "maximum strength with minimum weight," while (to him) the whole is a mechanical triumph of great size, lightness and strength, which "baffles the Lamarckian as well as the Darwinian."

Beyond the more salient features above recapitulated, these memoirs are a storehouse of carefully recorded detail, of immense service for reference. Of the illustrations, no praise can be too high. There are eight plates, of which three are devoted to the Mosasaur, five to the Dinosaur; and all, with the exception of the third, which is an enlarged copy of a restoration of the skeleton incorporated in the text, are photographs of great merit. In addition, there are twenty-eight text illustrations, which, so far as they delineate parts of the actual remains, are ideal.

In conclusion, a word or two as to terminology and a looseness of expression, which we regret. In describing the unossified remnant of the coracoid as an "epicoracoid cartilage," and (using the term in its noun form) as an "epicoracoid" on one and the same page, the author is perpetuating a prevailing error against which we have more than once protested. The term "epicoracoid" is only applicable when a distinctly segmented element is present. Unfortunate, again, is the use of the term (p. 181) "sterno-coracoid plate." The sternum, which is apparently meant, is compared with that of certain living lizards; but when of these it is found that while at most three pairs of ribs contribute to its formation, in two of the species a second sternal cartilage is present, the comparison of *Tylosaurus*, with its ten pairs of costal ribs, is at least strained. Indeed, in its elongation and apparent longitudinal cleavage—its two most distinctive characters—the sternum of this aquatic reptile anticipates conditions independently realised later in time by that of certain Cetacea. Equally regrettable is the application of the term "dorsal" to those vertebræ possessed of free ribs. This term is one of orientation, and "thoracic" would have been preferable, except that in *Diplodocus* all the vertebræ between the third or fourth cervical and sacrum are rib-bearing. The old terms "thoracic" and "lumbar" have ceased to be tolerable in their original sense; and in view of the general presence of lumbar ribs among the terrestrial vertebrata and of the importance, both morphologically and physiologically, of the costal sternum, the suggestion that in the future we must enumerate the parts of the pre-sacral vertebral column of the Amniota in relation to the sternum may be revolutionary, but it will assuredly have to be adopted.

Zoology is pre-eminently that branch of pure science cultivated in the States, and our American *confrères* have a partiality for "big" game. It is pertinent to the present occasion, with its allusions to the Cetacea, to remark that rumour reaches us that they have lately come into possession of a complete *Zeuglodon* skeleton. If so, we can desire nothing better than that it may be monographed either in or on the lines of the memoirs under review; and we sincerely hope that the treasure in store will prove a more genuine concern than that of the famous giant Cetacean now preserved in the Palæontological Division of the Berlin Museum, which, having been publicly exhibited in that city as a mysterious creature of some 114 feet in length, was proved by Johannes Müller to embody the remains of individuals of two distinct species, and by him reduced to the less pretentious proportions of but some sixty to seventy feet.

We note that in the description of the Tylosaurus limb (Fig. 9) the word "left" should read "right"; and that in the table on p. 212, the reputed length of Diplodocus in metres is misleading, by omission of that of the caudal vertebræ, which, if added, would more than double the record given. G. B. H.

A NATURALIST IN CHILE.

Temperate Chile. A Progressive Spain. By W. Anderson Smith. Pp. x + 400. (London: Adam and Charles Black, 1899.)

MR. ANDERSON SMITH, formerly a member of the Scottish Fishery Board, is well known for his sympathetic descriptions of the wild life of the western highlands of Scotland. In the course of a visit to southern Chile a few years ago, the object of which is not clearly stated, but appears to have been some study of natural conditions, possibly on behalf of the Chilean government, he made notes on the country from many points of view, which are published in the volume before us.

The author's style is original, and indeed a little difficult on account of the wealth of simile and half-concealed allusion which it displays, so that the reader's mind is every now and then drawn from the matter in hand to think who "Thomas, not the rhymer, but the proser" may be, to marvel why Chile should be termed a "toy republic," to recollect where the "comforts of the Salt-market" originated, or even to wonder if "Fresh fields and pastures new"—applied to a forest country too—may after all be the correct quotation. The arrangement of the matter in the descriptive parts is not systematic, and one can only gather the dates of the visits to various settlements with difficulty and without precision, which in a description of a progressive country is a real drawback. The map of Chile supplied, although clear and full for its scale, ought to have been supplemented by a cutting from the Admiralty chart of the neighbourhood of Chiloe, the topography of which cannot be found in any English atlas; without a detailed map the description of the various short journeys is not easy to follow.

Apart from these details of literary form and illustration, the book is both charming and valuable. It deals with a region of which little or nothing has been written in English by any naturalist since Darwin's "Voyage"; and it appears at a convenient time, for the Chilean government is again exerting itself to induce emigrants from northern Europe to make their home in the new lands of the far south.

The descriptions given of the civilisation, social life, and political systems of the Chileans are not attractive. How far they are just we cannot say; but it would perhaps be fairer to judge the people and methods of any republic in Latin America by comparison with those of the other republics than by any absolute standard or even by the criteria of Europe. Still, for any one who contemplates residence in Chile, the opinion of an observer so competent and impartial as Mr. Anderson Smith is of very great value, and should be carefully considered.

The struggle of high culture with barbarism in southern Chili is almost pathetic. Luxurious Pullman cars land the passenger in the midst of literally pathless forests, through which a track must be cut before a horse can pass. Yet wires fixed to the trees allow of telegraphic and telephonic communication with hamlets which lie weeks apart for the traveller. One reads with envy of a postal system so generous that newspapers are carried free in the mails, and with disgust of post-office administration so hopeless that letters lying in the head-office at Valparaiso are refused to the addressee on application, in order to save the trouble of looking for them, and afterwards returned to Europe.

The thriftlessness of the lower classes, half or wholly Araucanian, is horrifying even to one accustomed to the not too enterprising crofters of the West Highlands. They live contentedly in houses or huts without furniture and in matters of food take little thought for the morrow or even for the day. Mr. Smith found a number of well-housed Indians with boats and fishing tackle at a station in Chiloe quite without food, and with the utmost difficulty induced them to take out a net. The result was good—"A second draw produced a fair supplement, but was purposely taken by the lazy rascals where the chance was less. A further draw we could not persuade them to try. Why? Because they would have required to carry the fish to the house, a hundred yards or so from the river, for there were at least three hundredweight of beautiful robalo some 6 to 8 pounds weight each. And yet these people were starving!"

The heavy rainfall and mild climate of the south of Chile produces a forest growth of a luxuriance and variety more to be expected in the torrid than in the temperate zone. Yet in many parts this growth appears to be recent. Near Osorno great trees were found growing in deserted gold workings of the present century, and an old Indian woman remembered the time when there were no trees and the guanacos (which do not inhabit forests and now keep to the eastern side of the Cordillera) used to come down from the mountains to the pastures where all is now grown with timber. On Chiloe and the islands and coasts further south the forest seems to be primeval. The great trees are smothered by long slender canes and creepers, and every branch drips with a rich variety of moss and ferns, while the bird-life is of remarkable variety and beauty. On the coast, where the trees come down to the very edge of the sea, the tropical humming-bird and pelican may be seen together with the penguin of the antarctic. The water-fowl of the rivers, many of which are quite overgrown with forest trees rooted in the midst of the permanent stream, are equally varied. Mr. Smith has much to say of the quetru or steamer-duck, so-called from its curious stroke like the action of a paddle steamer, a bird with a head like an anvil and a skin so tough that it can hardly be penetrated by shot.

The fish, and still more the edible molluscs, of the rivers and coasts are referred to very frequently, but from the economic rather than the scientific point of view. There are oysters of good quality, but the gigantic mussels of several species are more sought after. These, as well as limpets and other "shell-fish," are dried in immense quantities, and strung together like onions find their way over the whole of Chile, being much esteemed as food.

As to the colonists who are struggling to clear the forests and form homes in that land of perpetual cloud, Mr. Smith gives the first place for thrift, cheerfulness and ingenuity to the French; the Germans have established themselves firmly as the commercial and manufacturing people of southern Chile; but although many capable and prosperous British settlers were met with, the attitude of the author towards the bulk of his countrymen in Chile is that of the candid friend who recognises room for improvement rather than matter for praise.

HUGH ROBERT MILL.

RECENT PUBLICATIONS FROM KEW.

List of Published Names of Plants introduced to Cultivation, 1876–1896. *Kew Bulletin of Miscellaneous Information.* Additional series iv. Pp. ix + 410. (London: Eyre and Spottiswoode, 1900.)

Hand-List of Tender Dicotyledons cultivated in the Royal Gardens, Kew. Pp. xxx + 691. (Kew: Royal Gardens, 1899.)

WHEN a collection of dried plants is received from any quarter, there is generally no particular necessity for naming them at once. Time can be expended in sorting, examining and naming the specimens.

It is otherwise with cultivated plants. These are for the most part introduced by the nurserymen; and when it suits their purpose to launch them into commerce, a name must be given to them at once.

To the credit of the great nursery firms, it may be stated that they do endeavour to ascertain, from Kew or elsewhere, the true name of the plant they are about to "send out." Very often, most often, perhaps, the material sent for investigation is not sufficient for the purpose. Years, it may be, may elapse before a particular plant flowers and reveals its identity.

It is obvious that the business man cannot wait. The only course left to him, therefore, is to adopt a conjectural or a provisional name. Long experience in handling plants often enables the plantsman to make conjectures, which afterwards prove to be correct. In other cases, where there is no obvious clue, a provisional name is adopted. The abbreviation "hort." is, or should be, appended in such cases when writing the name, in order to avoid unnecessary trouble to the student and monographer.

Natural hybrids are not unfrequently imported, especially among orchids, and these have to be named according to their presumed parentage.

Not unfrequently the guess of the importer is borne out by the skill of the cultivator, who, by impregnating the flowers of one species with the pollen of another, gives rise to a hybrid corresponding with that produced naturally. Such hybrids, natural or artificial, are generally honoured with specific names in Latin, but differentiated by the addition of a ×.

Nowadays, the number of species introduced by collectors is, at any rate, relatively much smaller than it used to be. Nevertheless, the aggregate of so-called "new plants" is much larger.

Of late years, too, new forms have been obtained in great abundance, either by selection or by cross-breeding, and these new forms require to be named. It is among the secondary hybrids and selected "strains" of particular species that we get the names which afford amusement to the public, and which, moreover, indicate what is occupying the public mind. Of late, we have seen plants named in honour of Lord Roberts and other South African heroes; whilst, as if to show the cosmopolitanism of horticulture, the names of President Kruger and General Cronje have not been wanting from the labels of plants exhibited before the Royal Horticultural Society.

The personal authority for the names has been uniformly omitted from the book whose title stands at the head of this notice, as it was found in too many cases impossible to assign it with certainty. We may acquiesce in this omission, but we demur to the further statement that "the reference given is to the publication in which the plant is first described or figured." Take, for instance, on the first page, *Abies brachyphylla.* The reference given is to the *Revue Horticole*; whilst *Abies Eichleri* is attributed to the *Florist* and *Pomologist.* Both these plants were described elsewhere prior to their publication in the periodicals mentioned; and so with a large number of others.

It is, of course, very desirable that all names be duly registered. Some of them are important to the botanist, others to the physiologist, and others more particularly to the gardener. A tribute of recognition is due from each of these groups of workers to the authorities of the Royal Gardens, Kew, for the compilation of the volume before us, and to the Government for giving it publicity. Without attempting to gauge the scientific value of the names, the compilers have searched the records in the horticultural Press and tabulated them in.

the present volume. It makes no pretension to be a scientific enumeration, but it will be of the greatest service to those who occupy themselves with the numerous scientific questions that arise in connection with cultivated plants, such as heredity, adaptation to varying conditions, variation, selection, cross-breeding, the origin of species, &c.

The book has reference to the introductions made within a period of twenty-one years, and the total number of names registered is no fewer than 7600, of which the majority are orchids, an indication of the taste and fancies of the times.

It is of interest to note that whilst in the early part of the century New Holland and the Cape of Good Hope furnished a very large proportion of the introductions—now the majority of the actually new plants "have been derived from the United States of Colombia, the Malayan and Polynesian regions."

The second volume referred to at the head of this notice is another of those very serviceable hand-lists which we owe to the director of Kew and his staff. The list includes the majority of what are called stove and greenhouse plants, omitting orchids and other monocotyledons elsewhere treated. This list is not a mere compilation of published names, but is an enumeration drawn up with as much scientific accuracy as the nature of the case permits.

It will thus, with the lists previously published, be invaluable to the botanist and to the cultivator who is interested in the plants he grows for reasons other than the mere attractiveness of their appearance or their economic use.

The director contributes a preface containing some very interesting information concerning the history of the Kew collections, and of the structures built to contain them. The Temperate House, now completed by the construction of two wings, is no less than 628 feet in length, and, what is of more importance, it is filled with well-cultivated plants of botanical or economic interest. The part that Kew has played in the collection and distribution of cinchona, india-rubber and other products, is appropriately referred to in the preface. It reminds us that whilst we are proud, as we have every reason to be, of our National Garden as such, we have also reason to rejoice in the great benefits it has been the means of conferring on humanity at large.

Maxwell T. Masters.

OUR BOOK SHELF.

Les arbres à Gutta-Percha, leur culture. Mission relativ. à l'acclimatation de ces arbres aux Antilles et la Guyane. Par Henri Lecomte. Pp. 95. (Paris: G. Carré et C. Naud, 1899.)

M. Lecomte was charged by the French Minister of the Colonies to effect the plantation of gutta-yielding plants in the French colonies of the new world. For this purpose he took with him, in wardian cases, plants belonging chiefly to the genera *Palaquium* (*Dichopsis*) and *Sideroxylon*, and in the small *brochure* before us he embodies an account of his expedition in the form of a Report to the Minister of the Colonies, and also includes in it a statement respecting the indigenous trees, such as *Mimusops Balata*, which he found already growing wild in Guiana.

The first portion of his book is devoted to a short sketch of the various plants which yield gutta-percha, and it appears to be largely drawn from the monograph on the Sapotaceæ by Burck. It cannot be said, however, that M. Lecomte has contributed much to the story of the discovery of these economically important trees, and indeed he seems now and then to have fallen into inaccuracies. Thus he states that gutta-percha was introduced by Montgomery (*sic*) into Europe in 1832, whereas it would seem that Montgomerie, although he first met with the substance in 1822, lost sight of it for twenty years, and it was not until 1843 that he sent home his first specimens from the East. M. Lecomte states that *Palaquium* (*Isonandra*) *Gutta* is extinct, but nevertheless there appear to be still a few trees known in Singapore besides those growing in the Buitenzorg garden.

The chief source of the best gutta at the present day is, as the author remarks, the closely allied species *P. oblongifolium*, which, previously distinguished as a variety of *P. gutta*, was raised to specific rank by Burck. The native name in Perak for *P. oblongifolium* is given by M. Lecomte as *Taban merah*, whilst it is stated by Obach that this name really belongs to *P. gutta*, the other plant being known as *Taban sutra*. In this M. Lecomte adopts the views of Burck (Rapport Gutta-Percha, 1884), who has expressed the opinion that *P. oblongifolium* is the real *Taban merah*, since *P. gutta* was not found by him to occur in the Malay peninsula, but only in Singapore.

It is of course possible that this may turn out to represent the true state of the case, since, although differing in habitat, the two species (?) closely resemble each other; but if so it is a pity that the matter was not more fully enquired into, as the native names are of some importance in a matter of this kind. If Burck should prove to be correct in his statements, its wide geographical range, extending from Malacca to Sumatra and Borneo, would perhaps indicate that *P. oblongifolium* ought to be regarded as the parent species, *P. gutta* representing a local off-shoot which has developed in, and is confined to, a very limited area. But in any case it is clear that several questions with regard to the mutual affinities of these plants still await definitive solution.

The book is an interesting record of an endeavour to extend the cultivation of a most important series of tropical economic plants, and it is sincerely to be hoped that the efforts made in this direction will be crowned with success.

J. B. F.

Determination of Radicles in Carbon Compounds. By Dr. H. Meyer. Authorised translation by Dr. J. B. Tingle. Pp. x + 133. (New York: J. Wiley and Sons; London: Chapman and Hall, Ltd., 1899.)

There is no doubt but that the original edition of Dr. Meyer's "Anleitung zur quantitativen Bestimmung der organischen Atomgruppen" supplied a want which had been felt for some time by all who had seriously taken up the study of organic chemistry, as well as by more advanced workers engaged in original investigations. The translation, which has now been provided, is thoroughly up-to-date, and, in the author's words, "has been further improved by certain changes in arrangement which Dr. Tingle has made."

It might, perhaps, be suggested that but little distinction is drawn between methods which are purely qualitative and those which also admit of quantitative treatment, in spite of the fact that, according to the translator, one of the main objects of the book is "the introduction of some quantitative work into the college courses of organic preparations"; generally speaking, however, the arrangement is excellent, and the numerous references to the original papers is a noticeably useful feature in a work of this kind.

The statement that "considerable care has been bestowed on the proof sheets" is hardly borne out by the results.

F. S. K.

Unités électriques absolues. By Prof. G. Lippmann. Pp. ii + 240. (Paris: Carré and Naud, 1899.)

THIS treatise is the reproduction of professorial lectures delivered at the Sorbonne in the session of 1884-85, and consists mainly of three parts. The first part deals with the electrostatic system of units, the second with the electromagnetic system, and the third with the electromagnetic theory of light. These are preceded by an introduction, which treats of units in general and the *c.g.s.* system. At the close of the book are two supplements, dealing respectively with the conservation of electricity and Lippmann's electrodynamometer.

The treatment is chiefly mathematical, the experimental methods referred to being described in outline. The analysis is, however, simple and the text illustrated by a hundred excellent figures. Indeed, the book is on the whole so good and clear that one regrets the more that the dimensional formulæ have not been brought up to date by embodiment of the progress made in the fourteen years which have elapsed between the delivery of these lectures and their publication. In our view, the value of the book would have been much enhanced by the introduction in it of Prof. Rücker's work on the usually *suppressed* dimensions of μ and k (see paper read before the Physical Society of London, November 24, 1888; NATURE, vol. xxxix. p. 165).

This, impossible in the lectures themselves delivered in 1884-85, was both possible and highly desirable in the book of 1899. E. H. B.

Elementary Practical Physiography (*Section II.*). By J. Thornton, M.A. Pp. viii + 208. (London: Longmans, Green and Co., 1900.)

THIS is an effort to meet the requirements of candidates for the Queen's Scholarship in Section II. of the syllabus of elementary science. Its scope is best described by the sub-title "A Course of Lessons and Experiments in Elementary Science," but it is necessary to add that the only branches of science touched upon are chemistry and astronomy. In both these subjects some knowledge gained by experiment and observation is now expected; but though the author claims to have kept this in view throughout, there is little in the book to entitle it to be called practical. It is true that reference is made to seventy-four experiments in chemistry, but they are for the most part better adapted as suggestions for the teacher than for performance by the student. In the astronomical section an excellent course of reading lessons is provided, but the author has by no means taken sufficient advantage of the opportunity of directing the student's attention to the heavenly bodies themselves. Instead of the descriptions of simple apparatus for making observations which might have been expected, such, for instance, as the measurement of altitude and azimuth, half-a-dozen class-room demonstrations are alone given.

Objection may be taken to the author's statement that "most of the diagrams are new and original"; many of them seem familiar, though they may have been re-drawn for their present purpose. A. F.

Atlas de Photomicrographie des Plantes Médicinales. Par MM. les Drs. Braemer et Suis. Pp. vi + 230; 76 plates. (Paris: Vigot Frères, 1900.)

THIS book consists of series of plates derived from microphotographs of the ordinary medicinal plants. To the plates relevant to each plant a descriptive text is added, dealing with the morphology of the respective plant. The microscopic sections are very clear and well reproduced.

The book ought to be useful to those interested in *materia medica*; but although we know of no similar work, we are afraid it will only appeal to a relatively small circle of readers.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Effects of Lightning upon Electric Lamps.

IN a communication to NATURE (p. 391), Prof. Wood pointed out the similarity of the features exhibited in Mr. Webb's photographs to the trails of luminosities exhibited in a picture taken with a moving camera.

To this I replied (p. 413), saying I had understood that the camera was fixed, and calling attention to two features which seemed to show that the phenomenon was real.

An independent suggestion similar to that of Prof. Wood, from another quarter, accompanied by photographs purposely taken with a moving camera,[1] subsequently came before me. This helped to arouse suspicion, and it occurred to me as conceivable that though the camera was fixed, Mr. Webb might as a matter of convenience have taken it up before he capped it; and if so, trails might have been left from the short exposure between lifting and capping. I wrote to him accordingly, suggesting that he should try the effect of lifting before capping. This led him to try the effect of exposure with a moving camera, with the result that there appears to be no doubt now that such was the origin of the supposed effects. In his reply, enclosing photographs taken with a camera which was purposely moved, Mr. Webb writes: "I had made so sure that there was no shake of my camera, in spite of your frequent suggestions to the contrary, that I cannot even now understand it, placed as it was on the balcony rail, excepting in the No. 6 or five-flash exposure, when I wilfully raised or depressed the camera a little to avoid getting two of the horizontal flashes on the same plane of horizon."

I must now refer briefly to the two arguments I used (p. 413) in support of the reality of the effects. I pointed out that in Fig. 4 there was a real decrease of scale in the luminosities about the nine more distant lamps, in accordance with the increasing distance from the camera. I confess it seemed to me that the difference of scale, though real, was not as great as I should have expected, but I had no measurements of the distances of the several lamps from the camera whereby to calculate what the difference of scale should have been if the luminosities were real, and of the same size for the different lamps. A difference of scale might be produced in a moving camera if the exposed plate had a movement of rotation about the line of sight. The other argument was founded on the visibility of the discharge. It seemed to me that such a discharge as those shown for instance in Fig. 1, taken as real, might be expected to be seen directly if the eye were defended from too much glare of the lightning, and I suggested to Mr. Webb to be on the look-out if an occasion should occur. He states in his letter to NATURE (p. 343), that he actually saw such a discharge. I think it is not difficult to reconcile this with the supposition that there is no real discharge. The observer on the look-out would have his eye directed to the lamp, and when the flash came might unintentionally look in a somewhat different direction. In the rapid rotation of the eyeballs the image of the lamp would leave a trail on the retina, which might easily be mistaken for an actual luminous discharge.[2]

The beading of the discharge now presents no difficulty. Indeed, the first idea which naturally occurs to one on seeing it is that it might be connected with the rapid alternation of the current; but so long as the picture is supposed to represent a real discharge, it seems difficult to imagine how the alternation could possibly account for the beading.

Cambridge, March 23. G. G. STOKES.

The Absorption of the Becquerel Rays by Solid and Gaseous Bodies.

I WISH in this note to give some observations recently made with regard to the absorption of the Becquerel rays. Though the experiments are not complete, it is hoped that the results

[1] [The photographs referred to were taken by Mr. J. Williamson, of Hove, the electric lamps towards which his camera was directed being those along King's-road, Brighton. The effects were produced by giving a stand exposure of from five to ten seconds, and then moving the camera about for a few seconds with the cap still off.—Editor, NATURE.]

[2] Mr. Webb has suggested to me another explanation.

already obtained may be of sufficient interest to justify preliminary publication. The experimental details will be more appropriately given with the completed experiments.

Curie has shown that the rays from active barium compounds are of two kinds. One kind is easily absorbed, and is not deflectable by the magnet. The other kind is much more penetrating, and does suffer deflection in a magnetic field. It is to the latter kind exclusively that the experiments refer.

The intensity of the radiation was measured by the electrical conductivity of air exposed to it. It was again measured after partial absorption by a plate of the material under investigation.

In the following table the first column gives the coefficients of absorption λ defined by the equation

$$r = r_0 e^{-\lambda d},$$

while r_0, r, are the initial and final intensities of the radiation, and d the distance traversed.

Material	Coefficient of absorption	Density	Coefficient of absorption / Density
Platinum ...	157 6	21·5	7·34
Lead	62·5	11·4	5·48
Silver	65·7	10·6	6·20
Copper ...	49·2	8·95	5·50
Iron	52·2	7·76	6·74
Tin	51·2	7·3	7·01
Zinc	40·3	7·2	5 58
Mica ...	10·8	2·74	3 94
Glass	12·5	2·73	4·58
Aluminium ...	11·6	2·7	4 30
Celluloid ...	5·45	1·36	4·01
Ebonite ...	4·77	1·14	4·18
Card	3·84	1·0	3·84
Sulphur dioxide[1]	·0413	·00758	5·45

It will be seen that, although the coefficient of absorption is not accurately proportional to the density, yet the departure from this relation is not very great, if the enormous range of density be taken into account. Thus between solid platinum and the compressed sulphur dioxide used, there is a three thousand-fold difference of density. The quotients $\frac{\text{absorption}}{\text{density}}$ are respectively 7·3 and 5·45. It is interesting to compare these results with Lenard's observations on the absorption of the kathode rays (*Wied. Ann.* vol. lvi. p. 255). He found that the above relation between absorption and density held to about the same degree of approximation. The coefficients of absorption for the kathode rays are, however, some five hundred times greater than for the rays investigated in my experiments.

We may, I think, fairly consider that the approximate proportionality between absorption and density is an additional argument in favour of the view that the deflectable Becquerel rays are of the same nature as the kathode rays. To account for the enormously greater penetrating power of the latter, one must suppose either that the particles constituting them are much smaller, or that their velocity is much greater.

R. J. STRUTT.

Planets at their Greatest Brilliancy.

MR. DENNING'S able and lucid article upon the planet Mercury (NATURE, March 1) induces me to send a few notes. With inclined elliptical orbits it is a complicated matter to determine when an interior planet is at its greatest brilliancy. But if the orbits are assumed circular and coplanar, interesting results are easily obtained.

Theory shows that there is a certain elongation, at which the interior planet, viewed from the exterior one, has a maximum brightness. Now, for a given elongation, there are two distances, a long and a short one, between the planets. Consider only eastern elongations. It will be found that Mercury has its greatest brilliancy (for mean distances and circular orbits) when its elongation is 22° 19′, and when its distance (1·00) from the earth is the larger of the two distances possible for this elongation. The illuminated phase is 0·60. Thus Mercury is brightest *before* its maximum eastern elongation of 22° 47′.

[1] Saturated vapour at 13° C.

Venus has its greatest brilliancy at elongation 39° 43′; but its distance (0·43) from the earth must be the smaller of the two possible ones. The phase is 0·27. Thus Venus is brightest *after* its maximum elongation of 46° 20′.

But, if from Venus we view Mercury, then (as in the case of the earth and Venus) we must take the shorter distance for maximum brilliancy. The elongation is 31° 36′, distance 0·54, phase 0·40. Thus Mercury, seen from Venus, is brightest after its maximum eastern elongation of 32° 21′.

That a planet should be brightest exactly at maximum elongation involves, I find, the following relationship between the radii vectores: the radius vector of the exterior planet should be just $\sqrt{5}$ times that of the interior one. When the factor exceeds $\sqrt{5}$, the interior planet is brightest before maximum elongation. When the factor falls short of $\sqrt{5}$, the interior planet is brightest after maximum elongation. Circular orbits are assumed. For the pairs, Mercury-Venus, Venus-Earth, Earth-Mars, Jupiter-Saturn, the factor is less than $\sqrt{5}$. But for Mercury-Earth it is greater; hence Mercury is brightest before maximum elongation east, a fact clearly brought out by Mr. Denning's observations. On several occasions I have seen Mercury with the unaided eye, and, generally, after greatest eastern elongation, when the conditions are less favourable than before it.

C. T. WHITMELL.

Leeds, March 5.

P.S.—The American *Ephemeris* for 1900 shows that the maxima of brightness for Mercury occur very irregularly. One maximum occurs 6 days before greatest east elongation, another only 1½ days after superior conjunction. Eccentricity accounts for these irregularities.

The Use of Silica in Thermometry.

I HAVE just learnt from your last number (p. 521) that Mons. A. Dufour has recently exhibited two silica thermometers in Paris, and that he proposes to study the suitability of silica for use in thermometers.

As I had the honour of exhibiting silica tubes of various sizes last June at the soirée of the Royal Society, and also then exhibited, in conjunction with Mr. Evans, our process for making such tubes, I am anxious at once to state that I have continued to study the applications of silica in conjunction with Mr. H. G. Lacell, and that we have at this moment the bulbs and stems of four delicate silica thermometers ready to be joined and filled as soon as their scales and some fittings are delivered. In February last we filled one of these ungraduated thermometers and tested it. It was shown to our colleague, Mr. J. E. Pearson, but was afterwards cut in two in order to alter the length of the degrees (20 mm.), as they were not quite as long as we then wished them to be.

I may add that the scales for these thermometers have been ordered, through the Cambridge Instrument Company, of Messrs. Zeiss, and that a special glass thermometer has been constructed for use in studying their zero points, which has now been in the hands of the Superintendent at Kew for some days.

Clifton, April 2, 1900. W. A. SHENSTONE.

The Natural History Museum—A Correction.

IN a paper of mine on *Ilyopsyllus coriaceus*, which appeared recently in the *Natural History Transactions of Northumberland and Durham*, I referred to certain dissections—which had been described by Mr. Thomas Scott, and are now in the Natural History Museum at South Kensington—as having "deteriorated so as to be useless," at the same time ascribing this statement to Prof. T. Jeffrey Bell, who had kindly examined the dissections at my request. The statement, so far as Prof. Bell's authority is concerned, is not quite accurate, and at his request I wish to be allowed to correct it in your columns. What Prof. Bell told me was that the dissections consist of "nothing but unrecognisable fragments," and that "Mr. Pocock, who had charge of the Crustacea in 1893, says the tube came there in the state it is in now."

I think I need scarcely add that my words, as quoted above, were not meant in any way to impute negligence or want of care to the officials of the Museum.

G. S. BRADY.

The Durham College of Science, Newcastle-upon-Tyne, March 29.

New Mode of Using the Concave Diffraction Grating.

I GREATLY regret that in a note of mine on a "new mode of using the concave diffraction grating," in the "Astronomical Column" of March 22 (p. 501), I wrongly interpreted a sentence of Prof Rizzo's article, which led me to think it was inconvenient for him to use the instrument in the usual way. The words "Dr Rizzo investigated this disposition on account of being unable to use the instrument as usually set up," should therefore not have been included THE WRITER OF THE NOTE

Internal Stresses in Iron and Steel.

CAN you kindly inform me where I may obtain a copy of the researches of General Kalakoutsky on the "Internal Stresses in Cast Iron and Steel," translated by the late Sir William Anderson, F.R.S., Director-General, Royal Ordnance Factories. THOS. ANDREWS.

Sheffield, March 27.

THE work in question—"Investigations into the Internal Stresses in Cast Iron and Steel," by General Nicholas Kalakoutsky—was published by George Reveirs, 4 and 5 Graystoke Place, Fetter Lane, E.C., in 1888.

Second-hand copies can occasionally be procured from dealers in technical books. B. H. B.

ELECTRICITY IN WAR.

UNDER the Presidency of the late Dr. Hopkinson, the Institution of Electrical Engineers established an Electrical Engineer Volunteer Corps affiliated to the Royal Engineers. Lord Kelvin is now its Honorary Colonel; the well-known electrical and mechanical engineer, Mr. R. E. Crompton (formerly Captain in the Rifle Brigade) is its Major. It is a corps consisting of 350 young men, most of whom have had a scientific education; they are all engaged every day in practical electrical engineering work; many of them are constantly engaged in inventing new apparatus and improving old apparatus; all of them are athletic, and enjoy such exercise as the volunteer drill affords; many of them are experienced bicyclists; all of them are curious as to the existing applications of electricity in warfare, and in consequence of their unfamiliarity with existing apparatus are very likely to quickly notice methods of improving it.

Hitherto many of these men have had a yearly drill in the management of the electrical apparatus in use for submarine mining and home defence.

I would point out that the ordinary volunteer drill of these men is only a part of their preparation for the nervous tension of an enemy's presence. There is no more trying experience than that of a young engineer in a central electric light station when the "peak" of the evening load is coming on, and every appliance is worked to its highest capacity; when the stoker cannot get enough draught for his boilers, and a short-circuit suddenly takes place. It is interesting to note how the man who was nervously afraid of himself beforehand, braces himself up to meet the emergency, and to his own wonder afterwards, manages to do exactly the right thing at the critical moment. A man who has proved his coolness in this sort of way is not likely to be flurried in the field, even when a rain of those most dangerous of all missiles, the 37 mm. Vickers-Maxim shells, are exploding about his search-light.

A few years ago, when Major Crompton vainly urged the necessity for the provision of new apparatus, practice in the use of existing field search-lights, &c., such as might lead to better designs, and money to enable such better apparatus to be constructed and tested, some of us felt very strongly that the War Office was wasting an invaluable opportunity.

A committee of the Institution of Electrical Engineers was able to assure Major Crompton of considerable pecuniary help in case the War Office gave facilities, and it was proposed that the corps should take up some one problem at a time, and work it out to a thoroughly good practical result. For example, the production of a really good field search-light was proposed. To work awhile with the existing things, which were like ship search-lights carried upon ordinary waggons, and to expend all the ingenuity of the corps upon the creation of a piece of apparatus perfect for military purposes. This involves also the best design of mobile steam engine and dynamo plant; the best kind of cable, and the best ways of paying

FIG. 1.—Traction engine.

it out and reeling it in. It also involves the design of the best arrangement of telephonic communication between the generating plant, the lights, and the officers in command and the general officer, possibly miles apart.

Again, is there anything of greater practical importance

Fig. 2.—Mounted projector

than this? Suppose we have such electric generating plant in the field; the engine, which is a traction engine, may be utilised in actual traction. Or a spare dynamo may be sent forward across a river or up a kopje with a simple winch arrangement, which may quickly be set in position, so that waggons or the materials of a bridge may be hauled across the river, or the heaviest guns may be hauled up the hills, or ammunition hoists or pumps may be set in motion. Electricity gives us the means of transmitting power in great or small quantities to any distance for all sorts of purposes; and Major Crompton imagined the gradual working out of all such problems, one at a time, by this corps of men, whose qualifications were just perfect for such purposes. It is to be remembered that in such work the requirements of war service introduce special conditions such as never have to be taken into account by the ordinary engineer. Everybody understands something about traction engines. Now the best English traction engines are made to run on good roads; their wheels are, therefore, too small; their tires are too narrow; their spring arrangements, and therefore their gearing, are quite unsuited for motion on a South African veldt. Not only so, but they are designed for places where the supply of water is plentiful everywhere. A traction engine, using up at least a ton of water every five hours, is not quite what is wanted in a dry country.

I wonder if the War Office officials dream of the number of ways in which the scientific engineer might be made useful. A few really experienced practical electrical engineers will sometimes get together and unbend and talk of the things that might so easily be done, if instead of appointing third class men to important posts, the Government would really try to utilise the services of good engineers.

I shall not here refer to the fact that temptations are dangled before the eyes of third class men by unscrupulous contractors; about this side of the subject I do not care to speak. I think merely of the importance of the services of clever experienced men.

Even a good man would perhaps have but little chance of doing much service under existing arrangements. A Government prefers to spend ten millions of pounds in building ships that are something like existing ships, slight improvements on existing models, than to waste, as they would call it, a hundredth part of the sum in making experiments which would teach how ships may really be improved. And so it is in all branches of applied science. Bring forward a cut and dried scheme, perfect; be prepared to spend your own money in showing that it is good; if you have sufficient influence your scheme will be tried and may be adopted. But even a powerful clever head of a Government department must show a finished working thing to represent expended money. As this is so generally the case in all Government departments, it is probably not very fair to blame the War Department for not utilising the inventive and experimental talent of the Corps of Electrical Engineer Volunteers. Even if it could justly be blamed, there is now no desire to criticise the past inaction of the War Office. There is no inaction now; Major Crompton has been given a free hand in the equipment of active service contingents. He has worked night and day for two months, and his success has been marvellous. One of these contingents, consisting of fifty-eight men and six officers, started for South Africa a few days ago. Under Captain Lloyd, R.E., it took with it a complete equipment of two search-lights, including four waggons, each carrying 4 tons, and two traction engines, each with its dynamo as well as one spare dynamo, and I am greatly mistaken if this spare dynamo be not before long used as a motor for many useful haulage purposes. The dynamos are multipolar, semi-enclosed, 110 volts; 750 revolutions per minute; 80 amperes all day, or occasionally 100 amperes. Instead of working the projectors they may work

Fig. 3.—Mounted projector.

ordinary arc and incandescent lights for use with night working parties (24 arc lights with portable lanterns, as well as 200 incandescent lamps have been sent out). Future dynamos will have spare armatures wound for much higher voltages; also they will be driven from smaller fly wheels by chains instead of belts. The detachment takes with it twenty-five khaki-coloured, long-crank, specially strong bicycles. Fig. 1 shows the engine, but I am sorry to say that its dynamo has been removed from its front end and replaced by luggage. Special spring arrangements at the front end of the engine prevent hurt to the dynamo from jolts. I know of no other compound traction engine whose weight is only 8 tons. I am told that in practice it consumes about 32 pounds of water per hour per electrical horse-power developed—a wonderfully good result for so small an engine (maximum electrical power, probably 13). With a little experience this expenditure may be cut down to 28 pounds. It will be part of the regular drill of the men to run a search-light for a specified time, there being competition as to the expenditure of coal and water. When we consider that these very economical engines need about 400 pounds of water (they need also about 45 or 50 pounds of coal) per hour, we see the defect of the ordinary traction engine for army transport purposes. A third engine which is going out with Major Crompton and a second contingent this week will have partial condensation of its steam, so that the water will not all be wasted. It is to be hoped that so easily designed a thing as a traction engine with light surface condensing plant condensing all its steam will be in use before long. Major Crompton has had a considerable experience of engines in general, and of traction engines in particular, having carried out experiments on traction for the Indian Government long before he became identified with electrical engineering. I understand that the War Office is now considering his scheme for working the transport service of an entire division of the army, independently of all railways.

This is the first time that projectors have been fitted to special trails like gun-carriages. The carriages of riveted best cast steel are strong and light, as may be seen in Figs. 2, 3 and 4. The wheels are from the Royal Arsenal, and may be replaced if hurt in the field. The limbers are shown in Fig. 5. Poles and harness equipments for ten span of mules have been provided. The projectors may be hauled either by the engines, or by the mules, or by the men. The projectors are novel in design; almost the only feature of existing projectors embodied in them is the barrel. Their mirrors, glasses and divergers are mounted in aluminium. They have gun-metal bases moving in ball run turntables. They may be detached from their carriages and stand on the ground on their four feet. The Coles reflectors are of deposited copper faced with silver, and a thin coat of palladium to prevent tarnishing. The lamp mechanism is new, the pattern service lamp being far too heavy and clumsy; moreover, the usual arc-striking arrangement would be hammered to pieces by the vibration of the moving carbon when the lamp is travelling about. The new lamp locks the moveable carbon holder in position after the arc is struck, and the feeding movement is carried out by the shunt coil acting on the other carbon. These search-lights may be stationed a mile or more away from each traction engine, as there may be a fall of 52 volts between dynamo and arc. The main cables are of quite a novel kind. They are concentric cables with an insulated core, one-tenth of a square inch in cross section; they are armoured on the outside by a copper braiding, which forms the return conductor, but there are other forms of cable and uninsulated copper ropes for returns. The telephone arrangements are novel. Major Crompton has adopted the Swedish cavalry pattern of instrument, which can be used as a telephone, or the signals may consist of the "buzz" through a high resistance or through a very leaky circuit. On trial, he finds that there is very good speech through the telephones and two miles of bare wire on the wet grass. Of course there will be audible speech for, possibly, six miles, on dry grass. This fine (No. 22) copper wire may be laid from reels fixed on bicycles when the bicycles are going at ten miles an hour; and it may be picked up at a speed of four miles an hour. There is also a supply of the more usual concentric telephone cable, and twelve sets of combined telephones and buzz telegraph instruments have been sent out.

Fig. 4.—Projectors hauled by men.

Fig. 5.—Limbers.

I am not at liberty to publish an account of the novel ideas as to the best use of search-lights which Major Crompton hopes to illustrate when in front of the enemy's position. I think that the whole experiment is a hopeful one. Everybody knows the sort of athletic, energetic young men who are chosen for mountain battery work; they are as resourceful and cat-like as sailor men. Imagine such young men, with, in addition, the qualifications which I have enumerated, and you have some idea of these young electrical engineer volunteers. With Captain Lloyd and Major Crompton in command, it is to be expected that there will be a good return for the expense incurred. The money paid for equipment is only a very small part of the total expense of this experiment.

John Perry.

NOTES.

THE Antarctic expedition equipped and sent out by Sir George Newnes in August 1898, under the direction of Mr. Borchgrevink, has safely returned. The following cablegram, sent from the Bluff, Campbelltown, which is one of the southernmost ports on the south coast of the South Island of New Zealand, has been received by Sir George Newnes from Mr. Borchgrevink:—"Object of Expedition carried out. Furthest south with sledge; record, 78·50. Present position of South Magnetic Pole located. Zoologist Nicolai Hanson dead. *Southern Cross* safely at Stewart Island. Leaving for Hobart. All well. Borchgrevink." The expedition has thus been a very successful one so far as geographical results are concerned, and we trust that its success may be taken as an earnest of what will be accomplished by the expeditions which depart next year. The highest latitude reached by Ross, in 1842, was 78° 10′ S., this being the latitude at which his ships met with the great ice barrier. Mr. Borchgrevink has gone further than this, and he must have made a long journey by land to have reached lat. 78° 50′ S. It will be interesting to know the position of the magnetic pole located during the expedition. From the observations made during Ross's expedition it has been inferred that a magnetic pole is situated in lat. 73° 5′ S., and long. 147° 5′ E. This places the real southern magnetic pole not far from the position assigned to it by the calculations of Gauss, viz. lat. 72° 35′ S. and 152° 30′ E. Since Ross's expedition, however, nearly sixty years have passed, and it will be interesting to compare Mr. Borchgrevink's determination of the present position of the magnetic pole with that deduced by Ross, and that predicted from theoretical considerations. While upon the subject of Antarctic exploration, it is noteworthy that Prof. J. W. Gregory, who has succeeded the late Sir Frederick M'Coy as professor of geology at Melbourne, has been appointed director of the scientific staff of the British Antarctic expedition to start next year. The Scottish expedition referred to last week (p. 518) is to be a private expedition organised by Mr. W. S. Bruce, and will not be officially connected with the Royal Scottish Geographical Society.

THE Paris correspondent of the *Times* announces the death, after a long illness, of M. Joseph Bertrand, the eminent mathematician.

WE regret to record that Dr. St. George Mivart, F.R.S., the distinguished biologist, died on April 1, at the age of seventy-three.

AT yesterday's meeting of the Institution of Naval Architects, the gold medal of the Institution was presented to Mr. J. Bruhn, and the premium to Prof. W. E. Dalby.

AT a recent meeting of the American Academy of Arts and Sciences, the Rumford medal was presented to Mr. C. F. Brush for his electrical work.

PROF. P. TACCHINI has resigned the directorship of the Royal Italian Bureau of Meteorology and Geodesy after forty years of service. Prof. Luigi Palazzo has been appointed temporary director.

SIR WILLIAM T. GAIRDNER, F.R.S., professor of medicine in the University of Glasgow, has resigned his chair because he feels unequal to the task of the enormous amount of reading necessitated by the professorship in order to keep in touch with the developments of medical science, and also because he wished to give way to "a younger pair of eyes, and perhaps a younger brain as well."

A PASTEUR institute was opened at Antananarivo, the capital of Madagascar, on Friday last.

THE Actonian Prize of 100 guineas has been awarded by the Royal Institution to Sir William and Lady Huggins for their work, "An Atlas of Representative Stellar Spectra."

THE celebration of the jubilee of the Royal Meteorological Society began on Tuesday with an afternoon meeting, held in the Institution of Civil Engineers, with Dr. C. Theodore Williams, the president, in the chair. The president read an interesting paper on the history of the society, written by the late Mr. G. J. Symons. In the evening the Fellows and their friends attended a conversazione held in the galleries of the Royal Institute of Painters in Water Colours.

PROF. H. G. SEELEY, F.R.S., sends the following particulars from a communication received by him from Dr. Corstorphine. While Messrs. Rogers and Schwarz, of the Geological Survey of Cape Colony, were examining the Uitenhage or Sundays River beds, which are of Middle or Lower Jurassic age, Mr. Schwarz came upon the skeleton of a small Plesiosaurian about four feet long. The remains include the head showing the snout and palate, and the lower jaw. The teeth are in sockets, as usual, with fluted conical crowns and a cylindrical base. The largest teeth are in front. Thirty-eight vertebræ were collected, and one of the limb-girdles, regarded as that of the fore limb. The greater part of the flat, paddle-shaped hand is preserved. With this fossil were found *Astarte browni*, large Trigonias and *Olcostephanus atherstoni*.

WE regret to see in *Science* the announcement of the death, at her home in New York City, of Miss Catherine Wolfe Bruce, who made generous gifts for the advancement of astronomy to Harvard University, Columbia University and other institutions.

MANY naturalists and archæologists will regret to see the announcement of the death of Canon J. C. Atkinson, on March 31, within a few weeks of completing his 86th year. His well-known volume, "Forty Years in a Moorland Parish," published in 1891, was at once recognised as a work of permanent value, worthy of a place beside the immortal "Natural History of Selborne." Indeed, Canon Atkinson had many points in common with Gilbert White, being a keen naturalist and sportsman, as well as a highly-trained antiquary and philologist. Many generations of school-boys have derived their first interest in country matters from his still popular book on "British Birds and their Nests" and the contemporary volumes, "Walks and Talks" and "Play-hours and Half-Holidays," all of which are still in circulation.

A FEW particulars of the career of M. Samson Jordan, the distinguished French engineer and metallurgist, whose death we referred to last week, are given in the *Times*. He was born in Geneva in 1831. In 1855 he constructed the Saint-Louis blast furnaces, near Marseilles, of which works he was for some years engineer and afterwards a director. These blast furnaces were the first in France built for the purpose of smelting the pure, rich iron ores from Elba, Spain and Algeria, with coke as a fuel. To M. Jordan is due the introduction into France of iron and manganese ores from Spain and from the Mediterranean coast, as is also the manufacture of a special quality of cast iron. In 1862 M. Jordan removed to Paris, where he continued his professional work, and in 1865 he was appointed professor of metallurgy at the École Centrale des Arts et Manufactures, of which he was a former pupil. This appointment he held at the time of his death. M. Jordan in numerous ways promoted the advancement of the iron and steel industries in France. He was the author of several valuable metallurgical treatises. In 1874 he was elected President of the Société des Ingénieurs Civils de France, and an honorary member of the Society of

Engineers in England. He was also a member of the Iron and Steel Institute of Great Britain, of the Imperial Institute, and of the leading technical societies of France.

WE have to record with regret the death of Dr. Wilhelm Waagen, professor of palæontology at the University of Vienna. In 1865 he published at Munich an important essay on the classification of the Upper Jurassic strata, and subsequently gave much attention to the study of ammonites. On the death of Ferdinand Stoliczka in 1874, Dr. Waagen was appointed palæontologist to the Geological Survey of India. This post he was unfortunately compelled to resign at the end of three years, on account of his inability to resist the effects of a tropical climate. He, however, continued to labour at the Indian fossils, and after he had published his important memoir on the Jurassic Cephalopoda of Kach (1873-76), he devoted his attention to the remarkable series of fossils, ranging from the Lower Cambrian to the Trias, which had been obtained from the Salt Range. As remarked by Dr. W. T. Blanford, "his masterly summary of the geological results" thoroughly justified the award of the Lyell medal, which was made to Dr. Waagen by the Council of the Geological Society in 1898. He died at Vienna, on March 24, in the fifty-ninth year of his age.

THE announcement of the death of Prof. Pepper, formerly honorary director of the Polytechnic, Regent-street, and the inventor of the celebrated "Pepper's Ghost" effect and other illusions, came as a surprise to most men of science, for it was not generally known that until a few days ago he was still living. He assisted to popularise science in various ways, and was one of the founders of evening science classes in London. He lectured also for many years, making tours through America, Canada, and Australia, where he met with enthusiastic receptions. He was an honorary life member of the Institution of Civil Engineers, and a Fellow of the Chemical Society, and the author of the "Boy's Playbook of Science" and the "Boy's Playbook of Metals."

IT is officially notified that all applications for space at the Glasgow International Exhibition, which is to be opened in May 1901, must be lodged not later than June 1 with the General Manager, Mr. H. A. Hedley. There are in all eight classes, embracing agriculture, mining, industrial design and manufactures, machinery and labour-saving appliances in motion, locomotion and transport, marine engineering and shipbuilding, lighting and heating, science, education, music, sports and sporting appliances. Separate sections will be devoted to women's exhibits, archæology and fine art.

A REMARKABLE instance of the destruction of a species of bird by a hurricane is related by Mr. T. Digby Pigott in a recent issue of the *Times*. Before the West Indian hurricane of September 1898, one of the tamest and commonest birds on the island of St. Vincent was a small bronze-green humming-bird. It appears, however, that since the hurricane the bird has entirely disappeared. A friend of Mr. Pigott's, who was familiar with the bird, lately made a seven weeks' stay on the island, but did not see a single specimen; and upon inquiry he found that none of the birds had been seen since September 1898. The disappearance is the more remarkable as other humming-birds formerly less common than the one now missing are still to be seen in St. Vincent, though in diminished numbers. A possible explanation lies in the fact that the humming-bird which has apparently been extirpated was the smallest of the three species known upon the island, and therefore the most easily killed. Mr. Pigott has been unable to find the name of the bird that has disappeared; but his friend describes it as easily to be recognised by its habit of sitting with its crest erect.

AT the recent annual meeting of the Association of Chambers of Commerce, the following resolutions referring to the metric system were carried unanimously:—(1) That steps be taken by this Association to again urge Her Majesty's Government: (*a*) to introduce into and endeavour to carry through Parliament, as speedily as possible, a Bill providing that the use of the metric system of weights and measures shall be compulsory in this country within a period of not more than two years from the passing of the Bill; and (*b*) to adopt the system with as little delay as possible in all specifications for Government contracts. (2) That in the opinion of this Association it is necessary, in order to promote knowledge of the metric system of weights, measures and money among the people, that the Education Department should require Her Majesty's Inspectors to hold a real and effective examination of scholars in this system in the public elementary schools, and that a deputation of this Association do wait upon the vice-president of the Committee of Council on Education, and call his attention to the necessity of such examinations by Her Majesty's Inspectors.

THE Assistant Secretary to the Treasury Department of Washington, before whom a petition was recently brought by a number of persons in Buffalo as to the expediency of levying a tariff duty on electricity generated in Canada, and transmitted to the United States, has decided not to recommend such a proposal. The decision of the former Assistant Secretary Tichener has thus been upheld, and as a consequence it is agreed that no tariff will be collected on electricity.

THE post of Technical Assistant to the Imperial Department of Agriculture for the West Indies has been offered to and accepted by Mr. Wm. G. Freeman, B.Sc. Educated at St. Olave's Grammar School, Mr. Freeman obtained a National Scholarship in Biology, and spent three years at the Royal College of Science, making botany his special subject. He obtained the Associateship of the College, with a first class in botany, and was awarded the Edward Forbes medal and prize for biology. In February 1896, he went out to assist the late Dr. Tremen at the Botanic Gardens, Ceylon, and afterwards, Mr. Willis, the present director. In October 1897, he was appointed Demonstrator in Botany, under Prof. Farmer, at the Royal College of Science.

THE second number of the *West Indian Bulletin*, just published, is devoted to a report of the proceedings at the Agricultural Conference held at Barbados in January last. It contains the address of the President, Dr. Morris, and the various papers and discussions on them, which were recently described in NATURE by Prof. D'Albuquerque (pp. 392, 398).

DR. W. BUSSE, of Berlin, intends starting early in April for German East Africa, to investigate the flora of the steppes, for the purpose of discovering any plants of technical or medicinal value. He proposes to remain nine months.

FROM a summary of the mineral production of Canada in 1899, by Mr. E. D. Ingall, just published by the Canadian Geological Survey, it appears that the increase which has been so marked a feature during the past few years was sustained. Compared with the corrected total for 1898, the preliminary figures for 1899 show an increase of over 22·2 per cent., the increases for 1898 and 1897 having been nearly 35 per cent. and nearly 27 per cent. respectively. Of the increase of 22·2 per cent., 15·52 per cent. is credited to the increased output of gold from the Yukon placers, 2·92 per cent. to the increases in the other metallic products, and 3·84 per cent. to the growth of the non-metallic mineral industries.

REFERENCES to the work done at the Astrophysical Observatory of the Smithsonian Institution are made by Prof. S. P. Langley in his report upon the operations of the Institution for the year ending June 30, 1899. It has been shown that rock-salt prisms, whether obtained from mineral mined in Russia or Bavaria, have exactly the same refractive indices. It appears, therefore, that this interesting crystal, which from the time of Melloni to Prof. Langley himself has been chiefly used on account of its qualitative properties as regards the transmission of radiations, can now be used quantitatively as a standard of refraction to which all wave-lengths may be referred with the same order of precision as to the diffraction grating. Prof. Langley's measures of 1897–98, which determined the exact positions of 700 Fraunhofer lines in the infra-red spectrum of rock-salt, may thus be regarded as fixing constants of nature. As the wave-lengths of the lines were determined with an average probable error of three parts in 10,000, we are led to the surprising fact that, by working automatically in the dark, with the bolometer, it has been possible to analyse the infra-red solar spectrum with an accuracy comparable with that attained with much more pains through the eye itself.

All artificial lights, even the best, are extravagantly wasteful of energy, in that they lavish it in the infra-red, and not in the visible spectrum. Mr. C. G. Abbot, who has charge of the Astrophysical Observatory of the Smithsonian Institution, has examined the light emitted by the Welsbach mantle (which consists of impure thorium oxide) and other incandescent mantles, by means of the bolometer, with a view to comparing their efficiencies. Though the illuminating powers differ considerably, the distribution of energy is much less diversified than would be supposed, and shows clearly the wastefulness even of the Welsbach light as a source of illumination. The infra-red in each case includes by far the greater portion of the energy, and not the visible spectrum, as is the case with the sun, and still more, with phosphorescent substances. Excluding the infra-red radiation, the Welsbach mantle was found to be superior in light to the others experimented with, especially in the red, orange and yellow parts of the visible spectrum.

In a paper published in the *Geological Magazine* for March and April, Dr. C. Davison describes some of the less important British earthquakes felt during the years 1893–1899. The total number of shocks recorded in these seven years is forty-two, of which twenty-eight occurred in England and Wales, and fourteen in Scotland. In England, earthquakes were most numerous in the counties of Pembroke, Hereford and Cornwall; and in Scotland, in Annandale and Glen Garry, and near Comrie and Fort William. The earthquakes at the two last places are interesting from their connection with the two great faults which bound the Highland district; and the study of the shocks shows that the southern boundary fault near Comrie hades to the north-west, and the northern fault near Fort William probably to the south-east. A list of doubtful and spurious earthquakes is given, and among these are several which have been referred to by correspondents in Nature. Several local earth-shakes in mining districts are described, and Dr. Davison suggests another cause of some of these shocks besides rock-falls in old workings, namely, small fault-slips in those places where the coal has been worked right up to the fault, and so withdrawn support from the rock above.

Herr R. Parkinson has a unique knowledge of several districts of Melanesia, and he has recently contributed a very valuable paper on the ethnography of the North-western Solomon Islands to the *Abhandl. u. Berichte d. K. Zool. u. Anthrop. Mus, Dresden*, Bd. vii. 1899. He brings forward some fresh information on that evergreen topic of totemism. In Buka there are two clans which are called after their respective totems, the Fowl and the Frigate-bird, and members of the one clan must marry into the other. In North Bougainville the same clans exist, but in South Bougainville and in the neighbouring islands there are a number of bird clans; here also no one may marry into his own clan, though he may marry into any other. In all cases the children belong to the mother's clan. The lads are initiated into the *Rukruk* society in a tabooed clearing in the bush; as in Australia and elsewhere, a bull-roarer is whirled, and the women believe that the unearthly noise produced by this mystical instrument is the conversation between the initiates and the male and female spirit. After this ceremony the lad may marry. As Parkinson deals with other customs, music, houses, clothing, ornaments, money, utensils, weapons and the like, it will be apparent that this memoir is of considerable importance, especially as the author has peculiar facilities for gaining trustworthy information.

In the *Report* of the Rugby School Natural History Society for 1899 will be found an excellent plate of the skeleton of *Ichthyosaurus platyodon* disinterred at Stockton in 1898.

From the *Report* just to hand, the Ghizeh Zoological Gardens, under the direction of Mr. S. S. Flower, seem to be in a flourishing condition. By far the most interesting animals acquired during the year are the Proboscis Monkeys presented by the Netherlands Government.

As the result of an examination of the specimens brought back by the Harriman expedition, Dr. C. H. Merriam (*Proc.* Washington Academy, ii. pp. 13–30) describes no less than twenty-six mammals from Alaska and British North America as new. Although the majority of them are described as species, many naturalists will probably relegate at least a percentage to the rank of local races.

The *Sitzungsberichte* of the Royal Scientific Society of Bohemia for 1899 is a bulky volume containing a large number of papers on various subjects, many of which, from being written in Czech, are unfortunately a sealed book to the majority of Englishmen. Among interesting or important biological papers, we may call attention to one, by Herr Ryba, on a new *Megaphytum* from the Coal-measures; to a second, by Herr Smyčka, on the occurrence of the European Pond-tortoise in Silesia; and to a third, by Dr. Rohon, on the morphology of the Devonian fishes in one of the Petersburg museums.

Dr. O. Z. Bianco has sent us a copy of an interesting communication made to the Royal Academy of Sciences at Turin on February 11. The paper is intended to be a contribution to the history of meteorology, and contains an account of some recent investigations of Italian men of science upon the physical constitution of the atmosphere, founded upon the famous balloon ascents of Mr. James Glaisher in the years 1862–6, which still hold their place as the best and most extensive series that we at present possess. The principal object of the paper is the construction of improved barometric formulæ for the determination of heights.

We have received from Prof. G. Schwalbe an excerpt paper from the *Annalen der Physik* (iv. series, 1900), giving an account of his recent experiments upon Exner's theory of atmospheric electricity. The experiments, like those made some years ago (*Wied. Ann.* vol. lviii. p. 500, 1896), were carried on at the physical laboratory of the Agricultural High School at Berlin with the view of investigating the electrical behaviour of the vapours rising from electrified fluids. The author finds that such vapours carry no kind of electricity with them, and that consequently the experiments do not support Exner's theory, which explains the phenomena of atmospheric electricity by the transfer of the electric charge of the earth to the air by means of the evaporation going on from masses of water.

RECENT numbers of the *Communications* from the Physical Laboratory of the University of Leyden are occupied with work carried out in the cryogenic laboratory, which has been reopened after completing certain safety arrangements required by the Privy Council. Dr. H. Kamerlingh Onnes gives an account of certain methods and apparatus, including (1) a cryostat or boiling-glass and boiling case, for measurements with liquefied gases, especially oxygen; (2) the arrangement of a Brotherhood air compressor for the compression of gases to be kept free from admixture with air; (3) methods of pouring out little quantities of liquid nitrous oxide; and (4) boiling nitrous oxide in large quantities. In another issue, Dr. E. van Everdingen, jun., describes a continuation of his experiments on the Hall effect at the low temperatures now available, and has found no indication of a maximum value to this effect down to the boiling point of liquid oxygen. Dr. Fritz Hasenoehrl investigates the dielectric constants of liquid nitrous oxide and nitrogen, a branch of investigation previously carried out by Dewar and Fleming. The results are for nitrous oxide 1·933, and for oxygen 1·465, as compared with Dewar's 1·491, while the Clausius Menotti formula is at any rate not negatived by the experiments.

MESSRS. WATKINS AND DONCASTER have sent us their catalogue of natural history apparatus, books, birds, eggs, lepidoptera and other requisites of the field naturalist.

A SECOND edition of Part ii. of Prof. Chrystal's "Algebra" has just been published by Messrs. A. and C. Black. The principal changes occur in the sections on the Theory of Series, which have been rendered more useful to students proceeding to study the Theory of Functions. In the interests of the same class of readers, a sketch of the modern theory of irrational quantity has been added to the chapter. The first edition of Part ii. of Prof. Chrystal's work has already been noticed in NATURE (vol. xli. p. 338), and the merits of the work are so well known that it is unnecessary to do more now than announce the publication of the new edition.

THE London Geological Field Class, conducted by Prof. H. G. Seeley, F.R.S., offers exceptional opportunities of obtaining observational knowledge of the physical geography and geology of the London district. Visits are made to selected places on Saturday afternoons between the end of April and the beginning of July, and short addresses are given upon the characteristics of the rock structures and the development of the land forms seen during the excursions. The places to be visited this year have been selected with the view to illustrate the geological structure of the London basin by an examination of Cretaceous rocks at Godalming, Oxted, Gomshall and elsewhere, and of the Oolite of Bedford. The first excursion will be made on April 28.

SEVERAL parts of elaborate scientific memoirs in course of publication by Mr. W. Engelmann, of Leipzig, have been received from Messrs. Williams and Norgate. Included among these recent works are:—"Monsunia: Beiträge zur Kenntniss der Vegetation des süd- und ostasiatischen Monsungebietes" (Band i.), by O. Warburg; "Monographieen afrikanischer Pflanzen-Familien und Gattungen: IV. Combretaceæ excl. Combretum," by A. Engler and L. Diels; "Genera Siphonogamarum ad Systema Englerianum Conscripta" (Fasciculus i.), by Drs. C. G. de Dalla Torre and H. Harms; and "Conspectus florae graecae" (Fasciculus i.), by E. de Halacsy. In addition to these publications of the house of Engelmann, we have received from the firm of Gebrüder Borntraeger, Berlin, the first part of the first volume of "Die mikroskopische Analyse der Drogenpulver," an atlas for chemists and druggists, by Dr. Ludwig Koch. We propose to review these works when they have been completed.

THE question as to the origin of the energy possessed by the Becquerel rays is one of considerable interest. The existence of substances capable of emitting radiations possessing energy, without any appreciable loss of weight or introduction of work from external sources, would appear to be impossible from the view of conservation of energy. The measurements of M. Henri Becquerel upon the deviation of the radium rays in an electric field, taken in conjunction with those of M. and Mme. Curie of the charges carried by these rays, lead to results which show a way out of this difficulty, on account of the extreme minuteness of the quantities of energy in question. The calculations of M. Becquerel show that the energy radiated per square centimetre is of the order of one ten-millionth of a watt per second. Hence a loss of weight of about a milligram in a thousand million years would suffice to account for the observed effects, assuming the energy of the radium to be derived from an actual loss of material.

THE detailed study of the hydrocarbon indene has hitherto been hindered by the difficulty of obtaining it in large quantities in a pure state. In the March number of the *Journal* of the Chemical Society, Messrs. Kipping and Hall describe two new syntheses of indene, in which the yields are practically theoretical. Cinnamic acid is the starting point, from which α-hydrindone is prepared by methods previously described; the oxime from this is then reduced to α-hydrindamine, from which indene can be obtained either by heating the hydrochloride at 250° C., or by preparing the iodide of trimethyl-hydrindamine and submitting this to dry distillation. The indene thus prepared was shown to be identical with that synthesised by Perkin and Révay, and also with indene from coal-tar.

IT is now very generally agreed that the true constitution of the sulphites is represented by the unsymmetrical formula $R.SO_2.OR$, as opposed to the symmetrical $SO.(OR)_2$. One interesting outcome of the former view is that there should be isomeric double sulphites, the one $R.SO_2.OR'$, and the other $R'.SO_2.OR$, and Schwicker and Barth have indicated the existence of such isomers in the case of sodium potassium sulphite. Dr. Fraps, however, in the March number of the *American Chemical Journal*, after carefully repeating these experiments, has been driven to the conclusion that no such isomerism exists in this case. This coincides with the views of Hantzsch, who holds that structural isomerism is unknown in inorganic bodies.

THE additions to the Zoological Society's Gardens during the past week include a Secretary Vulture (*Serpentarius reptilivorus*) from South Africa, presented by Mr. James D. Logan, jun.; a Spanish Blue Magpie (*Cyanopolius cooki*) from Spain, presented by Mr. E. G. B. Meade-Waldo; a Greater Black-backed Gull (*Larus marinus*), European, presented by Mr. H. Clinton Baker; four Marbled Newts (*Molge marmorata*) from Bordeaux, presented by Mr. G. A. Boulenger, F.R.S.

OUR ASTRONOMICAL COLUMN.

NEW VARIABLE IN ANDROMEDA.—Dr. T. D. Anderson, of Edinburgh, has communicated to the *Astronomische Nachrichten* (Bd. 152, No. 3632) his observations of the variability of a new variable star in the constellation of Andromeda. The coordinates of the star's position are :—

$$\left.\begin{array}{ll} \text{R.A.} = & \text{0h. } 8\cdot5\text{m} \\ \text{Decl.} = & +46^\circ\ 12' \end{array}\right\} (1855.)$$

lying almost exactly on the boundary between Cassiopeia and Andromeda. It is not mentioned in the Bonn *Durchmusterung*. As measured from the comparison stars B.D. +46°·38 (8·5), 40

(9·6) and 48 (9·1), the following are the observed magnitudes of the variable :—

1900. Jan.	16	...	8·8
	19	...	8·7
Feb.	20	...	9·0
March	14	...	9·5

SOLAR ECLIPSES OF THE 20TH CENTURY.—In a reprint from the *Bulletin de la Société Astronomique de France* for November, M. Camille Flammarion brings together the local particulars for the eclipses of the sun which will be visible in Paris during the 20th century. Forty-three eclipses will be visible, but only thirty-three under good observing conditions. Special attention is drawn to the eclipses of April 17, 1912, and August 11, 1999, as although Paris is not included in the path of totality, in each case the central line of eclipse is only a short distance away from the capital. Maps are given of the paths of the shadow for both dates. These are also reproduced in the last number of the *Bulletin* (March).

A BRILLIANT FIREBALL.—On March 28, 8h. 31m., a very large meteor, giving several flashes like vivid lightning, was observed from the south-eastern parts of England. At Bishops Stortford, Herts, the light was so great that it illuminated the country, and three distinct explosions were observed. A sound like that of the roar of a distant cannon followed the disappearance of the meteor, and would indicate that it was 24 miles distant, but this is probably much underestimated. The meteor descended from the constellation Leo in the south. In Berkshire it was seen falling in Virgo, and it flashed out very brilliantly just prior to its disruption. The head of the meteor was very much brighter than Venus, and it travelled rather swiftly. Two vivid flashes were observed here as at Reading, where the terminal point of the flight was noted as being near ϵ Virginis. At the latter place the phenomenon ended in a cloud of sparks, and for a moment the sky and landscape were flooded in light. At Blackheath the meteor was seen by Mr. Crommelin, of the Greenwich Observatory. He estimated it as three times as brilliant as Venus at her brightest, and describes the terminal point as 1° N. of β Leonis. Many reports of this brilliant object are available for discussion, and it will be possible to determine its real path satisfactorily. Many large fireballs are directed in very slow flights from westerly radiants, but in this case the object moved swiftly, and probably had a radiant not far from the star ϵ in Ursa Major. Its position was over the east coast of Kent, and its height, when it finally burst and disappeared, about 52 miles.

MODERN EXPLOSIVES.[1]

THE subject of explosives is one which never fails to excite interest even under the most ordinary conditions, doubtless owing to the enormous potentiality of these substances, whilst at the present time more than usual attention is directed to them, it being scarcely possible to read a daily paper without finding some reference to the behaviour of various modern explosives in the theatre of war.

Explosion may be defined as chemical action causing extremely rapid formation of a very great volume of highly expanded gas, this large volume of gas being generally due to the direct liberation by chemical action and the further enormous expansion by the heat generated. Explosion itself may therefore be regarded as extremely rapid combustion, whilst the effect is obtained by the enormous pressure produced owing to the products of combustion occupying probably many thousand times the volume of the original body. The effect of high temperature is seen in the well-known case of explosion of a mixture of hydrogen and oxygen, where if the original mixture and the products of explosion are each measured at the same temperature above the boiling point of water, a less volume of gas (water vapour) is actually found. The explosion can only have been produced by the enormous expansion of this vapour in the first place by the heat of the reaction. Such an explosion when carried out in a closed bomb with the mixed gases under ordinary conditions of measurement produces a pressure of about 240 lbs. to the square inch. A more practical illustration is seen with nitroglycerine, which Nobel found yielded about 1200 times its own volume of gas calculated at ordinary temperatures and pressures, whilst the heat liberated expands the gas to nearly eight times this volume.

[1] A lecture delivered at the London Institution on February 12, by Mr. J. S. S. Brame.

Clearly, then, a substance for use as an explosive must be capable of undergoing rapid decomposition or combination with the production of large volumes of gas, and further produce sufficient heat to greatly expand these gases; the ratio of the volume of gases at the moment of explosion to the volume of the original body largely determining the efficiency of the explosive.

Explosives may be divided into two great classes—mechanical mixtures and chemical compounds. In the former the combustible substances are intimately mixed with some oxygen-supplying material, as in the case of gunpowder, where carbon and sulphur are intimately mixed with potassium nitrate; while gun-cotton and nitroglycerine are examples of the latter class, where each molecule of the substance contains the necessary oxygen for the oxidation of the carbon and hydrogen present, the oxygen being in feeble combination with nitrogen. Many explosives are, however, mechanical mixtures of compounds which are themselves explosive, *e.g.* cordite, which is mainly composed of gun-cotton and nitroglycerine.

Two methods are in common use for bringing about explosions—ignition by heat, thus bringing about ordinary but rapid combustion, molecule after molecule undergoing decomposition; and detonation, where the effect is infinitely more rapid than in the first case; in fact, it may be regarded as practically instantaneous. The result may be looked upon as brought about by an initial shock imparted to the explosive by a substance—the detonating material—which is capable of starting decomposition in the adjacent layers of the explosive, thus causing a shock to the next layer and so on with infinite rapidity. That the results are not entirely due to the mechanical energy of the liberated gas particles is shown by the fact that the most powerful explosive is not the most powerful detonator; neither is it entirely due to heat, since wet substances undergo detonation. The probability is that the result is brought about by vibrations of particular velocity which vary for different substances, the decomposition being caused by the conversion of the mechanical force into heat in the explosive, thus bringing about a change in the atomic arrangement of the molecule. According to Sir Frederick Abel's theory of detonation, the vibrations caused by the firing of the detonator are capable of setting up similar vibrations in the explosive, thus determining its almost instantaneous decomposition.

The most common and familiar of explosives is undoubtedly gunpowder, and although for military purposes it has been largely superseded by smokeless powders, yet it has played such an important part in the history of the world during the last few centuries that apart from military uses it is even now of sufficient importance to demand more than a passing notice.

Its origin, although somewhat obscure, was in all probability with the Chinese. Roger Bacon and Berthold Schwartz appear to have rediscovered it in the latter years of the thirteenth and earlier part of the fourteenth centuries. It was undoubtedly used at the battle of Crecy. The mixture then adopted appears to have consisted of equal parts of the three ingredients—sulphur, charcoal and nitre; but some time later the proportions, even now taken for all ordinary purposes, were introduced, namely—

Potassium nitrate...	75 parts
Charcoal	15 ,,
Sulphur	10 ,,
	100 ,,

Since gunpowder is a mechanical mixture, it is clear that the first aim of the maker must be to obtain perfect incorporation, and necessarily in order to obtain this, the materials must be in a very finely divided state. Moreover, in order that uniformity of effect may be obtained, purity of the original substances, the percentage of moisture present, and the density of the finished powder are of importance.

The weighed quantities of the ingredients are first mixed in gun-metal or copper drums, having blades in the interior capable of working in the opposite direction to that in which the drum itself is travelling. After passing through a sieve, the mixture (green charge) is passed on to the incorporating mills, where it is thoroughly ground under heavy metal rollers, a small quantity of water being added to prevent dust and facilitating incorporation, and during this process the risk of explosion is greater possibly than at any other stage in the manufacture. There are usually six mills working in the same building, with partitions between. Over the bed of each mill is a horizontal board, the "flash board," which is connected with a tank of water overhead, the arrangement being such that the upsetting of one tank discharges the contents of the other tanks on to the corresponding mill beds below, so that in the event of an accident the charge is drowned in each case. The "mill-cake" is now broken down between rollers, the "meal" produced being placed in strong oak boxes and subjected to hydraulic pressure, thus increasing its density and hardness, at the same time bringing the ingredients into more intimate contact. After once more breaking down the material (press-cake), the powder only requires special treatment to adapt it for the various purposes for which it is intended.

Within the last half-century an enormous alteration has taken place in artillery, the old smooth-bore cannon, firing a round shot, having gradually given place to heavy rifled cannon, firing cylindrical projectiles and requiring very large powder charges. This has naturally had its influence on the powder used, and modifications have been introduced in two directions—first, alteration in the form of powder, and second, in the proportions of the ingredients. As the heavier guns were introduced, a large grain powder which burned more slowly was adopted, but further increase in the size of the guns led to the introduction of pebble powders, which in some cases consisted of cubes of over an inch side. Such cubes having large available surface evolved the usual gases in greater quantity at the start of the combustion than towards the finish, since the surface became gradually smaller, thus causing extra strain on the gun as the projectile was only just beginning to move. General Rodman, an American officer, introduced prism powder to overcome this difficulty, the charges being built up of perforated hexagonal prisms in which combustion started in the perforations and proceeding, exposed more surface, the prisms finally breaking down into what was virtually a pebble powder.

In order to secure still further control over the pressure, modifications in the proportions of the ingredients became necessary; the diminution of the sulphur and increase of the charcoal causing slower combustion, and moreover the use of charcoal prepared at a low temperature giving the so-called "cocoa-powders."

The products of the combustion of powder and its manner of burning are largely influenced by the pressure, a property well illustrated by the failure of a red-hot platinum wire to ignite a mass of powder in a vacuum, only a few grains actually in contact with the platinum undergoing combustion. The gaseous products obtained are carbon dioxide, carbon monoxide and nitrogen, other products being potassium carbonate, sulphate and sulphide. The calculated gas yield at 0° C. and 760 mm. pressure is 264·6 c.c., whilst Noble and Abel actually obtained by experiment 263·74 c.c, numbers agreeing very closely. At the temperature of explosion this volume is enormously increased.

In 1832, Braconnot found that starch, ligneous fibre and similar substances when treated with strong nitric acid yielded exceedingly combustible substances, and Pelouze in 1838 extended the investigation to cotton and paper. Schönbein announced in 1845 his ability to make an explosive which he termed gun-cotton, and a year later Böttger made a similar announcement, and on a conference being held between these chemists their methods were found to be identical. The method was not disclosed at the time, since it was hoped that the German Government would purchase the secret, but in a very short time several investigators solved the problem, and attempts to make the new explosive commercially were common. Unfortunately the earlier product was unstable, and several disastrous accidents occurred which led to the abandonment of the experiments except in Austria. General von Lenk, who continued experimenting in that country, showed that if sufficient care was taken to ensure complete nitration and to remove all traces of free acid from the finished material, the substance was stable. He introduced a method of manufacture which was improved by Sir Frederick Abel in 1865. The physical character of the cotton fibre is such that it presents every obstacle to the removal of free acid, since it is built up of capillaries, but by reducing these tubes to the shortest possible length, as in Abel's process, the removal of acid is facilitated.

Since water is a product of the reaction of nitric acid on cellulose, the nitric acid would become diluted, forming "collodion cotton" instead of the more highly nitrated gun-cotton, and therefore sulphuric acid is used with the nitric acid to absorb this water, the usual proportions being three parts by weight of sulphuric acid (1·84) to one part by weight of nitric acid (1·52). Cotton waste, which has been picked, cleaned, cut into short lengths and dried, is dipped in 1¼ lb. charges in the acid, removed after five or six minutes, the excess of acid squeezed out, and the cotton placed in cooled earthenware pots for some twenty-four hours for nitration to be completed. The gun-cotton now goes through the lengthy process for removal of all traces of acid, starting with the removal of the greater portion of the acid by a centrifugal extractor, washing in water till no acid taste can be detected, boiling in water till free from action on litmus, reducing to pulp in a hollander, and, finally, the thorough washing of the pulp by more water. If the product now satisfies the tests for purity, sufficient alkali—lime-water, whiting and caustic soda—is added to leave from one to two per cent. in the finished gun-cotton. The pulp is drawn up into a vessel from which it can be run off in measured quantities into moulds fitted with perforated bottoms, the water being drawn off by suction from below, and, finally, a low hydraulic pressure is brought to bear on the semi-solid mass. The blocks are taken to the press-house and submitted to a pressure of some five tons per square inch, after which the finished block will contain from twelve to sixteen per cent of water.

From its chemical reactions gun-cotton must be regarded as an ether of nitric acid, a view first suggested by Béchamp. The point of ignition of the substance has been found to vary considerably, ranging from 136° to 223° C., this difference being probably due to variations in composition. Good gun-cotton usually ignites between 180° and 184°C. The combustion is extremely rapid when fired in loose unconfined masses, so rapid, in fact, that it may be ignited on a heap of gunpowder without affecting the latter. When struck between hard surfaces gun-cotton detonates, but usually only in that portion which is subjected to the blow. The volume of permanent gases evolved by the explosion of gun-cotton, as stated by different observers, has varied greatly. Macnab and Ristori give for nitrocellulose—13·30 per cent. nitrogen—673 c.c. per gram, calculated at 0° C. and 760 mm. Berthelot estimates the pressure developed by the detonation of gun-cotton—sp. gr. 1·1—under constant volume as 24,000 atmospheres or 160 tons per square inch.

Various attempts have been made to adapt gun-cotton for use in guns, but the tendency to create undue pressure led to its abandonment. In 1868, Mr. E. O. Brown, of Woolwich, showed that wet gun-cotton could be detonated by the use of a small charge of dry gun-cotton with a fulminate detonator, and since it can be stored and used in the moist state, it becomes one of the safest explosives for use in submarine mines, torpedoes, &c.

Nitroglycerine is a substance of a similar chemical nature to nitrocellulose, the principles of its formation and purification being very similar, only in this case the materials and product are liquids, this rendering the operations of manufacture and washing much less difficult. The glycerine is sprayed into the acid mixture by compressed air injectors, care being taken that the temperature during nitration does not rise above 30° C. The nitroglycerine formed readily separates from the mixed acids, and being insoluble in cold water, the washing is comparatively simple.

This explosive was discovered by Sobrero in 1847. Nitroglycerine is an oily liquid readily soluble in most organic solvents, but becomes solid at three or four degrees above the freezing point of water, and in this condition is less sensitive. It detonates when heated to 257° C., or by a sudden blow, yielding carbon dioxide, oxygen, nitrogen and water. Being a fluid under ordinary conditions, its uses as an explosive were limited, and Nobel conceived the idea of mixing it with other substances which would act as absorbents, first using charcoal and afterwards an infusorial earth, "kieselguhr," and obtaining what he termed "dynamite."

In 1875, Mr. Alfred Nobel found that "collodion cotton"—soluble gun-cotton—could be converted by treatment with nitroglycerine into a jelly-like mass which was more trustworthy in action than the components alone, and from its nature the substance was christened "blasting gelatine." The discovery is of importance, for it was undoubtedly the stepping-stone from which the well-known explosives ballistite, filite and cordite were reached. In 1888, Nobel took out a patent for a smokeless powder for use in guns, in which these ingredients were adopted with or without the use of retarding agents. The powders of this class are ballistite and filite, the former being in sheets, the latter in threads. Originally camphor was introduced, but its use has been abandoned, a small quantity of aniline taking its place.

Sir Frederick Abel and Prof. Dewar patented in 1889 the use of trinitrocellulose and nitroglycerine, for although, as is well-known, this form of nitrocellulose is not soluble in nitroglycerine, yet by dissolving the bodies in a mutual solvent, perfect incorporation can be attained. Acetone is the solvent used in the preparation of "cordite," and for all ammunition except blank charges a certain proportion of vaseline is also added. The combustion of the powder without vaseline gives products so free from solid or liquid substances that excessive friction of the projectile in the gun causes rapid wearing of the rifling, and it is chiefly to overcome this that the vaseline is introduced, for on explosion a thin film of solid matter is deposited in the gun, and acts as a lubricant.

The proportion of the ingredients are :—

Nitroglycerine	58 parts.
Gun-cotton	37 ,,
Vaseline	5 ,,

Gun-cotton to be used for cordite is prepared as previously described, but the alkali is omitted, and the mass is not submitted to great pressure, to avoid making it so dense that ready absorption of nitroglycerine would not take place. The nitroglycerine is poured over the dried gun-cotton and first well mixed by hand, afterwards in a kneading machine with the requisite quantity of acetone for 3½ hours. A water jacket is provided, since on mixing the temperature rises. The vaseline is now added, and the kneading continued for a similar period. The cordite paste is first subjected to a preliminary pressing, and is finally forced through a hole of the proper size in a plate either by hand or by hydraulic pressure. The smaller sizes are wound on drums, whilst the larger cordite is cut off in suitable lengths, the drums and cut material being dried at 100° F., thus driving off the remainder of the acetone.

Cordite varies from yellow to dark brown in colour according to its thickness. When ignited it burns with a strong flame, which may be extinguished by a vigorous puff of air. Macnab and Ristori give the yield of permanent gases from English cordite as 647 c.c., containing a much higher per cent. of carbon monoxide than the gases evolved from the old form of powder. Sir Andrew Noble failed in attempts to detonate the substance, and a rifle bullet fired into the mass only caused it to burn quietly.

Lyddite is probably the explosive which has received most notice during the past few months. In 1873, Sprengel, in a paper read before the Chemical Society, stated that "picric acid alone contains a sufficient amount of oxygen to render it, without the help of foreign oxidisers, a powerful explosive when fired with a detonator. Its explosion is almost unaccompanied by smoke."

Picric acid was first prepared by Hausmann in 1878, by treating indigo with nitric acid. It may be made by the direct nitration of phenol (carbolic acid), but a better result is obtained by first dissolving the phenol in sulphuric acid, forming phenol sulphonic acid, which is dissolved in water, and nitrating this compound with nitric acid (1·4). On cooling, the picric acid separates out, and is purified by recrystallisation from hot water, the yellow crystalline product being dried at a temperature not exceeding 100° C.

Picric acid containing as much as 17 per cent. of water can be detonated by a charge of dry picric powder; a thin layer may also be exploded by a blow between metal surfaces, its sensitiveness to shock being greatly increased by warming, for at a temperature just below its melting point a pound weight falling from a height of 14 inches will explode it.

The sensitiveness of picric acid can be reduced by converting the powder into larger masses, this being accomplished either by granulating it with a solution of collodion cotton in ether-alcohol, as in the earlier forms of mélinite, or by fusion, which takes place some twenty degrees above the boiling point of water, and casting directly into the shell, as in lyddite and possibly the mélinite of the present day. In any condition perfect detonation would yield only colourless gaseous products rich in carbon monoxide, but the bursting of a lyddite shell is frequently accompanied by a yellow smoke, probably formed by undecomposed acid in the form of vapour. The shells appear to burst in two distinct ways, in one case giving a sharp powerful explosion with enormous concussion and no yellow smoke, and the other a dull heavy report with the yellow smoke, the two results appearing to be due to perfect decomposition in the first instance, whilst in the second partial decomposition only probably occurs.

Various mixtures of picric acid or its salts, together with some oxidising agent, have been used from time to time, Abel's powder consisting of ammonium picrate, potassium nitrate, and a small quantity of charcoal.

It is impossible to deal with the numerous other explosives which are largely in use in such a survey as this, and therefore attention has been confined to those which play the most active part in modern warfare.

ANTI-PLAGUE INOCULATIONS.

THE final proof of Chapter iv. of the Indian Plague Commission Report, dealing with Haffkine's anti-plague inoculations, has already been briefly referred to (p. 422); the following are further notes upon its contents:—

The first paragraphs contain a brief review of the history of preventive inoculation, the Commissioners trace it up to Haffkine's anti-cholera inoculations, in which a measured quantity of bacteria of known virulence was used. The next practical extension is stated to be the anti-typhoid inoculations introduced by one of the Commissioners (Prof. Wright), in which dead cultures were used; the first of these inoculations were done in July and August 1896. Next, they say, come in chronological order the experiments of Yersin, Calmette and Borrel, conjointly in 1895, which showed it was possible to confer a certain amount of immunity against plague by injection of dead cultures of plague bacilli. Mr. Haflkine's anti-plague inoculations, the Commissioners say, represent an extension of this system of preventive inoculation to men. That Mr. Haffkine was not indebted to Yersin, Calmette and Borrel, nor to the system of anti-typhoid inoculation, for the suggestion to use dead cultures in his plague prophylactic, is evident from the words used by Mr. Haffkine in his lecture on "Anti-Cholera Inoculation" reported in the *British Medical Journal*, February 11, 1893: "The microbes introduced under the skin do not propagate, but after a certain time they die and disappear. It is the substances which they contain, and which are set free when they die, that act upon the animal organism and confer immunity upon it. It is found that the same result can be obtained if the microbes be killed before inoculation, and if their dead bodies only be injected." Prof. Wright recognises this, for, in his account of the first anti-typhoid inoculations, *Lancet*, September 19, 1896, he says: "I need hardly point out that these anti-cholera inoculations have served as a pattern for the typhoid vaccinations detailed above."

Had the Commissioners quoted Mr. Haffkine's experiments with sterilised cultures of cholera bacilli, the anti-typhoid vaccine and the anti-plague prophylactic of Yersin, Calmette and Borrel, would have been shown to be an extension of Haffkine's own anti-cholera vaccine rather than the other way about, as it would appear from the report.

The report goes on to a very stringent criticism of the method of preparing the prophylactic. A certain proportion of bottles were found to be contaminated. In dealing with large quantities of prophylactic, it is not unlikely that some bottles should become contaminated, possibly by some of the corks not being sterile, as Mr. Haffkine suggests. The fact was not brought before the notice of Mr. Haffkine, but was sprung upon the Commissioners and mentioned in the daily Press at the time, with the evident intent to detract from the value of the prophylactic. The Commissioners investigated the matter, but found no serious results could be traced to such accidental contaminations.

The comparative value of the bacterial sediment and of the supernatant fluid is discussed, and, finally, the method of standardisation.

The process of manufacture is criticised from the point of view of scientific manipulation in a properly equipped laboratory for experiments on a small scale. The Commissioners do not mention the fact that the prophylactic is made on a large scale, as much as 20,000 doses being turned out per day, and this in a laboratory with no proper equipment, and with an insufficient and partially inefficient staff. And now having adversely criticised the theory and methods of the General who is conducting the campaign against plague, one expects to find some radical alteration advised; but no, they turn round and join forces, saying, "We recognise that even though a vaccine which is insufficiently standardised, and which is occasionally contaminated, is from the scientific point of view a very imperfect vaccine, yet judged from the standpoint of practical life, such defects may very well be overlooked if the insufficient standardisation and the occasional contamination of the vaccine have not interfered in a sensible manner with its utility.

"This standpoint, which is indeed the only reasonable standpoint, is the standpoint which has been taken up by Mr. Haffkine in the statement that was handed in by him, and which is published, at his request, in our *Proceedings*."

The second part of the report criticises the statistics of anti-plague inoculations. In their summary, the Commissioners say that inoculation diminishes the number of attacks and diminishes the death-rate among those inoculated, that it does not appear to confer any degree of immunity till a few days have elapsed after inoculation, and that the protection lasts certainly for a considerable number of weeks, and possibly for some months.

They recommend that inoculations under safeguards and conditions stated in the report should be encouraged wherever possible, and in particular among disinfecting staffs and attendants of plague hospitals.

C. B. S.

EXPERIMENTAL STUDY OF FERTILISATION.

IN 1898 Prof. Yves Delage made a remarkable experiment.[1] He divided the unfertilised egg of a sea-urchin (*Strongylocentrotus lividus*) under the microscope into two parts—one containing the nucleus and the centrosome, the other simply cytoplasmic. Beside these he placed an intact ovum, and then supplied spermatozoa. Towards these the three objects showed equal "sexual attraction"; all three were fertilised; and all three segmented, the intact ovum most rapidly, the nucleated fragment more slowly, the non-nucleated fragment more slowly still. In one experiment, the development proceeded for three days, during which the intact ovum had become a typical gastrula, the nucleated fragment a smaller gastrula, and the non-nucleated fragment a quasi-gastrula with almost no cavity. In each case the cells showed nuclei. The conclusion was then drawn that *fertilisation and some measure of development may occur in a fragment of ovum without nucleus* or ovocentre, and it was suggested that we have in fertilisation to distinguish two processes:—(*a*) the stimulus given to the ovum by a specially energetic kinoplasm brought in by the spermatozoon, perhaps in its centrosome; and (*b*) the mingling of heritable qualities, or amphimixis. One may also note that the experiment was suggestive in furnishing experimental confirmation of what is generally assumed, that each of the sex-cells is a fully equipped potential individuality. Here we may recall the remarkable experiment of H. E. Ziegler,[2] who divided the just fertilised ovum of a sea-urchin in such a way that each half had one pronucleus, and observed that the half with the male pronucleus segmented and formed a blastula.

In 1899 Delage continued his experiments,[3] and with striking success. Non-nucleated fragments of the ova of a species of *Echinus*, of *Dentalium entale*, and of *Lanice conchilega* were effectively fertilised; they proceeded to develop, and gave rise to plutei, veligers, and trochophores respectively. The terms merogonic fertilisation and merogonic development are suggested to express the remarkable facts observed.

The segmentation of the fertilised non-nucleated fragment was practically normal in the sea-urchin, very irregular in *Dentalium*, less irregular in *Lanice* (the chief irregularity being lack of correspondence between the nuclear and the cytoplasmic divisions), but as the development proceeded some self-regulative process reduced the abnormalities to insignificance. The plutei only differed from the normal in the extreme reduction of the arms; the veligers and trochophores were almost typical. They showed no lack of vitality, and although further development did not occur, the same is usually true of normal larvæ reared in similar conditions.

[1] "Embryons sans noyau maternel." *C. R. Ac. Sci. Paris*, cxxvii. (1898), pp. 528–531.

[2] "Arch. Entwickelungsmechanik," iv. (1898), pp. 249–293, 2 plates, 3 figs.

[3] "Études sur la mérogonie." *Arch. Zool. expér.*, vii. (1899), pp. 383–417, 11 figs. See also *C. R. Ac. Sci. Paris*, cxxix. (1899), pp. 645–648.

As to the limits of possible merogony, Delage got some results which are nothing if not striking. A quarter of a *Dentalium*-ovum was fertilised and segmented; about a fifth of a *Lanice*-ovum was successfully treated; but the *chef d'œuvre* of experimental nicety was seen when 1/37 *of a sea-urchin ovum gave rise to an agile blastula.* Delage has christened his pigmy creations—tetartogonic, pemptogonic, &c.—but he seems to hesitate in regard to that arising from the 1/37, for he puts the title "triacosthedomogonique" in a footnote. That there is a limit to merogony he is convinced, but he will not at present fix it. It seems not inappropriate to recall Marchal's description[1] of the strange behaviour of the ovum of *Encyrtus fuscicollis* (one of the parasitic Hymenoptera), which gives rise to a legion of morulæ, and forms a chain of 50–100 embyros within one elongated amniotic envelope. For practical purposes it is convenient to remember that, just as four lancelet embyros may be got by shaking apart the first four blastomeres, so Delage by cutting a sea-urchin ovum obtains three larvæ from one egg.

The issues involved in these experiments are so serious (biologically) that one is naturally led to consider possible criticisms, which Delage in his candid scientific spirit has himself suggested. It is difficult to refrain from the suspicion that there may have been some mistake somewhere. The best criticism would, of course, be to repeat the experiments; but in default of this, let us briefly consider with the author some of the possibilities of error. (*a*) It may be suggested that the eggs experimented with had been previously fertilised by stray spermatozoa; but Delage's experience has been that the spermatozoa die 24–36 hours after liberation; and the water in which the eggs were placed had stood for three or four days in a stone cistern. Moreover, only in one case was segmentation seen among the eggs from which those experimented upon were taken. (*b*) It may be suggested that the segmentation of the fertilised non-nucleated ovum-fragments was not genuine, but a pathological fragmentation such as is occasionally observed after mechanical or chemical stimulation; but it must be remembered that larvæ were reared, and there were, of course, control observations on non-fertilised fragments. (*c*) It may be suggested that the nucleus was cut in the delicate operations, so that each part had really a portion of nucleus as well as cytoplasm. But it must be remembered that the nucleus is very small and very mobile, and thus runs little chance of being cut; in the clear ova of the sea-urchin it was sometimes seen after the operation in the larger part, only once in the smaller part, never in both. In the other two cases (*Dentalium* and *Lanice*) the opacity of the egg hides the nucleus. Perhaps the best answer is, that in one experiment three embryos were got from one ovum, and that fragments representing 1/10 and 1/37 of the total volume of the egg were also seen to segment. It seems, however, possible still to retort that the operation broke the nucleus and caused a distribution of nucleoplasm into the various fragments before they were quite separated.

What are the conditions of successful merogony? Delage failed with the ova of *Ciona*, *Haliotis*, *Chiton*, *Sabellaria*, &c., and he almost failed with those of *Lanice* until he learned the particular "tour de main" in cutting them. The experiment is not practicable except with eggs which are liberated separately before fertilisation. It usually fails if there is a shell. The ova to be tried by other experimenters should be naked or with a delicate glairy envelope, not too brittle, of firm consistence, and not less than 1/10 mm. in diameter. In all Delage's experiments there was a certain percentage of failure, due perhaps to the inability of the fragments to recover from their wounds, or to a diminution in the viscous substance which surrounds the ovum and keeps its parts together. But, in spite of these failures, the number of merogonic segmentations was generally at least equal to, and sometimes greater than, the number of segmentations among intact ova in similar conditions,—a remarkable fact which leads Delage to the daring suggestion that the absence of the female pronucleus may favour fertilisation. "*The female pronucleus is perhaps useful in securing for the embryo the advantages of amphimixis, but it is not useful in fertilisation nor necessary for the development of the parts of the organism.*"

The preceding paragraphs give the gist of Delage's remarkable experiments, but there are some less secure addenda which deserve notice. He has shown the possibility of merogonic hybridisation; he observed phenomena which point to a

[1] *C. R. Ac. Sci. Paris*, cxxvi. (1898), pp. 662–664. *Ann. Nat. Hist.* ii. pp. 28–30.

distinction between cytoplasmic and nuclear maturation; he reared a merogonic sea-urchin larva whose cells had the normal number (18) of chromosomes, although the spermatozoon-nucleus (the only one in this case) imported (it is presumed) but half that number. The last fact leads him to conclude that the number of chromosomes is a specific property of the cell.

Although Delage's experiments stand at present alone as regards the method pursued, there have been of late a number of experimental studies on fertilisation, all of which present points of great interest. From among these we select those of Prof. Jacques Loeb,[1] as it seems of particular importance that his results should be collated with those of Delage.

Loeb finds that the mixture of about 50 per cent. of $\frac{10}{8}$ *n* $MgCl_2$ with about 50 per cent. of sea-water is able to bring about (in the eggs of the sea-urchin *Arbacia*) the same result as the entrance of a spermatozoon. After being subjected to this mixture for about two hours, the eggs were returned to normal sea-water, wherein many developed, forming blastulæ, gastrulæ and plutei. Fewer eggs developed than in natural conditions, and the development was slow, but otherwise the results were normal. The author believes that the only reason why the eggs of this sea-urchin and of other marine animals do not usually develop parthenogenetically is the presence or absence of ions of sodium, calcium, potassium and magnesium. The two former require to be reduced, the two latter to be increased.

"*The unfertilised egg of the sea-urchin contains all the essential elements for the production of a perfect pluteus.*" All the spermatozoon *needs* to carry into the egg for the process of fertilisation are ions to supplement the lack of favourable ions, or to counteract the effects of the other class of ions in the sea-water, or both. "The spermatozoon *may*, however, carry in addition a number of enzymes or other material. But *the ions and not the nucleins in the spermatozoon are essential to the process of fertilisation.*"

It is interesting to observe that while Delage's experiments go to show that the nucleus of the sea-urchin ovum is not essential to development, Loeb's experiments go to show that the spermatozoon may (with intact ova) be dispensed with. What is now needed is a combination of the two modes of experiment.

J. A. T.

CHANGES OF COLOUR OF PRAWNS.

IT has long been known that the very numerous varieties of the prawn *Hippolyte* (*Virbius*) *varians* reflect, each after its kind, the colour of the weed or zoophyte to which they cling, and on which they find both food and shelter. A few naturalists, after noting this striking case of "protective resemblance," have detached some of the more brilliantly coloured specimens for the purpose of making a detailed subsequent examination. When they came to do this they found that the vivid brown and other tints had in the interval largely faded, or were replaced by others. This discovery has no doubt been made independently time after time, and has given point and emphasis to the essentially variable character of this prawn. Not only do individuals differ from each other, but any one of them is capable of altering its characteristic tint.

Thus, at the time when Keeble and Gamble began their observations,[2] *Hippolyte varians* was known to change colour, but while one author stated that a sympathetic colour-change was rapidly effected, as well in the dark as in the light, when weed of a new tint was introduced; another affirmed that even in the light the change was slow and did not always agree with the colour of the new weed. Yet a third author stated that darkness by itself has a distinct reddening effect. The only definite conclusion to be drawn from these curiously conflicting statements was that *Hippolyte* offered a fine field for research, and that though a few strollers had here and there plucked an ear or two of corn, there was a fine harvest still to be gathered.

After two years' work on the coasts of Lancashire and of Normandy, Keeble and Gamble have come to the conclusion that three kinds of colour-change may be distinguished in *Hippolyte*.

[1] On the nature of the process of fertilisation and the artificial production of normal larvæ (plutei) from the unfertilised eggs of the sea-urchin. (*Amer. Journ. Physiol.* iii. (1899), pp. 135–138.)

[2] "The Colour-Physiology of *Hippolyte varians*." By F. W. Keeble, Caius College, Cambridge, and F. W. Gamble, Owens College, Manchester. Read before the Royal Society on November 23, 1899.

I. First, a periodic and rhythmic cycle of change composed of a diurnal and a nocturnal phase of colour. Towards evening a decided red tinge—a sunset glow—makes its appearance, and this ushers in the nocturnal change. A green tinge ensues, which spreads fore and aft from the middle of the body. Presently this green colour gives place to an azure-blue colour, which is the characteristic nocturnal tint, and is accompanied by a greatly heightened transparency in the tissues. Under natural conditions this colour-phase persists until daybreak. At the first touch of dawn it disappears, and that of the previous day is gradually reassumed.

More striking even than the distinctive colours is the periodicity of the nocturnal and diurnal phases. Thus, in constant darkness a nocturne (that is a prawn in the nocturnal colour-phase) recovers to its diurnal colour. In constant light, a diurnal form passes over to the nightly phase. Though light often induces, and induces with marvellous rapidity, a recovery from the nocturnal colour to that of the previous day, yet it is often powerless to overcome the habit of the animal. The periodicity is only worn down in the course of two or three days.

It follows that since the colour of *Hippolyte* is a function of the time of day, that time must be taken into account in an investigation on the colours of Crustacea.

II. The second kind of colour-change is the susceptibility of *Hippolyte* to changes of light-intensity. Although the periodic habit of the prawn is the hitherto unknown and yet dominant factor, yet its force is greatest at the times of the assumption of the nocturnal phase, and the resumption of the diurnal tint. At other times external conditions may modify the colour of the animal to a large extent, and the chief agent in the production of these modified colours is the varying amount of light reflected from or scattered by, surrounding objects.

An almost black prawn changed in a few minutes, after being placed in a white porcelain, to a transparent and colourless condition. Further, a ready and almost infallible means of producing green prawns is to place them just after their capture in a white jar, and cover the mouth of the vessel with muslin. Under these circumstances the change—from brown to green, for example—takes place in from thirty seconds to one minute.

Speaking generally, exposure to a low light-intensity during the day favours an expansion of the red pigment, and so produces brown or even reddish effects. Hence, probably the red colour of these prawns at sunset; while an increase in the amount of light, especially if scattered from a white smooth surface, produces a green effect by expanding the blue and yellow pigment and causing the red to contract.

III. The third change differs chiefly from the second in its rate of progress. It is the very slow sympathetic colour-change which ensues when adult prawns, taken from a food-plant of one colour, are placed with the weed of a new colour. Thus, if green *Hippolyte* be placed with brown weed, and the light-intensity maintained unaltered, as far as possible in comparison with the light-conditions of its former habitat, the prawns will retain their green colour even for a week or more, but in the end give way and become brown. Their subsequent recovery when placed with green weed is more rapid. Keeble and Gamble have repeated such experiments time after time in the open, and under as natural conditions as possible, and found that the prawns were either quite refractory or responded in this slow manner. Yet these same specimens, as each evening drew on, underwent the colour-changes culminating in the nocturnal hue with the greatest readiness, and recovered as quickly the next morning to the tint of the previous day.

The great difficulty in ascertaining whether *Hippolyte* responds to change in the colour of its surroundings by a sympathetic change of its own bodily tints is now clear. It lies in their marvellous sensitiveness to changes of light-intensity, as apart from colour, and is increased by the dominant and periodic colour-changes which subvene night and morning. If it were possible to eliminate these two factors, then we might be able to detect the response of *Hippolyte* to colour or change of colour *per se*; in fact, Keeble and Gamble have made an attempt. By the use of colour-screens, based on the instruments used by Landolt and other workers, the prawns are subjected to red, green and blue light, and also a width of a spectrum from the red to the green. The results of these experiments are curious. They show that even when the light transmitted by the screen, and falling on the prawns, is high (the incandescent lamp and a mirror being used to effect this), yet that with red, green and blue light the colour of the animal becomes more or less rapidly of the nocturnal tint, and the tissues acquire the characteristic transparency. Further, that if these screens be employed all night the prawns do not recover so soon the next morning as do those which are simultaneously exposed to the same source of light in open white dishes. Without attempting to fully explain this effect of monochromatic light, Keeble and Gamble conclude that the prawns do not respond to light of any colour in virtue of its specific wave-length, and that in so far a colour-sense cannot be demonstrated.

Other experiments, however, show that under natural conditions *Hippolyte varians* has the power of choosing from a mixed quantity of weed that one on which it naturally occurs, and with which it agrees in colour. This power of choice is, however, very erratically exhibited. Nevertheless, it would appear to be the chief means of safety should the prawn be violently washed away from its usual habitat.

The colour-changes in *Hippolyte* are largely, if not entirely, controlled by the nervous system. That the eyes are not essential to the daily rhythmic colour-cycle is shown by the fact that blinded prawns nocturne and recover as completely as normal ones, but more slowly and somewhat more erratically. The periodicity does not reside in the eyes and optic ganglia. It is a function of the rest of the nervous system. That the eye is a most important auxiliary in modifying the control of the central system cannot be doubted; but it cannot be supposed that the light, acting through the eye, differentiates such stimuli as to cause each colour-variety to show, as in a mirror, the pattern of its weed. There must be local control, and this, under the strong central organisation, seems to be the efficient force.

The paper closes by a note on the response of the chromatophores of the *zoea*-larva of *Hippolyte*. These colour-elements develop before the time of hatching, and occur, chiefly in pairs, symmetrically throughout the body. Changes of light-intensity, such as alternately placing the larvæ on a black and then a white ground, are rapidly followed by changes in the pigments. In the former case, the yellow-green pigment expands; in the latter, it contracts and the red pigment spreads out. So far as the observations went, these larvæ did not exhibit a blue nocturnal colour phase, and further investigation, upon which the authors are engaged, will have to decide at what period in the life-history periodicity sets in; whether there is a particular phase in development during which the young prawn is specially sensitive to the colour of its surroundings; and if at that time its diurnal colour becomes relatively fixed, as the animal grows into these surroundings.

NATURE STUDY IN RURAL SCHOOLS.

EVERYONE who is familiar with the work of our Education Department knows that the Inspectors are given explicit instructions to discountenance the unintelligent teaching of science, and to do everything in their power to encourage the observation and study of natural objects and phenomena. The "object lessons," which are given in the lower standards, are intended to lead the pupils to use their eyes and compare one thing with another; and though they have become in some schools of too detailed a character to develop the faculties of observation and reasoning, the fault is chiefly due to the fact that many teachers are not observers of nature themselves, and are therefore unable to describe natural things except in the language of the text-book. Every effort has, however, been made by the Education Department to show teachers that this is not the kind of teaching intended to be given as object lessons. Several circulars have been issued containing instructions as to what should be done, and the new Board of Education has shown sympathy with the work of arousing interest in nature by issuing a circular, from which the following extracts have been taken, to managers and teachers of rural elementary schools. The issue of this document by Sir G. W. Kekewich at the very commencement of the work of the Board of which he is the secretary, may, we trust, be taken as an indication that increased attention is to be given to the teaching of scientific subjects in elementary schools:—

The Board would deprecate the idea of giving in rural elementary schools any professional training in practical agriculture, but they think that teachers should lose no opportunity of giving their scholars an intelligent knowledge of the surroundings of ordinary rural life and of showing them how to observe the processes of nature for themselves. One of the main objects of the teacher should be to develop in every boy and girl that habit of inquiry and research so natural to children; they should be encouraged to ask their own questions about the simple phenomena of nature which they see around them, and themselves to search for flowers, plants, insects, and other objects to illustrate the lessons which they have learnt with their teacher.

The Board consider it, moreover, highly desirable that the natural activities of children should be turned to useful account —that their eyes, for example, should be trained to recognise plants and insects that are useful or injurious (as the case may be) to the agriculturist, that their hands should be trained to some of the practical dexterities of rural life, and not merely to the use of pen and pencil, and that they should be taught, when circumstances permit, how to handle the simpler tools that are used in the garden or on the farm, before their school life is over.

The Board are of opinion that one valuable means of evoking interest in country life is to select for the object-lessons of the lower standards subjects that have a connection with the daily surroundings of the children, and that these lessons should lay the foundation of a somewhat more comprehensive teaching of a similar kind in the upper standards. But these object-lessons must not be, as is too often the case, mere repetitions of descriptions from text-books, nor a mechanical interchange of set questions and answers between teacher and class. To be of any real use in stimulating the intelligence, the object-lessons should be the practising ground for observation and inference, and they should be constantly illustrated by simple experiments and practical work in which the children can take part, and which they can repeat for themselves at home with their own hands. Specimens of such courses can be obtained on application to the Board of Education. These may be varied indefinitely to suit the needs of particular districts. They are meant to be typical and suggestive, and teachers, it is hoped, will frame others at their discretion. Further, these lessons are enhanced in value if they are connected with other subjects of study. The object-lesson, for example, and the drawing lesson may often be associated together, and the children should be taught to draw actual objects of graduated difficulty, and not merely to work from copies. In this way, they will gain a much more real knowledge of common implements, fruits, leaves, and insects than if these had been merely described by the teacher or read about in a lesson-book. Composition exercises may also be given—after the practical experiments and observations have been made—for the purpose of training the children to express in words both what they have seen and the inferences which they draw from what they have seen; and the children should be frequently required and helped to describe in their exercise books sights of familiar occurrence in the woods and in the fields. Problems in arithmetic connected with rural life may also be frequently set with advantage.

The Board of Education also attach considerable importance to the work being done by the elder scholars outside the school walls, whether such work takes the form of elementary mensuration, of making sketch plans of the playground and the district surrounding the school, of drawing common objects, ponds, farms, and other suitable places under the guidance of the teacher, or of the cultivation of a school garden.

The teacher should as occasion offers take the children out of doors for school walks at the various seasons of the year, and give simple lessons on the spot about animals in the fields and farmyards, about ploughing and sowing, about fruit trees and forest trees, about birds, insects and flowers, and other objects of interest. The lessons thus learnt out of doors can be afterwards carried forward in the schoolroom by reading, composition, pictures, and drawing.

In this way, and in various other ways that teachers will discover for themselves, children who are brought up in village schools will learn to understand what they see about them, and to take an intelligent interest in the various processes of nature. This sort of teaching will, it is hoped, directly tend to foster in the children a genuine love for the country and for country pursuits.

It is confidently expected that the child's intelligence will be so quickened by the kind of training that is here suggested that he will be able to master, with far greater ease than before, the ordinary subjects of the school curriculum.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

An association of American Universities has been formed for the purpose of considering matters of common interest relating to graduate study. The association includes most of the leading universities of the United States.

It has already been announced that a school of forestry is about to be established at Yale University. We now learn from *Science* that, at a meeting of the corporation on March 16, a gift of 150,000 dollars for this purpose was acknowledged. Mr. Henry S. Graves, assistant in the Division of Forestry, U.S. Department of Agriculture, has been appointed professor of forestry.

Sir George W. Kekewich, K.C.B., has been appointed Secretary of the Board of Education, which came into existence on April 1. A circular letter has been issued stating that in future all communications relating to elementary education should be addressed to the Secretary, Board of Education, Whitehall, London, S.W., and letters concerning science, art, and technical education should be addressed to the Secretary, Board of Education, South Kensington, London, S.W.

As the subjects which should form part of elementary education in rural districts have recently been much under discussion, it is of interest to call attention to a chapter on methods of instruction in agriculture, included in vol. ii. of the Report of the U.S. Commissioner of Education, for 1897–98. The chapter includes reprints of leaflets illustrating the educational work done at the Cornell Agricultural Experiment Station, and at Purdue University. The volume also includes reports of U.S. Consuls on school gardens and gardeners' schools in Russia.

The Cambridge Summer Meeting will be held on August 2–15, and August 15–27. Among the lectures to be delivered in the section on scientific progress are the following: *Physical Science.*—The development of the nebular theory in the nineteenth century, by Sir Robert Ball, F.R.S.; the spectroscope in astronomy, by Mr. Arthur Berry; the wave-theory of light, by Sir George Stokes, Bart., F.R.S.; advances in the science of electricity, by Prof. J. J. Thomson, F.R.S.; the conservation of energy, by Prof. J. A. Ewing, F.R.S.; chemistry and its applications, by Mr. M. M. Pattison Muir; electro-chemical methods, by Mr. D. J. Carnegie. *Biological Science.*—The theory of evolution and its influence on thought and research, under arrangement; researches on the brain, by Dr. Alex. Hill. There will also be lectures on some aspects of advance in the following sciences:—geology, by Prof. T. McK. Hughes, F.R.S.; anthropology, by Prof. A. Macalister, F.R.S.; agriculture, by Prof. W. Somerville; bacteriology, by Prof. Sims Woodhead. Mr. H. Yule Oldham will give a lecture on geographical exploration in the nineteenth century; Prof. W. M. Davis, of Harvard, U.S.A., will give six lectures on the study of the development of land forms. The study of special points in the following departments will be undertaken in sectional meetings:—chemistry and physics, under the direction of Mr. A. W. Clayden; evolution, under the direction of Mr. F. W. Keeble, Mr. C. Warburton, and others; anthropology, under the direction of Prof. A. C. Haddon, F.R.S. There will in addition be arranged, primarily for teachers, practical courses in chemistry and geography.

The Passmore Edwards Museum in the Romford-road, Stratford, is now approaching completion, and arrangements for the opening will shortly be made. The museum has been built and furnished by the Council of the County Borough of West Ham at a cost of about 9000*l.*, of which 4000*l.* was the gift of Mr. Passmore Edwards. The main portion of the museum will be devoted to the Essex Museum of Natural History, belonging to the Essex Field Club, which is deposited in the building under agreement between the club and the Borough Council. The remainder of the building will be used as an educational museum in connection with the adjoining Municipal Technical Institute. The scientific control of the Essex Field Club collections remains with the club, and they contribute 50*l.* a year towards the curatorial expenses, the council contributing 100*l.* a year. The club appoints the curator. At their meeting on March 27, the council resolved to set aside annually out of the Estate Duty Grant the sum of 1000*l.* for museum purposes. It is expected that from 500. to 600*l.* of this will be needed for the up-keep and maintenance charges, the balance being placed to the credit of a museum purchase fund, which will be treated as a capital fund, from which payments may be made from time to time for the purchase of objects and of the necessary cases, &c., in which to exhibit them. The Essex Field Club have appointed Mr. W. Cole as curator of their Natural History collections. The building itself and the educational collections of the council are under the charge of the principal of the Technical Institute, Mr. A. E. Briscoe.

SCIENTIFIC SERIALS.

Bulletin of the American Mathematical Society, February.—The opening articles respectively give abstracts of the proceedings and papers read at the sixth annual meeting, at New York, December 28, 1899, by Prof. F. N. Cole, and at the sixth semi-annual meeting, at Chicago, December 28 and 29, 1899, by Prof. T. F. Holgate.—On cyclical quartic surfaces in space of n dimensions, by Dr. V. Snyder, was read at the first of the above meetings. The method employed is a generalisation of that first employed by Darboux, using Lie's more general co-ordinates. For $n = 2$ (bicircular quartic curves) reference is made to memoirs by Casey, Darboux, Cox, Loria and others, where the curves have been discussed from a different point of view, and for $n = 3$ (cyclides) reference is again made to Casey, and to Maxwell, Cayley, Darboux, Reye, Loria, Bôcher and others. In the case of $n = 4$, the number of distinct types is 58, and of $n =$ higher numbers, the number of types has not been determined.—At the same meeting, Prof. H. Taber read a paper on the singular transformations of groups generated by infinitesimal transformations, and Prof. Dickson gave a proof of the existence of the Galois field of order p^r for every integer r and prime number p. Existence proofs have been given by Serret (*Alg. Sup.* vol. 2) and by Jordan (*Traité des Substit.* pp. 16, 17). The developments used by Serret are lengthy, and the short proof by Jordan assumes with Galois the existence of imaginary roots of an irreducible congruence modulo p. The present proof proceeds by induction. Assuming the existence of the GF$[p^n]$, it derives that of the GF$[p^{nq}]$, q being an arbitrary prime number. Since the GF$[p]$ exists, being the field of integers taken modulo p, it follows that the GF$[p^q]$ exists, and by a simple induction that the GF$[p^r]$ exists for r arbitrary.—Dr. Lovett contributes a lengthy review of the "Leçons nouvelles sur l'analyse infinitésimale et ses applications géométriques" of Ch. Méray (1st part, 1894; 2nd part, 1895; 3rd part, 1897; and 4th part, 1898).—Varied information of interest to mathematicians occupies the "Notes" and "New Publications."

Annalen der Physik, No. 2.—Solubility of carbonic acid in alcohol between $-67°$ and $+45°$, by C. Bohr. The absorption of carbonic acid in alcohol increases rapidly at low temperatures. The coefficient is 1·97 at 47°, 4·46 at zero, and 39·4 at $-65°$. The coefficient of evasion at zero is 0·524, and the coefficient of invasion 2·375.—Specific heats of metals, alloys and graphite at low temperatures, by U. Behn. This paper deals with the specific heats of antimony, tin, cadmium, silver, zinc and magnesium, brass, graphite and three tin-lead alloys. Of these, only graphite and magnesium show a very considerable fall of specific heat down towards the temperature of liquid air. Many of the curves are probably parabolic, and concave towards the axis of temperatures.—Heat of sublimation of carbonic acid, and heat of evaporation of air, by U. Behn. The former is 142·4 calories, and the latter 50·8 calories.—A vacuum electroscope, by H. Pflaum. By exhausting a gold-leaf electroscope to such a degree that no vacuum discharge was able to traverse it, the author proved that an extreme vacuum is a perfect insulator, and that electrostatic forces act across it with great intensity.—The experimental basis of Exner's theory of atmospheric electricity, by G. Schwalbe. The author has made further experiments to show that a vapour arising from an electrified liquid is incapable of conveying away any of the charge. He explains the contrary results obtained by Pellat, on the ground of loose particles adhering to the vessels used. Solid particles are capable of conveying away the charge. Exner's theory of atmospheric electricity, as derived from the evaporation of natural bodies of water, is not confirmed.—Discharge of statical electricity from points, by H. Sieveking.—Negative electricity begins to be discharged from a point at a lower potential than positive electricity, and the quantity discharged is also greater. Positive electricity is chiefly discharged along the axis of the point. Gases may be arranged in accordance with their capacity of encouraging the radiation of negative electricity. Oxygen is at the top of the series, and carbonic acid at the bottom.—Reflective power of metals and glazed mirrors, by E. Hagen and H. Rubens. The authors study the reflecting powers of silver, platinum, nickel, steel, gold and copper for the various parts of the visible spectrum. They also test various speculum metals. That of Brandes and Schünemann has a reflecting power of only 50 per cent., but is eminently durable. It consists of 41 parts copper, 26 nickel, 24 tin, 8 iron and 1 antimony. Mach's aluminium-magnesium alloys have the highest reflective power.—Electrostatic effects in connection with vacuum discharges, by J. Stark. When a continuous current is sent through a vacuum tube, and matters are so regulated that the discharge is only just able to pass, the current becomes a periodic one. The kathode is set into a state of vibration, and gives a musical note. The vibrations are due to the periodical attractions of the charges on the wall of the tube.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 7.—"*Polytremacis* and the Ancestry of Helioporidæ." By Prof. J. W. Gregory, D.Sc. Communicated by Prof. Ray Lankester, F.R.S.

The Blue Coral, *Heliopora caerulea* (Pall.) is one of the most isolated of living animals. It is the only known species of its genus, and it has recently been described as the only member of its family. Some Palæozoic corals have a very similar structure; but the view that these extinct Heliolitids are allied to the Helioporids is strongly opposed by some eminent palæontologists. If these authorities be right, then *Heliopora* is an animal with no close living relations and with no known ancestors. The only fossil that has been regarded with any probability as a possible link between *Heliopora* and the extinct Heliolitidæ is the Cretaceous coral *Polytremacis*. This genus was founded by d'Orbigny in 1849, but unfortunately its affinities and structures are still in doubt.

In preparing a description of a new species of *Heliopora* from Somaliland, the author was led to examine the material in the British Museum collection. The results seem to confirm the old view of the affinity between the Heliolitidæ and the Helioporidæ, by showing that *Polytremacis* is truly intermediate between the two families. In that case *Polytremacis* is of considerable phylogenetic interest as an ancestor of *Heliopora*.

Linnean Society, March 15.—Mr. G. M. Murray, F.R.S., in the chair.—Prof. Farmer exhibited (as lantern-slides) several photographs of dissections of flowers, and made remarks on the utility of such illustrations for teaching purposes.—Mr. R. A. Rolfe exhibited specimens and drawings of *Paphiopedilum*, both of species and hybrids, with their capsules, to illustrate remarks on the hybridisation of orchids.—Mr. I. H. Burkill gave an abstract of a report on the botanical results of an expedition to Mount Roraima, in British Guiana, undertaken in 1898 by Messrs. F. V. McConnell and J. J. Quelch. Acknowledged authorities on plant-geography had considered it probable that the vegetation of the summit of Mount Roraima, when better known, would compare well with that on the Paramos of Venezuela; but this was not the case. The characteristics of the treeless Paramos were absent from Roraima; and *Bonnetia Roraimae*—the commonest of species on the summit—attained, where sheltered, a height of forty feet. Lower than the Paramos on the slopes of the Andes was the *Befaria* zone, and to this the upper flora of the mountain was to be ascribed, the rest of the vegetation being of a Brazilian type. Many of the plants collected were of anatomical interest; the huge mucilage-cells of the leaf of *Bonnetia Roraimae* and the quaint pitchers of some of the *Utriculariae* were especially noteworthy. The complex chain of mountains to which Roraima belongs includes other peaks of similar height, such as Duida over the Upper Orinoco; but in this direction the chain terminates with the low-lying forests of the Casiquiare, which has barred immigration from the higher Andes. The additions to botanical knowledge now made by Messrs. McConnell and Quelch might be said to emphasise the remarkable similarity which had been found to exist in the floras of Roraima and the Kaieteur Savannah.

Zoological Society, March 20.—Dr. W. Blanford, F.R.S., Vice-President, in the chair.—Prof. F. Jeffrey Bell exhibited a collection of Land-Planarians made by Dr. Goeldi in Brazil. This, like many other collections of Land-Planarians, had been confided to Prof. Graff for description, and some of the specimens were the types of new species described by that author in his magnificent monograph on these animals. The collection before the Society had been sent to Mr. Sclater with the request that he would deposit it in the British Museum, where it would be a valuable and welcome addition to the already good collection in that institution.—Mr. G. A. Boulenger, F.R.S., exhibited a specimen of *Polypterus lapradii*, Steindachner, with large external gills, recently brought home from the Senegal by M. P. Delhez. The fish measured 390 millimetres, and was therefore the largest on record in which this larval character had been retained. In connection with this interesting example, Mr. Boulenger also exhibited a full-grown female of the Common Newt (*Molge vulgaris*), from the environs of Vienna, bearing well-developed external gills.—Mr. S. L. Hinde read a series of field-notes on the mammals which he had met with during five years' residence in East Africa, and illustrated with lantern-slides from photographs of the animals taken in their native surroundings. Some of the points specially dwelt upon were the preservation of game-animals in East Africa, and the possibility of the acclimatisation of East African animals in the British Isles.—Mr. W. Bateson, F.R.S., exhibited a specimen of an Isopodous crustacean, *Asellus aquaticus*, in which one of the antennules was replaced by a well-formed mandible. The case was to be regarded as an instance of Homœosis, or the transformation of one organ into the likeness of another with which it is in serial homology.—A communication was read from Mr F. P. Bedford on the Echinoderms collected by himself and Mr. W. F. Lanchester in Singapore and Malacca.—Mr. F. E. Blaauw gave an account of the Zoological Garden of Berlin and of the progress which it had made under the management of the last three Directors—Dr. Bodinus, Dr. Max Schmidt and Dr. L. Heck.

Royal Meteorological Society, March 21.—Dr. C. Theodore Williams, President, in the chair.—Reference was made to the loss which the Society had sustained by the death of Mr. G. J. Symons, F.R.S., and a note of condolence with his relatives was passed by the meeting.—Twenty-seven new fellows were elected, as well as two honorary members, viz. M. Albert Lancaster, Director of the Belgian Meteorological Service, Brussels, and General M. A. Rykatcheff, Director of the Central Physical Observatory, St. Petersburg.—The following papers were read:—The ether sunshine recorder, by Mr. W. H. Dines.—Remarks on the weather conditions of the steamship track between Fiji and Hawaii, by Captain W. W. C. Hepworth.—Comparison by means of dots, by Mr. A. B. MacDowall.

PARIS.

Academy of Sciences, March 26.—M. Maurice Lévy in the chair.—Deviation of the radiations of radium in an electric field, by M. Henri Becquerel. Previous experiments on the behaviour of that portion of the radium rays deviable in the magnetic field showed that this part of the radiation had the greatest analogy with the kathode rays. To demonstrate the complete identity of these two kinds of rays, it was necessary to establish the existence for the rays from radium either of a transport of a negative charge or a deviation in an electric field. M. and Mme. Curie have recently proved the existence of the former property, and in the present paper experimental proof is given of the latter.—On apparatus in fused quartz, by M. Armand Gautier. Remarking on the paper of M. Dufour in the last issue of the *Comptes rendus*, M. Gautier recalls that he used tubes and spirals of quartz in 1869. In conjunction with M. Moissan, the author attempted, unsuccessfully, to prepare quartz connecting tubes for the fluorine apparatus.—On the transformation of fat into glycogen in the organism, by MM. Ch. Bouchard and A. Desgrez. In previous papers, it has been shown that a person receiving no food may gain as much as 40 grams in an hour, a gain for which it is only possible to account by assuming an absorption of oxygen above that required for the formation of respiratory carbon dioxide. The hypothesis was put forward that this increase of weight is due to an incomplete oxidation of fat, probably to glycogen. The experiments now given show that it is the muscular, and not the hepatic glycogen which arises from the incomplete oxidation of fats.—M. Hittorf was elected a correspondant for the section of physics in the place of the late M. Wiedemann.—Remarks on an earthquake at Batavia on September 30, 1899, by the French Consul at Batavia.—On surfaces for which the lines of curvature of a system are equal, by M. A. Demoulin.—Remark on a note of M. A. Korn. entitled "On the method of Neumann and the problem of Dirichlet," by M. W. Stekloff.—On the liquefaction of mixtures of carbon dioxide and sulphur dioxide, by M. F. Caubet. Eight gas mixtures of varying composition were studied. The results are exhibited in the form of curves.—Limited chemical reactions in homogeneous systems. The law of moduli, by M. A. Ponsot.—On the selenide of zinc and its dimorphism, by M. Fronzes-Diacon. Since blende occurs both in hexagonal and cubical forms, and the selenide of zinc obtained by M. Margottet belonged to the cubic system, the author attempted to prepare an hexagonal form. The crystals obtained by the interaction of zinc chloride vapours and hydrogen selenide diluted with nitrogen belonged to the hexagonal system.—On the hydrated peroxides of barium, by M. de Forcrand. A thermochemical paper.—A new compound of antipyrin with mercuric chloride, by MM. J. Ville and Ch. Astre. The compounds obtained are of the type $2(C_{11}H_{12}N_2O).HgR_2.HR$, where R represents the halogen.—On the constitution of isolauronic acid, by M. G. Blanc.—On the combination of basic with acid colouring matters, by M. A. Seyewetz.—On the law of separation of hybrids, by M. Hugo de Vries. The experimental results given are wholly covered by the following law: if D be the grains of pollen or ovules having a dominant character, and R those which have a retrograde character, the number and nature of the hybrids is represented by the formula

$$(D+R)(D+R)=D^2+2DR+R^2,$$

in which D and R are equal; that is to say, there will be 25 per cent. of D, 50 per cent of DR, and 25 per cent. of R.—Concerning the contradictory results of M. Raphaël Dubois and M. Vines on the supposed digestion in Nepenthes, by M. E. Couvreur. The assumption of a proteolytic ferment in such carnivorous plants as the Nepenthes is unnecessary, and the author upholds the correctness of the views of Dubois as against those of Vines.—On the foldings of the Paris basin, by M. Munier-Chalmas.—Characteristics of a specimen of petroleum shale from the Megalong Valley, by M. Eg. Bertrand. A comparison of the microscopical appearances of the Blackheath and Megalong Valley shales.—Comparative estimation of alcohol in the blood of mother and fœtus and in the milk after the ingestion of alcohol. Remarks on the estimation of alcohol in blood and in milk, by M. Maurice Nicloux. The ingested alcohol passes from the mother to the fœtus and is also present in the milk. The proportions of alcohol in the blood of mother and fœtus are practically identical.—The absorption of iodides by the human skin, by M. F. Gallard. The arms and hands were immersed in the solution, and the iodine estimated in the urine.—On the comparison of the barometric movements (at latitude 50° of Greenwich meridian) caused by the movements in declination of the sun and moon, by M. A. Poincaré.

DIARY OF SOCIETIES.

THURSDAY, April 5.

Royal Society, at 4.30.—On the Weight of Hydrogen desiccated by Liquid Air: Lord Rayleigh, F.R.S.—Combinatorical Analysis: The Foundations of a New Theory: Major MacMahon, F.R.S.—Über Reihen auf der Convergenzgrenze: Dr. E. Lasker.—Extinct Mammalia from Madagascar. I. *Megaladapis insignis*, sp. n.: Dr. C. I. Forsyth Major.—The Kinetic Theory of Planetary Atmospheres, Part I.: Prof. Bryan, F.R.S.—Observations on the Effect of Desiccation of Albumin upon its Coagulability: Prof. J. B. Farmer.

Royal Institution, at 3.—Equatorial East Africa and Mount Kenya: H. J. Mackinder.

Mathematical Society, at 5.30.—The Orthoptic Loci of Curves of a Given Class: A. B. Basset, F.R.S.—On Weierstrass's Canonical Reduction of a "Scharr" of Bilinear Forms: T. J. Bromwich.—Communications by Prof. Burnside, F.R.S., and Prof. Love, F.R.S.

Linnean Society, at 8.—*Sphenophyllum* and its Allies, an Extinct Division of the Vascular Cryptogams: Dr. D. H. Scott, F.R.S.

Chemical Society, at 8.—(1) The Liquefaction of a Gas by "Self-Cooling": A Lecture Experiment; (2) Note on Partially Miscible Aqueous Inorganic Solutions: G. S. Newth.—The Decomposition of Chlorates. II. Lead Chlorate: W. H. Sodeau.—The Interaction of Mesityl Oxide and Ethyl Sodiomethylmalonate: A. W. Crossley.—The Bromination of Benzeneazophenol: J. T. Hewitt and W. G. Aston.

Institution of Electrical Engineers, at 8.

Röntgen Society, at 8.—The Influence of the X Rays upon the Growth and Development of Micro organisms: Dr. Norris Wolfenden and Dr. Forbes Ross.

Institution of Naval Architects (Society of Arts), at 12.—On Large Cargo Steamers: Prof. J. H. Biles.—The Practical Results of some Innovations in Modern Shipbuilding: A. B. Wortley.—The Strength of Elliptical Sections under Fluid Pressure: Captain G. W. Hovgaard.—On Yacht Measurements, together with some Remarks on the Action of Sails: H. C. Vogt.——At 7.—On the Balancing of Steam-Engines: Herr Otto Schlick.—The Engines of the Corvette *Jeneral Baquedané*: M. Sandison.—On the Uniformity of Turning Moments of Marine Engines: Prof. Lorenz.

FRIDAY, April 6.

Royal Institution, at 9.—Solid Hydrogen: Prof. J. Dewar, F.R.S.

Geologists' Association, at 8.—Zonal Features of the Kentish Chalk-Pits between London and the Medway Valley: G. E. Dibley.

Institution of Civil Engineers, at 8.—Experiments on Struts with and without Lateral Loading: H. E. Wimperis.

Malacological Society, at 8.—On the Genus *Acavus*: (*a*) from an Anatomical Standpoint: W. B. Randles; (*b*) from a Conchological Standpoint: E. R. Sykes.—Description of a New *Bulimulus* from Parana, Brazil: J. Cosmo Melvill.—Anatomical Notes on *Neptuneopsis gilchristi*, Sowerby, and *Volutilithes abyssicola*, Adams and Reeve: M. F. Woodward.

Institution of Naval Architects, at 12.—The Pressure on an Inclined Plane, with Special Reference to Balanced Rudders: Prof. H. S. Hele-Shaw, F.R.S.—On the Action of Bilge Keels: Prof. G. H. Bryan, F.R.S.—On the Influence of Depth of Water on the Resistance of Ships: Major Giuseppe Rota.——At 7.—On Mysterious Fractures of Steel Shafts: Signor Roberto Schanzer.—Corrosion and Failure of Propeller Shafts: A. Scott Younger.

SATURDAY, April 7.

Royal Institution, at 3.—Polarised Light: Lord Rayleigh.

MONDAY, April 9.

Victoria Institute, at 4.30.—Egyptian Chronology: Rev. Dr. F. A. Walker.

TUESDAY, April 10.

Institution of Civil Engineers, at 8.—The Development of the Manufacture and Use of Rails in Great Britain: Sir Lowthian Bell, Bart., F.R.S.—The Wear of Steel Rails in Tunnels: Thomas Andrews, F.R.S.

Royal Photographic Society, at 8.—The Municipal Encouragement of Photography: Thomas Bedding.

WEDNESDAY, April 11

Royal Astronomical Society, at 8.

CONTENTS.

THURSDAY, APRIL 12, 1900.

RECENT BOOKS ON PHYSICS.

A Text-Book of Physics. By W. Watson, A.R.C.S., B.Sc. (London). Pp. xxii + 896. (London: Longmans, Green and Co., 1899.)

Heat for Advanced Students. By Edwin Edser, A.R.C.S., &c. Pp. viii + 470. (London: Macmillan and Co., Ltd., 1899.)

Text-Book of Experimental Physics. By Eugene Lommel. Translated from the German by G. W. Myers, of Urbana, Illinois. Pp. xxi + 664. (London: Kegan Paul, Trench, Trübner and Co., Ltd., 1899.)

IT is a pleasure to welcome a general text-book of physics by one of the younger generation of physicists, who has had wide experience in the modern methods of teaching and investigation. Since the general recognition of physics as an experimental science, these methods have changed so much that, although one could not but admire the skill and perseverance shown in re-editing the older text-books and writing them up to date, it was obvious that a great improvement could be effected by making a fresh departure.

In the arrangement of his book, Mr. Watson has adhered in the main to the order of exposition sanctioned by long experience, and has avoided the error, into which some recent writers have fallen, of attempting to revolutionise the basis of physical teaching. The author's guiding principle has been convenience of sequence from the point of view of simplicity and clearness of explanation, and he has thus succeeded in producing a work which the average student may be expected to follow with little or no previous acquaintance with the subject. This is a thoroughly practical basis, and will commend itself to students and teachers alike. As illustrations of this method, we may notice the introduction of a very useful chapter on wave-motion and water waves, with explanations of interference and other phenomena, before the discussion of Sound and Light. In a similar manner, the composition of simple harmonic motions is taken at an early stage as an illustration of periodic motion, instead of being reserved for the section on Sound. A great deal is gained in clearness, and saved in space, by taking difficulties of this kind in detail in their proper place.

Another feature of the book which will commend itself to a large class of students who are compelled to study physics without the aid of the higher mathematics is the elimination of purely mathematical difficulties. Some limitation of this kind is clearly essential in a general text-book, and the author appears to have exercised a nice discrimination in the selection of difficulties to be omitted. By curtailing the mathematics, he has also been enabled to devote more space to the explanation and illustration of purely physical questions, and to include many results of recent research which do not involve mathematical treatment. As an illustration of these points, we may quote the chapters on "Change of State," and on the "Ionisation Theory of Electrolysis," which subjects are treated from a modern standpoint.

In selecting the illustrations for the work, it has been assumed that the student will have access to a laboratory, and will supplement his reading with a practical course of experimental work. For this reason, no attempt has been made to supply elaborate figures of apparatus, or descriptions of details of construction and adjustment which the student can acquire much more effectually by laboratory practice. The illustrations are for the most part of a purely diagrammatic character, and are intended solely to elucidate the text, and not to take the place of the actual apparatus. There is no doubt that the general appearance of the book might be rendered more attractive, and its interest to the general reader, as distinguished from the practical student, would be increased by the insertion of a number of carefully printed and executed woodcuts of instruments and apparatus; but such illustrations belong properly to descriptive and technical treatises, and would be out of place in a text-book. Diagrammatic illustrations are really of much greater educational value when carefully designed, as they can be made to emphasise the essential points of the method or experiment, and are more easily remembered and reproduced than more elaborate pictures. The habitual use of such illustrations also tends to develop the diagrammatic faculty of thinking and working in diagrams, which is so extremely valuable to the experimentalist in designing apparatus or working out a method of research.

We are inclined to think that the utility of the book to the average student would be increased by the adoption of a more distinctive setting for the statement of laws and definitions, and that it would in many cases be desirable to emphasise more categorically the particular points in each law which are capable of definite experimental verification. The majority of students are too ready to accept a formula, and to regard as time wasted any attempt to prove it. They often acquire a fatal facility in dealing with symbols, which may perhaps suffice for examination purposes, but which does not correspond to a real understanding of the subject, and is of little educational value, and readily forgotten. Another addition, which would be of real value to the teacher as well as to the student, would be a carefully selected list of numerical examples, arranged to illustrate the various sections. It would be difficult to make a suitable collection, as nearly all extant text-books are lamentably deficient in this respect; but we are convinced that it would be of great use, and we may hope to see something of the kind in future editions.

In matters of detail a few errata may be noted by the careful reader, but this is natural, if not excusable in the first edition of a new book, and the majority have doubtless been already corrected. A purist might here and there find fault with the turn of an expression, or a specialist in some particular department might criticise some statement or explanation as being incomplete or misleading; but the book as a whole is remarkable for clearness and correctness of exposition, and must be regarded as a valuable and original contribution to our text-books of physics.

The object of Mr. Edser's book is to give a comprehensive account of the science of Heat, both in its theoretical and experimental aspects, so far as this can be done without the use of the calculus. The descriptions of the experiments to be performed by the students are intended to be sufficient to enable them to secure accurate results. It is remarkable that this combination of the theoretical and the practical is not more often attempted. A book on any branch of experimental physics necessarily contains so much description of experimental work, that the additional instructions necessary to enable the student to carry out the experiments for himself would not add greatly to the length of the book. In a similar manner, a book intended simply for practical work in the laboratory generally and necessarily contains so much theory that it would not be a difficult matter to include all that the student would be likely to require in this respect.

The limitations which the author has imposed upon himself with regard to the use of the calculus apply chiefly to the section on thermodynamics. The method of expansion by the binomial theorem is used instead. The proofs are worked out from first principles, and are therefore generally longer than they would have been if the methods of the calculus had been assumed. But as a compensation they are much more instructive. The method of proof compels a close attention to each detail of the work, which is likely to result in a much clearer grasp of the physical meaning of the equations than the mechanical performance of mathematical rules for differentiation or integration. The student who has failed to follow the purely geometrical treatment of the same subjects in Maxwell's "Theory of Heat," will probably find these sections extremely helpful. They may be also strongly recommended to the mathematical student who does not desire to regard physics merely as a mathematical exercise.

In the selection of the experiments to be performed by the student, the author appears to have erred on the side of making them too simple, and of not exacting a sufficiently high standard of accuracy of the advanced student. He very rightly lays great stress on the importance of accurate thermometry, on which nearly all experiments depend. He might with advantage have given some details of the "variable zero method" of employing mercury thermometers, so ably expounded by Guillaume, which is now so generally used for accurate work. The method is laborious, but possesses undoubted advantages, and ought to be described in an advanced text-book, especially as it does not present any great theoretical difficulties. In determining the expansion of glass by means of the mercury weight thermometer (p. 68), the advanced student should be instructed to use the accurate equation $g=(m-m_g)(W-w)/W$, instead of the approximate equation $g=m-m_g$, which is given in nearly all the text-books. He should not be permitted to make an error of 1·6 per cent. in his calculation, when he may easily obtain observations correct to a tenth of 1 per cent. Similarly, in a text-book for advanced students, it would be more instructive if the author, in introducing a description of some of the old time-honoured experiments, had ventured to be a little more critical of their weak points, and to explain why they failed, or in what respect the deductions made from them were uncertain, or how they could be improved. It seems a pity at the present day, for instance, to repeat Tyndall's fairy tales about the absorption of heat by vapours without adding a large proportion of salt.

A special section is devoted to electrical thermometry, including an explanation of the principles of the methods employed, which is simple and at the same time fairly complete so far as it goes. We may note, however, in passing, that a platinum thermometer cannot in general be calibrated by reference to the absolute zero, as the resistance of the pure metal "tends to vanish" at a much higher temperature (*Phil. Mag.* Feb. 1899). Also that if a reasonably sensitive galvanometer is used, the heating effect of the current ought not to exceed a hundredth of a degree. The section contains an account of the thermocouple, thermopile, radio-micrometer and bolometer, which should be useful as well as interesting. In other subjects also, such as the liquefaction of gases, the book appears to be well up to date within the limits which the author has set himself. The whole arrangement is extremely clear and practical, and well adapted to meet the needs of students, who will find the most important points distinctly emphasised. There is a useful summary at the end of each chapter, and an excellent collection of examination questions. Considering its small size, the book contains a remarkable amount of information.

In the preface of Prof. Lommel's "Text-Book" the following explanations occur:—"The present text-book has grown out of the author's lectures, and is intended to develop the subject on an experimental basis in such a manner as to make the book easily accessible to beginners. But in order to meet the needs of higher schools and colleges, paragraphs in 'fine print' are interspersed, which contain the most important mathematical developments in terse and simple form. The author, as a general rule, has employed pure German words rather than technical expressions from foreign tongues, *e.g.* *wucht* instead of energy of motion or kinetic energy, and *spannung* instead of potential and difference of potential. The translator has not preserved the author's distinction between 'potential' and 'tension' (*spannung*), but has otherwise attempted only a faithful and worthy reproduction of the original."

These aims and endeavours on the part of the author and translator appear as a possible explanation of the introduction of several rather unfamiliar terms to English readers, such as "living force" for kinetic energy, "laws of shock" for impact, "stretch" for extension, "melting heat" for heat of fusion, "overmelted" for superfused, and similar phrases. The word "tension" certainly seems to be rather overworked, as it is used for the pressure of gases and vapours, as well as for electric potential, and even in one place for energy of position. On the other hand, we observe the apparently needless introduction of such words as "gyrotrope," "pachytrope," "rheotome," "rheometer" for the more familiar commutators, switches and galvanometers. The frequent use of oxygen for hydrogen, calcium for potassium, and coal for carbon are possibly simple *errata*.

The author has endeavoured to follow the historical order as being the most natural and interesting in the development of each part of the subject. The names and dates introduced in following this plan are often instructive and show a greater familiarity with English work than is common in Continental text-books. We may instance the dates, Boyle 1662, Mariotte 1679. The author nevertheless continues, in accordance with foreign usage, to quote the law Boyle discovered as "Mariotte's." He also gives a figure illustrating Cavendish's method of demonstrating the law of the inverse square in electrostatics, but the name of Cavendish is not mentioned, and the figure is labelled "Coulomb's Law."

It is probable that the historical motive is to be held responsible for the retention of many old experiments and figures of archaic apparatus. This is in many cases most desirable and instructive, provided always that the later developments are explained and illustrated so as to point the contrast. The experiments of Wheatstone (1834) on the "velocity of electricity" are of the highest interest and educational value, but it is not fair to leave the student with the conclusion, "Both electricities pass, then, simultaneously from the coatings of the jar, and meet midway between them. The velocity of propagation in a copper wire was found to be 430,000 km. By a different method Siemens (1876) found for the velocity in an iron wire 240,000 km." Again, it is certainly instructive to give a figure of the early type of German mirror galvanometer with a massive four-inch bar magnet inside a rectangular coil, but it is a mistake to ignore the essential improvements introduced by Thomson (Lord Kelvin), and to leave the student with the impression that the instrument figured is the type of a modern sensitive galvanometer. Similarly, in the section on the liquefaction of gases, we have an illustration of Pictet's historical apparatus (1877), and we are informed that "Hydrogen was liquefied at a pressure of 650 atmospheres and a temperature of $-140°$. On opening the tap an opaque stream of liquid of steel-blue colour escaped, at the same time the solidified hydrogen upon the floor produced a rattling sound as of falling shot." It is stated on the previous page that the critical temperature of hydrogen is $-174°$. No later experiments are mentioned. Such omissions as these can hardly be justified even in the most elementary work, and cannot fail to produce the impression that the book is not sufficiently up to date to satisfy the requirements of modern scientific education.

In endeavouring to explain a new term, it is often considered necessary in elementary text-books to put the idea into somewhat vague and general language, rather than in the form of a precise definition, because the more exact statement may fail to convey the idea intended. We are inclined to doubt the wisdom of this course, which appears to be carried too far by the author. The following are a few samples of the kind of statement to which we refer.

P. 24. "*Work.*—When a force acting on a mass sets it in motion, the force is said to do work, and the result of its action is called work." "In transforming forces into work, the question is not alone whether work is done, but also in what time it is accomplished. The work done in one second is called the 'effect' of the force."

P. 289. "*Equilibrium in Conductors.*—When a conductor has attained a condition of electrical equilibrium, the electrical forces, and accordingly also the electrical potential, are everywhere 0. This merely says that in a position of equilibrium, every point in and upon a conductor has the same potential."

P. 372. "*Wheatstone's Bridge.*—If the branches *amb* and *anb* of the current are connected by a cross wire *mn*, called a 'bridge,' two currents flow in opposite directions in the bridge. If these currents have equal strength they neutralise each other and no current passes through the bridge. . ."

P. 377.—"Edison's (1879) incandescent lamp depends upon the heating action of the current. A charged filament of hemp, or cotton, of high resistance (*e.g.* 140 ohms) and bent into the form of a horseshoe, is enclosed in an exhausted glass globe to protect the filament from burning, while a current of about 100 volts passing through it heats the filament to incandescence, giving it an intensity of approximately fifteen candles." (Nothing more is said on the subject of incandescent lamps.)

The paragraphs "in fine print" contain the majority of the formulæ, and are intended to meet the needs of higher schools and colleges. They appear, however, to be of too disconnected and occasional a character for the purpose. A good deal of small print, *e.g.* three pages on thunder and lightning, is of very elementary and purely descriptive character. On the other hand, some rather difficult points are discussed in the "coarse print," *e.g.* the "Second proposition of the Mechanical Theory of Heat. Entropy. Kinetic theory of gases." In discussing the Second Law of Thermodynamics and the Dissipation of Energy, no allusion is made to reversible cycles, and the information imparted is necessarily so incomplete that no application could be made of it. Mayer's calculation of the mechanical equivalent is given, but Joule's experimental verification of the assumption upon which it rests is entirely ignored. It may be questioned whether there is any profit in introducing such points if they cannot be adequately discussed. It is not very easy to follow the principle upon which the selection or omission of subjects for discussion is based. The book as a whole does not appear to be sufficiently definite and practical to be suited for class or examination work according to English standards. It is possible that it may be more suited to the methods in vogue in Germany or America.

Hugh L. Callendar.

TWO NEW ZOOLOGICAL HANDBOOKS.

A Manual of Zoology. By the late Prof. T. J. Parker and Prof. W. A. Haswell. Pp. xv + 550. (London: Macmillan and Co., Ltd., 1899.)

An Elementary Course of Practical Zoology. By the late Prof. T. J. Parker and Prof. W. N. Parker. Pp. xii + 608, with 156 Illustrations. (London: Macmillan and Co., Ltd., 1900.)

PROFS. PARKER AND HASWELL have embarked upon a difficult and somewhat ambitious undertaking. To compress an account of practically the whole animal kingdom, with 300 illustrations, into a handbook of 550 pages, intended for beginners, is certainly no light task at the present day. Such manuals were quite possible so long as it was considered sufficient for a book of this kind to deal with the exteriors and the habits of animals, and to consist for the greater part of illustrations of monkeys, beasts and birds, while about one-fifth or less was taken up by reptiles, fishes and insects, with perhaps a figure or two of zoophytes or diatoms from Barbados earth. But the book before us is nothing if not scientific and modern in its treatment of the subject. It attempts in the first place to do justice to the claims of every one of the principal existing groups of animals, fairly and without favour or prejudice, giving an outline of the structure and morphology of the more important types in each class. In the second place, it introduces the reader to the fundamental conceptions and problems of zoology, such as evolution, classification and phylogeny, distribution in space and time, conjugation, fertilisation, development, and the cell theory. In a work of scope so wide and comprehensive, with at the same time such narrow limits of space, it requires much care and ingenuity to steer a just course between the Scylla of over-condensation and perplexity and the Charybdis of vague incompleteness. The inexperienced reader becomes bewildered, in the first case with excess, and in the second with lack of detail, so that he is at a loss how to sort out, or how to connect, the material which he absorbs. The danger is, therefore, that a treatise of this kind may be used less by the beginner, who requires to be stimulated and interested, than by the more advanced student, who desires merely to "look up" work he has done; in other words, that it may degenerate into a mere cram-book. It must be admitted, however, that if it is possible to succeed in such a task, the authors have done so. The book contains a great store of information, chosen with judgment and set forth with skill. In order to avoid as much as possible the dangers above pointed out, the authors have restricted the extent of ground covered by leaving out some of the less important groups, such as Chimæroids among fishes, by omitting all descriptions of extinct groups, and by dealing only very briefly with embryology. Perhaps the chief value of the work is in its numerous and admirable illustrations, of which the authors had a copious stock to draw upon in the pages of their larger two-volume "Text-Book." Amongst them are some coloured diagrams of the circulation of the blood in various types, for the most part clear enough, but Fig. 204, illustrating the circulation of a fish, certainly requires a good deal of looking at before its meaning can be grasped. The book is intended, we are told, principally for the requirements of the students in higher classes of schools; but is it necessary, even in this educational stratum, to explain the meaning of commensalism by coining and printing such a word as "messmateism," which looks at first like some new form of theosophy? These are, however, but minor points. Judged as a whole, the book is one which fills a distinct gap in zoological literature, and fills it well, as a handy book of reference, though we are inclined to think that the authors have attempted rather too much, and that the class of readers who will benefit most by their work will not be quite those for whose use the book was intended.

The second book mentioned at the head of this notice will be welcomed by many as a handy and inexpensive manual of zoology adapted to the needs of elementary, and especially medical, students, which is at the same time free from the faults and vices of the harmful, unnecessary cram-book. It is written on the same plan as the well-known "Elementary Biology" of Huxley and Martin; that is to say, a certain number of types are selected, and a connected account of each one is given first, after which follow practical directions, necessarily rather brief, for its study and dissection. The examples selected are *Amoeba* and some other unicellular organisms, illustrative of the differences between animals and plants; *Hydra* and *Bougainvillea*; the earthworm, crayfish and pond-mussel; and the amphioxus, dogfish, frog and rabbit. The frog is taken first and dealt with in detail, occupying nearly half the book, as an introduction to biology in its various branches—anatomy, physiology, histology, embryology, classification and various biological problems. Then follow the descriptions of the other types, beginning with the unicellular forms and ending with the vertebrates; and a final chapter deals with the cell and with fertilisation and embryology. The illustrations are numerous and useful, some of them from familiar clichés, others appearing for the first time. The book, it may be safely predicted, will become popular and will run through further editions, in which, doubtless, alterations will be made to keep it up to the level of advances in science. In the present issue, the most recent standpoint of vertebrate embryology is not quite adequately represented. Thus more might have been made of the frequent occurrence of what may be termed the amphioxus stage in the embryonic development of many systems of organs in Craniata, as for instance the appearance, in the development of the vascular system, of a splanchnopleuric subintestinal vein, prior to the formation of the somatopleuric system represented by the cardinal veins, &c., and the origin of the heart itself from the anterior portion of the former system. Again, in the urogenital system the differences between pronephric and mesonephric tubules, both in development and structure, and the homology of the former with the excretory tubules of amphioxus, might at least have been alluded to. The authors do not raise the question as to whether pronephric and mesonephric tubules are to be regarded as homodynamous or not, but leave one rather with the impression that they are; it is surely time now, however, that the English, no less than the German, student (and, for that matter, the English teacher and examiner also) should be told clearly that they are not. The concluding chapter of the book might, in fact, have its interest, as well as its value, increased in many particulars, without adding half a page to its length. But this detracts little from the usefulness of the book as a guide and help to the student and teacher of zoology, and as such it may be confidently recommended.

E. A. M.

THE TEACHING OF METEOROLOGY.

Practical Exercises in Elementary Meteorology. By Robert DeCourcy Ward, Instructor in Climatology in Harvard University. Pp. viii + 195. (Boston, U.S.A.: Ginn and Co., 1899.)

MR. ROBERT D. WARD has written a book for the use of schools and training colleges, which we should think would be very popular with teachers and pupils alike. With the former, because he indicates to them the proper method of giving instruction in meteorology, and, at the same time, supplies so many valuable hints, that he makes their work more profitable, without increasing the severity of their duties. To the latter, because his object is, among others, to turn the numerous meteorological observations that are made at many high schools to practical account, to clothe the dry bones of mere instrumental readings with an intelligent purpose, and to infuse a new and sustained interest into a mechanical routine. Nothing, we imagine, can be more wearisome than the continual record of temperature and pressure and other data of which no definite use is made. The educational value of such a practice must be very slight, and Mr. Ward has recognised the necessity of improving this mechanical record, and, at the same time, of investing the ordinary class teaching with a definite practical purpose. He has taken both pupils and teachers by the hand in a way that should produce most encouraging results. Doubtless many others have perceived defects in the methods of teaching meteorology, but it is Mr. Ward's merit that he has known how to apply a practical remedy. He, first of all, takes his pupils without instruments, and shows how much can be done by the exercise of ordinary intelligence and trained organised powers of observation. Many a teacher, we imagine, when he sees the numerous questions which Mr. Ward puts, and to which intelligent answers can be given by simple, if acute, observation, will take shame to himself that he has not adopted similar, and even extended, methods for infusing life and interest into the study of a science that is too often regarded as dull and insipid. Here is a specimen, taken at random, of what a pupil is expected to acquire from his own observations.

"Wind and Precipitation. Are any particular wind directions more likely than others to give us rain or snow? Are these the same winds as those which give us the most cloudiness? What winds are they? Has the velocity of the wind any relation to the rain or snow-storm? Does the wind blow harder, before, during, or after the rain or snow? What changes of wind direction have you noted, before, during, or after any storm? Have you noticed these same changes in other storms? Are they so common in our storms that you can make a rule as to these changes?"

None of these questions, it is to be observed, are answered. The answers are to be derived from the student's own notes, which he is shown how to make, and of which he is expected to keep a tabulated record.

Mr. Ward wisely keeps his description of instruments within very moderate bounds; such information is to be found elsewhere, and the object here is rather to induce the student to discover for himself the most important facts in weather conditions, and to proceed to the study of climate and the possibility of weather prediction. With the latter view, means are provided for constructing synoptic weather maps over the area of the United States; and the lessons to be learnt from the study of these maps are brought out by a series of pertinent questions in the manner already illustrated. After familiarity with the construction of weather maps and the method of determining gradients and similar elementary points have been acquired, the pupil is led to the study of the interrelations of the different weather elements, and particularly of the forms, dimensions and movements of cyclones and anti-cyclones, the main features of whose characteristics the pupil is taught to derive for himself from the actual, and not specially prepared, weather maps.

A series of so-called problems in observational meteorology is added, in which the same manner of teaching is preserved. Questions connected with vertical gradients in temperature, with humidity, clouds, &c., carefully graduated according to the student's supposed progress in the study of weather phenomena, are submitted for his consideration, the object being generally to discover the explanation of observed facts. A few useful tables are also given, and in an appendix are some useful hints to teachers, which the author's experience suggests as likely to be of assistance and, at the same time, explanatory of his own purpose. The plan of the book is based on the recommendations in the Report on Geography of the Council of Ten, and is very intelligently pursued. The author shows throughout the earnestness and the capacity of a true teacher, and we hope that his book and his methods of teaching will obtain a wide currency, suggesting as they do a vast improvement on the training generally in vogue. There remains still a further question, which the author does not broach, and on which it is probably preferable to maintain a discreet silence. How far is meteorology perfected as a science to warrant its employment as an educational force, demanding the exactness, and supplying the training, which the older and more recognised means have hitherto supplied?

OUR BOOK SHELF.

Lectures on Some of the Physical Properties of Soil. By Robert Warington, M.A., F.R.S. Pp. xv + 231. (Oxford: Clarendon Press, 1900.)

THIS is a subject of deep interest to the student, and of no small practical importance to the farmer. As Mr. Warington indicates, it is one that has not received a great deal of experimental attention in this country, nor does it usually form a separate subject for class-room treatment. In England we have in the past depended chiefly on the text-books of Fream and Munro, to which may now be added some excellent American manuals, notably that by King. These lectures by Warington form a welcome addition to our literature, and they are worthy of a larger audience than that which surrounded the Sibthorpian chair.

Two of the five chapters are concerned with the relationship of the soil to water. This is a matter which the cultivator—by attention to tillage, cropping and manures—can turn to good practical account. By draining, he can get rid of excessive moisture, while by introducing humus to a dry soil, and by the production and preservation of a fine tilth, he can conserve moisture and place it more fully at the disposal of plants. Farmers and gardeners who read these lectures will learn that there are other ways of providing crops with water than by the use of the water-cart or the watering-pan. In forestry, too, much may be done, by attention to cultural measures, to place an increased supply of water at the disposal of trees, and on these measures the success of woods on dry ground largely depends.

Possibly the chapter that deals with the movement of salts in the soil is the one that will appeal most directly to the farmer. Much of the success of manuring depends on the suitable relationship of fertilisers to soil and climate. Substances that are firmly held by the soil may be used without fear of loss even on light soil and in a district of large rainfall, whereas substances for which soil has but little affinity must be applied with much discrimination. Other things being equal, sulphate of ammonia is more suitable than nitrate of soda for use in the West of England, whereas the order is reversed in the drier climate of the Eastern districts. The behaviour of soluble plant-food under the influence of heavy rainfall should be considered by farmers in purchasing their supplies of spring manures. The excessive rainfall of the past winter—especially coming, as it did, after a long period of drought—must have very seriously depleted the soil of its natural nitrates, so that increased purchases of active nitrogenous manures for the crops of the current year are clearly indicated.

Let us hope that the reception given to the present volume will induce the author to proceed, without delay, to redeem his provisional promise of a work on the cognate subject of the chemistry of soil. W. S.

Electric Wiring, Fittings, Switches and Lamps. By W. Perren Maycock, M.I.E.E. Pp. xv + 446; with 360 illustrations. (London: Whittaker and Co., 1899.)

Electric Bells and Alarms. By F. E. Powell. Pp. 77; with 51 illustrations. (London: Dawbarn and Ward, Ltd.)

MR. PERREN MAYCOCK, who has already written a number of excellent text-books on electrotechnical subjects, has produced in the present case a book which, while offering no particular attractions to the non-technical reader, undoubtedly serves the purpose for which it is written; namely, to give a thorough idea of present practice in the electric lighting of buildings. The book is the more welcome since the widespread introduction of 200 and 220 volt lamps during the last three years has rendered all books dealing with electric-light fittings written previous to that time seriously out of date. It is not merely the perfecting of the 200 volt lamp which has rendered this change possible. The design of lamp-sockets, switches and fuses has been of late much improved. The fewness of parts, the simplicity of construction, and the ease and security of wiring of the modern lamp-socket are in striking contrast to the older fittings. These improvements, though apparently trivial, are none the less important.

Another change of the last few years has been the gradual displacement for all but street lighting of the open arc by the enclosed arc lamp, with its greatly lengthened arc and its increased electromotive force and reduced current. Mr. Maycock's passing description of the Nernst lamp reminds one that that most promising novelty has not yet made its *début* as a commercial article.

The illustrations to the text are numerous, and the sectional drawings on the whole very clear. The practice of taking illustrations largely from manufacturers' trade-lists, which is usually to be deplored, is in the present case justified. In no other way could the fittings at present available be properly described. We recommend Mr. Maycock's book as the best we have seen on the subject.

Mr. Powell's unpretentious little book or pamphlet on electric bells and alarms forms No. 3 of the "Model Engineer" series. It furnishes the reader with an attractive and satisfactory account of the various forms of a most useful, if humble, piece of electrical apparatus.

D. K. M.

Report of the Marine Biologist for the Year 1898. *Cape of Good Hope Department of Agriculture.* Pp. v + 362. (Cape Town: Richards, 1899.)

THE Cape Government is to be congratulated upon the success which has attended its efforts to investigate the sea-fisheries of the Colony. Dr. Gilchrist, the marine biologist who was appointed to inquire into the best means of developing the fisheries, was undoubtedly well advised in securing, at the very commencement of his undertaking, a properly equipped steam fishing vessel of sufficient size and power to safely keep the sea, and the results recorded in the present report justify, in a manner almost beyond what could have been anticipated, the expense which the purchase and up-keep of such a vessel has entailed. It has been clearly shown that the seas around the Cape of Good Hope contain a vast source of unexploited wealth, the development of which would provide a valuable and healthy addition to the food-supply of the people. So far as can be gathered from the report, the only difficulty to be contended with is that of getting the fish to the centres of population in a fresh condition. With a climate such as that of Cape Colony it would seem that the best means of overcoming this difficulty is by the use of refrigerating chambers both on the fishing-vessels themselves and on the trains used for transporting the fish by land.

The present report does not attempt to deal with the more scientific aspects of fishery investigation, although there is evidence that this side of the question is not being altogether neglected. It is of the greatest importance that the newly discovered fishing-grounds should be very thoroughly investigated at the present juncture, before much fishing has taken place upon them, and this investigation should deal, not only with the fish population, but quite as thoroughly with the lower forms of life, which are the food of the fishes. Such an investigation will be invaluable in after years, as it will make it possible to ascertain exactly what influence constant fishing has produced, and many evils which have arisen in the European fisheries may be avoided. It is greatly to be desired that the Government of the Cape of Good Hope will show themselves sufficiently enlightened to realise the immense value of accurate scientific investigations at the present time, and the unique opportunity which they now possess—an opportunitg which will probably never return—of developing their fisheries upon sound and scientific principles, based upon a trustworthy record of facts. E. J. ALLEN.

Science Course for Secondary Schools. By G. Robb and J. Mirguet. In Three Parts. I. "Practical Physics," pp. 167; II. "Notions of Physics," pp. 247; III. "Practical Chemistry," pp. 182. (Cairo: National Printing Office, 1898–99.)

THESE three small volumes have been specially compiled to meet the requirements of the Science Syllabus prescribed by the Ministry of Public Instruction to be used in the Secondary Schools under the management of the Egyptian Government.

Part i., "Practical Physics," consists of a series of experiments illustrative of the initial phenomena to be observed by the elementary pupil during his first year. The plan adopted is to first describe an experiment, and afterwards enunciate the law to be associated with it. The first five chapters deal with measurements of length, area, volume, force and weight, succeeding chapters being devoted to density, composition of forces, centre of gravity and equilibrium, properties of matter, elementary hydrostatics and theory of gases. The text is sufficiently ample for clearness without being so detailed as to take the place of a text-book.

Part ii., "Notions of Physics," is in effect a text-book for the assistance of second year pupils in following the series of demonstrations given by the teacher, which constitute the whole of the second year's course. If, as the author's statement appears to indicate, it is a fact that for a complete year the students simply attend a course of experimental lectures without doing *any* practical work themselves, this would hardly, according to modern views, be consistent with the pupils obtaining the maximum advantage from their instruction. The opening chapters deal with the phenomena connected with motion, gravitation, inertia and energy, all units measurements and numerical examples being expressed in the metric system. Following these are sections treating of the elementary phenomena of heat, light and electricity. Magnetism, however, strangely enough, appears to have been entirely neglected, but no statement is made in explanation of this somewhat unusual omission. The arrangement and style of both text and illustrations are very good, the only objectionable feature being the ambiguity of a few of the mathematical signs, this being probably explained by the statement of the author that French types were used in this book. Some 240 illustrations add considerably to the utility of the volume.

Part iii., "Practical Chemistry," presents, in the form of a number of described experiments, the mode of preparation and properties of the more common elements and simple compounds. In addition to the actual descriptions of these bodies, much correlative matter is also included as to their distribution and economic use. A noticeable omission, from the reader's point of view, is the fact that no equations representing the preparations and reactions of the various substances are given in the text. A collection of equations is, however, given in an appendix at the end of the volume, but it is specially mentioned that the matter contained in this appendix is beyond the scope of the examination. Seeing that this is the third year of the pupil's training, and considering the important manner in which chemical equations enable a student to more easily understand the nature of a reaction by showing at a glance how the several constituents of a mixture arrange themselves, it is difficult to agree with such an omission. The experiments themselves are well chosen, and are usefully illustrated by numerous cuts of the apparatus in position. Each substance is discussed under the headings:—(1) Preparation; (2) Physical properties; (3) Chemical properties; (4) Occurrence and Uses.

L'Échappement dans les Machines à vapeur. By G. Leloutre. Pp. 156. (Paris: Gauthier-Villars. Masson and Co., 1900)

Produits aromatiques; artificiels et naturels. By Dr. G. F. Jaubert. Pp. 169. (Same publishers.)

THESE two volumes are the latest additions to the comprehensive series published as the Encyclopédie scientifique des Aide-Mémoire. M. Leloutre has for many years carried on experimental and analytical researches upon steam engines, with particular reference to the condition of the steam in a cylinder during compression and exhaustion, and under different conditions. In the present volume he extends the results arrived at in his "Théorie générale de la machine à vapeur," and adds to his fundamental equations for the analysis of the trial of a steam engine a sixth term depending upon the condition of the steam in the cylinder at the end of the exhaust.

The natural and artificial aromatic substances at present known are tabulated by Dr. Jaubert. They are arranged in five classes, namely, aromatic alcohols; aromatic acids; terpenes; camphors; alcohols, aldehydes and terpene acids. A short description is given of the characteristics of each class, and following it are tables showing the commercial name, scientific name, empirical and constitutional formulæ, method of preparation, references to literature, properties and characteristic reactions. The study of these compounds is now the most important branch of organic chemistry, not only from the point of view of pure science, but also on account of their commercial value. The book should therefore be found of service to both chemists and pharmacists, as a convenient work of reference.

Grundzuge der geographisch-morphologischen Methode der Pflanzensystematik. By Dr. R. von Wettstein. Pp. 64. Mit 7 lith. Karten und 4 Abbildungen im text. (Jena: Gustav Fischer, 1898.)

THIS suggestive little work, coming as it does from the pen of Prof. von Wettstein, will be read with attention by all who are interested in the wider problems of systematic botany. The author contends that a separation of species or sub-species on morphological grounds alone is unsatisfactory, and he reminds his readers that the appreciation of differences by this method must be ultimately a purely subjective one, and that the conclusions arrived at are liable to be vitiated on several grounds. Von Wettstein pleads for a more general recognition of the geographical areas occupied by species, and considers that a careful study of these will eliminate errors due to modifications depending on climatical or other physical conditions; and it is well known how efficient these are in producing races which, though retaining a general resemblance to a common ancestor, may yet be greatly dissimilar amongst themselves.

He applies his methods to a study of the Endotricha-series of Gentians, and thus comes to reduce the twenty-two species to six ground-forms or genuine species.

He further discusses some of the Euphrasias, and arrives at a corresponding result. It may, however, be urged that this method also is open to objection, and that more is to be got out of the study of species by experimental cultivation—an arduous task, but one which will perhaps yield more fruitful results than even the application of the geographical-morphological method.

Dreams of a Spirit-Seer, illustrated by Dreams of Metaphysics. By Immanuel Kant. Translated by E. F. Goerwitz, and edited with an introduction and notes by Frank Sewall. Pp. xiv + 162. (London: Swan, Sonnenschein and Co., Ltd., 1900.)

THE chief object in publishing this translation of Kant's "Traüme," which first appeared in 1766, is to show the relation between the philosophy of Kant and the teachings of Swedenborg. Students of metaphysics and psychology will appreciate this aid to a study of Kant's philosophical development.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

On the Process of Dyeing with Woad Alone.

IN my paper in NATURE (February 1, 1900, p. 331) on the blue colour in woad, no account is given of the method by which prepared woad can be used for dyeing wool blue. Some of my friends have suggested that the above-named communication was, in consequence, like the play of *Hamlet* with the Prince of Denmark left out. The request for information then made as to the *modus operandi* of the mediæval dyers who used woad and woad alone for dyeing blue has up to the present yielded no response.

There exists a tendency to believe that by long-continued cultivation the woad now grown and prepared in this country has lost its power of dyeing blue, and is only of use in setting up fermentation in the indigo vat. It is, however, very improbable that a plant like *Isatis tinctoria* should entirely lose so characteristic a property as that of indigo-formation. It was, however, possible that some variation in the details of its manufacture might have had this effect. That fresh woad still can be made to yield indigo was shown, and the process of extracting it given in detail, in the paper above referred to.

Prepared woad is a dark brown, earthy-looking paste having an ammoniacal odour, yielding a yellowish-brown solution to water, and looking as unlikely a source of a blue dye as could well be imagined. A supply having been obtained from the Parson Drove Mill, a series of attempts were made in flasks and beakers to get the blue colour, but they all proved unsuccessful. It was then determined to experiment on a larger scale. Having secured the assistance of a colleague, Mr. C. G. Barrett, we started an eight gallon vat in a small barrel, in a steam laundry. The directions of Hellot were closely followed—woad, weld, bran, madder, lime and hot water were duly mixed, the vat carefully covered, and periodically stirred—the result being, not a little to my surprise, that at the end of twelve hours a skein of wool, after an hour's immersion in the filthy-looking liquor, turned a good "pastel blue" on exposure to the air. A number of experiments were then made on a smaller scale, which we found answered equally well, and proved that it is as easy to dye wool blue with our English woad to-day as it was 300 years ago; any housewife could do it now, if need be, as easily as then. It is simply a question of digesting the woad at a temperature of from 100° to 140° F. (40° to 60° C.) for a prolonged period. We found half a pound of woad (500 grammes) to a gallon (4 litres) of water quite enough to yield good results. The water should be poured on the woad nearly boiling, the vessel closely covered at first, and kept heated to the above temperature. This can very conveniently be done by placing it on the brickwork of a steam boiler. In from ten to twelve hours small bubbles will begin to appear on the surface of the liquor; a little recently slaked lime (6 or 7 grammes) should now be stirred in, one noticeable effect of which will be the generation of an ammoniacal odour. A small pattern of wool left in for an hour will become pale blue on exposure to the air. In the course of a few hours a gramme or so of bran will set the fermentation up again, which in its turn can be controlled by adding lime. In this way the process may be kept going on for several days.

The longer and more often the patterns are immersed the darker they become—at first pale blue, they will eventually become dark blue—almost black. The paler shades are apt to have a green tint, and it was "to kill the green" that the older books on dyeing recommend the addition of a small quantity of madder.

It must be remembered that the quantity of indigo in woad is but small, so that experiments with less than half a pound are not likely to be successful; the great point, however, is keeping the temperature about 100° to 120° F. for many hours.

Our ancestors had neither steam boilers nor thermometers, but they would be able to keep the contents of an earthen vessel "nicely warm," as judged by the hand, by placing it on the hearth, when the embers were kept alight all night, for in those times kindling a fire by flint and steel was always an undertaking.

My thanks are due to Mr. C. G. Barrett for his great help in conducting these experiments, and for the facilities he has afforded for carrying them out, as well as to Mr. Fitzalan Howard, Prof. Penzig, of Genoa, and Sir Thomas Wardle.

King's Lynn, March 31. CHARLES B. PLOWRIGHT.

Illogicality concerning Ghosts.

MR. HERBERT SPENCER, exposing the various inconsistencies that occur so frequently in the ghost-stories of the savage races, says:—"How illogicalities so extreme are possible, we shall the more easily see on recalling certain of our own illogicalities. Instance . . . that familiar absurdity fallen into by believers in ghosts, who, admitting that ghosts are seen clothed, admit, by implication, that coats have ghosts—an implication they had not perceived" ("The Principles of Sociology," 3rd edition, vol. i. p. 104). It seems interesting to note that the same opinion was expressed about nineteen centuries ago by the Chinese philosopher, Wang Chung (*circa*, 27–97 A.D.), whose sceptic remarks on the traditions of all manners, handed down to his time in the Middle Kingdom, form a celebrated work named "Lun Han" or "Balance of Discussions." In its twentieth book (fol. 14–15 in Miura's edition, Kyôto, 1748), he says:—"Since the beginning of the world, so vast has been the number of the deceased, that it enormously exceeds that of the whole present population. Therefore, should every one become a ghost after death, man is bound now to meet a ghost at each step on the road, and should he see ghosts in his dying moments, he ought to find not one or two singly, but several millions of them collectively filling the space. When a man dies by a weapon, his blood, the essence of his life, turns to what is termed *ignus-fatuus*, which has no resemblance to him, but gathering itself into an amorphous mass, looks like the light of fire. It is the ghost of blood, and presents an aspect quite different from a live man's blood, and, as the essence of life has been separated from the man's body, it cannot resume his shape in life. If all ghosts be seen in the form of dead corpses, you have reason to suspect the dead to become the ghost. . . . And, equally, a disordered fellow might be true in seeing a ghost of his live friend visiting him. But how could he see a dead man in his shape of lifetime? . . . . As warm ashes, even after the fire has gone out, can be made to produce it again, we may with some reason suggest the possibility of a dead man appearing in the same form as alive. When we know well, however, that a fire once extinguished can never burn anew, it is evident that a dead man can never become a ghost. And now, what is the ghost? All say it is the soul of a deceased. *Then, even if it could be seen by man, it ought to appear stark naked and fully disrobed: for the clothes have no soul to cover the dead man's soul; while the latter has no material body to put on a material raiment.* Soul is an outcome of blood and breath, which, though dependent on body during man's life, are the things distinct from it; hence it might be still well to suppose soul able to survive body as a ghost. But the clothes consist of nothing but threads, cotton, hemp and silk, which have all no intercurrence of blood and breath imparted by the wearer's body; nor do they possess any blood and breath of their own; so that even when they keep their form entirely, they are as soulless as a human corpse; and how then could they resume their former shape after their total decomposition? Thus, saying that a ghost appears clad necessitates the admission of its possession of body; which view itself militates against the definition of the ghost, because, according to this statement, the said ghost is a composite of the ghosts of body and clothes, which is essentially different from the soul of a deceased individual."

It is curious to observe that Wang Chung himself is quite illogical in esteeming it just to suppose a ghost able to appear only divested: for, according to his own proposition, the soul exists only in blood and breath; while the body, though very closely connected with them during life, is, after death, as severed from them as the ever lifeless and soulless clothes; so that, should it be necessary for a ghost to appear divested, it would be equally so to appear disembodied at the same time.

April 2. KUMAGUSU MINAKATA.

Fertilisation of Flowers in New Zealand.

ON p. 16 of your issue of November 2, 1899, reference is made to an article in the London *Quarterly Review*, by "A Field Naturalist," in which the writer expresses the opinion that "under natural and equal conditions, self-fertilisation of flowers is both the legitimate fertilisation and the most productive." I have not seen the article, but would like to place on record the following facts, which may be of interest to botanists in this connection.

I have cultivated most of the common flowers of the European and North Temperate region during the last thirty years, and have kept a pretty close record of their behaviour under the somewhat altered conditions in which they are placed in New Zealand. In this part of the colony the climatic conditions are not very dissimilar to those of the milder and moister parts of Britain, but the insects are, of course, totally different.

Previous to 1885, when humble-bees were first introduced into New Zealand, certain flowers, which were freely cultivated here, never produced seeds under natural conditions. But since the bees have become numerous and have spread over the colony, the conditions have quite changed. Primroses, cowslips, and the various hardy hybrid primulas all seed freely. So do pansies, crocuses (except the common yellow Dutch, which does not seem to be fertilised by the bees), Canterbury bells, antirrhinums, and many others which formerly never seeded. Now we find the plants in the spring-time surrounded by crowds of self-sown seedlings.

The bees were introduced, as is well known, by the Canterbury Acclimatisation Society, for the purpose of fertilising the flowers of the common red clover—*Trifolium pratense.* It was supposed at the time, that the insect which was introduced was *Bombus terrestris*, which, by the way, is unable to fertilise the flowers of red clover on account of the shortness of the trunk. As a matter of fact, some of the nests brought out to the colony were those of *B. terrestris*, but among them were also two varieties of *B. hortorum*, and it is this latter long-trunked species which is now so abundant, and fertilises so many of the introduced flowers.

In spite of the fact that primroses and other flowers are now enabled to produce seed by the agency of the bees, attempts to introduce them into the woodlands and open spaces and to get them to go wild there are still quite unsuccessful. Certain grasses, particularly cocksfoot, *Poa annua* and *Poa pratensis*, are too aggressive, and choke out nearly all other small vegetation.

GEO. M. THOMSON.

Dunedin, N.Z., February 16.

JUBILEE OF THE ROYAL METEOROLOGICAL SOCIETY.

THE Royal Meteorological Society attained its Jubilee on Tuesday, April 3, having been founded on April 3, 1850; and this fiftieth anniversary was celebrated by the holding of a commemoration meeting, a conversazione, and a dinner.

The commemoration meeting was held at the Institution of Civil Engineers, in the afternoon of the 3rd inst., and was numerously attended. The following delegates from other societies had been appointed, most of whom were present, viz., the Royal Society, Prof. J. J. Thomson, F.R.S.; Royal Astronomical Society, Mr. E. B. Knobel, President; Royal Geographical Society, General Sir Henry W. Norman, G.C.B., G.C.M.G., C.I.E.; Geological Society, Mr. J. J. H. Teall, F.R.S., President; Institution of Electrical Engineers, Prof. Silvanus P. Thompson, F.R.S., President; Royal Agricultural Society, Sir Ernest Clarke, Secretary; Royal Horticultural Society, Sir Trevor Lawrence, Bart., President; Royal Botanic Society, Major J. W. N. Cotton; Scottish Meteorological Society, Mr. R. C. Mossman; Sanitary Institute, Mr. A. Wynter Blyth; Hertfordshire Natural History Society, Mr. J. Hopkinson; and Oxfordshire Natural History Society, Mr. H. Balfour, President. The German Meteorological Society sent, as their delegate, Prof. Dr. G. Hellmann.

The Secretary, having read a number of letters and telegrams, the President, Dr. C. Theodore Williams, expressed his great pleasure and satisfaction in receiving good wishes and congratulations from so many friends, and especially from foreign meteorologists and meteorological societies. He then read the address which the late Mr. G. J. Symons, F.R.S., had prepared for the occasion, and added some remarks of his own in appreciation of Mr. Symons, and also on the work of the Society.

The earliest English meteorological observer and recorder, of whom the work has come down to the present day, was the Rev. William Merle, whose record of observations for the seven years 1337–1344 is still preserved in the Bodleian Library at Oxford. The earliest English book on the weather was issued about 1530, the title being "Godfridus: Here begynneth The Boke of Knowledge of Thynges Vnknowen apperteynynge to Astronomye, with certayne necessary Rules," &c. Among the early meteorological authors and observers, Mr. Symons mentioned the Rev. Dr. John Goad, 1686; the Hon. Robert Boyle, 1659; Dr. Robert Plot, 1683; and Sir Christopher Wren, 1697.

The first English Meteorological Society was founded in 1823, on the suggestion of Mr. J. G. Tatem, but it only survived for a few years. A second Society was started in 1836 by Mr. W. H. White, which continued in existence for some years, and included among its members the late John Ruskin. The present Society was founded on April 3, 1850, by Mr. James Glaisher, F.R.S., with the co-operation of Dr. J. Lee, F.R.S., and several others. This was called "The British Meteorological Society" until 1866, when a Royal Charter of Incorporation was obtained, and the name was changed to "The Meteorological Society." In 1882 Her Majesty the Queen accorded the Society permission to adopt the prefix "Royal." For many years the Society had no habitation; but in 1872 a room was engaged at 30 Great George Street, Westminster, and an assistant secretary appointed. Since that time great progress had been made, the work of the Society had greatly increased, and a large and valuable library had been got together. The offices now comprise a suite of rooms at 70 Victoria Street. Both Mr. Symons and Dr. Williams referred, in some detail, to the work which had been done by the Society, and to the investigations which were still in progress.

Congratulatory addresses were delivered by Prof. J. J. Thomson, F.R.S., Mr. E. B. Knobel, Mr. J. J. H. Teall, F.R.S., Mr. R. C. Mossman and Mr. A. Wynter Blyth. Dr. G. Hellmann handed to the President an address from the German Meteorological Society, and also spoke of the valuable work accomplished by the Royal Meteorological Society. The President then presented to the delegates a commemoration medal which had been struck for the occasion.

A conversazione was held in the evening at the Royal Institute of Painters in Water-Colours, Piccadilly. In addition to the music provided by the Royal Artillery String Band and by the "Schartau" Part-Singers, an exhibition of meteorological instruments, &c., was arranged in an adjoining room. This included many interesting and historic instruments, among which were some used by Dr. Livingstone in his travels through Africa, and the aneroid barometer used by Mr. Glaisher and Mr. Coxwell in their famous balloon ascent from Wolverhampton on September 5, 1862, when they attained an altitude of seven miles from the earth. During the evening lantern demonstrations were given (1) by Mr. T. C. Porter (of Eton), showing the growth of eclipse of the shadow of the Peak of Teneriffe by the shadow of the earth; (2) by Colonel H. M. Saunders on clouds; and (3) by Mr. W. Marriott, on meteorological phenomena and portraits of presidents of the Royal Meteorological Society.

On Wednesday morning, the 4th inst., a large number of the Fellows went down to Greenwich, and were, by permission of the Astronomer Royal, shown over the Royal Observatory. In the afternoon a visit was paid to the Painted Hall and the Naval Museum.

In the evening a dinner was held at the Westminster Palace Hotel, under the presidency of Dr. C. Theodore Williams. General Sir Henry W. Norman, in responding for the Army, stated that as senior officer he had taken Lord Roberts under fire for the first time. He also brought a message from the Royal Geographical Society congratulating the sister society on the attainment of its jubilee. Mr. W. N. Shaw, F.R.S., in proposing the toast of the evening, said that the history of the Royal Meteorological Society was fifty years of development and co-operation in meteorological research—a development which had taken place chiefly in the direction of combining the observations of many persons in different parts of the country for the single purpose of advancing our knowledge of atmospheric phenomena. Dr. Williams, the President, replied. In replying for "The Delegates from other Societies," Prof. Silvanus Thompson, F.R.S., spoke of the contact of electricity with meteorology, and pointed out how that science had keenly interested many of the inquirers into magnetic and electrical matters, from Boyle to Lord Kelvin, for it was impossible for a man to work at physics generally without coming across the physics of the earth, the atmosphere and the sea. Speaking of the interference caused to magnetic and meteorological observations by leakage from electric-light and traction systems, he said such leakage was quite unnecessary. It arose from the adoption of methods that had, perhaps, been adopted without due consideration, and it was possible to propel electrical tram-cars without corrosion of gas and water-pipes, and without disastrous consequences to meteorological and magnetic observations.

PROGRESS IN NORTH-WESTERN AMERICA.[1]

THIS book, excellent of its kind, is primarily intended for the sportsman, though possessing also a wider interest. Two-thirds of its contents and the majority of its illustrations are devoted to the description of those forms of the animal life of Western America which men most eagerly kill for pleasure or profit. The wapiti, the "antelope-goat," the moose, caribou and deer, the bighorn, the prong-buck, the bears and the bison, are all in turn discussed, generally with vivid personal reminiscences of their pursuit and slaughter amid their natural surroundings. Interesting chapters are also written on the seal and other fur-bearing animals of the Pacific Coast, and on the salmon of the British Columbian rivers; and four of the later chapters of the book (pp. 225–315) contain an account of the author's experiences as a pioneer in the Kootenay district of British Columbia. In the opening up of this district Mr. Baillie-Grohman played a conspicuous part, and in view of the rapid development which it has undergone during the last ten years, some permanent historic interest will no doubt attach to this account.

The reckless waste which has accompanied the inrush of civilised man upon the wild lands of Western America must have struck every observant traveller. The prairies robbed in a few years of their slowly accumulated fertility; the grazing lands of the dry region overstocked and ruined; the ancient forests among the mountains destroyed wholesale by fire; the mineral deposits hastily and carelessly ransacked—in every quarter is shown the same hurry to grasp an immediate advantage without the slightest regard for the future. But it is upon the indigenous animals that the destructive propensities of these modern times have fallen with direst effect, driving harmful and harmless species alike towards the irrevocable doom of extinction.

Even while we may acknowledge that the past history of life on the earth is one long record of extinction of life-forms, and that the spread of mankind must almost inevitably bring about the destruction of all the larger animals not directly serviceable to him, the process is none the less grievous to contemplate, especially when, as in this case, it is carried on wantonly and inexcusably in advance of the needs of the community.

Like many another sportsman, Mr. Baillie-Grohman laments the havoc wrought by others, while indirectly taking credit to himself for his own moderation and "scientific" methods. But in reading his book we fail to find cause for exonerating him from the stigma of having aided in the unnecessary slaughter of some of the most characteristic, most beautiful and most harmless animals of the continent. It is true that to some extent he selected his game, and did not kill indiscriminately; but in reading his pages we are impressed again and again with the lack of any adequate reason for the great aggregate destruction he chronicles. He remarks:—

"Trophies of the chase can be regarded from two different points of view—*i.e.* from that of the naturalist, as more or less valuable contributions to our knowledge of natural history; and, secondly, from a purely sporting point of view. To the scientific investigator desirous of establishing the length, the widest spread or the greatest circumference of the 'largest on record' of some particular species, it is naturally a matter of indifference who killed the bearer of the trophy deserving that distinction. To the sportsman, on the other hand, who disdains to adorn his walls with spoils that he has not obtained himself, it is a matter of interest what other fellow sportsmen have shot, while the fact that some skin hunter

Fig. 1.—Fur Seal Rookery on the Prybiloff Islands.

[1] "Fifteen Years' Sport and Life in the Hunting Grounds of Western America and British Columbia." By W. A. Baillie-Grohman; with a chapter by Mrs. Baillie-Grohman. Illustrated by 77 photographs, including the best trophies of North American Big Game killed by English and American Sportsmen, &c. Pp. 403. 8vo. (London: Horace Cox, 1899.)

of Wyoming or Montana has bagged a wapiti with antlers, or a bighorn with horns an inch or two larger than the best of his own killing, remains a matter of indifference" (p. 43).

But the "scientific investigator" need not have been dragged into the argument; it is "a matter of indifference" to him also that an individual of a species already thoroughly studied should in some minor characteristic exceed its fellows by an inch or two, and it is not in *his* interests that the indiscriminate collecting of "trophies" can be justified.

In commenting on the abortive attempts which have been made, both in British Columbia and the United States, to arrest the destruction by the enactment of game-laws, Mr. Baillie-Grohman has some pertinent remarks. He says:—

"To have to acknowledge that the destruction of big game there" (*i.e.* in the hunting grounds of the Rockies) "was the work of one single generation is not a pleasant truth for the 'Makers of the West.' Until the completion of the first trans-continental railway, thirty years ago, the muzzle-loaders of white men had made no serious impression upon bison and wapiti, upon bighorn and deer. . . . Unjustifiable as the rapid extinction of the red man will appear to our grandchildren, the extermination of the animals that dwelt on his plains, that roamed his forests, or that filled his rivers, must seem even less excusable, for, in their case, protection should have been as possible as is in civilised communities the enforcement of laws protecting human life. But the frontiersman, . . . in his fierce and utterly selfish attack upon nature, waged a merciless war, the like of which no country has ever seen, for in days of older conquests the scientific means of wreaking destruction in such a wholesale manner were lacking. The finely-sighted Sharp breech-loader, with which he rolled over in one 'stand' as many as forty or fifty bison in as many minutes, . . . is as much an invention of our time as is the giant powder (dynamite) cartridge, with which he kills by one explosion literally hundreds of salmon and trout in a single deep pool. A vastly increased network of railways assists him in reaching hunting grounds. . . . Even the telegraph wire . . . was pressed into service. . . . The same merciless war against nature was waged by the miner and prospector; the one, by depositing vast masses of worthless 'tailings' and rock *débris* into fertile valleys . . .; or by setting fire to the forests in spots likely to contain mineral wealth. Thus were denuded by conflagrations, which the writer has known to last in the Kootenay country and along Puget Sound from May to October, thousands and tens of thousands of square miles of country covered with the most superb woods to be seen in any part of the world" (pp. 28–30). . . .

"And what about the game-laws? . . . The laws, and sufficiently good laws, were there all right enough on paper, and, what is more, they had been framed at a sufficiently early date to have saved the bulk of the game, only there was nobody to enforce them. That was the crux of the whole question" (p. 33).

But in reading Mr. Grohman's eloquent denunciations, one cannot help feeling that it is his sense of the slaughter having been done by the wrong persons and in the wrong manner that has aroused his anger, and not the mere fact that the animals have perished. It seems to be implied that such game should have been reserved for "sportsmen," and not have fallen to the despised "hide-hunters" and "meat-hunters." Yet it is these latter, after all, who could give the better practical excuse for the mischief they have done.

The incongruity of the author's attitude is curiously exemplified in the latter part of the chapter (ii.) above-quoted, where he mentions the "pettifogging meanness" of the British Columbian game-laws and the "absurd jealousy of English sportsmen," and especially where he undertakes to give "a few practical hints concerning the working of the game-laws of the Western States." After a brief reference to the wide privileges of a settler, who can kill game for his own use practically at any season of the year, we read:—

"What is the use, one may well ask, of the Montana law limiting a stranger to two wapiti so long as there are no officials to see that this number is not exceeded? In a country where in the wilder parts you can still travel and hunt for weeks without seeing a human being, it would require an army far larger than that of the whole United States to enforce such regulations. And even were such an army available, the investment of 50*l.* in a 'ranch' makes the stranger a 'settler' in the eyes of the law.

FIG. 2.—Salmon leaping an 18 ft. high fall on White Bear River, Labrador.

"*In one respect care has to be exercised: it is concerning the trophies. These should not be brought to the railway stations in numbers exceeding the law's limit, for blackmailers, prompted by the reward in the shape of half the fine, have of late years more than once caused English as well as American shooting parties considerable trouble and expense. The task of transporting the trophies out to the railway should be left to your hunter or guide to accomplish after you have left. If he is worth his salt, he will manage to get eight or ten picked heads to the railway and dispatch them, packed in cases, without any trouble*" (p. 42, original not in italics).

Now how can the author—no doubt a staunch upholder of our own game-laws—defend this incitement to lawlessness? All game-laws must be essentially arbitrary conventions, and can only be supported on a conventional basis; and if it be a crime to break such laws in our own country, it is equally a crime to break them across the Atlantic. Is, then, the risk of detection to be the only deterrent in these matters, and is the man to be called a blackmailer on the other side of the water who would be called a gamekeeper at home?

While we may regret the manner in which the author has gained his information, we may concede that he has written an interesting account of the animals he has hunted, though always from the standpoint of a sportsman. Of these the wapiti (*Cervus canadense*), the antelope-goat (*Haplocerus montanus*) and the bighorn (*Ovis montana*) appear to have constituted his favourite prey, and are consequently most fully described and illustrated.

In the chapter on seals, Mr. Grohman condemns pelagic hunting in unmeasured terms:—

"Pelagic sealing is a cruel and most wasteful method of obtaining peltry which can be secured by 'land killing' at the rookeries without inflicting suffering and without any appreciable waste. Those who dispute this do so either from ignorance of the true facts or from interested motives" (p. 192).

Regarding the salmon of the Pacific Slope, he has the same black record to make of reckless waste and rapidly diminishing resources, stating, on the authority of a Canadian Blue Book, that at one of the Alaskan canneries "in one day 20,000 fish, of an average weight of 10 lbs. each, were thrown away because of the inadequate appurtenances of the establishment and the suddenness of the run" (p. 222).

In the later chapters of his book Mr. Baillie-Grohman gives an entertaining account of his rough and varied experiences as a pioneer in Kootenay, where, among other matters, he was himself hunted and nearly shot by a lawless prospector who had a grievance against him. Mr. Baillie-Grohman took up from the Provincial Government an extensive concession of lands subject to summer floods in the Lower Kootenay valley, and his scheme for the reclamation of these lands affords a striking commentary on the abnormal relations which exist between the main valley system and the present drainage of this region. The physiography of the mountainous country westward from the Rockies to the ocean abounds in anomalous characters which are as yet for the most part unexplained, offering many magnificent problems for the student of the evolution of land-forms; and of these none is more remarkable than the case in question.

The Columbia river, rising in Columbia Lake, flows at first north-westward and afterwards southward, throwing a loop of magnificent proportions northward around the Selkirk Range; while its great tributary, the Kootenay, makes a similar but diametrically opposite loop southward, crossing the United States boundary line into Montana and Idaho, and then recrossing to reach its confluence with the Columbia; and the two rivers thus encircle a huge oval tract of mountains over 300 miles in length. Now, the Kootenay some 80 miles below its source swings into the depression which contains the Columbia Lake, only one mile distant from it, but flows thence southward away from the lake. Mr. Baillie-Grohman's plan was simply to make the circlet of waters complete by turning the Kootenay into the lake.

"The piece of land lying between the two waters was a level stretch of gravel shelving from the river to the lake, the latter being about 11 feet lower than the Kootenay. With such a fall in less than a mile it practically needed very little work, for, once a big ditch was cut, the rushing Kootenay, at that point a rapid stream some 300 feet wide, would do the rest. By turning off such a large quantity of water it was expected that the overflow of the bottom land 300 miles further down would be prevented. It was really restoring things to their original condition, for there is no doubt that a comparatively short time back the Kootenay river forked at the Canal Flat, the northern branch flowing over the flat where I proposed to make the canal, while the southern occupied its present bed" (p. 261).

But rival interests were involved. The Canadian Pacific Railway had been planned to run along part of the Columbia valley just above high-water mark, and its authorities took alarm at the possibility of a vast increase in volume of the river, and prevailed upon the Federal Government to stop the scheme. The upshot, as told by Mr. Baillie-Grohman, is by no means to the credit of the Dominion and Provincial Governments. And thus the waters of the Columbia and Kootenay, after so nearly embracing in their youth, have still to make their separated journey of, together, nearly 800 miles before they unite in full maturity.

In his rendering of the colloquial slang of the West, Mr. Baillie-Grohman is not particularly happy. The examples he gives are generally overdone, the really vigorous expressions being weakened by being crowded in unwarranted sequence. When he defines a "rustler" as being synonymous with a pilferer, he is decidedly mistaken (pp. 276–8). The "rustler" is a man of energy and resource, one fit for any emergency—a man who, in Western parlance, "could hang himself up on a nail to sleep," and there is no opprobrium implied in the term. The point is of some importance, as a stranger to the country, following Mr. Baillie-Grohman's usage of the word, might unwittingly give serious offence.

The illustrations of the book, reproduced from excellent photographs, deserve praise. They have been selected to show the character and conditions of the country as well as its animal life, and serve this purpose well, though they are not always strictly applicable to the text.

G. W. L.

EUGENIO BELTRAMI.

BY the death, on February 18, of Prof. Eugenio Beltrami, after a long illness followed by an unsuccessful surgical operation, Italy has lost a mathematician who did much to bring his country to the forefront in the mathematical world almost simultaneously with the ascendancy of Italy in the world of politics.

Eugenio Beltrami was born at Cremona on November 16, 1835, of a well-known and highly-cultured Italian family. After completing his school curriculum in his native town, he went to Pavia, and then studied mathematics for three years under Brioschi. For some years Beltrami had to earn his own living, and an appointment in the Administration of the Italian Railways, which he held first at Verona, and then at Milan, if it afforded him no scope for his mathematical abilities, at any rate furnished him with the means of subsistence. At Milan, in 1860, Beltrami became acquainted with Cremona, whose influence, combined with a study of the works of Gauss, Lagrange and Riemann, opened the way for his development of higher geometry, in which branch of mathematics Beltrami published his first papers, in 1862, in the *Annali di Matematica*.

In the same year he was appointed professor extraordinarius in algebra and analytical geometry at Bologna, and in the following year he became professor ordinarius of geodesy at Pisa, where he enjoyed the friendship of Riemann and Betti. In 1866, Beltrami returned to Bologna, where he occupied the chair in rational mechanics. Two years later appeared what has been aptly regarded as Beltrami's masterpiece, the "Saggio d'interpretazione della geometria non euclidea," published in the *Giornale matematico di Napoli*. We learn that Beltrami's attention was first attracted to this subject by an observation of Lagrange on maps, in which geodesics are represented on a plane by straight lines, and was thus led to consider the properties of surfaces on which the geodesics are represented by linear equations in curvilinear co-ordinates. Beltrami found that such surfaces were the same as surfaces of constant curvature.

He was thus led to examine the properties of the surface of constant negative curvature, to which he gave the name of *pseudosphere*, and the geometry of such a surface was found to be identical with the geometry of Gauss and Lobatschewsky. As his old pupil and successor at Pavia, Prof. Carlo Somigliana, remarks, "It can thus be said that although the germs of his results can be traced back to some of his predecessors, and, in particular, can be found in the profound considerations of Riemann, and other advances have come subsequently, yet his work represents and synthesises the most decisive step that has been made in modern times by the geometric conception of real space."

Nor was the "Saggio d'interpretazione" by any means Beltrami's only contribution to mathematical literature at the period under consideration. We find him extending the properties of surfaces of constant curvature to n dimensional space; and his papers on differential parameters, on the flexure of ruled surfaces, and on the general theory of surfaces, published a few years previously to the "Saggio," are well known to mathematicians.

In 1873, Beltrami migrated to Rome as professor of rational dynamics and higher analysis, and was elected a Fellow of the Italian equivalent of our Royal Society, the Reale Accademia dei Lincei. His sojourn in Rome was of brief duration; for, much to the regret of his friends there, he went to Pavia in 1876, where he lectured on mathematical physics and higher mechanics, and it was not until 1891 that an opportunity offered itself for him to return to Rome. It was only two years ago that Beltrami was prevailed on to accept the office of President of the "Lincei," and last year he was unanimously elected to the senatorial rank. As a general rule, however, he avoided all public appointments, and the only other post he held was on the Italian Council of Education. He preferred to devote his entire energies to the studies in which he was interested, and sought no scientific distinctions; still, the laurels which he had well earned were freely showered on him by the academies of Bologna, Lombardy, Turin, Naples, Paris, Göttingen, Brussels, Munich and Berlin; and the London Mathematical Society was also proud to place his name on its list of foreign mathematicians.

We have hitherto spoken chiefly of Beltrami's work as a pure mathematician, but his later investigations tended more especially in the direction of applied mathematics. Hydrodynamics, theory of potential, elasticity, physical optics, electricity and magnetism, conduction of heat and thermodynamics were all made the subject of papers, each of which "shed a bright light on some difficult or controversial point." In the theory of the potential considerable simplifications of method were made, and the papers on potentials of symmetric distributions and on the attractions of ellipsoids are described by Somigliana as "true models of classical elegance." In the theory of elasticity, Lamé's equations were shown to be intimately related to the euclideity of space, and the generalisations for spaces of constant curvature opened up a new field for research, of which Beltrami endeavoured to make use in accounting for the uncertainties in Maxwell's theory, which substitutes action in a continuous medium for action at a distance.

The last period of his researches was devoted to developing Maxwell's theories of electro-magnetic phenomena, a difficult task, for which Beltrami's mathematical knowledge well fitted him. All who have read Maxwell's treatise realise that it contains many obscure points and demonstrations of hardly a rigorous nature, and most of those who have failed to follow his arguments have preferred to regard the results as statements of Maxwell's views, rather than inquire into the validity of the reasoning on which they were based. Beltrami, on the other hand, being well versed in the art of exact expression and the elegances of neatness of analytical form, was not contented with Maxwell's rough-and-ready methods, but devoted long hours of deep thought to co-ordinating and perfecting the ideas which he regarded as incomplete. Among his latest contributions to the *Atti dei Lincei* we notice a paper on thermodynamic potentials published in 1895.

As a professor, Beltrami's lectures are said to have been characterised by the same perfection of style and exactness of form which are so conspicuous in his writings. His genial manner and high culture made him a centre no less in general society than in the scientific world. Shakespeare's epithet, "Cunning in music and in mathematics" well applies to Beltrami, and we learn from Signor Pietro Cassani's obituary address to the Venetian Academy, that having been taught music in his early days by his mother, and afterwards under Ponchielli, he would often delight his friends by his renderings on the piano of the masterpieces of Bach, Mendelssohn and Schumann.

The life that has been brought to such a sad close must have been in many respects an ideal life. Beltrami had every opportunity for devoting himself to the studies which he chose as his life's work; he knew nothing of rivalries and petty jealousies, as he made no enemies; but, on the other hand, we cannot but suppose that his experience of the necessities of making the best of somewhat uncongenial surroundings during his years of railway work had a beneficial influence on his after life, in preventing Beltrami from attempting to live up to a false ideal. His loss adds another to the many gaps in the mathematical world, but his published works form a fitting memorial of their author, and several of them bid fair to be handed down to posterity among the mathematical classics.

We are indebted to Prof. Blaserna, of Rome, for much valuable information on which this account is based.

G. H. BRYAN.

PROF. ST. GEORGE MIVART.

BY the sudden death, at the age of seventy-two, of Prof. St. George Mivart, the world in general and science in particular are distinctly the poorer. For he was essentially a many-sided man; and although an energetic and accurate investigator in several branches of biology, was in no sense a specialist whose efforts were restricted to the elucidation of abstruse facts or the elaboration of theories in which the general public could take little or no interest. On the contrary, ever since 1870, when he first began to contribute to the higher grade of popular reviews, he has kept himself constantly in evidence, and has thus become known to a very wide circle of readers, especially as the apostle of the evolution of organic nature under divine guidance.

St. George Mivart was born at his father's house in Brook Street, Grosvenor Square, on November 20, 1827. He was educated successively at Clapham Grammar School, Harrow, King's College, London, and St. Mary's College, Oscott; his adoption, in 1844, of the principles of the Romish faith being at that time a bar to his matriculating at Oxford, where it was his father's intention that his education should have been completed. In 1851 he was called to the Bar at Lincoln's Inn, but his legal career, if he ever practised at all, was a brief one; and in a short time his attention was concentrated first on medical and later on biological studies. By 1862 Mivart had made such a reputation in medico-biological studies that he was appointed a lecturer at the Medical School of St. Mary's Hospital. Previously to this, in 1885, he became a Fellow of the Zoological Society, of which body he was elected a Vice-President in 1869, and again in 1896; indeed, he continued in the latter office till 1899, when he was compelled by ill-health to resign. In 1869 his merits were recognised by admission to the Fellowship of the Royal Society. He was likewise a Fellow of the Linnean Society of London, of which body he was Secretary from 1874 to 1880, while he subsequently served for many years on its Council, and at one time as a Vice-President. In 1874 he was appointed Professor of Biology at University College, London. In 1876 he was created a Ph.D. of Rome by the Pope, while in 1884 the degree of M.D. was conferred upon him by the University of Louvain. Subsequently he was nominated Professor of the Philosophy of Biology in the last-named University.

Although various scientific memoirs had previously appeared from his pen, it was in 1870 that Dr. Mivart made his first appearance as an essay-writer in popular reviews; and from that date onwards communications of this nature in the *Quarterly*, *Fortnightly*, and *Contemporary Reviews*, and the *Nineteenth Century*, have made his name a household word. All these were marked not only by conspicuous originality of view, but likewise by a high degree of literary and controversial merit. It is not, however, these communications that it is our present intention to describe. With the appearance, in 1871, of "The Genesis of Species" (two editions of which were issued during the first year of its existence), Dr. Mivart may be said to have first come into prominent public notice; and the attention it attracted may be gathered from the criticisms which it drew from Prof. Huxley and other distinguished evolutionists. As is well known, the author in this volume seeks to put natural selection somewhat in the background as a factor in the evolution of animal life, and to bring into prominence the guiding action of Divine power. An advocate for "creation," the author was careful to distinguish between *absolute* and *derivative* creation; stating that it was with the latter alone that the evolutionist had to deal. At the same time he laid stress on the opinion that while man's body was the result of evolution, the origin of his intellect must be sought elsewhere.

The elaboration of his views as to the relationship existing between human intellect and animal nature in general was given first in "Nature and Thought; an Introduction to Natural Philosophy" (1882), and finally in "The Origin of Human Reason" (1889), as well as in various serial articles.

But on these and kindred subjects Dr. Mivart could not have spoken with authority unless he possessed an accurate knowledge of the physical relationships between man and the other Primates, as well as those between the latter and the lower Vertebrates. And, in 1873, the appearance (in Macmillan's "School Class Books") of "Lessons in Elementary Anatomy," and also of a separate essay on "Man and Apes," showed how wide a grasp the author had obtained of Vertebrate anatomy generally, and of that of the Primates in particular. Within such a small compass as the "Lessons," there are few, if any, works where the student can gather such an amount of information.

Dr. Mivart's great interest in the Primates led to his being asked to contribute the article "Apes" to the ninth edition of the "Encyclopædia Britannica"; and the excellence of that essay led, with the author's permission, to the incorporation of its substance in "The Study of Mammals," by Flower and Lydekker. To the same great undertaking Dr. Mivart also contributed the articles "Skeleton" and "Reptiles." The latter article showed that, although the author devoted much of his attention to the anatomy of Mammals, yet that other groups of Vertebrates engaged a considerable portion of his energies. During the seventies, for instance, he published in the *Trans. Zool. Soc.* a "Memoir on the Axial Skeleton of the *Struthionidae*," a second on that of the *Pelecanidae*, and a third dealing with the structure of the fins of the Elasmobranch fishes, and the nature and homologies of Vertebrate limbs generally. The first of these three is an important contribution to our knowledge of the osteology of the Ratite Birds, being even at the present day an epitome of the greater portion of our information on this subject. And his devotion to Avian anatomy continued to occupy much of his attention even in his later years, as is attested by his papers on the bony structure of certain Lories and Parrots which appeared in the *Proc. Zool. Soc.* for 1895 and 1896. In 1892 appeared a small volume on "The Elements of Ornithology," in which Dr. Mivart gives his views on the vexed question of Avian classification. In this he follows, to a great extent, the system proposed by the late Mr. Seebohm.

To revert to his favourite study of Mammals, in the sixties Dr. Mivart was much occupied with the anatomy of the Insectivora, the results of his work being published in the *Journ. of Anatomy and Physiology* for 1867 and 1868, and in the *Proc. Zool. Soc.* for 1871. Subsequently his attention was turned to the Carnivora, and the year 1881 was signalised by the appearance of his work, entitled "The Cat; an Introduction to the Study of Backboned Animals, especially Mammals." To a great extent this volume was modelled on the lines of Huxley's "Crayfish," published a year earlier. And it affords an admirable example of how the detailed study of one particular animal may be made the starting-point of a general survey of its near and remote kindred.

The study of the anatomy of the Cat naturally led Dr. Mivart to devote his attention to that of the other Carnivora; and in 1882 two papers dealing with the classification, distribution, and anatomy of the Æluroid Carnivora were published by him in the *Proc. Zool. Soc.* Three years later (1885) these were followed by a memoir in the same serial, in which the Arctoid Carnivora were dealt with in a similar manner. The amount of detailed work in these three papers, and the elaborate manner in which it is classified and arranged, is worthy of all admiration, and renders them a mine of information for the anatomist. Unfortunately the author paid no attention to the palæontological aspect of the subject, and was accordingly unaware how essentially false and misleading is the division of the Carnivora into the Æluroid, Cynoid, and Arctoid groups.

After devoting so much time to the study of the first and third of these groups, Dr. Mivart turned his attention to the third; and in 1890 three papers on the *Canidae* made their appearance in the *Proc. Zool. Soc.* In the same year the quarto "Monograph of the *Canidae*" saw the light.

To this long list of literature, which only embraces a portion of Dr. Mivart's work, it must suffice to add that a small but useful little volume from his pen, entitled "Types of Animal Life," made its appearance in 1893.

The result of all the work bestowed on the Carnivora and Insectivora was largely to increase our knowledge of the anatomy of these groups; the most remarkable feature connected with these investigations being the care bestowed on the arrangement and tabulation of the data acquired. In this respect Dr. Mivart's work is a model for future investigators.

As a lecturer, Dr. Mivart was frequently before the public, both at the Zoological Gardens and at the London Institution; and he had that charm of manner and intonation which could surround with a halo of interest even the driest and apparently most unpromising subjects of zoological research. This charm of manner—largely due to a suave and old-fashioned courtliness which survives only in a few instances at the present day—was equally conspicuous in the ordinary intercourse of life. And to all who enjoyed the privilege of his acquaintance and friendship, his cordial greeting—whether when acting in the *rôle* of host, or at a casual meeting—will long survive as a pleasant memory of a remarkable and distinguished personality.

R. L.

NOTES.

The Huxley Memorial Statue will be unveiled at the Natural History Museum on April 28, at 1.15 p.m. Sir J. D. Hooker, G.C.S.I., F.R.S., who was Huxley's life-long and most intimate friend, will present the statue on behalf of the subscribers, and H.R.H. the Prince of Wales will receive it on behalf of the Trustees of the British Museum. Invitations are being sent out to the subscribers, and seating accommodation is being prepared for about three hundred persons expected to attend; there will be additional accommodation for those who are content to stand in the galleries overlooking the ceremony. The statue, which is in white marble, is the work of Mr. O. Ford, R.A., and will be mounted on a marble pedestal, and placed under the arch of the first right-hand recess on entering the Hall of the Museum. This position has been decided upon after careful consideration, and trial with others, as fufilling the conditions of lighting, &c., which will enable the statue to be seen to the best advantage.

Invitations have been sent out for the first (or gentlemen's) soirée of the Royal Society, to be held on Wednesday, May 9.

The eighth "James Forrest" lecture of the Institution of Civil Engineers will be by Sir William Preece, K.C.B., F.R.S., on Monday, April 23, the subject being "The Relations between Electricity and Engineering." The lecture will be repeated on the afternoon of the following day.

Prof. W. Hittorf, professor of physics at Münster, has been elected a correspondant of the Paris Academy of Sciences, in succession to the late Prof. Wiedemann. The election of Sir George Stokes as Foreign Associate of the Academy left a vacancy for another correspondant in the section of physics, and Prof. Van der Waals has been elected to fill it.

The next meeting of the Physical Society will be held on April 27, at 8 p.m., at the Solar Physics Observatory, South Kensington, when Sir Norman Lockyer, K.C.B., will give a short account of the physical problems now being investigated at the Observatory, and their astronomical applications. If the night is fine, the 36-inch reflector, and 10-inch and 9-inch refractors, will be used for the observation or photography of celestial objects and their spectra. The large Apps-Spottiswoode coil and Rowland grating will also be shown in operation.

The following are among the lecture arrangements at the Royal Institution, after Easter:—Dr. Hugh Robert Mill, three lectures on studies in British geography; Dr. Alexander Hill, two lectures on brain tissue considered as the apparatus of thought; Prof. Dewar, four lectures on a century of chemistry in the Royal Institution; Prof. Stanley Lane-Poole, two lectures on Egypt in the Middle Ages; Dr. Alfred Hillier, two lectures on South Africa, past and future. The Friday evening meetings will be resumed on April 27, when a discourse will be given by the Right Hon. Lord Kelvin on nineteenth century clouds over the dynamical theory of heat and light; succeeding discourses will probably be given by Prof. T. E. Thorpe, Prof. J. A. Ewing, Mr. Francis Fox, Sir Henry Roscoe, and others.

On the recommendation of the Fire Brigade Committee, the London County Council have agreed to accept the offer of the Wireless Telegraph and Signal Company (Marconi system) to instal and maintain for a period of two years, in consideration of an annual payment of 50*l.*, the necessary electrical instruments to enable communication to be maintained between the fire-station at Streatham Green and a temporary sub-station in Mitcham Lane, Streatham.

Prof. A. R. Forsyth, F.R.S., has been elected a member of the Athenæum Club under the provisions of the rule which empowers the annual election of nine persons "of distinguished eminence in science, literature, the arts, or for public services."

The first of a series of four zoological lectures will be delivered in the Zoological Society's meeting-room on Thursday next, April 19, at 4.30 p.m. Mr. A. Smith Woodward will speak on the subject of the animals of Australia, and will discuss the difficult question of the origin of Australian fauna.

Dr. W. S. Church has been re-elected president of the Royal College of Physicians of London, by a practically unanimous vote.

The *British Medical Journal* states that, by a recent order of the French Army Medical Service, medical officers are directed to use injections of antitetanus serum in large and repeated doses in all cases of pronounced tetanus. This order is based on the fact that experience has shown that such injections have a favourable effect in many cases.

The exhibition of pictures by the National Record Association, at the rooms of the Royal Photographic Society, will close on Saturday, April 21. On Wednesday, April 25, Mr. F. H. Evans will inaugurate an exhibition of his photographs (mainly architectural) at 8 p.m. with an address. Tickets may be had on application to the secretary of the Society.

To afford an opportunity for observing the total solar eclipse of May 28, from the deck of a ship, the Orient Line have arranged to navigate the Royal Mail steamer *Ormuz* so as to bring the ship upon the central line of totality, off the coast of Portugal, at the time of the eclipse. The journey will be from London or Plymouth to Gibraltar or Marseilles, and the *Ormuz* will leave London on May 25. Passengers will be able to return from Gibraltar or Marseilles by sea, or can travel back from Marseilles overland. The complete journey can be made in fifteen days.

Science states that Princeton University will send a party to Wadesboro', North Carolina, to observe the eclipse of May 28, that place having been selected because it is the most easily accessible of the stations where the weather probabilities are equally good. The party will probably consist of Profs. Young, Brackett, Magie and Reed, Mr. McClenahan, Mr. Russell and Mr. Fisher, with perhaps one or two others. The work undertaken will be mainly spectroscopic, including particularly a determination, both photographic and visual, of the position of the corona line. A set of photographs of the corona will also be taken, and careful visual observations will be made to determine the relations between the corona and the solar prominences.

Sir Andrew Douglas Maclagan, whose death is announced, was born at Ayr on April 17, 1812. He was Surgeon-General to the Queen's Bodyguard, Scotland; vice-president of the Royal Society, Edinburgh; honorary member of the Royal Medical Society, Edinburgh; professor of medical jurisprudence and public health in Edinburgh University from 1862 to 1892, when he retired; president of the Royal College of Physicians, Edinburgh, 1884; and president of the Royal College of Surgeons, Edinburgh, 1859–60.

We have just received news of the death of Mr. George Highfield Morton, well known for his researches on the geology of Lancashire and North Wales. The first edition of his "Geology of the country around Liverpool" was published in 1863; a second edition, which included an account of the north of Flintshire, was issued in 1891, and an appendix to this work, with a geological map of the district, was published in 1897. Mr. Morton contributed many papers to the Liverpool Geological Society, of which he had been president; his more important researches being on the Glacial and Triassic deposits near Liverpool, and on the Lower Carboniferous rocks and fossils of North Wales. He was elected a Fellow of the Geological Society in 1858, and was awarded the Lyell medal in 1892. He was a constant attendant at Section C of the British Association, and was highly esteemed by all who knew him, as a quiet, unostentatious, but most zealous and enthusiastic worker. He died on March 30, aged seventy-three.

It was announced at the opening meeting of the Institution of Naval Architects last week, that the council have accepted an invitation from the president of the Association Technique Maritime, M. L. de Bussy, to take part in the International Congress of Naval Architects and Marine Engineers, which is to be held in connection with the Paris International Exhibition. To promote the success of this Congress, it has been determined not to hold a separate summer meeting of the Institution this year. An invitation has been received and accepted from the Lord Provost, Magistrates, and council of Glasgow, to visit that city in the year 1901. The council have awarded a gold medal to Mr. J. Bruhn for his paper on "The Stresses at the Discontinuities in a Ship's Structure," and a premium to Prof. W. E. Dalby for his paper, "The Balancing of Engines with special Reference to Marine Work." In the course of his presidential address, the Earl of Hopetoun referred to the necessity for restricting the employment of wood in all fighting ships. Many foreign nations are entirely abandoning the use of wooden decks and wood fittings in their military marines. Among the subjects of papers brought before the Institution were:—The action of bilge keels, by Prof. G. H. Bryan, F.R.S.; changes and developments in the construction of ships for the mercantile marine during the last forty years, by Mr. B. Martell; distribution of pressure due to flow round submerged surfaces, by Prof. Hele-Shaw, F.R.S.; strength of elliptic sections under fluid pressure, by Captain W. Hovgaard; mysterious fractures of steel shafts, by Signor R. Schanzer; experimental method of ascertaining the rolling of ships on waves, by Captain G. Russo; influence of depth of water on the resistance of ships, by Major G. Rota; and the balancing of steam engines, by Herr Otto Schlick.

An interesting illustrated article upon the construction of the electric railway to the summit of the Jungfrau, and the electric locomotives in use upon the completed sections, appears in the *Engineering Magazine* (April). The total expense of boring the tunnel, which will be ten kilometres long when completed, is expected to be 200,000*l.* The method of boring is to pierce a series of holes about a metre deep with two electric drills, and then to explode cartridges in them. As the blasting operations can only take place about four times a day, the daily progress is comparatively small—only four metres. The débris passes into tipping waggons worked by an endless rope, and is emptied out at the nearest cross tunnel. At the entrance to the gallery there is a temporary building containing two three-phase 200-kilowatt transformers, reducing pressure from 7000 to 500 volts. The three-phase, low-tension currents thus obtained are used for driving the electric drills, working a ventilator to clear out the smoke after an explosion, and providing power to melt snow for the drills. When the tunnel reaches a height of above 3000 metres, it is expected that difficulties will be encountered on account of mountain sickness. At present the majority of the workmen employed are Italians, but above 3000 metres it is almost certain that they will have to be replaced by Swiss mountaineers. The last station of the railway will be about 66 metres below the summit, which is 4166 metres above sea-level, and the journey from it to the summit will be accomplished by means of a lift. A permanent meteorological observatory wil be erected on the summit, the Railway Commission providing 100,000 francs towards its establishment, and 6000 francs annually towards its maintenance.

A preliminary report on the determination of the mass of a cubic decimetre of water is published to the *Procès verbaux* of the French International Committee of Weights and Measures, by Dr. C. E. Guillaume. The method adopted was essentially the same as those used in previous determinations, consisting in the observation of the weight of water displaced by a body the dimensions of which were carefully measured. Dr. Guillaume employed cylindrical forms, and from the mean of observations made with five cylinders of varying dimensions, the specific mass of water at 4° was found to be 0·999936.

Some observations on the influence of heating on the passage of electricity through rarefied gases are contributed to *Wiedemann's Annalen* by Herr J. Stark. When the space between the electrodes is just sufficient to prevent a discharge from taking place, the introduction of an incandescent body causes the discharge owing to the resistance of the gas decreasing on its being heated. Similarly the fall of resistance caused by the use of an incandescent kathode enables a comparatively small electromotive force to produce a luminous discharge. Herr Stark has passed on to consider the case where the electromotive force is about 100 volts. higher than that which would just suffice for the discharge. In this case it is found that by the introduction of a white-hot body all luminosity may be made to cease, the electric discharge being dark. This effect the author attributes to the heated gas having lost its power of phospherence during the passage of electricity, a transformation which, moreover, is to be accounted for by the gas becoming dissociated by the action of heat, coupled with the property that no phosphorescence occurs in a dissociated gas.

A reinvestigation of the question as to whether the viscosity of dielectric liquids is affected by a uniform electrostatic field is given by Dr. G. Pacher and Dr. L. Finazzi in the *Atti del R. Istituto Veneto*, lix. 2. Contrary to the results of Duff and Quincke, no variations in the viscosity were observed to be caused by the electric field. The method of experimenting was to measure the time of efflux through a pair of liquid condensers, and the liquids operated on were distilled water, ethyl-alcohol, ether, benzol, oil of turpentine and sulphide of carbon. The times of efflux vary slightly in individual experiments, owing to errors of observation; but there is no difference between the means of the results for charged and uncharged condensers beyond what is naturally attributable to accidental causes.

The chief theorem of Lie's theory of continuous groups receives discussion at the hands of Mr. Stephen Elmer Slocum in the pages of the *Proceedings* of the American Academy of Arts and Sciences. The theorem in question is that a particular system of r independent infinitesimal transformations generates a continuous group with r parameters, that is, a group with r parameters in which each transformation can be generated by an infinitesimal transformation of the group. Prof. Study, however, has shown that, notwithstanding the infinitesimal transformations of the special linear homogeneous group satisfy Lie's criterion, nevertheless, not every transformation can be generated by an infinitesimal transformation of this group. Consequently Lie's theorem is subject to certain limitations. So far as Mr. Slocum is aware, the precise nature of the error has not been pointed out, and to show wherein it consists is the object of his paper. The author carries out for a particular group the successive steps in Lie's demonstration of the first fundamental theorem of his theory, upon which the chief theorem, namely the second fundamental theorem, rests. At a certain point in this demonstration an assumption is made in which Lie's error consists.

In the *Meteorologische Zeitschrift* for January, Dr. H. Hergesell continues his valuable discussion of the results of recent international balloon ascents. In this paper he discusses the effect of the density of the air upon the coefficient of inertia of a ventilated thermometer. With respect to the ascents of unmanned balloons, he finds that the registering thermometers, although they may be properly protected against solar radiation, only give accurate results during the ascent, and that even these results require a two-fold correction, owing to the radiation of the parts of the balloon in the vicinity of the thermometers and to the sluggishness of the instruments. The observations during the descent must be used with great caution, as in many cases the thermometers are coated with a deposit of aqueous vapour, which obstructs their proper working. With respect to the temperature conditions of the higher air-strata, the observations up to an altitude of 10,000 metres show in all cases a decrease with height of 40° C. or more. In no case is a decrease in the magnitude of the variation shown with increasing altitude. The various ascents show a great mobility of temperature according to locality; at the same hour differences of 30°–40° C. have been recorded in the higher strata which are only a few hundred kilometres apart.

MR. R. D. WARD records in the *Boston Medical and Surgical Journal* some observations on the condition of the air of an artificially heated room as regards moisture, during winter months. His observations show that the atmosphere of a room is often drier than that of many desert regions.

THE Latian earthquake of July 19, 1899, is described by Dr. A. Cancani in the last *Bollettino* of the Italian Seismological Society. At Frascati, Marino and Grottaferrata, much damage was caused by the shock, and several interesting examples are described. The record obtained by the great seismometrograph at Rocca di Papa shows two very distinct phases before the principal movement began, the first of which Dr. Cancani considers as responsible for the prior effects on animals, and the second for the preliminary sound heard by man. The shock was felt over an area of about 80,000 sq. km., and was also recorded by a seismometrograph at Catania, the waves having travelled there with a mean velocity of 5·5 km. per second. Earlier on the same day occurred the explosion of Etna, and the rainfall for the seven previous weeks was nearly three times the average for the time of year.

IT is but too seldom that our military officers stationed in remote districts devote some of their spare time to the investigation of the natural history of the surrounding country, and we have therefore the more pleasure in welcoming a paper in the *Journ. Asiatic Soc. Bengal*, for 1899, by Capt. A. H. MacMahon (son of General MacMahon), on the fauna of the Gilgit district. The author has added the Ermine to the list of Gilgit mammals, and has also shown that the Bharal (*Ovis nahura*) extends westward into the Hunza valley.—To the same journal Mr. de Nicéville and Major Manders contribute a paper on the butterflies of Ceylon, containing a complete list of the fauna.

ABNORMAL colour-variations in British Lepidoptera forms the subject of a paper (illustrated by a coloured plate), by Mr. Frohawk, in the April number of the *Entomologist*. Very curious is a brown variety of the Tiger-moth, in which the blue spots on the hind wings are, however, retained. In this communication the author very properly refrains from giving names to such individual "sports." Not so a writer in the April number of the *Journal of Conchology*, who proposes to designate a white snail from Gibraltar, *Helix marmorata*. var. *alba*. In view of the present employment of trinomialism to indicate geographical races, such a usage is quite unjustifiable.

THE third of the Liverpool Marine Biological Committee's Memoirs on typical British Marine Animals and Plants is to hand, under the title of "Echinus," by Mr. H. C. Chadwick. It is an admirably written and beautifully illustrated "booklet"; but if the editor wishes to attract popular attention to this series, would it not be better if he used the names "Cockle" and "Sea-urchin" in place of "Cardium" and "Echinus"?

THE issue of the *Proceedings* of the Philadelphia Academy of January 2 contains an interesting paper, by Mr. L. Stone, on the Birds and Mammals collected by a recent expedition to Point Barrow, Alaska. It is stated that, so far as the antlers are concerned, the Barren-ground Caribou of Alaska is indistinguishable from the Greenland Caribou (or Reindeer), although the two are generally regarded as distinct races.

PROF. SYDNEY YOUNG, F.R.S., contributes to the April number of *Good Words* an appreciation of the life and work of Dr. W. H. Perkins, F.R.S. The article is the third of a series, entitled "Present Day Leaders of Science."

THE first number of a new quarterly—*The Humane Review*—has been received. Mr. G. Bernard Shaw writes pleasantly upon nothing in particular, under the title of "The Conflict between Science and Common Sense." He seems to be grieved because science is progressive, and that cherished beliefs of yesterday are disturbed by discoveries of to-day. Mr. W. H. Hudson laments the disappearance of the Furze Wren, or Dartford Warbler, from most parts of England. Other articles deal with various ethical and humanitarian subjects.

THE discovery of Dr. Cohen that metallic tin can exist in two modifications, white and grey, only one of which is stable at a given temperature, led him to study the velocity charge of white tin into grey tin (see NATURE, p. 330). It was found that the velocity for the temperature interval, 10° to 20° C., was extremely small, so small that years would be necessary to prove the change. Dr. Cohen now quotes (*Zeitschrift für Physikalische Chemie*, **23**, 59) some remarks of Dr. Gowland upon the condition of a pewter vase of date about 350 A.D., from which it would appear that the change into grey tin was practically complete after 1500 years, a conclusion confirmed by a dilatometric study of some of the material.

THE field of research opened up by M. Becquerel by his discovery of the radiation from uranium salts, is now being rapidly enlarged by many workers. Besides the radio-active elements, polonium and radium, discovered by M. and Mme. Curie, particulars are given by M. A. Debierne, in the *Comptes rendus*, of another element having similar properties, but belonging to the iron group of metals. It is extracted, like polonium and radium, from the residues from the treatment of pitchblend, and is named by the discoverer actinium. As is the case with all these elements, they have not been obtained even in an approximately pure state, the most that can be done being to concentrate the radio-active material in certain precipitates. Thus the chemical reactions of the most active actinium material so far obtained, and also the spectroscopical examination, show that the product is an impure thorium. It can be shown, however, that the effects observed are due neither to polonium nor radium.

THE additions to the Zoological Society's Gardens during the past week include a Chacma Baboon (*Cynocephalus porcarius*, ♂), a Vervet Monkey (*Cercopitheeus lalandii*, ♀), two Yellow-billed Ducks (*Anas undulata*) from South Africa, presented by Mr. J. E. Matcham; a White-collared Mangabey (*Cercocebus collaris*, ♀), a Ludio Monkey (*Cercopithecus ludio*, ♀) from West Africa, presented by Mr. D. J. Jones; two Bonnet Monkeys (*Macacus sinicus*, ♂ ♀) from India, presented by Mr. T. W. B. Lindgren; a Fennec Fox (*Canis cerdo*, ♂) from North Africa, presented by Dixon Bey; a Marabou Stork (*Leptoptilus crumeniferus*) from Africa, presented by Mr. Justice H. G. Kelly; a Wedge-tailed Eagle (*Aquila audax*) from Australia, presented by Colonel R. B. Ingram; four Spot-billed Ducks (*Anas poecilorhyncha*) from India, presented by Sir Ed. Chas. Buck, K.C.S I.; a Common Duiker (*Cephalophus grimmi*, ♀) from South Africa; a Small clawed Otter (*Lutra leptonyx*), a Bengal Monitor (*Varanus bengalensis*) from India; a Common Hare (*Lepus europoeus*), British; a Greater Sulphur-crested Cockatoo (*Cacatua galerita*) from Australia, deposited; two Squirrel-like Phalangers (*Petaurus sciureus*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

ROTATION PERIOD OF VENUS.—A telegram just received from Herr Backlund, through the Centralstelle at Kiel, reads as follows:—"From four spectrograms Belopolsky has been able to confirm the *short* rotation period of Venus."

ELLIPTIC ELEMENTS OF THE VARIABLE Y CYGNI.—Prof. N. C. Dunér, of Upsala, has computed the elliptic elements of the Algol Variable Y Cygni, and gives his results with a derived ephemeris in the *Astronomische Nachrichten*, Bd. 152, No. 3633.

Elements of Y Cygni.

Epoch	$t_0 = 1885{\cdot}0 + 342{\cdot}8930$d.
Anomalistic motion of apse line ...	$\omega = 0°{\cdot}035928$
Eccentricity	$e = 0°{\cdot}14535$
Anomalistic revolution	$U = 2{\cdot}996933$d.
Semi-major axis	$A = 8{\cdot}0$

PHOTOMETRIC OBSERVATIONS OF MERCURY DURING SOLAR ECLIPSES.—Dr. G. Müller, of Potsdam, has for some years made systematic measurements of the brightness of the planet Mercury for phase-angles varying from 50° to 120°. No observations could be made nearer than 50° from the sun. From his results, he finds that the relation giving the light-curve of Mercury is almost identical with that obtained by other workers in the case of the moon. This similarity could be very severely tested if the brightness of the planet could be determined directly at the phase-angles from 0° to 50°. In the *Astrophysical Journal* xi. pp. 144–147, he suggests that an excellent opportunity to carry out this work will be presented during the coming total eclipse in May 1900. The phase-angle for Mercury at the time of the eclipse will be about 7°, and its angular distance from the sun about 2°.

Venus will be the most suitable object for comparison, being about 40° east of the sun at the time of the eclipse, with a phase-angle of 113°. It will be advisable to use small objectives of very short focus, so that the images of the planets may appear as practically points of light; it is also desirable to employ only those photometers with which (as is the case of Zöllner's) the effect of the different brightness of sky background is eliminated.

VARIATION OF LATITUDE.—Prof. Th. Albrecht, of Potsdam, gives a *résumé* in the *Astronomische Nachrichten*, Bd. 152, No. 3633, of his continued discussion of the results obtained at various stations for the motion of the earth's pole. The observations have been made at the following stations:—Tokyo, Kasan, Moscow, Pulkowa, Prague, Potsdam, Lyons, New York, Philadelphia and Washington, during various periods extending from 1892·3 to 1899·9. The co-ordinates of the pole as deduced from these new results are plotted in continuation of Prof. Albrecht's former curve. During the period 1895·0 to 1895·6, the motion appears from the curve to have been in the opposite direction to that followed since, although several complete revolutions have taken place.

PLANETARY WORK AT THE MANORA OBSERVATORY.—Herr Leo Brenner communicates to the *Naturwissenschaftliche Wochenschrift*, Bd. xv. No. 13, pp. 145–150, his report of the work done at the Manora Observatory during the past year. Besides the drawings of the planetary markings, which is the chief undertaking of the institution, the scope of routine work included observations of the sun, zodiacal light, double stars and meteors. The report is illustrated by twenty-eight reproductions of drawings of the planets Mars, Jupiter and Saturn, showing the various markings mentioned in the text. The spots on the ball of Saturn appear to have been continually seen.

THE DEVELOPMENT OF ASTRONOMY IN AMERICA.

SIXTY years ago the United States had scarcely a single observatory properly equipped for the pursuit of astronomical studies. To-day that country is possessed of the finest observatories in the world, manned by observers of the greatest skill, who devote themselves untiringly to the advancement of the oldest of the sciences.

The success of the American astronomers during this short period has been remarkable. To them we owe important discoveries and precious records in nearly every branch of theoretical and practical astronomy, and especially of late years in the department of astronomical physics. It is impossible here to recount the whole fruits of their labours, but it is worth while to recall a few of the results which we owe to their industry.

The first striking discovery in America was that of Hyperion, the seventh satellite of Saturn, by G. P. Bond, in 1848. In the same line of work, Hall was rewarded in 1877 by the discovery of the tiny satellites of Mars, and more recently Barnard astonished the world by his detection of the fifth satellite of Jupiter, while Pickering claims to have established the existence of a ninth satellite of Saturn. In planetary studies generally, the Americans have been well to the front, and we have seen the unusual spectacle of a powerful refractor primarily devoted with marked success, by Mr. Lowell, to the delineation of the surfaces of our nearest planetary neighbours. Numerous measurements of the dimensions of the various members of the solar system have also been made, and the theory of their motions has been greatly advanced, notably by the well-known investigations of Newcomb.

Cometary astronomy has likewise benefited by their zeal, many new discoveries having been made, and the orbits of a large number calculated; in this branch the Americans are now more active than ever, no less than six of the seven new comets discovered in 1898 being to their credit. Important investigations relating to meteorites and the orbits of meteor swarms have also been carried out, and the name of Prof. H. A. Newton will always be associated with this department of astronomical research.

Sidereal astronomy has been enriched by numerous star catalogues, and double-star observation has been brought to a high standard of perfection by the assiduous efforts of Burnham, Hall and See; while Pickering's "Harvard Photometry" has given us an invaluable record of the magnitudes of thousands of the brighter stars. The study of variable stars has also been very productive, our most important catalogue of these objects being due to Chandler, while a unique atlas of variable stars is in course of publication by Prof. Hagen; here, as in many other directions, Prof. Pickering's ingenuity has been displayed, and he has shown among other things how variables of short period can be readily detected, and the changes studied, by photographic means.

Our catalogues of nebulæ discovered since the time of the Herschels include a large number of entries to the credit of American observers, Lewis Swift having specially distinguished himself in this field of work.

Notable work has also been done in the domain of solar physics. Young's observations of the chromospheric spectrum have only been surpassed by the most recent eclipse photographs, and Prof. Hale was the first to initiate a regular photographic record of the forms of the chromosphere and prominences. Quite recently, the great telescope of the Yerkes Observatory has been used for a very detailed examination of the spectrum of the chromosphere, and even the most minute structure of the carbon flutings in the green has been successfully observed. To Prof. Rowland we owe a great catalogue of close upon twenty thousand of the Fraunhofer lines, the positions of which are stated with a degree of accuracy never before attempted; and physicists and astronomers throughout the world are indebted to this observer for the magnificent diffraction gratings which his skill has placed at their disposal. By the invention of the bolometer, Langley has opened up a new region of the spectrum, and has made numerous important observations by its aid. At the present time a committee of American astronomers is organising the work to be undertaken during the total eclipse of the sun next May, and from a preliminary report which has been issued we gather that they are fully alive to the opportunities which such an event affords.

Astronomy owes an immense debt to photography, and it should not be forgotten that the first photographic impression of a star was obtained on the other side of the Atlantic, by Prof. Bond, in 1850. Among those who early recognised the possibilities of astronomical photography was Rutherfurd, of New York, who obtained numerous pictures of the sun, moon and stars in the early seventies, the full value of which has only lately begun to appear. It was there also that Dr. Draper, in 1872, secured the first photograph of a stellar spectrum which revealed anything relating to the composition of a star, and that Barnard, in 1892, made the first discovery of a comet by the aid of the camera.

The story, however, by no means ends with this pioneer work; celestial photography has been pursued with the greatest success in every direction, notable among the results being Barnard's photographic delineation of comets, nebulæ, and the Milky Way, and the magnificent spectroscopic work of the Henry Draper Memorial carried on by Prof. Pickering at Harvard College.

Within the last few years the energetic director of the Harvard College Observatory has been enabled to extend his operations by the erection of a well-equipped observatory in the clear air of Arequipa, Peru, spectroscopic and other data on a uniform plan for the whole celestial vault being thus secured. Prof. Pickering has, in fact, developed the photographic side of his work into a wonderful detective force, so perfectly organised that no new star of reasonable brightness can escape detection, and no important change in a known star go unrecorded. The munificent gifts to the Harvard Observatory have thus, in Prof. Pickering's hands, been put to the best possible uses.

The work of the Lick Observatory is also largely photographic. Here, the great refractor has been employed with the greatest success by Prof. Campbell in photographing the spectra of nebulæ and bright line stars. More recently special attention has been given to the photographic determination of stellar velocities in the line of sight, with the result that a dozen or so of spectroscopic binaries have already been detected, Polaris and Capella being among the most interesting systems thus recognised. Quite recently, marvellous results have been obtained by Prof. Keeler in photographing the forms of nebulæ with the Crossley reflector. The Director's report for the year ending September 1, 1899, indicates a remarkable state of activity among the comparatively small staff of this observatory. The success of these observers is doubtless in some measure due to the wisdom displayed in the limitations which they have set to their work. A well-defined programme, and concentration upon it, appears to be the policy adopted, and the truly scientific spirit which controls their investigations is exhibited by the following remarks from Prof. Keeler's last report: "Comets which are bright enough to be easily seen at the leading observatories receive only occasional attention, while comets which, by reason of their faintness or unfavourable position, are difficult of observation, are followed as closely as possible. . . . The Lick Observatory makes the most of its natural advantages; and extended theoretical researches, which can be made as well in a city as at a fine observing station, do not form part of our general plan." In this way the output of useful observations is greatly increased, and the co-ordination of different facts can be carried on by workers generally. The same spirit prevails at Harvard Observatory, where "precedence has been given to physical work, since less attention is paid to such work elsewhere," and the photographic records there accumulated have been placed at the service of any one properly qualified to discuss them.

The Yerkes telescope, in the hands of Burnham, Barnard and Hale, has already been very productive. One of the most important pieces of work undertaken here is the photographic registration of the spectra of the Piscian (III.*b*) stars; and the wealth of detail recorded in such difficult objects is truly remarkable.

But it is by no means only in observatories furnished with giant telescopes that astronomical science has been advanced. Admirable work has also been done in unpretentious establishments, and, indeed, with no observatories at all. Gould's investigation of the Milky Way and the distribution of stars is a case in point, and to take another example, a vast amount of energy has been expended in perfecting the *American Ephemeris* and *Nautical Almanac*. Chandler's masterly investigations of the variations of terrestrial latitude also demand separate mention.

Terrestrial researches bearing on astronomical phenomena have not been neglected. Newcomb and Michelson's determinations of the velocity of light are classical examples, and among more recent work reference may be made to Rowland's determinations of the origins of a vast number of Fraunhofer lines, and to Humphrey's and Möhler's investigations of the displacement of spectrum lines due to pressure.

It will be seen, even from this incomplete statement, that the output of astronomical work in America has been very great, and there is every indication that it will go on increasing. The rapid development is doubtless due to various causes, not least among them being the unstinted support given by private benefactors. The American astronomers undoubtedly also owe a great debt to their opticians and engineers, the Lick and Yerkes refractors, with their apertures of 36 and 40 inches respectively, being the crowning triumphs of the instrument makers. Messrs. Alvan Clark's telescopic object glasses have long been justly held in high estimation all over the world, and the skill of Messrs. Warner and Swasey has been fully equal to the task of successfully mounting their mammoth productions.

Some of the success of the Americans may perhaps be attributed to their wise selection of sites for their instruments, when they have been free to exercise their judgment. The Lick Observatory, at an elevation of 4000 feet, is favoured with exceptionally good atmospheric conditions, and the sites of the Yerkes and various other observatories were only decided upon after very careful trials.

Instrumental equipment and good climate, however, are not the only requisites for a successful observatory. Much depends upon the men at the little ends of the telescope tubes, and, we may add, upon the men at their desks or in their laboratories, who bring their minds to bear upon the explanation or utilisation of the phenomena observed, besides suggesting further observations. The training of astronomers is therefore of as much importance as the provision of instruments. Fortunately, America can boast of unparalleled facilities for this necessary training. Students' observatories abound, and in many cases instruction of the most advanced character is obtainable. Of elementary instruction it is scarcely necessary to speak; but American students are to be congratulated if the teaching generally is on such enlightened lines as those indicated in Miss Byrd's "Laboratory Manual of Astronomy," and Prof. Todd's "New Astronomy." A most valuable paper, by Prof. E. S. Holden, on the teaching of astronomy in primary and secondary schools and in the university has recently been published.[1] During the early years of a child's school-life, the lessons must necessarily be simple; and Prof. Holden gives an extremely suggestive sketch of the methods which should be followed, bearing in mind that "the main point is to open the eyes and mind, and the sun and stars are convenient for the purpose." To the teachers of astronomy in secondary schools Prof. Holden also gives many valuable hints. Here astronomy is to be regarded as an "information study," as well as an educative one, and suggestions as to simple apparatus to facilitate the teaching are given.

From our present point of view, however, the most interesting part of Prof. Holden's paper is that referring to the courses of instruction in astronomy offered by some of the American universities and colleges. Particulars are here given of the instruction carried on in fifteen institutions, and they illustrate in the most satisfactory manner the advantages enjoyed by the American student who wishes to acquire an extended knowledge of the subject. The courses are in several cases remarkably comprehensive, and in five of them astrophysics takes an important place in the curriculum. In every case there appears to be an adequate supply of instruments and observatories, and for students desiring to specialise there are abundant opportunities of entering even the best observatories.

The course at the University of Chicago is perhaps the most complete, but the syllabus is too long for quotation; suffice it to say that it includes every department of theoretical and practical astronomy, the astrophysical instruction being carried on at the Yerkes Observatory by the distinguished staff of resident professors and observers. The Director of the Yerkes Observatory some time ago made the following statement as to the relation of that establishment to the work of students:—

"After completing the necessary preliminary work in Chicago, students who desire to devote special attention to observational astronomy or to astrophysics are admitted to the Yerkes Observatory at Lake Geneva, where they are given every possible facility. In addition to pursuing the courses of instruction enumerated in the *Annual Register* of the University of Chicago, students at the observatory may take part in the regular work of research. As soon as they have had sufficient preliminary training, they are encouraged to undertake original investigations of their own." From other notices we gather that this privilege is not restricted to students from Chicago.

At the University of California also an admirable course of astronomy is offered, one item of which may be quoted as illustrating the attention given to practical work:—

"4 A. Practical astronomy. Lectures and observatory work. Navigation and nautical astronomy. Practical work in the

[1] "Report of the Commissioner of Education, 1897-98." Vol. i. p. 869. (Washington, 1899.)

observatory. Six hours observatory, first half. Three hours lecture and six hours observatory, second half."

The University possesses an excellently equipped students' observatory, in addition to the world-famous establishment on Mount Hamilton. Graduates of the University, or indeed of other universities of equal standing, are received at the Lick Observatory to pursue a higher course of instruction in astronomy; every facility consistent with the scientific work of the establishment will be given them, and they will usually be assigned as assistants to some of the astronomers. An illustration of the bond between the greater and lesser establishments is afforded by the recent computation at the students' observatory of the elements of a comet from observations telegraphed by the astronomers at Lick. (Pub. Ast. Soc. *Proc.* vol. xi. No. 70 p. 190.)

From the information which Prof. Holden has collected, we gather that special students of promise have also the privilege of entering into the regular work of the observatories at Harvard College, and the Universities of Yale, Michigan, Virginia, Wisconsin and Pennsylvania.

The special value to the student of this association with the staff of an observatory is admirably stated by Prof. Holden in a report on the Lick Observatory, from which he makes the following quotation: "No institution in the world is better fitted to give such instruction, and there is a special impetus to be gained in an observatory which is regularly pursuing work of discovery and research. The student comes directly into the current, and learns far more by observation of the methods of others than by the study of text-books. He can take part in the regular work of the observatory also." This happy arrangement is not only beneficial to the student. Prof. Holden further remarks: "It is a great advantage to the university as a whole to count among its members a considerable number of active and ambitious young men who are able to work with some independence to advance science, and not merely to acquire what is already known. They set a standard of scholarship to all the undergraduates. Such students can take a useful part in the actual observations of every day as assistants, and after some practice they become valuable aids in our work of computation and observation, and supplement the permanent force of the observatory in an important degree."

No wonder that with advantages like these there is an adequate supply of highly-trained young astronomers capable of fully developing the great resources which the scientific spirit of wealthy Americans has placed at their disposal. It appears to us that it is precisely for want of opportunities for securing the necessary technical training to future observers that the astronomical development of our own country proceeds less rapidly than that of America. While it is possible to obtain a certain amount of tuition in spherical astronomy, and here and there a modicum of practical instruction in the older branches of the subject, facilities for the study of astrophysics are almost completely lacking, and it is a deplorable fact that the universities are especially deficient in this respect.

Under the Science and Art Department a general study of astronomy is encouraged, but the subject is incorporated with a variety of other subjects, under the comprehensive title of Physiography, and no separate certificate for astronomy is granted.

At the universities, astronomical teaching appears to remain in much the same position as the teaching of chemistry and physics before the introduction of practical work in those subjects, the prevailing idea apparently being that if a mathematician can be placed at the head of affairs in an observatory, it matters little who makes the actual observations, or whether observations are made or not. There can be little doubt that means exist for establishing schools of astronomy comparable with those which have arisen for other branches of science, and we sincerely hope that the need for serious attention to practical teaching in astronomy will soon be recognised.

So far as we know, there is only one institution in Great Britain where any attempt is made to give practical instruction in astronomical physics, and even in this case the greater part of the instruction is necessarily of a somewhat elementary character, in consequence of the small amount of time available for the subject.

It is a natural consequence of our inadequate provision for technical education in astronomy—more particularly in the newer branches—that vacancies in our observatories must be filled by observers who have still to make practical acquaintance with the work expected of them. Much loss of time and apparent inactivity is the result.

It may be urged that benefactors of the science of astronomy are less numerous here than in America, but the generous gifts of Dr. F. McClean to Cambridge University and the Cape Observatory, and of Sir Henry Thompson to the Royal Observatory, Greenwich, remind us that they are not wholly wanting. Besides, there are already numerous observatories scattered throughout the country which might be made more productive by putting them in the hands of observers who have received adequate training. Public interest in astronomy is by no means absent, and British observatories would, perhaps, receive a much increased measure of support if it were not for the possible impression that the best work can only be done in America, and that instruments of the largest size are alone useful.

THE FLIGHTLESS RAIL OF NEW ZEALAND.

THE most important ornithological event in New Zealand, in recent years, was the capture of a fourth specimen of the Takahe (*Notornis hochstetteri*), on the west side of Lake Te Anau, in August 1898. Prof. W. B Benham sent us an interesting description of the bird at the time of its capture (vol. lviii. p. 547), and a more detailed account by him is referred to in a paper, by Sir Walter L. Buller, in vol. xxxi. of

Fig. 1.—The rare *Notornis* of New Zealand.

the *Transactions* of the New Zealand Institute (1898), which has just reached this country. The following particulars, with the accompanying illustration, have been derived from this source:—

In size the bird is like a goose, but in colouration it resembles the Pukeko; its breast is a beautiful rich dark blue, becoming duller on the neck, head, abdomen and legs. These last are clothed with feathers for a greater distance than in the native turkey, but they are relatively shorter and much thicker than in the latter bird. One of the most noticeable characteristics of the bird is its beak—a large equilateral triangle of hard pink horn, with one angle directed forwards. At the upper side of the base of the beak is a bright red band of soft tissue, like an attempt at a "comb," such as is possessed by an ordinary rooster, only transversely placed. The whole is a handsome bird of heavy gait, absolutely unable to use its wings for their natural purpose of flying. Indeed, one of the interests of the bird zoologically is that, like several native birds of New Zealand, it is flightless, though its congeners in other countries are able to fly. The Takahe is closely allied to the Pukeko, and not far removed from the Brown Woodhen; all these belong the family of Rails, which usually frequent more or less marshy ground, and in countries other than New Zealand are able to fly as well as other birds. On the other hand, the Takahe can run very actively, and its powerful beak must be a formidable weapon, which it could use with effect on enemies when at close quarters.

The specimen captured in 1898 is a young female, of practically the same size as the bird examined by Sir W. Buller twenty years earlier. The first specimen of the bird ever captured was taken in 1849, and its skin is now in the British Museum (Natural History). The second was caught in 1851, and is also in the British Museum collection. The third was captured in 1879—nearly thirty years after the second had been taken—and its remains were purchased by the Dresden Museum for one hundred guineas. The specimen caught in 1898 appears to be much the best yet obtained, and as much as 300*l.* was offered for it. The rarity of the *Notornis* and other members of the New Zealand fauna makes it essential, as Sir W. Buller points out in his paper, for naturalists to do everything in their power to possess, if not a few living representatives, at any rate a full life-history of the expiring forms.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

A COURSE of six free public lectures on "Prehistoric Chronology" will be delivered by Prof. Montelius at University College, London, on Tuesdays and Fridays at 4 p.m., beginning on Friday, May 4.

MR. J. F. HUDSON has been appointed mathematical lecturer at University College, Bristol, in succession to Mr. J. F. McKean, who has been appointed a mathematical lecturer at the Royal Naval Engineering College, Devonport. Mr. Hudson has for the past three years been assistant lecturer in Jesus College, Oxford, and assistant demonstrator of physics in the Oxford University Laboratory.

MR. W. TUCKER, C.B., a principal assistant secretary to the Board of Education, has retired from the service on reaching the age of sixty-five. The following promotions have been made in the office of the Board of Education:—Mr. J. White (assistant secretary) to be a principal assistant secretary; Mr. F. R. Fowke (assistant director for science), Mr. H. W. Hoare, Mr. W. I. Ritchie, and Mr. H. M. Lindsell to be assistant secretaries.

THE following appointments have been made by the Irish Department of Agriculture and Technical Instruction:—To be superintendent of statistics and intelligence branch, Mr. W. P. Coyne, professor of political economy and jurisprudence, University College, Dublin. To be inspector in agriculture, Mr. J. S. Gordon, Department of Agriculture, Edinburgh University, principal of the Cheshire County Council Agricultural and Horticultural School.

IN commemoration of the fiftieth anniversary of the foundation of the North London Collegiate School for Girls, and in honour of the late Miss Francis Mary Buss, a jubilee number of the school magazine was published on April 4. Mrs. Sophie Bryant, D.Sc., describes the foundation and growth of the school, and shows that it has been a very important factor in the development of secondary education for women. During the past twenty years 59 old students have passed Part I. of the Tripos examinations of the University of Cambridge, and 7 have passed Part II., while 10 have qualified for the ordinary degree. It is noteworthy that 33 of the 59 who passed Part I. took mathematics and natural science as their subjects, and 5 of those who went on to Part II. At Oxford University 9 old students have passed the Honours Moderations (8 taking mathematics), and 8 have passed Final Honours. The College has 116 old students who are graduates of London University, 22 being Bachelors of Science, 4 Bachelors of Medicine, 2 Doctors of Science, and 1 Doctor of Medicine. Since the opening of the degrees of London University to women, 1220 women have graduated, and the North London Collegiate School claims 10 per cent. of this number as old students.

SCIENTIFIC SERIALS.

Bulletin of the American Mathematical Society, March.—Prof. Pierpont, in an article on mathematical instruction in France, gives an account of the way in which France is educating students who wish to become mathematicians, and indicates rapidly what positions a talented young man may hope to reach, how he attains them, and what his duties are in the various stages of his progress. He subsequently calls attention to the advantages which Americans can enjoy in studying mathematics in France, particularly in Paris. The article should be useful.—Prof. Ernest W. Brown reviews M. Poincaré's "Cinématique et Mécanismes, Potentiel et Mécanique des Fluides," the *Annuaire* of the Bureau des Longitudes for 1900, and the "Elements of Precise Surveying and Geodesy," by Mansfield Merriman.—Prof. F. Morley gives a sketch of E. Duporcq's "Premiers principes de Géométrie Moderne," a work to give students, who have some acquaintance with analytic geometry, a liking for the purely geometric point of view.—Prof. F. Cajori briefly notices "Opinions et curiosités touchant la Mathématique d'après les ouvrages Français des xvi^e^, xvii^e^, et xviii^e^ siècles," by G. Maupin (a work, apparently, which merits a place in a modern "Budget of Paradoxes"), and "La Mathématique: Philosophie, Enseignement," by C. A. Laisant.—The number closes with the usual items of "Notes" and "Publications."

THE March issue of the *Bulletin de la Société Astronomique de France* contains an interesting article on solar and lunar halos, with particulars and illustrations furnished by several contributors. Reproductions are given of two excellent photographs obtained by M. Basile de Balasny, at Poltava in Russia, one showing distinctly the halo, the other a definite column of light appearing as a prolongation of the sun above the horizon, the time being just after sunset. The same journal contains four photographs of the eclipse of the moon, December 16, 1899, by M. l'Abbé Moreux; M. Flammarion also continues his illustrated series of naked eye drawings of the moon.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 29.—"Certain Laws of Variation." By H. M. Vernon, M.A., M.D., Fellow of Magdalen College, Oxford. Communicated by Prof. Lankester, F.R.S.

In a former paper (*Phil. Trans.*, B, 1895, p. 577) it was shown that the ova of the Echinoid *Strongylocentrotus lividus* were extraordinarily sensitive to their environmental conditions at the time of impregnation. For instance, by keeping the mixed ova and sperm in water at about 26° or 8° C. for an hour, the plutei obtained after eight days' development were some 5 per cent. smaller than those from ova kept at about 20° at the time of impregnation.

By splitting up into groups the 20,600 measurements which have been made from time to time on *Strongylocentrotus* larvæ, according to the amount of effect which had been produced in their size by varying degrees of favourable and unfavourable environment, and by determining the average variability of the larvæ in each group, it was sought to prove the existence of a law of variability. This may be worded as follows:—"An organism varies least when it is best adapted to its surroundings, so that the less it is adapted the more variable does it become."

Entomological Society, March 21.—Mr. C. O. Waterhouse, Vice-President, in the chair.—Mr. R. McLachlan exhibited an extraordinary aberration of *Enallagma cyathigerum*, Charp. The remarkable feature consisted in the predominance of black over blue in the coloration of the abdomen.—Mr.

M. Burr exhibited a macropterous var. of *Xiphidium dorsale*, Latr., captured by Mr. Harwood near Clacton, remarking that the fact of this species presenting a macropterous form was apparently unrecorded hitherto.—Mr. W. J. Kaye exhibited *Nyssia hispidaria*, an asymmetrical specimen taken on Wimbledon Common.—Mr. C. O. Waterhouse exhibited a tube which formed the entrance to a nest of a *Trigona*, sent from Singapore by Mr. H. N. Ridley. He also exhibited a portion of the resinous mass formed within the trees by these bees, and stated that one of these masses sent from Penang by Mr. Ridley weighed 15 lbs. The true nest of the *Trigona* consists of an irregular mass of cells filled with honey, quite distinct from the resinous formation.—A paper was communicated by Mr. W. H. Ashmead, Assistant-Curator of the U.S. Nat. Hist. Museum, on "The aculeate hymenoptera of the Islands of St. Vincent and Grenada, with additions to the parasitic hymenoptera, and a list of the described hymenoptera of the West Indies."

Royal Microscopical Society, March 21.—Mr. A. D. Michael, Vice-President, in the chair.—A microscope presented by Mr. F. R. Dixon-Nuttall was referred to by Mr. Nelson, who said it was a microscope made by Benjamin Martin, dating about the year 1765. A solar projecting apparatus was packed in the same box; this was the invention of Dr. Lieberkühn, who brought it to London in 1740. Cuff improved it by adding the mirror in 1743. Mr. Nelson then called attention to a number of microscopes which had been sent for exhibition. The first noticed was by Plösel, and was kindly sent by Mr. C. L. Curties; this had already been illustrated in the *Journal*, but he asked the Fellows to inspect the coarse adjustment, which was very peculiar. The milled heads were of large diameter, a projecting stud was fitted on the inner side of each; from these studs descended a pair of links connecting them to similar studs fitted on to the sides of the body of the microscope; on turning the milled heads the studs moved through an arc and thus raised or lowered the body of the instrument. The next five microscopes were sent for exhibition by Messrs. Spiers and Pond. One, a French model, had a push-tube coarse adjustment and a short lever nose-piece fine adjustment. A vertical slot was made in the outer tube or sleeve to allow the fine adjustment to move up and down when the coarse adjustment was being effected. Another and smaller instrument was fitted with a simple mechanical coarse adjustment, which appeared to be a modification of the Plösel adjustment just described. The connecting links of the latter form were omitted; radial slots in the milled heads engaged the stud pins fitted on the sides of the body, so that when the milled heads were turned through a part of a circle the body was raised or lowered. In a yet smaller microscope there was an ingenious detail of construction in the method of securing the outer tube to the limb, by inserting the screws from the inside of the tube and screwing into the limb, a much superior plan to that of putting them in from the other side. There was likewise a diminutive microscope measuring about three inches high, of a cheap type. The next microscope was sent by Mr. Ernest Barker; it was a pocket form, the case measuring, when closed, $4\frac{1}{2}'' \times 2'' \times 1\frac{3}{8}''$. It was an ingeniously arranged little instrument, and very suitable for field work.—Mr. Nelson read an extract, sent by Mr. Jerome Harrison, of Birmingham, from Dr. Hooke's "Microscopium" (1678), describing a method of using convex lenses ("globules") by contact with water. Mr. Nelson thought it interesting to know that the immersion objective was not such a modern invention as was generally supposed. The chairman said this was a very interesting record, showing once more that there is nothing new under the sun. Mr. Nelson said Mr. Powell had just pointed out to him that these lenses of Hooke's differed from the immersion objectives of the present day, which had flat fronts, whereas in Hooke's lenses the water was applied to a convex surface, and so formed a sort of concave lens which corrected to some extent the chromatism of the glass.—Messrs. Swift exhibited a new pattern microscope, the upper portion of which was a replica of the Continental form, while the lower part was of the English type. The vertical axis was thrown more forward than usual, to admit of a larger stage being fitted.—Mr. Rousselet read a note in reference to a large selection of slides of new, rare and foreign rotifera which was exhibited under about thirty microscopes. Special reference was made to specimens of *Trochosphaera solstitialis*, *Apsilus lentiformis* and *Asplanchna herricki* which is much like other species of Asplanchna in shape, but possesses a small glandular organ with the tube opening outward, which is not known to occur in any other rotifer, and the function of which is quite unknown. In addition to this collection there were two specially well-mounted slides of Stephanoceros and Floscularia to show what can be accomplished in the way of preserving rotifers.

Geological Society, March 21.—H. W. Monckton, Vice-President, in the chair.—On a bird from the Stonesfield slate, by Prof. H. G. Seeley, F.R.S. The varied affinities of this large Carinate bird appear to lie midway between the ducks and geese on the one side, and the herons and flamingos on the other. It may be placed in a new family; but its characters are in all respects such as might have occurred in an existing bird. There is no indication of affinity to the *Archaeopteryx*, or that the bird diverged in any way from modern types.—The Lower Ludlow formation and its graptolite fauna, by Miss Ethel M. R. Wood. After dealing with the literature of the stratigraphical and palæontological sides of the subject, the author passes to a full consideration of the sequence and character of the Ludlow rocks in the following localities:—The Ludlow district, the Builth district, the Long Mountain; and gives a briefer account of those of the Dee valley, the Lake district, Southern Scotland, Dudley, and the Abberley Hills While the Wenlock shales are characterised by *Cyrtograptus* and by the *Flemingii*-type of *Monograptus*, in the Lower Ludlow shales the *colonus*- and spinose forms of *Monograptus*, such as *M. chimaera*, are abundant. The line between Lower and Upper Ludlow is drawn at the top of the Aymestry limestone. The Lower Ludlow rocks are divided into five graptolitic zones, which are not constant in character or thickness in the different areas.

Anthropological Institute, March 27.—Mr. C. H. Read, President, in the chair.—A discussion of "Native life and customs in Sarawak" was opened by Prof. A. C. Haddon, who exhibited a series of lantern-slides, made from photographs taken by members of the recent Cambridge Anthropological Expedition. The earlier ones illustrated the river scenery of the Baram district of Sarawak, and the way in which travel is accomplished in that region, while the remainder were mainly concerned with the domestic life of the natives. All the houses, as was shown in the photographs, are built on the banks of rivers, and are of great size, a village usually being composed of a single house or of a long string of intercommunicating houses. These are built on posts, 10 ft. or 15 ft. in height, and each consists of a long verandah in which is centred nearly all the social life of the community. Hanging from its rafters are usually trophies of skulls of the inhabitants' enemies; under the skulls a fire is kept burning and many sacred objects are associated with them, including stone implements which are handed down from father to son, and in some cases are looked upon as the teeth and toe-nails of the Thunder God. The verandah is often decorated with carvings and painted boards, and ornamentation of various kinds, according to the artistic genius of each tribe, is found on the implements and objects of every-day use. A partition, which runs the whole length of the building, separates the verandah from the dwelling-places of the various families, each of which inhabits a private set of rooms opening by one door into the verandah. Outside the houses are wooden images, posts, and sacred stones at which offerings are made on important occasions. The occupations of the natives were also illustrated.—Mr. C. Hose, resident of Baram, Sarawak, also showed some slides, and said, in reply to a question based upon the statements of Bock and other travellers, that cannibalism existed in Borneo, that there were cases in which human flesh was eaten, but he did not think they could be properly called cannibalism. Sometimes they cut off strips of flesh from their enemies, but these were not eaten, as some observers had too hastily concluded. On the contrary, they were stored in bamboos and used as an offering to the hawks from which the omens were taken. The occasions on which human flesh was eaten were cases of chronic illness in which a small piece, swallowed with great difficulty by the patient, was supposed to be curative. In Dutch Borneo the people did roast and eat human flesh, but only very rarely, and the practice had been stopped by the Dutch. When a male child about fourteen years old was very ill, it was thought proper to keep him alive, if possible, at the expense of a female life, which was less valuable; hence, as a last chance of saving his life, a sister would be sacrificed, and a small piece of the flesh given to the boy to eat. A large part of Mr. Hose's valuable collection of native objects from Baram was exhibited during the evening.—At the forthcoming meeting, Tuesday, April 24, Prof. Haddon will give a similar account of the researches of the Cambridge Expedition in Torres Strait, and Dr. Rivers will describe his genealogical method of collecting social and vital statistics, which was applied with success in the same district.

Zoological Society, April 3.—Prof. G. B. Howes, F.R.S., Vice-President, in the chair.—Mr. G. E. H. Barrett-Hamilton contributed a paper, entitled "Notes on *Mus sylvaticus* and its Allies, Subspecies and Geographical Variations."—A communication was read from Mr. Stanley S. Flower containing an account of the Mammals of Siam and the Malay Peninsula.—Mr. A. Smith Woodward communicated a paper, by Dr. Einar Lönnberg, on a piece of skin found along with the remains of *Grypotherium* in Cueva Eberhardt, Patagonia. A detailed description and comparison of the specimen led to the belief that it belonged to the extinct horse—*Onohippidium*. Dr. W. G. Ridewood added a note on the structure of the hair bordering two equine hoofs, probably fœtal, found in the same cave by the La Plata Museum expedition. The hair agreed in most respects with that described by Dr. Lönnberg, and thus seemed to confirm his determination.—Mr. C. Warburton exhibited and described a remarkable new Attid Spider (*Mantisatta trucidans*), the chief characteristic of which was the possession of predaceous front legs, the spines being so arranged as to form a prehensile weapon. It had been taken in Borneo.

Mineralogical Society, April 3.—Prof. G. D. Liveing, F.R.S., Vice-President, in the chair.—Prof. W. J. Lewis showed the application of Grassmann's method to the calculation of the angle between two poles.—Mr. R. W. H. T. Hudson gave a solution of the problem to determine the position of points and planes after a rotation through a definite angle about a known axis.—Mr. L. Fletcher described the methods employed in the chemical analysis of the Mount Zomba meteorite.—Dr. A. Hutchinson gave the results of a determination of the refractive indices of chalybite and diallogite.—Mr. G. T. Prior pointed out the close crystallographic relationship between hamlinite, florencite, beudantite and svanbergite, and showed that in chemical composition these minerals, together with plumbogummite (hitchcockite), all conform to formulæ analogous to that of hamlinite if, in the case of beudantite and svanbergite, one molecule of P_2O_5 be regarded as replaced by two molecules of SO_3, *i.e.* by S_2O_6; in conformity with this result the alkaline earth in svanbergite was found to be strontia and not lime.—Mr. Prior also contributed a paper on Ægyrine- (and Riebeckite) -Anorthoclase rocks from near Adowa, Abyssinia, which form a series strictly analogous to Brögger's "Grorudite-Tinguaite" series of the Christiania district, the more acid group containing quartz, and the more basic, nepheline.—Prof. H. A. Miers exhibited specimens of anatase and brookite from Tremadoc.

Mathematical Society, April 5.—Lieut.-Colonel Cunningham, R.E., V.P., in the chair.—The following communications were made:—On the addition theorem for the Bessel functions, by Mr. H. M. Macdonald.—The orthopticloci of curves of a given class, by Mr. A. B. Basset, F.R.S.—The uniform convergence of Fourier's Series, by Prof. Love, F.R.S.—Extension of orthogonal and Boolian co-variants, by Major MacMahon, F.R.S.—A paper was also received from Mr. Bromwich, entitled "On Weierstrass's canonical reduction of a 'schaar' of bilinear forms."—The chairman announced that the May meeting would be made "special," in accordance with a resolution already made known to members.

MANCHESTER.

Literary and Philosophical Society, April 3.—Prof. Horace Lamb, F.R.S., President, in the chair.—A paper on "Aërial Locomotion" was read by Mr. Henry Wilde, F.R.S.

EDINBURGH.

Royal Society, March 19.—Lord Kelvin, President, in the chair.—Dr. Thomas Muir communicated three papers: (1) A development of a Pfaffian having a vacant minor; (2) the theory of alternants in the historical order of its development up to 1841; (3) Jacobi's expansion for the difference-product, when the number of elements is even. In the first paper, the expansion was obtained as a sum of partial products, each of which was a minor determinant multiplied by the complementary minor Pfaffian of the original Pfaffian; and the third paper contained a proof of Jacobi's rule for expanding the difference-product $\zeta^{\frac{1}{2}}(a, b, c \ldots)$ as a series of partial products, each of which is a Permanent multiplied by a Pfaffian.—Dr. A. Galt read a paper on the heat of combination of metals in the formation of alloys, completing the work of previous papers on the same subject. It was shown that, in the formation of copper and zinc alloys, the heat of combination was negative for small percentages of copper; then, as the amount of copper was increased, it became positive, and obtained a maximum when the percentage of copper was about 38. For higher and increasing percentages of copper the value of the heat of combination gradually fell off to zero.

PARIS.

Academy of Sciences, April 2.—M. Maurice Lévy in the chair.—On a new gaseous body, sulphur perfluoride, by MM. H. Moissan and P. Lebeau. By the action of fluorine upon sulphur two fluorides of sulphur are produced, only one of which is absorbed by potash. The unabsorbed gas, which is very stable towards chemical reagents, has the composition SF_6.—On the origin of the fossil trunks in the coal-measures, by M. Grand' Eury. From a study of the positions in the coal-measures in which *Cal. cannoeformis*, *Arthropitus* and *Calamodendron* occur, the author concludes that there can be no doubt that these Calamites are not in the position in which they originally grew, as is proved by the numerous adventitious roots surrounding the stems.—Report on a memoir of M. Torres, entitled "Calculating Machines." The paper gives a complete theoretical solution of the problem of constructing algebraical or transcendental functions by machines. There is also an account of a machine actually constructed for the solution of certain types of algebraical equations of which frequent use is made.—Prof. Van der Waals was elected a Correspondant in the Section of Physics in the place of Sir G. G. Stokes, elected Foreign Associate.—Remarks on the criterium of Tisserand, by M. Gouey. A discussion of a theorem given by Tisserand to decide if two different orbits given by observation may or may not belong to the same comet, owing to the effect of attraction of a planet.—On differential equations of the third order with fixed critical points, by M. Paul Painleve.—On an inversion of a double integral, by M. J. Le Roux.—On the geometrical applications of Abel's theorem, by M. Ch. Michel.—On a machine for solving equations, by M. Georges Meslin. The machine consists of a balance carrying upon its beams at varying distances from the point of support a series of solids of revolution, partially immersed in a liquid. If the depth immersed is x, the forces exercised upon the solids are represented by x^n, $x^{n'}$, $x^{n''}$; they act at distances p, p', p'', and there is the force A acting at unit distance. Hence x satisfies the equation

$$px^n + p'x^{n'} + \ldots + p''x^{2''} = A,$$

and the height x will be the solution of the equation. The solution of the equation $5x^3 - 4x^2 - 7x = A$ is worked out as an example.—On the property of certain bodies of losing their phosphorescence by heat, and of recovering it on cooling, by M. Gustave le Bon. Some radio-active barium chloride was found to lose its power of phosphorescing at 200°, but to regain it on cooling. Quinine sulphate was found to behave in a similar manner.—Velocity of propagation of electro-magnetic waves in bitumen, and in bitumen-covered wires, by M. C. Gutton. It was found experimentally that in bitumen the electro-magnetic waves are propagated with the same velocity, whether they are guided by wires or not.—On the production of electrostatic images in sensitised plates, by M. W. Schaffers. The results obtained are of interest from the point of view of the exploration of an electric field.—On the influence of iron on the discharge of a condenser through an induction coil, by M. G. A. Hemsalech. The introduction of the iron diminishes, and finally destroys, the oscillatory character of the current, the changes being readily studied by the appearance of a Geissler tube placed in the circuit. The effect of the iron is analogous to that produced by the introduction of a large resistance.—On some optical peculiarities of Geissler tubes under the influence of a magnetic field, by MM. N. Egoroff and W. Georgiewsky.—The use of new radio-conductors for telegraphy without wires, by M. C. Tissot. The Branly tube is placed in a magnetic field, the lines of force of which are parallel to the axis of the tube, the powder being composed of some magnetic substance—steel, nickel or cobalt. The sensibility of the apparatus is thus greatly increased, messages being readily received from a station 30 kilometres distant, and at the same time the regulation and adjustment of the tube is rendered much more simple.—The auto-cohesion of charcoal, and on the application of this discovery to telephonic apparatus for receiving the signals in wireless telegraphy, by M. Thomas Tommasina. A description of an instrument for receiving the Hertzian waves by means of a telephone. The apparatus is very sensitive, and works quite regularly even with such a strong current as three accumulators in series.—On a new radio-active element, actinium, by M. A. Debierne. The new element is obtained from the residues of pitchblende, and, except for its radio-activity, behaves as an impure thorium salt.—Solubility of a mixture of salts having a common ion, by M. Charles Touren. An experimental study from the Nernst point of view of the solubility of mixtures of potassium chloride and nitrate, and of potassium bromide and nitrate, the results being given graphically.—Action of hydrogen upon antimony sulphide, by M. H. Pelabon. The interaction of hydrogen and sulphide of antimony in sealed tubes at 440° showed that the composition of the gaseous mixture, hydrogen sulphide and hydrogen, was constant and independent of the amount of solid sulphide or of antimony present. At 625° the results were similar, and the inverse reaction of hydrogen sulphide upon antimony reached practically the same equilibrium.—On an arsenide of nickel, by MM. Albert Granger and Gaston Didier. Reduced nickel heated in a current of carbon dioxide carrying the vapours of arsenic trichloride gives an arsenide, Ni_3As_2.—On the biphosphide of tungsten, by M. Ed. Defacqz. By the action of dry hydrogen phosphide upon tungsten hexachloride at 450° C. a new compound, WP_2, is obtained, the properties of which are given. A chlorophosphide, a double phosphide, and another new phosphide were obtained from this.—On a new terpenic alcohol and its derivatives, by M. P. Genvresse. The new alcohol, pinenol, $C_{10}H_{16}O$, is obtained by the action of nitrous vapours upon pinene or essence of turpentine. A new oxime, pineononoxime, is obtained at the same time, the ketone corresponding to which is readily obtained by the oxidation with chromic acid of the pinenol.—Action of phenyl isocyanate and isothiocyanate upon the dibasic acids, by M. Élophe Bénech. The Haller reaction is a general one, and allows of the preparation of azelaic dianilide; phenyl isothiocyanate behaves like the isocyanate with fatty dibasic acids, with the exception of the malonic acids.—Influence of an active vegetation upon the formation of thuyone and thuyol, by M. Eugène Charabot.—Considerations on the differences which exist between the fauna of the Opistobranchia of the ocean coasts of France and of the Mediterranean coasts, by M. A. Vayssière.—On the zoological affinities of the Phoronidia and Nemertinæ, by M. Louis Roule.—On the embryonic development of the Cestodia, by M. G. Saint-Remy.—Sounding and analysis of the sediment of Lake Galescu in the Southern Carpathians, by MM. de Martonne and Munteanu Murgoci.—On the strata near Bray, by M. Munier-Chalmas.—Contribution to the study of the antileucocytic serums and their action on the coagulation of the blood, by M. C. Delezenne.—On the fixation of alkaline bases in the mineral skeleton of the human fœtus during the last five months of pregnancy, by M. L. Hugounenq. An analysis of the changes in the ratio of soda to potash in the mineral skeleton of the fœtus from the fourth to the ninth month.—On the physiological properties of nitriles, by M. Edmond Fiquet. An experimental study of the toxic effects of injections of acetonitrile, sodium cyanacetate, cinnamic nitrile, and sodium α-cyanocinnamate.—Variations in the amount of iodine present in the thyroid gland of the newly-born under divers pathological influences, by MM. Charrin and Bourcet.—Experimental reproduction of caries of the teeth, by M. J. Choquet.—On a new pathogenic microbe in the rabbit, *Bacillus myophagus cuniculi*, by M. C. Phisalix. The bacillus is found in a rare disease of the rabbit, chiefly affecting the muscles.—Heterotopic differentiation. The teratological process, by M. Étienne Rabaud.—Therapeutic action of the acid phosphoglycerides, by M. G. Bardet.

AMSTERDAM.

Royal Academy of Sciences, February 24.—Prof. H. G. Van de Sande Bakhuyzen in the chair.—Prof. Van Wyhe read a paper on a simple and quick method of preparing picrocarmine.—Prof. W. H. Julius read a paper on solar phenomena considered in connection with anomalous dispersion of light.—The following papers were presented for publication in the *Proceedings*:—Entropy of radiation (ii.), by Mr. J. D. van der Waals, jun.—A paper on the formation of trisubstituents of benzol from disubstituents, by Prof. A. F. Holleman.—Enantiotropy of tin (iv.), by Dr. Ernst Cohen.—Inquiries into the system $TlNO_3 + AgNO_3$, by Dr. C. van Eyk. Melted mixtures of the two salts successively deposit: rhombohedral and then rhombic $TlNO_3$ on the $TlNO_3$ side, and rhombohedral and then rhombic $AgNO_3$ on the $AgNO_3$ side, while out of the mixtures of 48–52 mol. per cent. the double salt $AgNO_3$ is deposited, which melts at 83°. Below 27° this salt undergoes a change, either by passing into another modification or by splitting up into its components.—Rational curves in space, by Prof. Schoute.

DIARY OF SOCIETIES.

WEDNESDAY, APRIL 18.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Demonstration on the Structure of some Palæozoic Plants, with Sections of the Plants thrown on the Screen: Wm. Carruthers, F.R.S.

THURSDAY, APRIL 19.

LINNEAN SOCIETY, at 8.—Alpine Vegetation of Tibet and the Andes: W. Botting Hemsley, F.R.S., and H. H. W. Pearson.—On some Mosses from China and Japan: E. S. Salmon.

FRIDAY, APRIL 20.

EPIDEMIOLOGICAL SOCIETY, at 8.30.

CONTENTS.

THURSDAY, APRIL 19, 1900.

ECONOMIC SCIENCE.

The Distribution of Income. By William Smart, M.A., &c., Adam Smith Professor of Political Economy in the University of Glasgow. Pp. xv + 341. (London: Macmillan and Co., Ltd., 1899.)

POLITICAL Economy is frequently called the dismal science. Just as frequently it is denied the name of science at all, and the denial is fully justified as regards many books on Political Economy, which are full of vague speculation and rhetoric. A book like the present, however, shows the reality of the science, and how far, indeed, it is from being more dismal to the ordinary man than any other science which requires close thinking to understand it. A little reading of the present book will, indeed, prove to any intelligent reader that the analysis of the processes of exchange, which it is the function of Political Economy to examine and explain, is full of constant interest. Mr. Smart's special object is to show the distribution of the aggregate of what people call their individual incomes, and incidentally he throws a great deal of light on the production of the incomes themselves and what is meant by it, as well as on the automatic organisation of industry, which is the condition of the production and distribution. As a corollary, he discusses, from a somewhat novel point of view, the question of the socialistic organisation of society, by which so many think the present organisation can be superseded; and the proof he furnishes that production and distribution cannot but go hand in hand, and that equitable distribution is better provided for by the present organisation than in any other conceivable way, will be found most striking, and impossible for the Socialists to answer.

The initial point of the analysis is the connection which the author establishes between the aggregate of the individual money incomes of a community and the real income of that community; that is, the actual commodities and services which are represented by the money incomes. The reason for this is well set out in the introductory chapter. A man of business and individuals generally reckon their incomes in money. The income is so much "money." The economist, on the other hand,

"becomes so conscious of the inadequacy and ambiguity of the money measurement that he often fights shy of it altogether, and speaks of income as commodities and services, forgetting that in so doing he has stepped off the platform of the ordinary man. At the same time it may be confessed that he is not altogether consistent in this attitude. Usually, when he passes from the consideration of the making of goods to that of selling them and paying the various makers for the making, he falls into the habit of the people around him, and thinks of income as merely so many shillings or sovereigns."

The author does not fail, however, in his identification of the two things, and in proving the identity he establishes very clearly how production and distribution go hand in hand, and that the one, in a modern industrial community, is not conceivable without the other.

Without going into the detail of the author's classification of income, which is hardly necessary in a general study, except for purposes of illustration, we may simply notice that there are three main classes of money income in a country like the United Kingdom. First of all there is the money income arising from the rent of land and houses, and the interest or profits upon capital. Second, there are the money incomes of the professional classes, of the army, navy, and civil services, and of others who render services to the community, but who are not usually spoken of as the working classes. Third, there is the income of the working classes themselves, the sum paid to them for the labour which they expend. Practically, there is no theoretic distinction between the second and third classes of income. The income in both cases is a payment for services rendered. Even the first classes of income, however, cannot be considered as purely the return upon idle capital, which is received by the fortunate possessors of the capital. Nothing is more interesting in the author's analysis than his demonstration of the amount of labour and anxiety which goes to the making of profits upon capital in almost any form, the capital which can bring in an income to its possessor almost without labour being much more limited in fact than is usually imagined. It is clear also that the share which is paid in respect of capital for a given production still leaves the amount of the share which is paid in respect of labour enormously greater, in fact inconceivably greater, than the amount which would come to labour without the capital. The author shows very clearly also, in a most interesting chapter (Chapter xi.), that a vast amount of service is rendered to the community which is unpaid, particularly, in this country, the labour of men engaged in public services, such as members of Parliament, municipal, county and parish counsellors, magistrates, students, explorers, managers of public institutions, and the like. To these must be added the greatest unpaid service of all, that of women in the household. The resources of a community accordingly are not merely the paid services which constitute the aggregate of the money incomes, but those other services also by which the community benefits, although they are not paid for or assessed in any way.

The main point of the analysis, as it proceeds, is apparently to be found in Chapter xii., in which it is established that the money income is limited by the real income, the two things being identical, and that in the distribution of the real income an increase that goes to one contributor means a deduction from all the other contributors and *vice versâ*. It follows from this also that the total production of the community is the measure of what can be distributed, and the only way in which the community as a whole can advance is by an increase of the total production or an improvement in quality.

The author gives here a very good illustration, that of a rich man's daughter, of whom the complaint is sometimes made that by going into the labour market and competing with working women who have to depend upon their work for a livelihood she takes the bread out of their mouths.

"Let us suppose that she has been getting a dress allowance of 30*l.* from her father, and that in view of her making 12*s.* 6*d.* a week in typewriting he stops the allowance. There is no difference to the girl except the honest glow of independence. But what of the father?

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He has now a sum of 30*l.* of unspent income. Suppose, to make the argument quite clear, that with this sum he engages another typist in his own office. Is this not a new opening in the industry? And granted that Miss Dives has displaced another typist, if this displaced one gets the new situation, has this competition taken the bread out of Miss Lazarus' mouth? The position, of course, practically, is that the new typist has added a new sum of wealth to the community, and is paid by the value of this new sum."

In this way the author deals with the popular fallacy that there is in a community only so much work to go round, and that if some are unemployed, the way to get this margin into work is to shorten the hours of those who are employed. The exact reverse is the truth. The way to produce more employment is to increase the production of those who are already employed, and so cause a greater demand for labour upon which the value of that increased production is spent.

The author discusses at great length, in the second part of the book, the principles of distribution, and we are sorry that we have not left ourselves space to follow him as much as we should like. The demonstration is clear, however, that no distribution of the aggregate income of a community upon any principle of equal needs or other such principle dreamed of by Socialists is even conceivable, and that the only way, in fact, that rough justice can be done is by the income of each individual being assessed at what his services fetch in the open market. This is the essence of the individualistic structure of society, and its justification is that there is no other way of measuring individual services against each other.

Altogether, we must commend the book very highly as a careful study of most difficult problems. The author's style is clear and pointed, and there is not an obscure page in the book. It is an excellent work to put into the hands of the economic student. R. GIFFEN.

PRACTICAL MATHEMATICS.

Practical Mathematics. Summary of Six Lectures delivered to Working Men by Prof. John Perry, D.Sc., F.R.S., February and March 1899. (London: Eyre and Spottiswoode, 1899.)

THESE Lectures were delivered as introductory to the new subject of Practical Mathematics, recently established in the examinations of the Science and Art Department; but, incidentally, they serve to show how we have come by our state of lethargy, out of which we have had so rude an awakening.

Recent events in South Africa have given a shock to our insular self-sufficiency, and made the reflective tremble to think what would have happened, remembering the fate of France, if we had been involved with a real European power, with no opportunity of gaining time for a reorganisation of our antiquated methods.

We have lost initiative and flattered our own superiority, instead of observing the marvellous progress of other countries; and this self-sufficiency is especially noticeable in our scientific and practical methods, so that among us it was considered hopeless for a benighted foreigner, French or German, however hard he might work, to rival methods we could acquire without effort.

Our practical men have been content to jog along by rule of thumb and the knowledge acquired from endless mistakes, imagining the rest of the world felt its way in the same blind fashion; holding no communication with the theorists, who, as mostly engaged in the educational line, were high up in an æthereal plane of thought, and despised all practical applications of theory to nature, ignoring the ideas which are in the course of transforming the conditions of civilisation.

These Lectures on Practical Mathematics are useful in lifting the thoughts of the working man out of his narrow groove; and are also worth the study of the pure theorist, in showing him how to take the additional and difficult steps, hitherto neglected, but required for making his theory of immediate practical utility; at the same time to give him some useful hints for smoothing the initial path of mathematics from needless difficulties.

The Lectures begin with some valuable advice on the proper method of performing the simple arithmetical operations, a subject which is carried out with us in a scandalously antiquated manner. The keynote of practical numerical computation is given in § 3:—

"When calculating from observed quantities, it is *dishonest* to use more figures than we are sure of."

Suppose π is to be squared, taking its value as 3·1416; according to our obsolete methods, the result would be worked out to nine significant figures, even if five only were to be retained; the proper method, of writing the multiplier in reverse order, is explained on p. 4; so, too, with division on p. 5. Mantalini had the true arithmetical sense when he passed his remark on the bill of sale; but our schoolmasters proceed on the proverb—"Take care of the pence, and leave the pounds to take care of themselves"—thus reversing the relative importance of the figures.

Prof. Perry is a true disciple of Squeers, the discredited inventor of our modern system of technical education, hampered as he was by an incompetent demonstrator. After giving the smallest possible preliminary explanation, he makes the student think out the principles for himself in the course of a variety of well-chosen applications of actual interest. The Slide Rule, never mentioned in scholastic treatises, is introduced at once for practical calculations; this instrument rejects automatically all the unimportant and *dishonest* figures in the arithmetical operations of multiplication, division, involution and evolution. After a short description with a diagram, Prof. Perry finishes with the sound advice:—

"Think it out for yourself; practise multiplying simple numbers; *ask nobody to help you*, and you will rapidly get familiar with, and fond of, the Slide Rule."

The celluloid scale of the latest patterns enables the figures to be read off with such increased accuracy that the Slide Rule may now supplant all books of Mathematical Tables and Logarithms for physical and engineering purposes, as measurements can rarely be made beyond four significant figures in Lord Kelvin's opinion.

A Table of four-figure Logarithms and Antilogarithms is appended, and further on a method is given (due originally to Mr. Edser) of calculating these logarithms, with which must be contrasted the elaborately difficult treatment of ordinary mathematical treatises, depending on that elusive abstraction, the Exponential Theorem, which, as these Lectures show, may be omitted and disregarded in a course of Practical Mathematics. We remember the elaborate and majestically slow overture of Todhunter's Differential Calculus, wherein the initial motive of the Exponential Theorem is developed at such length, pausing to investigate the influence of fractional as well as infinite steps in the neighbourhood of the limiting infinity. No wonder the subject of the Calculus was a sealed book to all but a few of our students. Contrast this with the good fortune of the French schoolboy, who is introduced to the notions of the flow of variable quantities, and to the sacred symbols of the little d and the long $\int$ in a course of elementary algebra, such as "Cours d'algèbre élémentaire, conforme aux derniers programmes."

Omitting all reference to the Exponential Theorem, and dealing only with the common logarithms employed in ordinary calculations, the number x is defined as the logarithm of y from the relation $10^x=y$, $x=\log y$.

Then, by employing the ordinary arithmetical operation of square root, Mr. Edser has given a ready method of starting a calculation of the logarithms, or rather the antilogarithms, as follows :—

x	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{8}$	$\frac{1}{16}$	$\frac{1}{32}$
y	$\sqrt{10}$	$\sqrt[4]{10}$	$\sqrt[8]{10}$	$\sqrt[16]{10}$	$\sqrt[32]{10}$
y	3·1623	1·7783	1·3336	1·1548	1·0746
$\log y$	0·5000	0·2500	0·1250	0·0625	0·03125

The cube root of 10, worked out by ordinary arithmetical methods, and the fifth root of 10, obtainable by Horne's method, will provide additional antilogarithms; and thence by multiplication, we find y for $x=\frac{3}{32}, \frac{5}{32}, \ldots, \frac{3}{16}, \ldots$; and plotting these relations by a curve on squared paper (NATURE, p. 415, March 1, 1900, Dr. A. Dufton), we can arrive at the simple results of $10^{0·30103}=2$, $10^{0·4771}=3$, $10^{0·8451}=7, \ldots$; and thence construct the chief divisions of the Slide Rule, and by further interpolation calculate the Table of four-figure antilogarithms and logarithms, which suffice for all practical purposes.

Even the theoretical student, who cultivates mathematics as a subject which he will be called upon to teach in his turn, but never to employ on vulgar practical applications, would profit by approaching the study of logarithms in the same way. Afterwards he may open a page of seven-figure logarithms, and consider how much calculation has been expended on it; he will be surprised to find that, after he has written down the logarithms of a few of the composite numbers to serve as bench marks, the Arithmometer set at a constant difference will run out the intermediate logarithms as fast as the handle can be turned, with an occasional change in the eighth decimal of the difference, wherever a bench mark shows that it is required. A little elementary drill of this kind will soon substantiate Prof. Perry's complaint (p. 38):—

"Some friends of mine assert that no man or boy ought to be allowed to use logarithms until he knows how to calculate them. They say this, knowing that the calculation is a branch of Higher Mathematics, and that the average schoolboy, after six years of mathematics, finds it hopeless to even begin the study of the Exponential Theorem. It is a hard saying! It is exactly like saying that a boy must not wear a watch or a pair of trousers until he is able to make a watch or a pair of trousers. It is the sort of unfeeling statement which so well illustrates the attitude of the superior person."

The essentials of the subject of Analytical Geometry, which blocks the way in our present system of mathematical instruction, are given here under the title of Squared Paper. After an encomium on its practical virtues, Prof. Perry has the audacity to follow the Continental lead, and carry his audience straight up to the Calculus.

Accurate diagrams on this squared paper are given of the elementary curves, the graphs of x^n, x^{-n}, $\sin x$, $\cos x$, $\tan x$, e^{bx}, . . ., as well as of the ellipse and hyperbola, practically all the mathematical principles required for the graphical representation of the variation of physical quantities.

The exponential curve, the graph of e^{bx}, represents a quantity which grows or dwindles at constant compound interest or discount like a row of organ pipes, the rate of extinction of light, or the diminution of the density of the atmosphere in a balloon ascent.

The graphs of $y=x^n$ and x^{-n} are the representation of quantities, such that 1 % increase in x causes n % increase or decrease in y. This is the familiar statement of a complicated mechanical law, such as Froude's Law, which asserts that in similar steamers over a given voyage 1 % increase in speed requires 6 % increase in tonnage and coal capacity, and 7 % increase in engine power.

When the practical man is compelled to invoke theory to his aid, it is generally in some such manner as the above; from a known performance, say, of a steamer, he has to argue the requisite alterations, expressed in %, for slight differences in a new design.

The empirical formulas of internal ballistics and of armour-piercing are all examples of the same theory; the index n, sometimes carefully guarded as an official secret, is at once revealed by plotting on Human's logarithmic co-ordinate sheets, which the possessor of a Slide Rule can readily construct for himself; and Mr. Vincent has shown, in his Report to the British Association, 1898, that the semi-logarithmic co-ordinates can be employed usefully, in which a combination is made of the Slide Rule Graduations with the equidistant graduations of the foot or metre rule.

In answer to his question on p. 53, for a method of finding a^n, where a and n are any numbers, the author may be referred to Mr. Lanchester's radial cursor attachment, as well as to the double-logarithmic scale, which he will find described in the Catalogue of the Mathematical Exhibition at Munich, 1893, as the invention of Blanc, of Hamburg; and M. d'Ocagne's "Traité de nomographie," recently reviewed in NATURE, will provide a complete description of all such methods of graphical calculation.

Euclid supplies the place in our schools of the study of Formal Logic, so far as the essentials of strict demonstration; but as no one employs the syllogism, not even Euclid, and time is limited now there is no longer the lack of the Middle Ages in subjects of scientific interest, the working man student is recommended by Prof. Perry to condense the essential facts of Euclid's "Geometry" into a few pages of careful instrumental construction, supplemented by perhaps half a page of Algebra for the fifth and sixth books, and introducing at the outset the circular functions of Trigonometry, and, most important of all, the ideas and sacred symbolism of the Calculus.

Valuable collections of examples are interspersed throughout the Lectures, all having a definite practical numerical character, or the interest of the practical illiterate mechanic would be lost; but we think the navigator would object to the units employed in Example 9, p. 113. An advertisement in the daily press warns us that these Lectures to working men are to be discontinued, and so we are disappointed of the hope of a similar course, illustrated by practical examples, on Mechanics, in which, to employ the author's words, the occult phenomena described by the writers of cram-books on Mechanics to be used in preparing for certain examinations will find no place. Each exercise will fix firmly in the mind of the student the fact that a certain principle is of importance outside examination rooms; and the student, when he works out an answer which every practical illiterate mechanic knows to be ten times too great, will not complacently rest satisfied with this absurd answer, and talk about its being "theoretically" right.

The author has dared to introduce a lecture on Vectors and their use and treatment—that is, Quaternions in their simplest form, *pace* Prof. Tait. The resolution and composition of directed quantities follows in a simple manner, on a railroad of mathematical argument, without blowing up any culverts and bridges by such artificial obstructions as Duchayla's demonstration of the Parallelogram of Forces.

The ideal treatise is the judicious combination of the Inwit and Outwit. These Lectures, in their assigned scope of immediate practical application, work as far as possible on the Outwit principle, while there are tendencies in the world of abstract mathematics to exclude Outwit as far as possible, and to proceed entirely by Inwit; and this latter method interests and commends itself to the philosophic contemplative mind. Thus an increasing gap is arising between the two lines of thought, as the man of action must proceed at once on the available rational theory; and he will incline to the treatment advocated with so much eloquence in these Lectures on Practical Mathematics. A. G. GREENHILL.

A SYSTEM OF MEDICINE.

A System of Medicine by Many Writers. Edited by Thomas Clifford Allbutt, M.A., M.D., LL.D., F.R.C.P., F.R.S. Vol. v. Pp. xiv + 1056. 71 illustrations; 7 charts; 3 plates. Vol. vi. Pp. xi + 944. 44 illustrations; 3 plates; 2 tables. Vol. vii. Pp. xii + 937. 34 illustrations; 3 plates. Vol. viii. Pp. xii + 998. 16 illustrations; 3 plates. (London: Macmillan and Co., Ltd., 1898–1899.)

PROF. CLIFFORD ALLBUTT is to be congratulated upon having completed what must have been a Herculean task. In a science which changes with the velocity of medicine, the time consumed in the appearance of a work is a very important factor. It is quite conceivable that during the period that must necessarily elapse between the first and the last volume of so monumental a work some discovery in medicine, or the cognate sciences of transcendental importance, might occur. Such a discovery might affect equally profoundly both the written and unwritten volumes. A system thus astride an epoch-making advance in the subject-matter of its theme might bring the editor into serious embarrassment. In this respect the lot of the present system has fallen in pleasant places. It has been launched into the tide of medical literature without any such contretemps, and the first volume may be considered, from the practical standpoint, as much up-to-date as the last.

In the space at our command it is of course impossible even to enumerate the contents of the four massive volumes before us.

Vol. v. is devoted to diseases of the respiratory and circulatory systems. Dr. Ewart writes two comprehensive articles on bronchitis and bronchiectasis. The monograph on pneumonia is from the pen of Dr. Pye Smith. This article contains an interesting critique of the bacteriology of pneumonia from the standpoint of the physician, and concludes with copious clinical statistics. Dr. Percy Kidd contributes a succinct account of consumption, and what must be regarded as a very fair *résumé* of the different methods of treatment and their results. Dr. Goodhart writes an able account of that enigmatical disease, asthma.

The second part of the volume treats of diseases of the circulatory system. The first three articles of this subdivision are of general interest. Sir Michael Foster contributes an essay on the general features of the blood. The clinical examination of the blood is fully dealt with by Dr. Copeman. In this article the massive literature of this subject is well condensed, no easy task; the essay is well up-to-date, and should prove most useful in conjunction with its copious and well-classified bibliography, not only to those who are simply interested in the subject, but to actual workers in the field. Prof. Sherrington has condensed much matter into little volume in his article on cardiac physics. What to leave out, and what to put in, in an article upon this subject, in this place, must be a matter of very great difficulty. We think the absolute value of the article has suffered somewhat from its condensation, and that more space should have been devoted to this subject. The physical and physico-chemical aspect of dropsy, which has received very scanty attention elsewhere, might well have been included in it. Functional disorders and mechanical strain of the heart are treated of at length by the editor. Here (p. 847), we notice a misprint; Prof. Zuntz' collaborator was Geppert, not Goppert. The volume concludes with articles on endocarditis and valvular disease.

In vol. vi. diseases of the circulatory system are continued. Sir Richard Douglas Powell contributes a full account of angina pectoris. After a preliminary division of the cases into two main classes, the author proceeds to give clinical examples. The article concludes with a consideration of prognosis and treatment. Dr. F. T. Roberts writes upon diseases of the mediastinum and thymus gland. The greater part of the author's space is devoted to the interesting and complicated subject of intra-thoracic new growths, which he handles in a most satisfactory manner. The articles on thrombosis and embolism are from the pen of Prof. Welch, and are treated very fully. A most copious bibliography is appended, amounting to six pages.

An interesting illustration of the essential unity of the nerve muscle machine is afforded by a study of the editor's attempt to consider in two separate sections diseases of the muscles and diseases of the nervous system. How far one can divide, from the standpoint of disease, the neuro from the muscular element is naturally of interest. As a matter of fact, however, it is to be noted that, whereas the division between these two classes of diseases in the general page of contents takes place between the articles upon facial hemiatrophy and general pathology of the nervous system, in the text this is not so, the division occurring between the articles upon erythromelalgia and diseases of the nerves. This may be due, of course, to accident; at any rate, it should be cleared up.

In the section devoted to diseases of the muscles, Prof. Sherrington contributes a most interesting article upon tremor, tendon-phenomenon and spasm, and Dr. Bevan Lewis one on the general pathology of the nervous system.

Space equivalent to two whole volumes or rather more is devoted to diseases of the nervous system, and the various articles upon the different subjects in this section are very complete. A few monographs are to be found here and there, in appropriate places, upon the general physiology and pathology of the subject. Noteworthy amongst these is Dr. Ferrier's essay upon the regional diagnosis of cerebral disease. In it the chief parts of the brain are considered seriatim, the effect of lesions of them described, some clinical cases given, and a bibliography appended to each section. This latter method will greatly facilitate reference, and might with advantage have been adopted in other instances. Dr. Bastian contributes an able essay upon aphasia and other speech defects. Hysteria forms a subject of an interesting monograph by Dr. Ormerod. The author discusses at some length the hypotheses of hysteria, and criticises the psychical speculations of Janet. Neurasthenia is treated of at length by the editor. He defends the entity of the disease, describing different forms of it according to the organ or set of organs presenting functional aberration. Prof. Victor Horsley writes upon traumatic neurasthenia. Under this term cases of nervous disturbance after railway accidents and other agencies producing sudden fear or emotion, &c., are considered. The article should prove useful to the medical advisers of railway companies; it concludes with a suggestive paragraph upon malingering and points of medical jurisprudence.

A section, occupying some four hundred pages, is devoted to mental diseases. In the editing of this section Prof. Allbutt has been assisted by Dr. Savage. Dr. Mercier contributes a philosophical article upon vice, crime and insanity. The volume concludes with a series of essays upon diseases of the skin. A short appendix, comprising an account of the recent researches on the malarial parasite, has been wisely added to supplement Prof. Osler's article on malaria in vol. ii.

The editor and his collaborators must be immensely relieved that so prolonged an effort has finally terminated. The fact that the system is somewhat more bulky than was originally intended can scarcely be considered a disadvantage. Portability is hardly expected of a "system"; further, Prof. Allbutt's work, taking in regard the voluminous increase which has occurred in medical literature in the interim, compares favourably, in so far as bulk is concerned, with its predecessor. It is sincerely to be hoped, and indeed expected, that the book will meet at the hands of the profession with that success which it richly deserves. F. W. TUNNICLIFFE.

THE NATURAL HISTORY OF WHALES.

A Book on Whales. By F. E. Beddard, M.A., F.R.S. With 40 illustrations by W. Sidney Berridge. Pp. xv + 320. (London: John Murray, 1900.)

THE editor of the "Progressive Science Series," Mr. Beddard, has undertaken the preparation of the volume "On Whales." Amongst the mammalia, no order is more remarkable than the Cetacea. The huge size, both in length and bulk, attained by many of the species, their fish-like habitat, the modifications in mammalian structure necessary to adapt them for a life in the water, and the difficulties attendant on their capture, have invested them with an interest which appeals to the popular imagination as well as to the naturalist. In writing this book, Mr. Beddard has had in view the compilation of a volume which, whilst based on scientific lines, should be expressed in language divested as far as possible of technicalities, so that the descriptions might be understood by educated persons generally. In this respect he has succeeded.

In the earlier chapters he describes the most characteristic features in the external form and in the internal structure of whales, and he compares them with other aquatic mammals. In their size, such species as *Balaenoptera musculus* and *B. sibbaldii* are not only the largest of living mammals, but there is no evidence of animals having in past times existed which possessed a greater magnitude, the most gigantic extinct Saurian reptile, or even the Iguanodon, dwindling into insignificance beside these monsters of the deep. The skeleton in the largest species, more especially the skull and spine, is characterised by the bulk of the bones. There seems to be a relation in the thickness of the tegumentary blubber and the quantity of its contained oil to the weight of the bones. In the Greenland Whale the individual bones are much heavier in relation to their size than in the Balænopteridæ, and the blubber is so much thicker in the former, that a *Balaena mysticetus*, without taking into account the much greater value of its whalebone, and estimating only that of its oil, repays the whaling seaman much more than the capture of Sibbald's Whale, although the latter may be from 20 to 30 feet longer. In the Sperm Whale, again, in addition to the valuable oil in the blubber, the cavity in its huge head contains many gallons of the peculiar fat, which, when solidified after the death of the animal, forms the well-known commercial article called spermaceti. The fat with which these animals are so abundantly provided, being of much less specific gravity than the medium in which they live, enables them, with comparatively little muscular exertion, to float on and near the surface of the water, and to breathe directly the air which is required in mammalian respiration. A feature in Cetacean anatomy is the great capacity of the thorax, the consequent large size and expansibility of the lungs, and the mobility of the ribs, which in the whalebone whales only articulate with the sternum by a single pair. The external configuration of the chest varies in different species; in *B. mysticetus* it is rounded laterally and somewhat barrel-shaped; but in the Finners it is more elongated in the dorsi-ventral diameter, and with a smaller diameter from side to side. In both forms it is capable of great expansion, so that the whale can dive to a great depth and remain under water for a considerable time, until the need arises to come to the surface to expire the contaminated air in the act of "blowing," and to take in a fresh supply.

In the chapters on classification, Mr. Beddard has very properly rejected many of the generic names introduced by the late Dr. E. Gray, who in his later life gave to each species a new generic name, and almost went so far as to regard each skeleton, or part of a skeleton, in the British Museum as representing a distinct species. He has adopted the more restricted nomenclature employed by van Beneden, Flower, Turner, and other recent cetological authorities. His descriptions of the specific characters are tersely put, and can be readily understood even by those who are not trained anatomists. The figures of the species, so far as he has provided illustrations, are characteristic, though in at least five instances his drawings have been made from the series of casts displayed in the Whale-room in the British Museum, the last administrative work discharged by Sir W. H. Flower, and not from the original drawings. We observe, however, that several of our British species are not figured; three species of Balænoptera, the Humpbacked Whale, the White Whale, *Lagenorhynchus albirostris*, and even the common Porpoise, except in its embryonic form, have not been included in the illustrations. This is much to be regretted, as one of the main objects of a semi-popular book of this kind should be to place in the hands of those who live at the seaside a work which will enable them to discriminate the species of whales, examples of which from time to time are stranded on our shores, and not to class them all together, as is too often done, as "bottle noses." How important it is to familiarise people who have some taste for natural history studies, with the means of recognising specific differences, is illustrated by Sowerby's Whale. The first example of this Cetacean was described by James Sowerby from a specimen stranded in 1800 on the shores of the Moray Firth. No further specimen was recognised in Scotland until 1872, since which date two specimens have been obtained in the Shetland Isles, two in the Firth of Forth, and in September of last year Mr. William Taylor secured three specimens—male, female and young—stranded in the Moray Firth only a few miles from the spot where Sowerby's original example was found. On the English coast a specimen was got in 1885 at Spurnpoint, and another in 1892 at Overstrand, near Cromer; but we know of only one specimen identified on the coast of Ireland. It is obvious, therefore, that this Cetacean is not so uncommon as was originally supposed. When those who dwell by the sea become more alive to the recognition of the specific characters of whales, we may reasonably hope that other species, now considered rare, may be found to be not infrequent visitors to our shores.

RESEARCHES ON GLYCOGEN.

Microscopic Researches on Glycogen. Part ii. Glycogen of Snails and Slugs, in morphological and physiological correspondence with the Lymph System of Vertebrates. By Charles Creighton, M.D. Pp. 127; 9 coloured plates. (London: Adam and Charles Black, 1899.)

PART I. of this work, which appeared about three years ago, treated of the physiological functions of glycogen. It contained a number of interesting records of microscopic work, and showed that glycogen is present in a number of situations, particularly during embryonic life, in which its presence was previously unsuspected. Claude Bernard, in his classical work on the subject, recognised the presence of glycogen in the placenta and many other embryonic structures, and Dr. Creighton amplified this by more numerous observations. As development progresses, and specialisation of function occurs, the glycogenic function is narrowed down to the liver and muscles instead of being widespread throughout the tissues. Dr. Creighton concluded, on what we regard as insufficient grounds, that the function of glycogen is much more important than physiologists have hitherto considered to be the case. He insists on its "formative" function, by which we suppose he means that it is an all-important or even essential substance in the construction of living matter, and he even assigns to it a respiratory function, believing that in early life it takes the place of hæmoglobin. His proofs of its oxygen-carrying capacity were even less complete than those of its formative properties.

All physiologists admit the importance of glycogen; they would require very stringent evidence, however, before they admitted that it is essential to the formation of protoplasm, or that a carbohydrate is capable of doing the work of a complex nitrogenous and iron-containing material like hæmoglobin. It is regarded rather as a storage or reserve product, part of the cell-contents rather than part of the cell-substance, and its use is doubtless principally by its subsequent combustion to contribute to the liberation of energy in the form of molar and molecular movement, work and heat.

In Part ii., which is now before us, we have as before a very elaborate series of microscopic observations, undertaken with infinite pains, and illustrated by excellent drawings. It treats of the various invertebrate classes, and shows the presence of glycogen in numerous situations; the work of others in the same connection has been collected with care. The proof that the substance is always glycogen would have been more complete if the observer had not limited himself to one test, namely, the micro-chemical reaction with iodine. Still, if we regard this as trustworthy, we have before us a valuable collection of observations which show how widespread the distribution of glycogen is, and we may safely draw the conclusion that its function is extremely important.

As before, however, we hesitate to follow Dr. Creighton in his speculations regarding the nature of these functions. For in addition to its formative and respiratory functions, the multifarious duties of lymph are now ascribed to this single and comparatively simple material. The arguments that lead to this startling conclusion are extremely curious to follow. He finds that in snails and slugs which have been specially worked at, glycogen is chiefly deposited in certain connective tissue corpuscles, which are designated plasma cells. These are principally arranged along the course of the blood-vessels, and in some instances they form a complete coating to the vessels. This is considered to indicate the existence of a primitive lymphatic system. If this is so, there should be evidence in the higher molluscs that this becomes more perfect, and the different stages in the evolution of the lymphatic vessels should be capable of demonstration. There is, however, no attempt to do this; in fact, it is admitted that in the highest molluscs, the cephalopods, which have a very perfect vascular system with arteries, veins and capillaries, this arrangement of the plasma cells does not occur, and these animals have little or no glycogen in their tissues. Moreover, if the arrangement and chemical construction of the plasma cells of the snail has the great morphological value attached to it by Dr. Creighton, it is remarkable that it is not found throughout the class of gastropod molluscs, to which the snail belongs; it is apparently limited to quite a few members of the group. So much importance is attached to this idea by the author, that he almost seems, though his words are not quite clear on this point, to assume that the snail and slug are, in the line of descent, very near ancestors of the vertebrate family. There is no attempt to show the links in the chain, nor to explain why an exceptional and almost accidental arrangement of connective tissue cells in one or two isolated molluscs should confer this honour upon such isolated specimens. We do not think that a theory of this kind will do much to shake the thoroughly well-grounded work of Haeckel and other morphologists.

To the physiologist the next conclusion drawn will be even more startling; it runs as follows: if the plasma cells represent a lymph system, the glycogen of those cells must represent lymph. It hardly seems worth while to argue against such an unwarrantable suggestion. Any other constituent of the plasma cells might equally well have been selected. Lymph is a complex fluid acting as a middle-man between blood and tissue elements; it is contained in spaces between and around the cells, not in the interior of their cell-substance. If one seeks for an analogy between the two mobile fluids of the vertebrate, in the invertebrates it will be found much more easily in many members of the worm group which have coloured blood in their vessels, and colourless fluid in certain parts of their body-cavity.

Dr. Creighton's production, therefore, though interesting as a record of observations, is most disappointing so far as conclusions are concerned. Wide, sweeping, almost revolutionary theories are advanced without a shred of real evidence to support them. If the book serves no other purpose, it will at least act as a warning example of the danger of drawing hasty generalisations from imperfect data, data gathered from the exclusive study of one particular small point with one exclusive method.

OUR BOOK SHELF.

The Elements of Alternating Currents. By W. S. Franklin and R. B. Williamson. Pp. 212. (New York: The Macmillan Company. London: Macmillan and Co., Ltd., 1899.)

In this book will be found a very fair *résumé* of the theory and practice of alternate current working, and of the modern developments associated with the use of polyphase currents and the induction motor.

It is interesting to compare a work such as the present, characteristic as it is of American methods, with similar works published in this country. Messrs. Franklin and Williamson's treatment of their subject is distinguished by conciseness, and by the almost total exclusion of anything of historical interest, though the authors, in the preface, acknowledge their great indebtedness to Steinmetz, "whose papers are unique in their close touch with engineering actualities." The beginner will, perhaps, find that the brevity of treatment renders the theory, and the usually excellent graphical constructions, here and there obscure. But, on the other hand, the comments upon the practical aspect of each question taken up are of great value, especially to readers in this country, where experience with polyphase currents is limited to some half dozen installations of but few months standing.

Continental engineers, accustomed to use the well-known Hartmann and Braun instruments, will be astonished to learn that "the only hot-wire instrument which is much used is the Cardew voltmeter." Under the heading "Revolving Contact Makers," the only form described is that using a jet of conducting liquid making contact with a revolving pin connected through the shaft of the alternator; while the much more convenient form with two brushes and a revolving piece of metal let into an insulating disc, which enables an electrostatic voltmeter to be momentarily connected across *any* two points in the alternator circuit, is not mentioned.

The chapters relating to the theory of the synchronous motor, the rotary converter and the induction motor contain information not easy to find elsewhere in accessible form. The short concluding chapter on the transmission of power, however, lacks a simple statement of the relative amounts of copper required by different systems of electrical transmission, and the respective merits of these systems as regards regulation.

Much information is to be found in this book in small compass, and it will prove of value to engineers engaged in alternate current practice. D. K. M.

Oysters and Disease: An Account of Certain Observations upon the Normal and Pathological Histology and Bacteriology of the Oyster and other Shellfish. By Profs. W. A. Herdman, D.Sc., F.R.S., and R. Boyce, M.B. Lancashire Sea Fisheries Memoirs. No. 1. Pp. 60; 8 plates. (London: George Philip and Son, 1899.)

The monograph before us gives the results of three years' work by the authors on oysters and disease. This thesis is, of course, by no means new to either the general scientific reader, the medical officer of health, or, indeed, the general public. Oysters have for several years been suspected, and, indeed, in some cases almost proved, to be the source of typhoid fever. A most interesting report was issued upon this subject by the Local Government Board, which, if the reviewer remembers rightly, was fully noticed in these columns. As the readers of NATURE are probably aware, as a result of this report, an Oyster Bill has been laid before Parliament.

So far as the present memoir is concerned, it may be divided into two parts. The first part deals with the "greenness" of oysters. This appears to be due in different kinds of oysters to different causes. In certain oysters it seems undoubtedly connected with the presence of an excess of copper; and so far as the Falmouth oyster is concerned, the authors confirm the earlier work of Prof. Thorpe in this connection. From the general histological standpoint, it is interesting to note that the authors found Macallum's hæmatoxylin method to be a very delicate test for copper as well as iron. But the presence of "greenness," even when connected with copper, does not necessitate the oyster in question being unfit for food. Some "greenness" has no relation with the presence of copper, as, for instance, in the case of Marennes oysters.

With regard to the bacteriology of oysters from the standpoint of disease, the monograph does not contain any very important additions to our knowledge. So far as concerns the subject of deepest interest to the public, namely, the relation between oysters and typhoid fever, the general reader will be relieved by Conclusion 12, p. 54:—

"Although we did not find the *Bacillus typhosus* in any oyster obtained from the sea or from the markets, yet in our experimental oysters, inoculated with typhoid, we were able to recover the organism from the body of the oyster up to the tenth day. We show that the typhoid bacillus does not increase in the body or in the tissues of the oyster, and our figures indicate that the bacilli perish in the intestine."

Scientific Papers. By John William Strutt, Baron Rayleigh, D.Sc., F.R.S. Vol. i. 1869–1881. Pp. xvi + 562. (Cambridge: At the University Press, 1899.)

THE publication of collections of scientific papers serves a three-fold purpose. It renders easy of access scattered papers for which search would otherwise have to be made through a considerable mass of proceedings, transactions and journals; it furnishes a history of the part played by the author of the papers in the onward progress of scientific knowledge, and it affords an insight into the thoughts which the author has put into writing at various stages of his lifetime. To adequately serve the last object the collection must be comprehensive, and no paper should be deemed too short or of too passing interest to be included in the series. We cannot do better than quote Lord Rayleigh's remarks on this point in the preface:—

"Some short papers of a rather slender character have been included: these may serve to mitigate the general severity. In consulting similar collections I have usually felt even more grateful for the reproduction of short and often rather inaccessible notes than for the larger and better-known memoirs."

Even the questions set by Lord Rayleigh in the Mathematical Tripos for 1876 are here reprinted, and the pages containing these will, we are certain, be well fingered in the copy which finds its way into the Cambridge University Library.

An analysis of the seventy-eight papers in the present volume, and which represent Lord Rayleigh's work in the period 1869–1881, gives the following results:—Acoustics and vibrations, 24 papers; optics, 23; hydrodynamics, 9; electricity, 6; dynamics, 5; pure mathematics, chiefly harmonic analysis, 6; various, 5.

It will be seen that the main portion of Lord Rayleigh's work in this period deals with sound and light. Many of the papers on the former subject have been included in his well-known "Theory of Sound," and are not reproduced; but readers of the latter book will learn from the references here given how much of the theory is due to Lord Rayleigh himself. We need only refer to the theory of resonance, the general theory of vibrations and its particular case of "approximately simple systems," the pitch of organ pipes. Of optical papers, the best known are Lord Rayleigh's investigations on the scattering of light by small particles, and on the colour and polarisation of the sky. We have also in the present volume papers on the construction of diffraction gratings and their reproduction by photography, experiments on colour, and optical investigations relating to the spectroscope. Lord Rayleigh's hydrodynamical papers on the stability and instability of jets are well known. The last paper in the volume is that on the infinitesimal bending of surfaces of revolution, which subsequently formed the subject of discussion at the hands of Prof. Love. The volume will be a welcome addition to our libraries, as will be those to follow containing Lord Rayleigh's later papers. G. H. B.

Ueber das System der Nagethiere; eine phylogenetische Studie. Von Tycho Tullberg. Pp. v + 514; 56 plates. (Upsala: Berling, 1899.)

THIS separately published memoir, with its own pagination, is an excerpt from the *Nova Acta* of the Royal Society of Upsala. It is not too lengthy for the due treatment of the subject, and it is very copiously illustrated. Dr. Tullberg has performed a useful piece of work in bringing together the bulk of what is known about the rodents into one comprehensive monograph; his proceeding might be well imitated for other orders, in view of enormous and increasing literature. The present memoir, however, is not a compilation in any sense of that word. The first part, which is rather more than one-half, consists of a series of descriptions of a large number of species of rodents examined by the author. These descriptions are quite full, and deal with external, as well as internal, characters. In some of the facts there detailed, we observe that the author is at variance with the statements of others. For example, he does not distinguish the two genera of Lemmings, which are a little apt to be confused, by the occurrence or non-occurrence of fur upon the soles of the feet. At this moment we are unable to confirm or to dispute his correction of current statements. The list of literature is an abundant one; but the author seems to have overlooked Mr. Beddard's paper upon the rodent brain, and Mr. Parson's account of the anatomy of the little known Cape Jumping Hare, Pedetes. Perhaps the MS. of the work was in type before the appearance of the last of these papers. The scheme of classification adopted by the author will not commend itself to all. The Sciuromorpha and Myomorpha of many are associated into a tribe, Sciurognathi, which is contrasted with the only other tribe of "simplicidentate" rodents, viz. Hystricognathi. The genus Pedetes, to which we have referred, is placed in the former, a view which we do not share. We would also follow Mr. Thomas and regard the genus Bathyergus as belonging to the Myomorpha, and not to the "porcupiny" rodents, where Dr. Tullberg places it. The criticisms, however, do not affect the general merits of this important contribution to our knowledge of the mammalia. F. E. B.

A Surgical Operating Table for the Horse. By J. A. W. Dollar, M.R.C.V.S. Pp. vi + 42. (Edinburgh: David Douglas, 1900.)

VETERINARY surgeons are well aware of the difficulty of controlling horses during operations. Mr. Dollar describes the methods in general use, and various operating tables used in France, Germany, Spain and elsewhere. A table devised by him, and described in detail, is a machine by means of which a horse can be supported in any position and operated upon. Numerous illustrations show the table in different positions during the actual progress of veterinary operations.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Eclipse-Wind.

ALTHOUGH meteorological observations during total eclipses of the sun are of secondary importance, the changes of temperature and humidity being well known, yet it is still uncertain whether those changes do occur in atmospheric pressure, and, consequently, of wind, which, theoretically, ought to result from the sudden chilling of the air by the passage of the moon's shadow, and the consequent increased barometric pressure out of which the wind should blow in all directions.

The letter of Mr. J. W. Evans, in NATURE of December 28, 1899, describing his observations during the Indian eclipse of 1898 is an interesting contribution to the subject of the "eclipse-wind," and brings to mind the special investigations undertaken by Prof. Winslow Upton and myself during the total solar eclipses of August 19, 1887, in Russia, and of January 1, 1889, in California, the results of which are described, respectively, in *Amer. Meteor. Journal*, vol. iv., and in *Annals Astron. Observatory of Harvard College*, vol. xxix. No. 1. Aneroid barometers, including a recording instrument, all with open scales, were used, and, in addition to the anemometer, a recording wind-vane was taken to California. There the sky was clear, but in the Russian eclipse it was heavily clouded. As regards the atmospheric pressure, it must be said that, while in both eclipses minute rises occurred during the total phase, yet they cannot be attributed with certainty to its influence, since similar fluctuations occurred on other days. As regards the wind, the eclipse appeared to produce an appreciable effect, for the wind backed (contra-clockwise) before totality, and veered (clockwise) to its original direction afterwards, its velocity diminishing as the eclipse progressed. This is what would be expected to happen at a station situated near the central path of a shadow moving north-east. In both eclipses it was nearly calm during totality.

With the hope of settling these questions, the writer joined the Harvard Observatory party that observed the total solar eclipse of April 16, 1893, in Chile, where not only was clear weather assured, but the regular diurnal period of the barometer afforded an excellent opportunity to study any non-periodic disturbance due to the eclipse. Besides the previous instruments, Richard's "statoscope," or differential barograph, was employed, with which, when the temperature is kept constant or allowed to change at a uniform rate, variations of pressure approximating 0·025 millimetre (1/1000 inch) of mercury are recorded. In order to secure a free exposure in all directions for the observations of wind, the station was located on the summit of a mountain. Notwithstanding perfect conditions—the day being clear, and a counterpart of those preceding and following—no unusual changes in pressure during any of the phases of the eclipse could be detected, and if any variation occurred, it was insufficient to disturb the regular diurnal period, and must have been of the order of a thousandth of an inch. The record of wind-direction again showed a backing of the wind prior to totality, and a veering round afterwards; but as these oscillations were not infrequent at other times, they cannot be ascribed certainly to the eclipse. The wind reached its minimum velocity soon after the first contact of the moon's limb, and steadily increased until after the fourth contact.

While these observations seem to prove that any change in the atmospheric pressure during a total solar eclipse is so small as to escape measurement, yet there does appear to be evidence of changes in the wind. Mr. Evans observed a contrary rotation of the wind to that described above; and the reports of the changes in wind during many eclipses, which were collected by the late Mr. Ranyard (*Memoirs Roy. Astron. Soc.* vol. xli. chap. xxxv.), are very contradictory.

Therefore, it would be interesting if, on May 28, observers along the path of totality in the United States and elsewhere would make frequent observations of the direction and strength of the wind. Still more valuable data could be obtained from a few self-recording wind-vanes and anemometers exposed high enough above the ground to be free from local influences.

A. LAURENCE ROTCH.

Blue Hill Meteorological Observatory, U.S.A., April 3.

Lord Kelvin's Origin of Granite.

IT is a sound maxim that if you want a thing done you must do it yourself. So, as no expert has replied to my query as to the soundness of Lord Kelvin's theory of granite, propounded in my letter of February 23, I have consulted a big Dana's "Mineralogy" with the following results.

It may be premised that Lord Kelvin assumes for his liquid lava a specific gravity of 2·50, but as according to Dana the basaltic lava of Kilauea is in one case as high as 3·20, the primeval liquid lava may have averaged 2·60.

Although 2·50 will work out well enough, 2·60 is much more striking as an illustration of the effect of the assumed convection currents upon volcanic minerals.

The following is a list of volcanic minerals in the order of their density, with a rough indication of their composition so far as soda, potash, lime, magnesia and iron are concerned:—

Nosean	Soda	2·25–2·40
Hauyne	Soda-lime	2·24–2·50
Leucite	Potash	2·44–2·56
Nepheline	Soda	2·50–2·65
Sanadine	Potash	2·56
Labradorite	Lime	2·67–2·76
Amphiboles	Magnesia, lime, iron	2·90–3·40
Pyroxenes	Magnesia, lime, iron	3·23–3·50

Free silica is represented by tridymite 2·28–2·33, instead of by the heavier quartz.

If we take 2·60 to be the specific gravity of the primeval liquid lava, the division between crystals that would float and those that would sink comes between sanadine and labradorite. Some little allowance should be made for expansion on heating.

According to these specific gravities, it would appear that the snow shower produced by the convection currents would not have the effect of silting up the lava ocean with granitic crystals set in a mother liquor of basalt, but would have the effect of differentiating the lava into light and heavy strata, until the convection currents themselves would be checked and the surface stratum, composed largely of potash and soda silicates, left free to freeze. And, we may note, that the upper stratum is composed of the raw materials of granite, while the lower stratum is composed of the raw materials of basalt.

At this point geology and petrology commence work, and what subsequently befals the primeval crust, after the advent of water and sediment, may be read between the lines of the great works of MM. Daubrée, Fouqué and Lévy.

The question of a floating crust affects no doubt the problem of the age of the earth, but that is beside my point, which is strictly confined to the origin of granite.

Torquay, April 3. ARTHUR ROOPE HUNT.

Is New Zealand a Zoological Region?

IN your issue of January 11, Mr. H. Farquhar wrote drawing attention again to the incongruity of associating New Zealand with Australia in a zoo-geographic sense. He correctly insists that the New Zealand fauna is *not* most closely allied to that of North-east Australia (Queensland). It is significant that those writers who advocate the alliance of New Zealand to Queensland have not seen either country, while those who deny such relationship have studied or travelled in both or either areas. No observer who had a first-hand knowledge of the two countries could agree with Dr. Sclater that "it is probable that the whole fauna of New Zealand has been originally derived from" Australia.

In the following number (p. 273), Dr. A. R. Wallace, writing in support of his own and Dr. Sclater's views, does not demonstrate or reaffirm their accuracy, but merely lays stress upon the inconvenience of an opposite view.

That an error is convenient is no good reason for its maintenance. Regardless of the direction in which they point, our first care must be the accuracy of facts and deductions.

But, as Dr. Wallace implies, there may be fairly laid upon destructive critics the burden of restoring by constructive work the effects of their ravages. "If," says Dr. Wallace, "antipodean naturalists restrict the 'Australian Region' to Australia and Tasmania, what shall be done with the remainder of his own Australian Region?" I have proposed (*Journ. Malacology*, iv. 1895, p. 55) that New Zealand, New Caledonia and neighbouring groups (inclusive certainly of the Solomons, perhaps of New

Guinea) might be collected into a Melanesian sub-region, and subordinated to the Oriental Region. Since I have elaborated these views in another place, I will here limit my argument to a couple of supporting references.

(1) When Dr. Wallace first returned from his Eastern travel his impression of a natural region was one "extending from the Nicobars in the north-west to San Christoval, one of the Solomon Islands, on the south-east, and from Luzon on the north to Rotti, at the south-west angle of Timor, on the south" (Report British Assoc. 1863, *Trans.* p. 107).

(2) Dr. W. Botting Hemsley has stated: "There is no doubt that the combined Fijian, Samoan and Tongan flora is eminently Malayan in character" (*Journ. Linn. Soc.* Botany, xxx. p. 211).

To map New Zealand thus as an extreme and impoverished outlier of the Oriental or Malayan Region would express but a part of her affinities, since it would ignore the Antarctic relationship. But zoo-geographic problems are too complex to be expressed in terms of colour on a map. If, however, New Zealand and related areas must be forced into one or other of the recognised divisions, then I submit that this arrangement would do less violence to nature than that accepted in the text-books.

Australian Museum. CHARLES HEDLEY.

Mercury Jet Interrupters.

MY attention was attracted recently by a brief notice that appeared in NATURE of March 1 (p. 421) of a new form of mercury jet interrupter devised and placed on the market by Messrs. Isenthal, Potzler and Co.

As that form of break appeared to be of interest to the readers of NATURE, a short description of one that I designed some months ago, along similar lines, may be of interest to some.

While experimenting with wireless telegraphy an interrupter of great frequency of break seemed desirable, and as I wanted also to know the rate of interruption accurately, it was deemed best to use some form of mechanical one. After investigating several kinds, the following one was finally decided upon as the most promising:—

An iron vessel, arranged as a Mariotte flask to maintain a constant head, holding about a pint of mercury, formed one terminal and a metallic plate the other. The plate was arranged below the vessel, and the mercury fell upon it, completing the circuit. In the bottom of the flask was a row of ten holes, arranged around in a circle, with nozzles fitted into them. On a vertical shaft, concentric with the row of nozzles, a series of mica sectors were arranged, so that, when revolving, they would cut the mercury jets falling from the vessel above. These strips were placed with the line of their edges parallel to the axis of the shaft. Thus they would break the circuit in several places at the same instant, giving a very sharp break.

It was found better to break the circuit by interposing an insulator than to break by opening the circuit with a conductor, as the wear at the spark tended to keep them all equal, so they automatically adjusted themselves to the best positions.

The object of the row of jets was to get a more rapid interruption. To break a single jet in five or six places simultaneously, and at the same time with a satisfactory frequency, was found to require too great a head and velocity of jet to be practicable, so by adopting a row of ten the frequency could be increased that many times. These jets are all in parallel, and when the mica strips are revolving the head is so adjusted, by the Mariotte flask arrangement and screws on the sides of the reservoir, that at the instant of interruption of one jet, all the others are in a state of interruption; but the one directly in front of the mica strips will be the first to make the circuit. Thus it continues to break at a rapid rate.

Greater rapidity of break can easily be obtained by increasing the speed, by increasing the number of nozzles, by increasing the number of sets of mica strips, or by any combination of the three.

This form of interrupter will be found quite useful to any one desiring a known rate, high frequency interrupter.

S. M. KINTNER.

Western University of Penna, Allegheny, Pa., April 2.

Tyndall's Ice Crystals.

WOULD you, or some of your readers, kindly inform me whether the ice crystals, as shown in Tyndall's "Form of Water," p. 33, are considered to represent skeleton crystals or solid ones arranged in patterns? J. A.

Tunbridge Wells, April 14.

MARINE ZOOLOGY IN AUSTRALIA.[1]

IN these columns was noticed recently the admirable activity of the various Australian museums in making known to science the natural objects of southern lands and seas. On that occasion it was an important addition to our knowledge of mammalian palæontology —Prof. Stirling's description of *Diprotodon* remains— that was especially under discussion. Now we have to record equally important investigations in marine zoology undertaken by the staff of the Australian Museum, Sydney.

Besides "guides" and "miscellaneous publications," the Sydney Museum issues a series of "records" for minor papers; "catalogues," which are large and fully illustrated, contain descriptions of many new species, and are really in some cases monographs; and "memoirs," such as the natural history of Lord Howe Island (1889); that on the Atoll of Funafuti more recently, in ten parts; and, finally, the "Scientific Results of the Trawling Expedition of H.M C.S. *Thetis*," of which Part i. is now before us. From the introduction, by Mr. Edgar R. Waite, we learn that this expedition was the outcome of a desire on the part of the Government of New South Wales to investigate the trawl fisheries of their coast. In 1898 H.M.C.S. *Thetis* was commissioned, the expedition was financed by the Colonial Government, and an experienced North Sea trawler was obtained, upon whose skill depended the successful working of the apparatus. Finally, the Trustees of the Australian Museum were asked to appoint one of their officers to join the expedition, and Mr. Waite was selected to act in that capacity. He tells us how a large and valuable collection was obtained and preserved (not without considerable difficulty, as experience showed that the *Thetis* was a most unsuitable vessel for the purpose), and promises that the various groups will be dealt with in detail by members of the museum staff in succeeding parts of the memoir. An "Addendum to the Introduction" on fishing with electric light—not yet brought to perfection—concludes with the sentence: "I lowered an incandescent lamp in a townet, and obtained a number of small invertebrates, thus reproducing the experiments conducted at the Liverpool Biological Station" (p 132). He does not tell us what the forms were which were obtained in the illuminated net. In the Liverpool experiments they were all actively swimming forms provided with eyes.

The remainder of the present part contains Mr. Waite's report upon the fishes. One hundred and seven species were taken, representing ninety-five genera, including one new genus, viz. *Paratrachichthys* (formed for *Trachichthys traill*i, Hutton). Nine new species are described, a number of others are new records for the colony. But it is very evident that, as Mr. Waite says, "the interest of the results is, however, not exhausted by an enumeration of the new or rare species; the expedition has been the means of materially extending the known range, both geographically and vertically, of several of our common food fishes. The breeding season of one or two species has been ascertained, . . . and our knowledge of the habits of the soles has also been extended." As the trawling was for the most part not carried on in really deep water, but within the limit reached by line fishermen, the scientific and economic success was all the more marked. As an example of the latter may be taken the information as to *Zeus australis*, a rare and valuable food fish, which was found under circumstances indicating that it may yet take its place as a popular and cheap food fish.

Of the nine new species described, perhaps the most interesting is the "ghost-shark" (*Chimaera ogilbyi*),

[1] Australian Museum, Sydney. Memoir IV. "Scientific Results of the Trawling Expedition of H.M.C.S. *Thetis*," &c. Part i. Pp. 132; 31 plates, frontispiece, and a chart. (Sydney, 1899.)

this being the first record of the genus south of the equator in the Eastern Hemisphere—seven specimens were taken, all, unfortunately, females.

The results of this expedition are evidently such as to encourage the Colonial Government in continuing the work, as Mr. Waite has been able, not only to add to scientific knowledge, but to obtain much information directly bearing on the fisheries. If all of our Sea Fishery Districts Committees were to combine in carrying on similar operations round our own coast, notable progress would be made towards obtaining that approximate "census" of our territorial waters which is required for the solution of both scientific and economic problems.

W. A. HERDMAN.

THE ORIGIN AND OCCURRENCE OF CAVE-ICE.

ALTHOUGH ice-caves and their phenomena present some of the most interesting problems in the whole range of physical geography, it is singular to note how comparatively little attention has been directed to their investigation, and how inadequate still is the sum total of observation and experiment hitherto carried out, for the full elucidation of the many questions which arise in connection with their study. A recent investigator in this field of research is Dr. Hans Lohmann, who, in an admirable treatise on cave-ice ("Das Höhleneis unter besonderer Berücksichtigung einiger Eishöhlen des Erzgebirges," Jena, 1895), has brought together the results of previous work on the subject, and incorporated an account of his own observations in the ice-caves of Saxony. It is here only possible to set forth in the merest outline some of the more interesting facts connected with these natural ice-stores, and to indicate in brief the theories that have been advanced to account for some of their phenomena.

Ice-caves have been defined as natural or artificial cavities in the earth, in which ice, formed within them, is preserved either the whole year round or for a greater part of it. They may be roughly divided into two classes, termed by Thury "static" and "dynamic," or, according to Fugger, the ice-caves properly speaking and the "wind passages." The first are blind caves with only a single outlet, while the caves of the second class have connection by passage or cleft between their inner end and the outside air at some point in the hillside higher than the main entrance. Almost all known ice-caves are situated in the north temperate zone (roughly, between 40° and 60°), and the few exceptions which lie nearer the equator are so highly situated that in winter the temperature within them falls below the freezing point. Generally speaking, the caves do not lie in high mountain regions, though all are located where snowfall is possible.

The causes which bring about the formation of the ice are to be looked for solely in the meteorological and climatic conditions of the localities in which the caves occur. In the case of blind caves, the floor of the cavity is situated at a lower level than that of the entrance, and when the outer atmosphere becomes cooled below the temperature of the inner air, the former, by reason of its greater density, sinks into the cave, slowly displacing the contained air and thus giving rise to an air-current which brings about the chilling of the cave. When the outside temperature rises, that of the cave begins to rise also, but only slowly at first, because the warmer outside air possessing a smaller specific gravity can no longer sink into the cave, and the heat is conducted to the interior very slowly. During such periods (the "closed periods" of Trouillet) a temperature curve, shown by a registering thermometer placed within the cave, assumes the form of an almost straight line. The inner temperature then lingers for a long time in the neighbourhood of the freezing point, but rises again with comparative rapidity when all the contained ice is at last melted.

The cold produced by evaporation within the cave also tends to lower the temperature, and in those ice-caves classed as "wind passages" the influence of evaporation in this direction is very marked. While in summer the air contained in the blind caves is perfectly still, a strong air-current is found to prevail at this season in the wind-passages. It has been observed that when the outer temperature was considerably higher than that within, the wind-stream was passing outwards; at such time as the inner and outer temperature were alike, the current was intermittent or not observable; but when the outer temperature was lower than the inner, the draught was passing inwards. In such cases we have two separate air columns of equal height, one situated within the mountain, the other formed by the outer atmosphere. As soon as a difference of temperature in the two columns is brought about, the tendency to restore equilibrium gives rise to the air-current through the cave, as a result of which the latter becomes cooled in the winter and gradually warmed during the summer. But the downward current which prevails in summer may sometimes bring about a considerable cooling within the cave through evaporation, and if the outer air be very dry the formation of ice may even take place. Systematic observation has made it clear that the potent factor in the production of ice within the caves is the air-current.

The ice itself, formed principally during the spring-time, when the conditions of temperature and water supply are most favourable, is distributed in a varying manner; it may clothe the floor, the walls and the roof as a close-fitting sheet, or may hang in curtain-like form from the roof, or give rise to the formation of ice-stalactites and stalagmites, according to the distribution and manner of the water supply from above.

In connection with the thawing of ice-stalactites, an interesting phenomenon may sometimes be observed. Since the collecting point of the drip which gave origin to the stalactite is situated in the centre of the base of the latter, the thawing action of the water from above may proceed in such a way as to eat out the centre of the stalactite, leaving its peripheral parts hanging as a mere shell or tube. This has been explained by the fact that the warmer water introduced, having a greater specific gravity than water at the freezing point, will tend to sink to the base of the little hollow formed at the root of the stalactite as a first result of thawing, and thus rapidly carry out its work as a vertical borer.

But perhaps the most interesting phenomenon exhibited by cave-ice, to the description and elucidation of which Dr. Lohmann has devoted special attention, is the peculiar structure known as the "prismatic" or "honeycomb" structure. At certain times the surface of the ice is found to be broken up by a net-like system of fine crevices, resulting in the production of meshes of varying and more or less irregular form. It has been found that, strictly speaking, this structure does not appear during the winter, nor does its formation occur in all cases at the same time of the year. While in some caves this splitting process has never been observed to take place before the end of August, the ice in the caves of Saxony have exhibited the structure in an advanced stage as early as the month of March. The size of the meshes is very variable, and they may reach dimensions so great as 400 square centimetres, or be so minute as to be observed with difficulty by the naked eye. The crevices may be merely superficial, or may penetrate the ice to a depth of several centimetres, there to cease abruptly, and thus give rise to a superficial "prismatic layer" sharply separated from the compact ice beneath. But the development of honeycomb structure often proceeds so far that a thin ice-sheet is completely penetrated by the net system, in which case the meshes on either surface of the ice-plate are of equal size.

As to the explanations which have been offered to account for the formation of the honeycomb structure, no theory seems to have been recently proposed which is not based upon that of Robert Emden, who supposed

Fig. 1.—Structure of exposed surface of wall-ice.

that in all ice masses exposed for some time to a temperature neighbouring on the freezing point, the minute first-formed crystals, even when possessing an irregular original arrangement, tend to undergo a complete rearrangement, and to form crystal units of ever-increasing size, having similarly directed axes. The dimensions to which these new crystal units will attain is determined by the temperature variations. Should the temperature rise and a thaw set in, those portions of the ice where the individual crystals are in contact with one another will be the first to be attacked, and the melting process will produce the appearance of the net system.

Since the rock in which the caves or drifts are formed always possesses a somewhat higher temperature than the air within the cavity, the coalition of the individual ice crystals in contact with the cave wall will take place at a somewhat earlier period than that of the crystals on the exposed surface of the wall-ice, for the inner side will be sooner raised to a temperature closely approaching the freezing point. But in like manner, as the general temperature rises, the inner surface of the wall-ice will become exposed to the action of actual thawing earlier than the free outer surface, and the development of the growing crystal units—the groundwork for the "cells" of the honeycomb structure—will receive an earlier check on the inner surface than on the free surface. This explanation has been given to account for the fact that the meshes in contact with the rock are smaller than those exposed to the cave air, as shown in the accompanying illustrations reproduced from Dr. Lohmann's paper, for which photographs were obtained from plaster casts of the ice surfaces.

But Emden's theory, as briefly sketched above, does not seem to explain certain facts observed in connection with the "prismatic" structure shown by some forms of ice. The peculiar form of the network developed, for instance, on the surface of an ice-stalactite, with its radially arranged tiers of "cells," requires further explanation. Lohmann ascribes an important part in determining the arrangement of the "cells" to the expansion and contraction of the ice under changes of temperature. Since the coefficient of expansion of ice is great, the surface when exposed to variations of temperature will undergo a splitting process, which will result in the production of so-called "elementary cells." These will then become crystal units (if not already such) by the process of coalition which Emden supposed to occur, and the ultimate dimensions of the prismatic structure are then

Fig. 2.—Structure of ice surface in contact with rock.

finally determined by a rise of temperature, forming spaces between the "cells" as above indicated. But while this improved theory seems to offer a fuller explanation of the observed facts, final proof of its value as a sound hypothesis is only to be sought in the evidence of further experimental investigation.

F. L. K.

NOTES.

Prof. A. A. Michelson, professor of physics in the University of Chicago, has been elected a correspondant of the Paris Academy of Sciences.

The first meeting of the International Conference for the Protection of Wild Animals in Africa will be held at the Foreign Office on April 24. The British representatives will be the Earl of Hopetoun, G.C.M.G., Sir Clement Hill, K.C.M.G., C.B, head of the African department of the Foreign Office, and Prof. Ray Lankester, F.R.S., director of the Natural History Museum.

To encourage the study of aërial navigation, a member of the Aéro Club of Paris has given the sum of 100,000 francs, to be awarded as a prize to the inventor of an efficient aërial machine. The test to be applied is that the machine shall travel from the grounds of the Club, or from the hills of Longchamps, to the Eiffel Tower, and then to return to the starting point. The length of the whole journey is about eleven kilometres, and it has to be accomplished in half an hour or less. The competition is international, and the offer will remain open for five years from the middle of the present month. The interest upon the sum placed at the disposal of the Club will be awarded annually for works or inventions bearing upon the problem of aërial navigation. Further particulars can be obtained from the secretary of the Club, M. Emmanuel Aimé, 48 rue du Colisée, Paris.

IT is proposed, in recognition of the great services rendered by the late Dr. D. G. Brinton to anthropological science by his teachings, numerous publications, and untiring zeal, to establish in his memory a Brinton chair of American Archæology and Ethnology in the University of Pennsylvania. At a memorial meeting held in January, the plan was favourably mentioned and grateful recognition was accorded to Dr. Brinton's unselfish devotion to his chosen life-work. The place selected for the chair seems especially appropriate, since the University of Pennsylvania now possesses Dr. Brinton's valuable library, his own gift shortly before his death. The association of Brinton's name with the University from 1886, when the chair of American Archæology and Linguistics was created for his occupancy, may in this way be made permanent. In order to accomplish the proposed plan, it will be necessary to secure an endowment of 50,000 dollars from individual sources. Patrons of science and others interested in the scheme should communicate with the Brinton Memorial Committee, 44 Mount Vernon-street, Boston, Mass., where further information is to be obtained if desired. Messrs. Drexel and Co., Bankers, Philadelphia, have consented to act as treasurers of the fund being raised.

WE regret to see the announcement of the death of Sir William Priestley, the distinguished physician, at seventy-one years of age. His father was a nephew of the discoverer of oxygen. Sir William Priestley received his medical education in London, Paris, and Edinburgh, and graduated as M.D. at the University of Edinburgh in 1853. He was a Fellow of the Royal Colleges of Physicians of London and Edinburgh, and of the Linnean Society, and also a member of several other learned associations. He published several works on natural history and medical science.

AT a meeting of the Liverpool Geological Society, held on April 10, reference was made to the death of Mr. G. H. Morton, whose services to geology were briefly described last week (p. 571). The following resolution was passed :—"That the members of the Liverpool Geological Society desire to record their deep sense of the loss which they and geologists generally have sustained in the death of Mr. George Highfield Morton. Mr. Morton was founder of the Society, serving it for many years both as president and honorary secretary, and up to the time of his decease he was a constant and highly-valued contributor to its *Proceedings*, enriching them with the results of his untiring energy and devotion to geological science. Whilst deeply regretting the irreparable loss, the members wish to express their keen appreciation of the value and extent of Mr. Morton's scientific work, especially of that portion of his work relating to Liverpool and its vicinity."

THE Paris correspondent of the *Chemist and Druggist* gives the following particulars about the late Dr. Henri Beauregard, professor of cryptogamy at the Paris School of Pharmacy. Dr. Beauregard was appointed assistant professor at the School in 1879, and held the post until 1894. He was soon afterwards nominated as the titulary professor of cryptogamy, and was also assistant for comparative anatomy at the Paris Museum. During this time he published several important works treating of insects, some of which have been recognised as standard works by the Academy of Sciences. At the School of Pharmacy he specialised in the study of micrography and cryptogamy, and published his "Guide to Practical Work in Micrography." In 1892 he was called upon to take the professorship of cryptogamy for twelve months, and thenceforward devoted himself entirely to that science. Dr. Beauregard's premature death is a distinct loss to French pharmacy and to the Paris School, where his scientific attainments and personal qualities were much valued and appreciated.

THE Athens correspondent of the *Times* announces that the excavations carried out by Mr. Arthur Evans and Mr. D. G. Hogarth in Crete continue to yield results of the highest interest. On that portion of the site of ancient Knossos which Mr. Evans has selected for investigation (Kephala) a Mycenæan palace has been discovered containing relics of extraordinary importance, by means of which the hitherto uncertain question of Mycenæan writing has been finally settled. In the chambers of the buildings have been found a whole series of clay tablets, analogous to the Babylonian, but with indigenous Cretan script.

DR. BERTHOLD LANFER, of the American Museum of Natural History, has just returned from two years of exploration in Northern Asia, as the representative of the Jesup North Pacific Expedition.

MESSRS. W. GOODFELLOW AND C. HAMILTON have lately returned from a successful expedition in the Colombian and Ecuadorian Andes, during which they made a collection of upwards of 5000 bird-skins, comprising examples of many rare species. The travellers landed at Buenaventura, on the Pacific Coast, in April 1898, and thence crossed the Andes into the valley of the River Cauca. This was ascended, and, passing through Popayan, Messrs. Goodfellow and Hamilton entered the Republic of Ecuador, at Tulcan, proceeding thence to Quito, where a lengthened stay was made. From Quito excursions were effected to Pichincha, and to the low country on the Pacific Coast near Santo Domingo. Leaving Quito on March 1 last year, Messrs. Goodfellow and Hamilton crossed the Andes to the upper waters of the Napo, and descended that river in canoes to Yquitos, in Peru, whence the journey home was effected by steamer. Mr. Goodfellow is preparing an account of the birds collected during this remarkable journey for the *Ibis*.

THE Council of the Zoological Society of London has given instructions for the publication of an Index-Volume to the new generic names mentioned in the volumes of the *Zoological Record* since 1879. This Index-Volume, in order to increase its usefulness, will include names accidentally omitted from Scudder's "Nomenclator" and from the volumes of the *Zoological Record*. Thus zoologists will have at their disposal (in the "Nomenclator Zoologicus," and the new "Index" together) a complete list of all the names of genera and subgenera used in zoology up to the end of 1900. It is earnestly requested that any one who knows of names omitted from Scudder's "Nomenclator" or from the volumes of the *Zoological Record*, will forward a note of them, together, if possible, with a reference as to where they have been noticed or proposed, so that the new list may be made as complete as possible. Such information should be addressed to the Editor of the *Zoological Record*, 3, Hanover Square, London, W.C., or to Mr. C. O. Waterhouse, British Museum (Natural History), South Kensington, London, who is engaged in compiling the list.

PROF. GUIDO CORA, of Rome, is engaged in the preparation of a work on his journey in Montenegro last summer, in which he explored particularly the eastern part of the land and some of the adjoining districts. He also examined the ruins of the Roman town of Doclea, where he found some new inscriptions.

MRS. LANKESTER, who died on April 9, was the widow of Dr. Edwin Lankester, and was well known as a popular writer on science. Among her books are "Wild Flowers Worth Notice," the literary portion of that large series of volumes "Sowerby's British Botany" (now in course of republication), and "Talks about Health."

The first of four zoological lectures arranged by the Zoological Society will be delivered to-day by Mr. A. Smith Woodward, who takes for his subject "The Animals of Australia." The remaining lectures are:—"The Freshwater Fishes of Africa," by Mr. G. A. Boulenger, F.R.S.; "The Gigantic Sloths of Patagonia," by Prof. E. Ray Lankester, F.R.S.; and "Whales," by Mr. F. E. Beddard, F.R.S.

On Tuesday next, April 24, Dr. H. R. Mill will deliver the first of a course of three lectures at the Royal Institution on "Studies in British Geography." On Thursday, April 26, Prof. Dewar will commence a course of four lectures on "A Century of Chemistry in the Royal Institution." On Saturday, April 28, Prof. Stanley Lane-Poole will deliver the first of a course of two lectures on "Egypt in the Middle Ages." The Friday Evening Discourse on April 27 will be delivered by Lord Kelvin, on the subject of "Nineteenth Century Clouds over the Dynamical Theory of Heat and Light." The discourse on May 4 is to be on "Pottery and Plumbism," and the lecturer will be Prof. T. E. Thorpe, F.R.S.

The annual general meeting of the Society of Chemical Industry will be held in London in July next. As the president, Prof. C. F. Chandler, and with him a considerable number of the members of the New York section of the society, will attend, it is hoped that the members of the London section will exhibit their appreciation of the hospitality extended in 1895–6 to the then president and the hon. foreign secretary of the society when visiting the United States. London members of the society have been invited to contribute to an expense guarantee fund.

The Jacksonian prize of the Royal College of Surgeons of England for the year 1899 has been awarded to Dr. Harry Lambert Lack, for a dissertation on the pathology, diagnosis and treatment of inflammatory affections of the nasal fossæ and associated sinuses and air cells. The subject for the prize for the ensuing year 1901 is "The Diagnosis and Treatment of Bullet Wounds of the Chest and Abdomen." The John Tomes prize, founded by the dental profession in honour of the late Sir John Tomes, F.R.S., has been awarded to Mr. John Howard Mummory, for his original and other scientific work on the subjects of dental anatomy, histology and pathology.

The fifth annual congress of the South-Eastern Union of Scientific Societies will be opened at Brighton on Thursday, June 7, when the Mayor of Brighton (Alderman Stafford, J.P.) will receive the members of the congress, and the president-elect, Prof. G. B. Howes, F.R.S., will deliver the annual address. On the following day, papers will be read on the skin of liquids, by Dr. C. H. Draper; the structure of the Lower Greensand near Folkestone, by Dr. H. C. Sorby, F.R.S.; dust, by Dr. H. Gabbett; science at the end of the eighteenth century, by Mr. Arthur W. Brackett; and the colouring of pupæ in relation to their surroundings, by Mr. F. Merrifield. A reception by the Mayor of Hove will be held on Friday evening, June 8, and Mr. Fred Enoch will lecture on "Wonders and Romance of Insect Life." On Saturday, June 9, Mr. F. Chapman will describe the Brighton Raised Beaches and their microscopical contents. In connection with the congress, a photographic exhibition is being organised in order to illustrate the various applications of photography to scientific work. The exhibition will not be limited to work done by members of the affiliated societies, and the committee will welcome any offers of loans that would be likely to prove interesting and suggestive. Intending exhibitors should communicate with Mr. H. E. Turner, Lindfield Lodge, Folkestone, not later than May 7.

An article in the current number of the *Fortnightly Review*, by Mr. Rollo Appleyard, states the case for engineers of the Royal Navy, and draws attention to their inadequacy, owing to defects on the Admiralty Board, to meet the demands which the conditions of naval war entail. It also gives an outline of the scheme of studies and examinations at Keyham College and at the Royal Naval College, Greenwich, through which the Engineer R.N. has to pass, and an account of his complex duties afloat. Notwithstanding these defects, it appears that engineers have not a single representative on the Admiralty Board. The question is scarcely one which can be discussed in our columns. On the other hand, it is too technical for the daily Press. It could best be dealt with by a great civil body of experts, such as the Institution of Civil Engineers, and it is sincerely to be hoped that they will give it consideration at an early date.

During a heavy thunderstorm at Herbertsdale, Cape Colony, on February 25, a remarkable fall of hail occurred. Mr. O. D. Deacon sends us a description of the storm received from his brother, who witnessed it. From this we learn that the hailstones ranged in size from marbles to small hen's eggs, and very many were of the size of turkey's eggs. Some of these had a very peculiar shape, being round and surrounded with spikes so as to present an appearance not unlike a hedgehog when rolled up in a ball, or like a bristly sea anemone. The hailstones were the largest Mr. Deacon had seen during a thirty-seven years' residence in South Africa, and their spiky character is of peculiar interest.

We have received from the Danish Meteorological Institute its *Nautical Meteorological Annual* for 1899, prepared under the superintendence of Captain V. Garde, R.D.N. With the exception of a slight change in the title, and the use of English instead of French alongside the Danish explanatory text, the form is the same as in the two previous years. The contents form a most valuable contribution to the meteorology of the northern parts of the North Atlantic, consisting (1) of the state of the ice on the east and west of Greenland, with charts, (2) of wind and sea-surface temperature charts, and (3) of meteorological observations taken every four hours at light and coast stations. We have already referred to the ice charts (Nature, March 1, p. 422) from an advance sheet. The wind charts comprise the area between Scotland, Iceland, and the west coast of Greenland, and very clearly represent, by means of roses, the relative percentage of frequency of the eight principal directions, and the average force in each of the months April to October, from ships' observations, from 1876 to 1895; each chart is accompanied by a short discussion of the chief results, and a statement of the average number of stormy days experienced in various districts. The charts of the sea-surface temperature show the mean values for each one-degree square, for the first and last halves of the month.

A good general view of the position of the mineral industries of the world can be obtained from Prof. Le Neve Foster's latest report (Mines and Quarries: General Report and Statistics. Part IV.—Colonial and Foreign Statistics.) From this rich source of information we learn that about 1,800,000 persons are employed in mining and quarrying in the British Empire, of whom nearly one-half are working in the United Kingdom. Foreign countries employ altogether at least two and a half million persons. Although the proportion of silver furnished by the British Empire is only one-ninth of the general total, it is pleasing to note that New South Wales, with its wonderful mines at Broken Hill, is now approaching Bolivia and the German Empire in productiveness. The British Empire produces seven-elevenths of the total tin supply of the world; in fact, the Federated Malay States alone yield more than one-half.

As regards safety, the collieries of the United Kingdom occupy a high place compared with those of the rest of the world. Prof. Foster sounds a note of warning to British mine-owners and points out that the parasitic disease known as ankylostomiasis is attracting the special attention of several foreign Governments, owing to the ravages which it is committing among colliers. From inquiries he has made among his colleagues, it appears that the disease is not known among British colliers; but as it has made itself a home in coal mines in Northern Europe, it might be introduced into this country by foreign workmen.

TWO interesting papers on changes in iron and steel rails were read at the meeting of the Institution of Civil Engineers on April 10. In the first of these, on "The development of the manufacture and use of rails in Great Britain," Sir Isaac Lowthian Bell, Bart., F.R.S., traced the history of the development of wrought-iron and steel manufacture, with particular reference to its employment for rolling into rails. The results of an experimental investigation of the deflection of rails at various speeds of the train, indicate that the deflection, and therefore the pressure on the rail, diminishes as the speed increases. The durability of rails manufactured by the basic process has proved equal to that of steel rails manufactured from hæmatite ore. In the second paper, on "The wear of steel rails in tunnels," by Mr. Thomas Andrews, F.R.S., the effects of the deteriorating influences peculiar to rails laid in tunnels were described. Among these are the increased corrosion of the surface of the rail, due to the action of moist vapours, and the increased chemical action of the ballast on the foot of the rail; the ballast, on account of its porous nature, absorbs the vapours and hence acts with increased deteriorative force on the rails. Mr. Andrews has made a careful examination of a rail which did its life's work in such a situation. The rail was laid in a tunnel for seven years, on a straight piece of road having a falling gradient of 1 in 90, and it carried the main-line traffic during this time without fracture. The tunnel was about 1000 yards in length, and it was situated fairly near the sea-coast. It lay in a direction nearly north and south. This fact was pointed out, as Mr. Andrews has observed indications that magnetisation exerts an influence tending to increase the corrosibility of steel in certain solutions The rail, which originally weighed 84 lbs. per yard, had lost weight at the rate of 2·8 lbs. per yard per annum, and on the face the rail had worn down to the extent of $\frac{3}{8}$-inch. The chemical analysis showed that sulphur was present in considerable excess, but otherwise the general composition of the steel was excellent. The physical tests showed a very good result, the strength of the metal being normal, and an elongation of 27 per cent. being obtained. From the results of the investigations, the conclusion was arrived at that, as a general rule, rails in tunnels should only be allowed to remain in the permanent way for one-half (or in some cases only one-third) of the time that is usually allowed for the ordinary use outside tunnels.

IN the *American Geologist* for last February, Prof. E. W. Claypole gives a brief description of an earthquake felt in southern California at 4 25 a.m. on December 25, 1899. The disturbed area is thinly populated, but the shock was felt for at least 150 miles from the coast. In the two villages of San Jacinto and Hemet, which stand in an elevated valley filled with detritus from the adjoining mountains, every brick building was seriously damaged by the shock. Prof. Claypole remarks that, from the continued occurrence of light tremors, the region would be a good one for making seismological observations.

AN important memoir, by Mr. R. D. Oldham, on the propagation of earthquake motion to great distances, has just been published in the *Phil. Trans.* of the Royal Society. The complete record of a distant earthquake, he remarks, shows three principal phases, differing in character and amount of displacement. During the first two phases, the motion is principally of a to-and-fro nature; while in the third phase, the movement is composed of long surface undulations resembling the swell of the ocean. In the first two phases, the surface-velocity increases with the distance from the origin, and in accordance with the hypothesis that they consist of elastic waves propagated through the earth at rates which increase with the depth below the surface. If the time-curves for the beginnings of the first and second phases are continued to the origin, they give initial rates of propagation which agree fairly closely with the probable initial rates of propagation of condensational and distortional waves in continuous rock; and Mr. Oldham therefore concludes that the first phase represents the arrival of condensational waves, and the second phase of the distortional waves, both having travelled along brachistochronic paths through the earth. In the third phase, the surface-velocity appears to be constant at all distances from the origin, from which we may infer that they are propagated as surface undulations. The velocity is not, however, the same for all earthquakes, but increases with the intensity; and from this fact, and the high velocity in the case of great earthquakes, it seems probable that the propagation of these waves is, at least in part, gravitational.

IN the *Transactions* of the Institution of Engineers in Scotland, Prof. Andrew Jamieson gives an account of his visit to Cape Town last year, undertaken for the purpose of investigating the action of electric tramway currents in disturbing the action of the submarine cables landed at the Cape. Prof. Jamieson summarises the various probable actions of the tramway currents on the cables as arising from (1) electrolysis; (2) affecting the potential of the earth connection to the receiving instrument; (3) direct electro-magnetic induction; (4) disturbances due to leakage or stray return currents from the tramway rails. It would appear probable from the discussion that the influence of earth-resistance is very considerable at the Cape. Prof. Jamieson reported that nothing short of a symmetrically arranged and specially made twin *twisted* core with double armouring would do for the shore end, and that it would not require to be more than from two to three nauts. It has since been stated that the recently laid shore end of the new cabl from Cape Town to St. Helena has been made and connected in this way.

MR. SAMUEL CUTLER, JUN., who has given especial attention to the development of the carburetted water-gas industry, describes the process of production, and various modern types of plants, in *Feilden's Magazine* for April. Carburetted water-gas, as its name implies, is water-gas carburetted, or enriched, with extraneous hydro-carbons, usually derived from petroleum distillates. The gas is now manufactured at more than sixty important gasworks in the United Kingdom, and the number of installations is rapidly increasing. As produced at the present time, the gas is as luminous and odorous as coal-gas, and in the United States it is supplied and used in its undiluted state, though it contains a much larger proportion of carbon dioxide than exists in coal-gas. Here, however, it is chiefly employed to enrich coal-gas. A Department Committee, appointed in 1898, reported in favour of a somewhat stringent limitation of the percentage to be supplied for illuminating purposes, but no legislative measure has yet been based upon the recommendations.

THE present commercial conditions in the vast Chinese Empire, and the possibilities of future development, are described in detail, and from many points of view, in the Monthly Summary of Commerce and Finance of the United States (December 1899), prepared by the Bureau of Statistics. During the short time in which foreigners have been admitted to the commerce of China, important developments have taken place. The 400,000,000 people have hitherto been served by 350 miles of railway, or less than one mile for each million persons. More than ten times this length of railway is, however, now projected, and not only projected in the ordinary sense of the term, but in many cases being actively pushed forward and with prospect of a comparatively early completion. With telegraphs connecting the capital with every province and also with the outside world; with steam navigation and foreign steam vessels penetrating to the very head of the many navigable waterways; with new treaty ports opening upon the coast and far inland; and with foreigners permitted to travel for business or pleasure to the remotest corners of the Empire and carry with them their merchandise and machinery, the changes which the commercial conditions of China are undergoing are well worthy of attention. The present report is full of valuable information to business men and students of political and commercial geography.

AN interesting and suggestive article, by Monsieur E. de Cyon, on the means whereby the "homing" pigeon ascertains the direction in which it should fly—in other words, its orientation—appears in the *Revue Scientifique* of March 24. After referring to the intimate connection between the migratory and the "homing" instinct, the author points out an important difference in the conditions under which migration and "homing" are carried out. In the former case the bird may have experience to guide it; and it is at least well acquainted with the neighbourhood in which it lives. On the other hand, a "homing" pigeon, after being carried a longer or shorter distance by train in a dark compartment, is suddenly let loose in some place it has never seen before, yet, after mounting in circles to a considerable elevation in the air, it suddenly starts in the direction of home, not unfrequently following the course of the railway by which it travelled. As the result of experiments, the author is of opinion that the retina and the nose take an important share in the orientation; the other conditions being a keen "local memory," and a high development of the cerebral organs connected with the nerves upon which this sense of orientation depends.

THIRTY-NINE new species of Weevils are recorded and diagnosed from Madagascar by J. Faust, and eighteen new and imperfectly-known species of beetles belonging to the genus Lomaptera and its allies from the Papuan region, are described by K. M. Heller in the *Abhandl. u. Berichte K. Zoolog. Anthr. Mus. Dresden*, 1899, Bd. viii. (*Festschrift für A. B. Meyer*). In the same volume, B. Wandolleck has an important memoir on the anatomy of the cycloraphous larvæ of Diptera, the form more particularly studied being the larva of *Platycephala planifrons*. It is illustrated by two plates of photographs of transverse sections through the larva, and by several cuts in the text. The volume closes with a paper, by J. Jablonowski, on the development of the medullary cord in the pike, illustrated by one plate. There is very little difference between the stages here described and those which other observers have recorded in various species of the Salmonidæ.

THE twenty-second annual meeting of the German Ornithological Society was held in Dresden in May 1897, and the papers read before that body have been published in the *Abhandl. u. Berichte K. Zoolog. Anthrop. Mus. Dresden*, Bd. vii. 1899. Besides other papers in the same volume there s one on new beetles from Celebes and from the Philippines, by K. M. Heller, and a memoir on the mammals of Celebes and the Philippine Archipelago, collected by the Sarasins and described by A. B. Meyer. This is a valuable piece of work from a faunistic point of view, several new forms are recorded and figured. An appendix on the spoon- or spatula-shaped hairs occurring in certain bats is added by J. Jablonowski.

A REPORT on the working of the Botanical Department (Jamaica) for the year ending March 31, 1899, appears in a supplement to the *Jamaica Gazette* for February 1, 1900.

"STUDIES of North American Grasses: The North American species of *Chaetochloa*," by Messrs. F. Lawson-Scribner and Elmer D. Merrill, is the subject of *Bulletin* No. 21 of the U.S. Department of Agriculture (Division of Agrostology).

OF equal value, from a systematic point of view, are the contributions from the Gray Herbarium of Harvard University, contributed to the *Proceedings* of the American Academy of Arts and Sciences. No. xvii. of the new series comprises new species and varieties of Mexican plants, by J. M. Greenman; synopses of the genera *Jaegeria* and *Russelia*, by Mr. B. L. Robinson; new *Dioscoreas* from Mexico, by Mr. E. B. Uline; new Phanerogams from Mexico and Central America, by Mr. B. L. Robinson.

THE firm of Gustav Schmidt, Berlin, is publishing, in twelve parts, a collection of forty-eight excellently-coloured plates of garden flowers and plants, under the title "Die schönsten Stauden für die Schnittblumen und Gartenkultur." The series of pictures, and the accompanying descriptive text, are edited by Messrs. Max Hesdörffer, E. Köhler and R. Rudel.

MESSRS. J. AND A. CHURCHILL have just published the third edition of an "Elementary Practical Chemistry and Qualitative Analysis," by Dr. Frank Clowes and Prof. J. B. Coleman. The book contains a good course of laboratory work, commencing with simple measurements and manipulations, which lead in an instructive way to analytical reactions of the commonly occurring metals and inorganic acid-radicles, and the means of detecting them.

WITH the copper apparatus for the preparation of fluorine, recently described, M. Moissan has been able to take up the examination of fluorides which could only be obtained hitherto in quantities too small for detailed study. It was shown some years ago that sulphur took fire in fluorine, and in the number of the *Comptes rendus* for April 2, M. Moissan gives a description of the properties and methods of isolation of one of the sulphur fluorides thus formed. Fluorine is passed over sulphur contained in a copper boat in an atmosphere of nitrogen, and the resulting gases cooled to $-80°$ C. in a mixture of solid carbon dioxide and acetone. By allowing the liquid thus obtained to boil off at the ordinary temperature, a mixture of fluorides of sulphur is obtained, partly absorbable by potash. The unabsorbed portion proved to be the hexafluoride, SF_6, which possessed remarkable properties for a fluoride, being a colourless, odourless gas, so inert in its behaviour towards reagents as to be comparable to nitrogen. It is unacted upon by prolonged contact with potash, by fused potash or lead chromate, and has no effect upon red-hot copper oxide; phosphorus and arsenic can be distilled unaltered in the gas, and sodium can be melted in it without change, the temperature having to be raised above the boiling point of the metal before reaction sets in. Further details of this interesting gas are promised.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*, ♂) from India, presented by Mr. T. Packer; a Barbary Mouse (*Mus barbarus*) from Barbary, presented by Master Chapman; a Lyre Bird (*Menura superba*, ♀) from South-East Australia, presented by Messrs. Carrick and Fry; a Roller (*Coracias garrulus*), European, deposited; two Australian Thicknees (*Œdicnennes grallarius*); two Masked Wood Swallows (*Artamus personata*); two —— Wood Swallows (*Artamus*, sp. inc.) from Australia, purchased; seven Barbary Wild Sheep (*Ovis tragelaphus*, 3 ♂, 4 ♀), born in the Gardens.

OUR ASTRONOMICAL COLUMN

COMPOUND PRISM OF UNIFORM DISPERSION.—Messrs. C. G. Abbot and F. E. Fowle, of the Astrophysical Observatory at the Smithsonian Institution, have been investigating the possibility of obtaining a combination of glasses, the relative dispersions of which would enable a compound prism to be made having a uniform dispersion similar to that given by a diffraction grating (*Astrophysical Journal*, xi. pp. 135-139). Their initial experiments were suggested by finding that a parallel-sided combination of three prisms, of which the central one was rock salt and the outer ones glass, gave a much more uniformly dispersed spectrum than either prism used separately. Sample prisms of various kinds of glass were then examined, and after finding two with considerably varying dispersions, prisms were made of such calculated angles that the irregularities of dispersion would be partly eliminated when the prisms were combined in opposite sense, *i.e.* the base of one to the apex of the other. Taking two such prisms, of 5° 10′ and 20° angle respectively, and allowing the incident light to first enter the thick prism, then after passing through this and the adjoining thin one, to be reflected back from the last face of the thin prism over its previous course, it was found that the combination had an extremely regular dispersion, and although the wave-length curve shows two points of inflection, throughout the remaining portions long stretches could be selected where the dispersion is practically uniform. It is thought that for only moderate dispersions the uniformity found will be such as to render corrections unnecessary when comparisons are being made with grating spectra.

DYNAMICAL CRITICISM OF THE NEBULAR HYPOTHESIS.—In the *Astrophysical Journal*, vol. xi. pp. 103-130, Mr. F. R. Moulton discusses at some length the bearing of modern dynamical treatment on the various problems involved in the nebular theory of cosmic evolution enunciated by Laplace. The various criticisms put forward may be grouped into three categories: (1) comparisons of observed phenomena with those which result from the expressed or implied conditions stated by the hypothesis; (2) discussion of the question whether the supposed initial conditions could have developed into the existing system; (3) comparisons of those properties of the initial system with the one now existing, which are invariable under all changes resulting from the action of *internal* forces.

Under the first section of the discussion it is pointed out that the fact of the planes of the planetary orbits presenting considerable variations among themselves, and also that four satellites revolve in planes making practically right angles with the average plane of revolution of the system, are in direct contradiction with one of the chief deductions from the hypothesis. Other objections concerning observed phenomena are the unaccountable and suspiciously irregular distribution of the masses of the planets, and the unexplainable anomaly in the motion of the inner ring of Saturn.

The objections considered under the second category are that the lighter elements would have escaped from the mass; that matter would have been detached continually instead of in rings at rare intervals; that if a ring were contracted into a planet except an infinitesimal remainder distributed along its path, the process of aggregation could not complete itself; that the gravitation between the masses occurring in the rare media would be so feeble that they would seldom come in contact, and that Roche's limit and a similar new criterion show that fluid masses of the density which must have formerly existed would be disintegrated by the disturbing action of the sun.

In the third section of the inquiry the question of conservation of *moment of momentum* is alone considered, but the results obtained are in such discordance with those required by the hypothesis as to indicate that the original nebulous mass, so far from being in any sense *homogeneous*, was *heterogeneous* to a degree hitherto considered improbable.

Involved in the validity of the above statements is the question of the age of the earth, which has been calculated on the theory of the sun's contraction from a gaseous sphere arranged in concentric envelopes.

THE CAPE STAR CATALOGUE FOR 1890.—We have lately received from Dr. Gill, Her Majesty's Astronomer at the Cape of Good Hope, a copy of the catalogue compiled from observations made at the Royal Observatory. The measures were made with the Cape transit circle during the years 1885-1895, all being reduced to the mean equinox, 1890·0, *without proper motion*. Until June 2, 1889, observations of all stars were made by the "Eye and Ear" method, but on that date the chronographic method of recording was introduced, and since that time has been included for all stars except those within 10° of the Pole. Except in a few cases, a reversing prism has been generally used, thus eliminating any error due to the direction of the star's apparent motion through the field of the eye-piece. In the determination of the declinations, evidence of considerable wear was found in the brass screws of the micrometers. These were replaced by new ones of steel, and, as a further precaution, three of the six micrometers were rearranged so as to reverse the direction of the readings. The discussion of the ten years' observations with steel screws shows that the non-periodic corrections are still very marked, but that the effects of wear are practically eliminated by the plan of reversing the alternate microscopes.

In addition, the declinations have had to be corrected for flexure, refraction, and change of latitude, this latter being taken from Albrecht. Tables of the flexure and latitude variations are given.

The transit circle with which the observations comprising the present catalogue were made is non-reversible, and will be in future exclusively utilised for zone observations, a new instrument being in course of construction for fundamental work hereafter. Considerable pains have been taken to investigate the degree of error introduced by variations in magnitude. No sensible systematic error in declinations is traceable to this source, but in right ascension it is found that the average observer measures the transits of faint stars too late as compared with bright stars, and it is emphasised that in all future catalogues of precision this personal error depending on magnitude should be carefully determined for all the observers.

The catalogue proper consists of the positions for 1890 of 3007 stars, each being designated by its Cape number, and its respective numbers in the catalogues of Lacaille, Bradley, Piazzi, British Association, and Gould. After the positions the corrections are given for annual precession, secular variation and annual proper motion.

The volume closes with three appendices giving comparisons with other catalogues, special observations of α Canis Majoris, α Canis Minoris, β Centauri and α_1, α_2 Centauri, owing to these stars having companions of considerable mass, and a discussion of the places and proper motions of twenty-four circumpolar stars used at the Cape for determinations of azimuth.

FLINT IMPLEMENTS FROM THE NILE VALLEY.

THE latest number of the *Bulletin* of the Liverpool Museums contains a profusely illustrated paper, by Dr. H. O. Forbes, on a collection of stone implements from the Nile Valley, made by Mr. Seton-Karr in 1896, and purchased for the Mayer Museum. The great bulk of the collection was made in Wady el Sheikh, a tributary of the Nile, opening from the south-east into the mud-plain of the river opposite El Fent, which is situated half-way between the stations of Feshn and Maghagha on the railway from Cairo to Assiout.

The material of which the implements are made is chiefly a yellowish-brown or pale grey, opaque, earthy chert, and is but rarely of the translucent chalcedonic variety from the chalk of England. The collection contains a large number of types which may be classed as bracelets, axe-like tools, leaf-shaped flints, knife-like instruments, hoes or agricultural implements, fabricators, scrapers, cores and flakes, and nondescript stones. The bracelet series shows all the stages in the manufacture of these delicate ornaments, and proves that the suggestion of General Pitt-Rivers, who figured two complete similar examples in the *Journal* of the Anthropological Institute in 1881, is probably incorrect, that they were formed from "morpholites," or siliceous sphæroid-shaped bodies occurring in the marine limestone, encircled by a belt or ring, which is divided from the main body only by a thin partition, while sometimes the ring alone is found. The series figured in the paper shows that a flat disk of flint was first prepared, and that this was then perforated by a dextrous stroke of a chisel, and the opening gradually enlarged till sufficiently wide to admit the hand. Of the axe-like tools of which nine, and the knife-like instruments of which sixteen, are illustrated, several specimens almost identical in form and size are figured by Prof. Petrie from Kahun, a XIIth Dynasty town, while others of the knives are of the same form as those seen in the process of manufacture in the wall-paintings of Beni Hasan. Many of the knives also bear a remarkable resemblance to the finest of those from Scandinavia. Several of the scrapers are almost black in colour, and, having a soft velvety surface, would pass for true palæoliths anywhere. Cores and flakes occurred in thousands along the Wady banks. Why so many thousands—all perfect as flakes—should have been struck off and never carried away is difficult to comprehend. Lastly, the collection contains a large number of long bars of stone partially worked, the use of which it is impossible to conjecture.

A map and several views are given showing Mr. Seton-Karr's collecting grounds along the Wady (Fig. 1); and these prove that the implements were scattered round the mines, excavations or pits whence the material was quarried. Each mine was also the site and the workshop of the skilled artificer. In many places shafts two feet in diameter were met with, often filled up with drifted sand, and surrounded by masses of excavated material neatly arranged round them. Their depth does not seem to have been great, nor do the flint-workers appear to have driven lateral galleries from the shafts. Most of the mines had a central work-place, round which the excavated material was heaped, and where most of the implements were found.

FIG. 1.—View of shafts on the level terrace-tableland, near Camp XI., 1896; showing the excavated material heaped round the central work-place.
(*From a Photograph by Mr. Seton-Karr.*)

The next questions discussed are the probable age of the Wady el Sheikh implements and how long the mines were worked. As no help in these questions is obtainable from legend or tradition, some clue is sought for in the patina or amount of discoloration the flints exhibit, for, according to Sir John Evans, "the safest, and indeed the most common, indication of an implement being really genuine is the alteration in the structure of the flints . . . and the discoloration it has undergone." A large proportion of the flints from the Wady el Sheikh are specimens broken in the making. In many instances the two portions, in falling to the ground from the maker's hands, dropped the one part with the upturned surface the reverse of that of its fellow, with the result that when the pieces are re-united the surfaces of the completed implement have each a moiety dark, the effect of exposure, and a moiety, in striking contrast, of nearly the original light yellowish-grey colour of the chert. In the two faces of the two halves every shade of patination from black through shades of yellow to the almost unchanged flint is to be found. Some gauge of the rate of this "æonic tinting" is given by Prof. Flinders Petrie, who states that "the old desert surfaces are stained dark brown by exposure during long ages, and this colour, varying from orange to black, is characteristic of all the flints of early age from this [Nile] plateau. It is certain that only a faint tinge of brown is produced on flints that are at least 7000 years old under like conditions, and this may give a slight scale of the ages that have passed since flint was worked here by palæolithic man." Dated by this standard, the bulk of the Seton-Karr collection ought to be many times 7000 years old. The great majority of the specimens, even the deepest stained, have their edges and the outlines of the flakings as sharp and unworn as the day they were made. A few, however, are deeply eroded by drifting sand, and others, in addition to their patination, have the glossy rounded angles and edges generally considered characteristic of palæoliths; there is nothing about them, however, to point to their being of a different age from their associates in the same workshop. All the implements were found round the mines; some are rude, because unfinished, and some are most beautifully flaked and finished knives (Fig. 2). A considerable number of the flints are so close in material, form and character to those figured by Prof. Petrie from the XIIth Dynasty town of Kahun, that there can be little doubt that both sets were made about the same centuries. Many of the implements are also of the same form as those pictured in the process of manufacture on the walls of Beni Hasan tombs belonging to the same dynasty and contemporaneous with the tombs. A few of the Wady el Sheikh instruments agree with some figured by Petrie as typical of the IVth Dynasty. The age, therefore, of the working of the quarries may be from 3900 B.C., but more probably from about the XIIth Dynasty; and consequently there is provided a scale for gauging the patination that can be acquired in that time. The amount of discoloration which appears also to vary with the quality or constitution of the flint, and the nature of the surface on which it lay exposed, would seem, according to the writer, therefore, to be a very uncertain criterion of age.

Hardly distinguishable from the flints of the Wady el Sheikh are numerous specimens found lying on the surface of the Nile plateaux by Seton-Karr, and near Esna and Ballas by Petrie and Quibell. "On the top of the 1400 feet plateau," the latter authors record, "are great numbers of worked flints of palæolithic type. . . . That the high plateau was the home of man in palæolithic times is shown by the worked flints lying scattered *around the centres where they were actually worked.* The Nile being far higher then, left no mud flats as at present for habitation; and the rainfall—as shown by the valley erosion and waterfalls—must have caused an abundant vegetation on the plateau where man would live and hunt his game." Along with the flints found in the Ballas desert, there were some "rounded flints, all stained dark brown; it is from such that these worked flints have been formed, and *the chips of working were scattered around.*" After stating these facts, Dr. Forbes continues, "it seems an extraordinary circumstance, and to me impossible to credit, that the nodules, the flakes and the implements should, notwithstanding the enormous rainfall . . . which ploughed out the side valleys opening on the Nile, be found lying, *even in a single instance*, in undisturbed association at the present day." The same criticism is passed upon the flint instruments also brought by Seton-Karr from Somaliland (of which the Liverpool Museum possesses a series), which have been described by Sir John Evans, before the Royal Society, as in form absolutely identical with some from the valley of the Somme and other places, and proving "the unity of race between the inhabitants of Asia, Africa and Europe in palæolithic times." Additional flints were later found "scattered all over the country, covering the ground sometimes for the space of half an acre," and there was discovered also an "unfinished spear-head on the ground surrounded by a mass of flakes and chips." This remarkable distribution over the country, Dr. Forbes remarks, "where no remains apparently exist of the deposits out of which they have been washed, seems difficult to reconcile with the usual process of denudation acting through the enormous period which has elapsed since the palæolithic age of Europe," and he disbelieves that "a nodule of stone surrounded by the flakes chipped from it tens or hundreds of thousands of years ago, could have remained undisturbed when the deposits by which it was covered have entirely disappeared"; he dissents also from the opinion that identity of form in the stone implements is sufficient evidence of unity of race or of close contact between the races who made them. He is of opinion, therefore, that none of the surface so-called palæolithic implements from Egypt and Somaliland "have yet been clearly proved to belong to that period, while the probability is that the bulk of them are of much later date." The only flint implements, Dr. Forbes adds, believed to be authentically palæolithic are the flakes and very rude scraper-like flints found by General Pitt-Rivers in the stratified indurated gravelly debris from a Wady near the Tombs of the Kings.

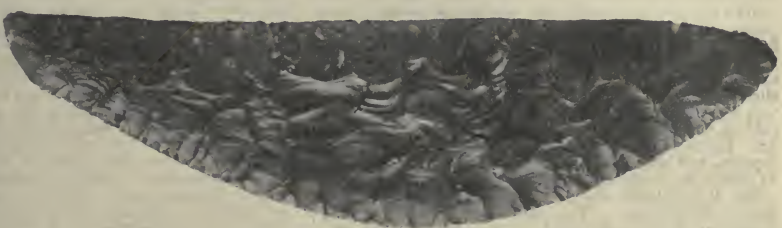

FIG. 2.—Flint knife from Wady el Sheikh.[2]

ON THE MECHANISM OF GELATION, AND ON THE STABILITY OF HYDROSOLS.[1]

GELATINE-WATER-ALCOHOL and agar-water are colloidal mixtures which form a gel on cooling and a sol on warming. In both cases the formation of the gel is due to the separation of the fluid mixture into two partially miscible fluids or phases. When a certain critical temperature is reached, one of the phases separates out as a cloud of droplets. With a further fall of temperature either this internal phase or the external phase becomes a solid solution, and forms a framework in the spaces of which the still fluid solution is lodged. Thus two distinct types of gel occur. In the one the structure is a solid mass, in which are embedded spherical spaces filled with fluid. In the other it is an open sponge-work of adherent solid spheres with fluid filling the meshes. The former is firm and elastic, the latter is brittle and undergoes spontaneous shrinkage. In the ternary mixture the gel has the former structure when the gelatine content of the mixture is high; the latter when it is low.

The hydrogel of agar is built of a solid solution of water in agar, which forms a framework holding a fluid solution of agar in water. The concentration of each of these two co-existent solutions is dependent upon temperature, but the values vary according to whether the system is cooled down or warmed up to a given temperature. The system therefore manifests a striking hysteresis. From the point of view of the phase rule the hydrogel of agar is a system of two components in three phases—a fluid, a solid, and a vapour phase. The composition of the phases should therefore be fixed by fixing either the temperature or the pressure. Fixing the temperature, however, does not fix the composition, and this is probably due to two things: (1) the fact that the surface which separates the fluid and solid phases is curved, and (2) the fact that that surface is freely permeable by the mobile molecules of water, but is relatively impermeable to the immobile molecule of agar. The system obviously has two pressures which determine equilibrium, a lower hydrostatic pressure on the convex side of the curved surface, and a higher on the concave side.

Hydrosols, such as those of gold, silver or hydrosulphides, are systems in which equilibrium is between a solid phase dispersed as minute particles, and a fluid phase which is a true solution of the substance of the solid phase. The behaviour of the particles in an electric field shows that each one is surrounded by a double electric layer, which can be destroyed by the addition of electrolytes, or, in some cases, by the removal of all electrolytes. When this is done aggregation or coagulation follows. The stability of these hydrosols, therefore, is due to a contact difference of potential between the solid and the fluid phases.

The addition of an electrolyte may bring about coagulation either by altering the potential of the fluid phase, so as to make it agree with that of the solid phase, or by furnishing "nuclei" about which the particles of solid aggregate. When the particles carry a negative charge, acids act by decreasing the positive charge of the fluid; when the particles carry a positive charge, alkalies act by decreasing the negative charge of the fluid. In these cases the coagulating power of the acid or alkali is directly measured by its chemical activity when dissolved in water. The relation is expressed by the formula

$$K = n\alpha(v + \nu)$$

when K is the specific molecular coagulative power of a substance as measured by the volume occupied by one gram mol., when it just suffices to coagulate the hydrosol.

The coagulating action of a salt is due to only one ion, which is always of the opposite electrical sign to the colloid particles. The valency of the active ion exerts a remarkable influence upon its coagulative power, the relation being approximately

$$I' : I'' : I''' = K : K^2 : K^3.$$

Therefore, to express the coagulating powers of salts, a factor which is approximately squared or cubed by a change from monovalent to di- or tri-valent ions must be added to the formula given above.

$$K = n\alpha(v + \nu)A^x.$$

Thomson has pointed out that double electric layers must be separated by a region of finite thickness, in which the components are in a state of uncompleted chemical combination. The solid and fluid phases in these hydrosols, therefore, are separated by a layer which possesses considerable chemical energy, and which is of very great extent, and this may account for their marked catalytic or ferment-like properties.

[1] Abstract of two papers read before the Royal Society, on January 25, by W. B. Hardy.

NORTH AMERICAN GEOLOGY.

THE publications of the Geological Surveys in the United States and in Canada are noteworthy for the exhaustive treatment, from an economic as well as from a scientific point of view, of the subjects dealt with. In dimensions, in type, and in wealth of illustration, the numerous volumes which are issued bear favourable comparison with works published elsewhere.

Reports of United States Geological Survey.

Attention was called in NATURE of June 22, 1899, to Parts ii. and v. of the "Eighteenth Annual Report of the U.S. Geological Survey." We have lately received Parts iii. and iv. of the same Report. Part iii. is a bulky volume of 861 pages, which relate almost wholly to economic geology. Mr. George F. Becker deals with the gold-fields of Southern Alaska, while Mr. J. E. Spurr and Mr. H. B. Goodrich contribute an elaborate report on the geology of the Yukon Gold District, in the same territory. To the last-named work special reference has already been made in NATURE (December 7, 1899, p. 124). The Yukon gold-field lies close to the British frontier; that of Southern Alaska, to which we now draw attention, fringes the coast from Sumdum Bay westward as far as Unalaska, the mines being partly on the mainland, partly on islands. Mr. Becker gives an account of the volcanic activity and changes of level which have affected the region. Volcanic eruptions have occurred in comparatively recent times, and the belt of activity seems to have existed since late Eocene or early Miocene times. The author describes the various eruptive rocks, and a few schistose rocks which appear to be altered eruptive rocks; he also contributes notes on glaciation. The ore-deposits occur in a belt which coincides with the planes of schistosity in the altered rocks, and it is considered that their origin is connected with eruptive phenomena. The minerals associated with the gold are quartz and pyrites, copper pyrites, galena, zinc-blende, &c. The author gives accounts of the mines, and of the placer deposits, and refers also to certain auriferous beach-deposits. At present the district is but imperfectly explored.

Mr. Bailey Willis reports on some coal-fields of Puget Sound, Washington. The coal-bearing formation (Puget group) is of Tertiary age; the lower beds being Eocene, while the upper beds may be Miocene. The prevailing rocks are sandstones, but the deposits vary from arkoses, consisting of slightly washed granite materials, to siliceous clays, and they contain much carbonaceous material and distinct coal-seams. These strata rest unconformably on metamorphic schists and limestones of Carboniferous and Jura-trias date, and they are in places overlain conformably by marine Miocene (Tejon) strata. Tertiary eruptive rocks of younger date are associated with the Puget group. They occur as dykes and flows in various forms of intruded and extruded igneous rocks. Glacial deposits extend over large areas. The Puget strata were deposited in marshes and shallow-water areas, and subsequently were subject to considerable disturbances which led to folding and over-thrust, followed by normal faulting. Variations in the quality of the coals is attributed to the pressure and movement which they have suffered. The coals range in character from lignites to what are termed bituminous lignites or steam coals, and bituminous coking coals.

The geology and mineral resources of the Judith Mountains of Montana, form the subject of a report by Mr. W. H. Weed and Mr. L. V. Pirsson. These mountains are one of the groups of the Great Plains of the North-west, the nearest peaks of the Rocky Mountains being thirty-five miles to the west. They rise like a great island above the plains to a height of about 2500 feet above this level platform, the most elevated peak being 6386 feet above the sea. Geologically the mountains have been formed by a number of independent, coalescing, dome-shaped uplifts, involving the sedimentary series from the Cambrian to Cretaceous, and they are penetrated by laccolitic and other intrusions of igneous rocks. It is remarkable that while the great series of sedimentary rocks is apparently conformable throughout, yet the earlier strata are steeply upturned along the flanks of the Rocky Mountains, and the disturbances die out eastwards over the area of the plains. No Permian or Trias sediments occur, and the region was probably a land-area during those periods. Descriptions are given of the Cambrian, Silurian, Devonian, Carboniferous, Jurassic and Cretaceous rocks, and of the numerous laccolitic intrusions which are all of acid type. Granites, syenites, diorites and nephelite-syenites are found, the latter being represented by rocks of phonolitic character. The ore-deposits (chiefly gold) and the Cretaceous coal are described.

Mr. Waldemar Lindgren furnishes an account of the mining districts of the Idaho basin and the Boise ridge, Idaho, with a report on the fossil plants of the Payette formation, by Mr. F. H. Knowlton. The region includes a portion of the lower Snake River Valley and adjacent mountains on the northern side, together with the entire drainage of the Payette, Boise, and Wood rivers. The Boise mountains attain elevations of over 7000 feet. The area consists largely of granite together with the "Snake River Tertiaries." These latter comprise early Neocene (Miocene) lake-beds, known as the Payette formation, with which are associated vast masses of basalts and rhyolites; and later Neocene (Pliocene) deposits together with the Snake River basalts. Sands and gravels of Pleistocene age also occur. Gold occurs in the granitic rocks or associated dykes and veins, and in placer deposits. Monazite is found in the sands of the lake deposits, and there is no doubt that it forms one of the original constituents of the granite of the Idaho basin. This mineral, which is a phosphate of the cerium metals and thorium, yields products of economic value in the preparation of incandescent gas lights of the Welsbach and other burners. Silver-ores also occur in the region.

A preliminary report on the mining industries of the Telluride Quadrangle, Colorado, is contributed by Mr. C. W. Purington. This is a region of striking topographical features, the mountains rise to over 14,000 feet, while some of the streams have cut precipitous channels in the mountain cirques or basins to a depth of 7500 feet. Telluride, a town of about 1500 inhabitants, is in the heart of the mining district. The first prospectors entered the region about twenty-five years ago, and the district has made a steadily increasing output from its discovery to the present time. As remarked by the author, it has been the history of many ore-producing regions that much more money has been expended in the mining (and we might add financial) operations than has been extracted from the ore taken out. The Telluride district is said to be emphatically one where the money value, represented by the labour and capital expended, has not equalled or even approached in amount the product of the mines in the precious metals. The lesson that is taught is that conservatism in mining is poor policy, and that new methods and devices to meet new conditions, for which no rules can be laid down, are necessary for the successful production of ore in newly exploited areas. The district is composed of nearly flat sedimentary beds, which rest on Archæan and extend in geological age from the Trias to the Tertiary. This vast series has been in places tilted up, deformed, injected and broken through by igneous rocks, of Tertiary or Post-Tertiary age.

The ridges of the mountains present exceedingly irregular, sharply cut and jagged lines, whose sharp gaps are generally the result of the more rapid weathering and wearing down of metalliferous veins and zones of mineralised rock. Such zones usually have most brilliant colours—red, white and yellow—and are visible across country for a distance of twenty miles. With regard to the scenery in general, it is remarked that the beauty of form and colouring is unsurpassed in the mountain regions of the world. The metalliferous portions of the rocks are thus largely exposed to view, and their origin is attributed to the subterranean tract from which the igneous rocks have come; surface waters having descended through fissures to the horizon of the heated magma, and having subsequently ascended heavily charged with mineral matter. The vein-filling is considered to be later than the newest lavas exposed in the region. The vein-deposits are valued chiefly for the gold and silver, while much gold in a finely divided state occurs in placer deposits. It is noteworthy that none of the tellurides or other possible rare compounds of gold occur in the area, so far as the present investigation has been able to determine. No silver-ore occurs which does not contain, in the free state, more or less gold; while the galena, considered as an ore of silver, is merely the gangue or mechanical matrix of gold.

Part iv. of the "Eighteenth Annual Report" deals entirely with hydrography. It is a huge volume of 756 pages, comprising (1) Report on the progress of stream measurements for 1896, by A. P. Davis; (2) The water resources of Indiana and Ohio, by F. Leverett; (3) New developments in well-boring and irrigation in South Dakota, by N. H. Darton; and (4) Water storage and construction of dams, by J. D. Schuyler. Among the matters discussed is the temperature of the deeper artesian waters in the Dakota basin.

We have received also Parts i., iv. and vi. of the "Nineteenth Annual Report for 1897-8," and portions of Part ii. Part i. comprises the report of the director, Mr. Charles D. Walcott, and it includes observations on triangulation and spirit-levelling.

Part ii., which includes papers chiefly of a theoretical nature, contains an elaborate report on the principles and conditions of the movements of ground-water, by Mr. F. H. King. The author deals with the water-holding capacity of natural soils, the depth to which ground-water penetrates, and its general movements. Movements are due to barometric pressure and to thermal agencies, to crust deformation and to rock consolidation. The original water laid down with sediments is considered as well as the subsequent capillary movements of ground-water. Interesting results are given of experimental investigations regarding the flow of water and kerosene through sand, sandstone, wire-gauze, &c.; and of the influence of the form, diameter and arrangement of soil and sand-grains on the amount of flow. An important record is given of the effect of the pumping of one well on another 1133 feet distant. Both wells were sunk in sandstone to a depth of about seventy feet. When pumping at the rate of about seventy-five gallons per minute from one well, a fall of water was detected in the other after the lapse of one minute and forty-five seconds. The pump was worked for ten minutes, and the fall of water in the second well continued for nearly fifteen minutes.

The article by Mr. King is followed by one on the theoretical investigation of the motion of ground-waters, by Mr. Charles S. Slichter.

An elaborate memoir on the Cretaceous formation of the Black Hills (Rocky Mountains), as indicated by the fossil plants, is communicated by Mr. Lester F. Ward, who has had the assistance of Messrs. W. P. Jenney, W. M. Fontaine and F. H. Knowlton. The forms described include a number of silicified Cycadean trunks, Conifers, Ferns and Equisetaceæ, also Dicotyledons belonging to the beech, oak, elm, mulberry and soapberry families. The work is illustrated by over a hundred plates, including one of Cycadean trunks from the Purbeck beds of the Isle of Portland, England, belonging to the U.S. National Museum.

Part iv., a volume of 814 pages, deals with hydrography: it contains a report, by Mr. F. H. Newell, on stream measurements; and an account, by Mr. Edward Orton, of the Rock waters of Ohio. The knowledge of the Ohio waters is mainly due to the boring operations in search of oil and gas. Mr. N. H. Darton furnished a preliminary report on the geology and water resources of part of Nebraska. Several illustrations are given of tors or outstanding masses of sandstone which, from being locally hardened, have withstood the effects of denudation. Other instances of fantastic weathering, seen in the "Chimney Rock" and "Toadstool Park," are effectively shown in plates.

Part vi. (in two volumes) contains an account of the mineral resources of the United States. In the first volume, the metallic products, coal and coke are dealt with; in the second volume, petroleum, natural gas, stone, clays, cement, precious stones, phosphates, mineral paints, &c. There are also notes on the mineral resources of Hawaii, and of the Philippine Islands.

Monographs of United States Geological Survey.

The twenty-ninth volume of the Monographs of the United States Geological Survey is a large work of 790 pages, on the geology of Old Hampshire county, Massachusetts, by Professor Benjamin K. Emerson. It is an elaborate memoir embodying personal observations which have extended over more than a quarter of a century; and it deals with a great variety of formations—Algonkian, Cambrian, Silurian, Devonian, Triassic and Pleistocene—also with various eruptive rocks, and their many economic products. In the Algonkian series there are gneisses often granitoid, and others yielding much graphite, likewise magnesian limestone. Of Cambrian age are various gneisses and associated schists and quartzite. A detailed description is given of the granitoid gneiss of Monson, which is extensively quarried, the yearly output being from twenty to thirty thousand tons. The author draws attention to a remarkable tendency to expansion which has been stored up in the gneiss, causing blocks to elongate when they are quarried. In the same way the expansion causes the horizontal sheets of the rock to rise, often quite suddenly, in considerable anticlines, with the arch as much as fifty feet long and the rise three or four inches. These anticlines form sometimes with explosive violence, throwing large fragments of the rock more than two feet from their original position. Evidently the rock has an elastic stress which expresses itself in expansion when the surrounding masses are removed.[1]

Among the rocks classed as Lower and Upper Silurian are sericite-schists, amphibolites and serpentines, of which petrographical descriptions are given. Not the least interesting feature in the geology is the great magnetite-emery bed which lies along the junction of hornblende-schist and sericite-schist, and was discovered in 1864. The emery is distinguished from corundum (pure anhydrous alumina) which also occurs, and is regarded as an aluminate of iron. A full account of this mineral vein is given.

When we come to the Devonian rocks we still find a series highly altered, comprising in the main quartzite, and various schists, together with limestones. The rocks appear to rest conformably on, and, indeed, to pass into what are called Upper Silurian argillites; nevertheless, the fossils, or rather impressions of them, which were obtained in the rocks, seem to be of upper Devonian type. Prof. J. M. Clarke remarks that they "are so distorted, obscure, and closely packed together, that a little imagination can construe them into species of all sorts of ages"; but he feels "reasonably secure" about a few, among which is a large spirifer, like *Spirifera disjuncta*. Workers among the Devonian rocks in parts of Devon and Cornwall would feel sympathy with the difficulties of accurate identification, and suspend judgment about the local relations of Devonian and Silurian. In a general chapter on amphibolites the author states that he has assigned most of them with more or less confidence to the list of altered sedimentary rocks. Passing on to the eruptive rocks, he describes various granites, aplite, quartz-gabbro, tonalite or quartz-diorite, diorite, diabase, and cortlandite (hornblende-pyroxene-biotite-peridotite).

The Triassic rocks comprise a series of sandstones, conglomerates and red shales, together with diabases. The shales contain impressions of salt-crystals, and among the conglomerates the author finds evidence which suggests the former presence of shore-ice. Most interesting are the observations on the preservation of reptilian foot-prints and rain-drops which occur in sandstones that rest on the broad sheets of trap. It is thought that the iron set free from the decomposing lavas below permeated the sediments and favoured the preservation of the tracks; it is also suggested that the heat of these great trap-sheets may have promoted rapid consolidation of the sand-layers by which they were quickly covered. In a few notes on the "Recent Progress in Ichnology," Mr. C. H. Hitchcock gives a list of the Ichnozoa of the Trias, including one marsupial, and many birds, dinosaurs, reptiles, batrachians, arthropods and mollusca.

In the account of Pleistocene phenomena we have references to Pre-Glacial drainage and erosion, descriptions of glacial lakes, and minor grooves and notches, and particular accounts of the till and various other drifts. The author remarks on the fragments worn by the agency of land-ice "into the peculiar shapes so characteristic of glacial accumulations, three- or four-sided forms, with irregular ends more or less elongate as the rock was more or less schistose, the sides flat or broadly convex, joined by rounded edges and scratched in various directions"; and he adds that "These peculiar forms, called by the Germans *dreikantner*, are as characteristic of the till as graptolites of the Silurian." Numerous sections are given of glacial deposits, many of which remind us of the drifts so well exposed on the coasts of Norfolk and Suffolk, which exhibit similar structures and contortions. The Pleistocene beetles are described by Mr. S. H. Scudder. The volume, which is well illustrated, concludes with a chronological list of publications on the district, the earliest of which is a reference to an ancient catalogue (1734) of objects of natural history formed in New England, by John Winthrop, F.R.S.

Monograph No. 31 contains an account of the geology of the Aspen mining district, Colorado, by Mr. Josiah E. Spurr, and it is accompanied by a large folio atlas of maps and sections.

In an introduction, Mr. S. F. Emmons points out that Aspen is one of the most picturesquely situated mining towns of the Rocky Mountain region; and that its great mineral wealth lies in a narrow belt of Palæozoic rocks, which are steeply upturned against granite, and broken in the most complicated manner by a network of faults.

[1] See also A. Strahan, on "Explosive Slickensides," *Geol. Mag.* for 1887.

The mines of Aspen were mainly discovered and opened by men whose most recent mining experience had been at Leadville, where the silver-ores were found principally at or near the contact of limestone, with overlying sheets of porphyry. The ores consist chiefly of lead and zinc sulphides, carrying silver, with a gangue of barytes, quartz and dolomite. Rich shoots of ore occur chiefly at the intersection of two or more faults, and the theory is advanced that while the minerals were deposited by hot waters, the solutions ascending along one of these channels were precipitated by solutions which circulated along the other.

The fundamental rock in the district is a granite, and this is overlaid by Cambrian, Silurian, Devonian, Carboniferous, Juratrias and Cretaceous. The Cambrian and Silurian formations are comparatively thin, and they consist largely of dolomitic sandstones and shales. The Devonian beds, which are very variable in character, comprise limestones and calciferous sandstones of no great thickness, and they are characterised by the presence of fishes of Devonian type. The Carboniferous and also the Secondary formations attain a great thickness. Into these strata, probably in Cretaceous times, there were intruded dykes of quartz-porphyry and diorite-porphyry. Great physical disturbances took place, accompanied by distinct systems of faults, some developed before, others after the deposition of the ores. In the author's opinion some faults have developed almost entirely in Post-Glacial times, the evidence resting partly on the preservation of scarps with slickensided fault-surfaces. He believes also that in many cases the fault-movement is going on at the present day. Since the beginning of the great disturbances, about 15,000 feet of sedimentary rocks have been removed by denudation; in later times by glacial action. A general ice-sheet at one time covered the whole of the Aspen district, leaving evidence of its presence in the rounded and fluted forms into which the hill-tops are carved, and in deposits of morainic material. When the ice-sheet shrank to smaller dimensions, there resulted local glaciers which followed the course of pre-existing valleys, and carved them into their present forms. At this period temporary lakes were formed by the damming up of glacial waters.

The author has given considerable attention to the subject of dolomitisation. He remarks that along the channels afforded by faults, hot spring-waters containing carbonate of magnesia rose and produced the dolomitisation of the limestone. Zones in the limestone following watercourses which are parallel to the bedding, or which cut across it, are locally altered to dolomite. There is evidence also of an earlier period of such chemical interchange, some of the Silurian and Carboniferous sediments having been early converted into dolomite by the action of magnesium salts contained in the waters of a great lake or inland sea, and in which they were concentrated by evaporation. These earlier dolomites are continuous over wide areas, with an almost uniform chemical composition.

Maryland Geological Survey.

Under the vigorous direction of the State Geologist, Prof. W. Bullock Clark, the Maryland Geological Survey has just issued its third volume; one of a series which in type and illustration is one of the most excellent of all the geological reports published in the United States. The present volume deals wholly with questions of economic geology treated from a scientific as well as a practical point of view. It is, in fact, a manual on road-materials and road-construction. The dependence of the highways upon the surface configuration of the land, and the bearing of the distribution of temperature and rainfall are pointed out. Attention is rightly paid to the relationship between the stony structure of the ground and the roads. The questions of construction and repair, and the qualities of road-metals are dealt with in detail, and the construction of sample roads is described. Various administrative matters are also dealt with. Illustrations are given of the method of road-making since early times; there are numerous photographic illustrations of types of roads formed of different materials, including types of bad roads in Maryland; and there are photo-micrographs of rock-sections of road-material.

Geology of Indiana.

A bulky volume of 1741 octavo pages forms the "Twenty-third Annual Report of the Department of Geology and Natural Resources for the State of Indiana," under the direction of Mr. W. S. Blatchley, State Geologist. It comprises the result of a careful survey of the coal area of Indiana, giving full details of the physical features and stratigraphy, of the mines and method of mining, with analyses of the coal. The work is profusely illustrated with maps and sections, and not the least interesting are the sections of faults and disturbances and evidences of irregularities in the coal-seams due to local thickening by disturbance, or to original deposition, or to erosion in Carboniferous or later periods. A report is made on the natural gas which occurs in the Trenton limestone, and is sealed up beneath the Utica shale. The first boring was made in 1884, and the gas was tapped at a depth of about 1100 feet. The Trenton limestone was proved to be both the source and the reservoir of the gas.

Geological Survey of Canada.

The "Annual Report of the Geological Survey of Canada for the year 1897 (1899)" has just reached us. It is a composite volume, containing six individual reports separately paged, but all indexed together with special references to each. As the progress of the survey has been noticed already in NATURE, when dealing with the Annual Summary Reports of the director, Dr. G. M. Dawson, it will suffice to call attention to this important volume which contains detailed accounts of Archæan, Palæozoic and Pleistocene deposits, with full descriptions of the economic products. There is a special report on the mineral resources of New Brunswick, by Mr. L. W. Bailey, and another on mineral statistics and mines, by Mr. E. D. Ingall. The volume is illustrated by a number of maps and plates. One of the most effective views is that of the Devil's Rapids on Chandière river, Quebec. It illustrates a report on the surface geology and auriferous deposits of South-eastern Quebec, by Mr. R. Chalmers.

ELECTRO-CULTURE.

THE results obtained by culture under the influence of electric light are fairly well known, and the growing of lettuce for salads, in spacious greenhouses with the aid of electric light, is already a profitable industrial pursuit in the United States (near Chicago and elsewhere). However, the use of electric currents for stimulating vegetation, although it was studied more than fifty years ago (by Ross, in 1844–46; continued by Forster, Sheppard, Fichtner, &c.), still remains unsettled. A communication upon this subject, made by a Russian engineer, V. A. Tyurin, before the St. Petersburg Electro-Technical Society, contains some welcome information upon the work done in this direction in Russia by M. Spyeshneff and M. Kravkoff. The former experimented a few years ago on three different lines. Repeating well-known experiments on electrified seeds, he ascertained once more that such seeds germinated more rapidly, a nd gave better fruit and better crops (from two and a half to six times higher), than seeds that had not been submitted to preliminary electrification. Repeating next the experiments of Ross—that is, burying in the soil one copper and one zinc plate, placed vertically and connected by a wire, he found that potatoes and roots grown in the electrified space gave crops three times heavier than those which were grown close by on a test plot; the carrots attained a quite unusual size, of from ten to twelve inches in diameter. Spyeshneff's third series of experiments was more original. He planted on his experimental plot, about ten yards apart, wooden posts provided at their tops with metallic aigrettes connected together by wires, so as to cultivate his plants under a sort of network of wires. He obtained some striking results, one of which was that the growth and the ripening of barley were accelerated by twelve days. Quite recently M. Kravkoff undertook a series of laboratory experiments upon boxes of soil submitted to electric currents. The temperature of the soil was raised by these currents; its moisture decreased first, but began to increase after a course of three weeks (the same increase of moisture was also noticed by Fichtner); and finally, the amount of vegetable matter in the soil was increased by the electric currents. With what is now known upon the influence of micro-organisms upon vegetation, further research on similar lines is most desirable and very promising.

SCIENTIFIC SERIALS.

THE *Journal of the Royal Microscopical Society* for April contains the President's Annual Address, the last instalment of his valuable series of addresses on the mathematics of the construction of microscopic lenses. In this address, Mr. E. M. Nelson devotes himself to the aplanatic immersion front and the Huyghenian eye-piece, and deals with the errors of this lens, viz. chromatism, curvature of image, distortion, and astigmatism.

A new feature in the present number is the extension of the bibliography to microscopical technique and bacteriology.

THE *Journal of Botany* for February, March, and April contains several articles of more than usual interest. Mr. C. R. P. Andrews records the discovery in the Channel Islands of two grasses new to Britain, *Phalaris minor* and *Milium scabrum*, both apparently native; and Mr. Arthur Bennett, the occurrence of *Potamogeton rutilus*, also new to Britain, in Surrey. Dr. A. B. Rendle reviews the British species of *Naias*, now amounting to four (including one found at present in geological deposits only), although the first discovery of the genus as British was as recent as 1850. The very useful review of the algological literature for 1899 will, we hope, be continued in future numbers.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, April 5.—"Further Note on the Influence of Temperature of Liquid Air on Bacteria." By Allan Macfadyen, M.D., and S. Rowland, M.A. Communicated by Lord Lister, P.R.S.

In a previous communication (*Roy. Soc. Proc.* February 1, 1900) it was shown that no appreciable influence was exerted upon the vital properties of bacteria when exposed for 20 hours to the temperature of liquid air ($-183°$ C. to $-192°$ C.). Further experiments have since been made in which the organisms were again exposed to the temperature of liquid air for a much longer period, viz. seven days.

The organisms employed were *B. typhosus*, *B. coli communis*, *B. diphtheriae*, *B. proteus vulgaris*, *B. acidi lactici*, *B. anthracis* (sporing culture), *Spirillum cholerae asiatica*, *Staphylococcus pyogenes aureus*, *B. phosphorescens*, a Sarcina, a Saccharomyces, and unsterilised milk.

Instead of being exposed as formerly on the actual media in which they were growing, the organisms were submitted to the cooling process in the form of a broth emulsion in hermetically sealed fine quill tubing. This allows of complete immersion, and effects a considerable economy in the amount of liquid air used, besides greatly facilitating manipulation. The liquid air was kindly furnished by Prof. Dewar, and the experiment was conducted in his laboratory.

In the course of the experiment, the loss by evaporation of the liquid air was made up by adding fresh portions from time to time. In this way the temperature of about $-190°$ C. was maintained uninterruptedly through the whole period of the experiment. At the same time considerable care had to be taken in conducting the first cooling, in order to avoid fracture of the quill tubes. A preliminary cooling was therefore effected by means of solid CO_2. After the expiration of a week, the tubes were removed with cork-tipped forceps, and placed in a strong glass vessel till thawing was complete. The tubes were then opened, and the contents transferred to suitable culture media. In each case, a direct microscopical examination was made to detect any possible structural changes.

It is a remarkable fact that, notwithstanding the enormous mechanical strain to which the organisms must have been exposed, a strain far exceeding in amount any capable of being produced hitherto by direct mechanical means, not the slightest structural alteration could be detected.

The sub-cultures made at the conclusion of the experiment grew well, and in no instance could any impairment in the vitality of the organisms be detected. In one or two instances only, growth was slightly delayed, an effect which might have been due to other causes. The photogenic bacteria grew and emitted light, and the samples of milk became curdled.

The above experiments show that bacteria can be cooled down to $-190°$ C. for a period of seven days without any appreciable impairment of their vitality.

It has not yet been possible to undertake the experiments with liquid hydrogen.

Geological Society, April 4.—J. J. H. Teall, F.R.S., President, in the chair.—Additional notes on some eruptive rocks from New Zealand, by Frank Rutley. The author suggests a comparison of certain ancient rhyolites of Great Britain with those of New Zealand affected by solfataric action. As to the causes which may convert a glassy into a lithoidal rhyolite, we still seem to lack information: it is possible that the action of steam may be instrumental in effecting such a change, but this is probably only an occasional agent, and the more general cause of such changes must be sought elsewhere.—On the discovery and occurrence of minerals containing rare elements, by Baron A. E. Nordenskiöld. The first mineral referred to is scheelite, and the next cerite, which contains no less than four rare metals. The incandescent light produced when the latter mineral is fused with charcoal-powder was first observed by Cronstedt in 1751. The discovery of glucina, lithia, selenium and yttria is next referred to. Minerals containing yttria and oxides related to it were, at one time, thought to be almost limited to certain pegmatite-veins running in a broad zone on both sides of the 60th parallel of latitude. Latterly, fluocerite, orthite and gadolinite have been found in Dalecarlia; and among these minerals Benedicks discovered a silicate of yttrium containing 1·5 per cent. of nitrogen and helium. The author discovered kainosite, a silico-carbonate of yttrium and calcium, among minerals from Hitterö; and the same mineral was subsequently discovered in the flucan, fissures, and drusy cavities at the Nordmarken mines. The last-mentioned discovery and others related to it appear to suggest that the mode of formation of fissure-minerals is not so unlike that of the pegmatite-veins of the primary rocks as is generally supposed. Thorium, discovered by Berzelius in 1829, was originally obtained from the rich mineral-locality of Langesund (called Brevig in mineralogical literature), but it has since been recorded from other localities, including Arendal and Finnish Lapland. It is now obtained from the monazite-sand of rivers in the Brazils and South Carolina. Thorite contains about ·5 per cent. of inactive gas, probably a mixture of nitrogen and helium; but the latter element was first obtained from the mineral cleveite, also containing thorium, discovered by the author in 1877. Other minerals bearing nitrogen, argon or helium are referred to; and under the head of minerals bearing tantalum, mention is made of Giesecke's discoveries in Greenland. Among these is fergusonite, one of the richest sources hitherto known for obtaining that mysterious gas, or mixture of gases, which on our planet seems to be almost exclusively confined to minerals containing rare earths. "The group of earths, as well as the group of gases, of which we are here speaking, might, therefore, be compared with certain genera among organic beings, whose species, having not yet fully differentiated, offer to the descriptive zoologist or botanist difficulties analogous to those with which chemists meet in endeavouring to separate the rare earths and rare gases."

PARIS.

Academy of Sciences, April 9.—M. Maurice Lévy in the chair.—Funeral orations on the late M. Joseph Bertrand, delivered by MM. Jules Lemaitre, Maurice Lévy, Berthelot, Gaston Darboux, A. Cornu, Duclaux, Gaston Paris, and Georges Perrot.—On the transmission of the radiation of radium through substances, by M. Henri Becquerel. In order to ascertain whether the rays transmitted through a screen are transformed rays from the radio-active source or secondary rays emitted by the screen, experiments were made on the shadow cast by a body placed on the side of the screen opposite to the source. It appears that part, at least, of the secondary radiation is not deviated in a magnetic field, as is the case with the radiation of radium, whilst another portion is possibly due to partial diffusion. The absorption of the incident radiation increases with the distance of the screen from the source, as has been previously observed.—On the density and analysis of sulphur perfluoride, by MM. H. Moissan and P. Lebeau. The density of the gaseous perfluoride of sulphur, the preparation of which was described in a previous communication, is found to be 5·03, compared with air. The analysis of the compound was effected by decomposing it by the vapour of sodium at a red heat, a mixture of sodium sulphide and fluoride being thus obtained, and also by heating with sulphur or selenium in glass vessels and measuring the volume of the silicon fluoride evolved. The results are in accordance with the formula SF_6, the hexavalent character of sulphur being thus clearly demonstrated.—On the fossil ferns of coal, by M. Grand' Eury. A description of the roots of the various species of ferns occurring in the fossil forests of the coal beds at Saint-Étienne.—Immunity against symptomatic carbuncle after the injection of preventive serum and natural virus, either separately or together. Experiments with sheep show that complete immunity is produced by successive inoculation with serum and virus, but not by the injection of a mixture of serum and virus.—M. Michelson was elected corresponding member for the Section of Physics.—Solar observations at the Lyon Observatory during the fourth quarter of the year 1899, by M. J. Guillaume.—On certain equations of Monge-Ampère, by M. J. Clairin.—On the general representation of some analytic functions, by M. Desaints.—New methods for maintaining the vibrations of tuning-forks, by MM. A. and V. Guillet. The electrical mechanism previously applied by A. Guillet to Lippmann's pendulum is perfectly adapted to the tuning-fork.—Experimental study of the movements produced in liquids by heat convection. Permanent control; cellular vortices, by M. Henri Bénard. A preliminary note. The liquid behaves as if divided into a number of regular prismatic cells, the dimensions and periodic movements of which depend on the experimental conditions.—On the duration of the emission of Röntgen rays, by M. Bernard Brunhes. The emission of X-rays produced by a rupture of the primary current of the induction coil lasts for about the ten-thousandth part of a second.—On the reflection and refraction of kathode rays and of the deviable rays of radium, by M. P. Villard. The author's experiments lead to the conclusion that the apparent transmission of kathode rays through metallic plates is due to a secondary emission. The deviable rays of radium behave like kathode rays, whilst the non-deviable rays include radiations of high penetrating power.—Negative electrification of secondary rays produced by means of Röntgen rays, by MM. P. Curie and G. Sagnac. Röntgen rays appear to bear no electric charge, but the secondary rays resulting from their transformation resemble kathode rays in being negatively electrified.—Heat of formation of hydrated and anhydrous strontium dioxide, by M. de Forcrand. The heat evolved in the conversion of strontium monoxide into the anhydrous dioxide is less by about one calorie than that evolved in the formation of barium dioxide, whilst, on the other hand, strontium dioxide has a greater affinity for water than barium dioxide.—On a new method of fractionating some rare earths, by M. Eugène Demarçay. The method is based on the crystallisation from nitric acid of the double nitrates of magnesium and the rare earths.—Formation of monomercurammonium iodide by the action of concentrated ammonia on mercurdiammonium iodide, by M. Maurice François. Monomercurammonium iodide, $NHgH_2I$, is prepared by adding successive small quantities of ammonia to mercurdiammonium iodide; it is a black, crystalline substance which does not become red on exposure to air, and is insoluble in ether.—On a crystalline selenide and oxyselenide of manganese, by M. Fonzes-Diacon. Manganese selenide, MnS, is obtained in cubical crystals by the action of hydrogen selenide on a solution of manganese acetate, by the reduction of manganese selenate with carbon in the electric furnace, and by fusing the precipitated selenide at a high temperature. Prismatic needles of the same substance are produced by the action of hydrogen selenide on manganese chloride at a red heat. A green oxyselenide is formed when manganese selenate is reduced by hydrogen at a bright red heat.—On the reducing action of calcium carbide, by M. Geelmuyden. The action of calcium carbide on boric anhydride at the temperature of the electric furnace results in the formation of calcium boride, CaB_6. Under the same conditions the sulphides of iron, lead, antimony, and magnesium yield calcium sulphide and the respective metals which, except in the case of iron, are volatilised. Aluminium sulphide is not reduced by calcium carbide.—On a new method for the preparation of double sulphates of chromium, by M. C. Pagel. In the destruction of organic matter by means of chlorochromic acid, as previously described, the double sulphates of chromium and sodium or chromium and potassium are formed; they crystallise in the hexagonal system.—Electrolytic estimation of lead in lead sulphate and chromate. Application to the analysis of lead glass and lead chromates, by M. C. Marie. The lead compounds are dissolved in a mixture of nitric acid and ammonium nitrate, and the solution electrolysed in the usual manner.—On $\alpha\alpha\beta$-trimethyl-β-oxyadipic acid, by M. E. E. Blaise. The lactonic acid corresponding with this acid is obtained by the condensation of methyl levulate with methyl bromisobutyrate in presence of zinc.—Action of amyl chloride on calcium carbide, by M. P. Lefebvre. The primary products of the action of amyl chloride on calcium carbide at a dull red heat are probably acetylene, amylene, and calcium chloride.—The nervous ganglions of the posterior roots belonging to the great sympathetic system, by M. Nicholas Alberto Barbieri.

DIARY OF SOCIETIES.

MONDAY, April 23.

Institution of Civil Engineers, at 8.—Eighth "James Forrest" Lecture: The Relations between Electricity and Engineering: Sir William H. Preece, K.C.B., F.R.S.

TUESDAY, April 24.

Royal Institution, at 3.—Studies in British Geography: Dr. H. R. Mill.

Institution of Civil Engineers, at 4.—Repetition of "James Forrest" Lecture by Sir William Preece, K.C.B., F.R.S.—At 8.—Annual General Meeting.

Anthropological Institute, at 8.30—The Ethnography of Torres Straits and British New Guinea: A Genealogical Method of collecting Social and Vital Statistics: Dr. W. H. R. Rivers.—Lantern Demonstration of Native Industries: Prof. A. C. Haddon, F.R.S.

Royal Statistical Society, at 5.—The Consumption of Alcoholic Beverages: H. Bence Jones.

WEDNESDAY, April 25.

Geological Society, at 8.—On Longmyndian Inliers at Old Radnor and Huntley (Gloucestershire): Dr. Charles Callaway.—On a Complete Skeleton of an Anomodont Reptile from the Bunter Sandstone of Riechen, near Basel, giving New Evidence of the Relation of the Anomodontia to the Monotremata: Prof. H. G. Seeley, F.R.S.

THURSDAY, April 26.

Royal Institution, at 3.—A Century of Chemistry in the Royal Institution: Prof. J. Dewar, F.R.S.

Institution of Electrical Engineers, at 8.—The Electric Transmission of Power: Prof. George Forbes, F.R.S.

Institution of Mechanical Engineers, at 8.—Road Locomotion: Prof. Hele-Shaw, F.R.S.

FRIDAY, April 27.

Royal Institution, at 9.—Nineteenth Century Clouds over the Dynamical Theory of Heat and Light: Lord Kelvin, G.C.V.O., F.R.S.

Physical Society (Solar Physics Observatory, Exhibition Road, South Kensington), at 8.—A short account of the Physical Problems now being investigated at the Solar Physics Observatory, and their Astronomical Applications: Sir Norman Lockyer, K.C.B., F.R.S.—Weather permitting, the 36-inch, 10-inch, and 9-inch telescopes will be used for the observation and photography of celestial objects and their spectra. The Apps-Spottiswoode coil and 21-ft. Rowland grating will also be in operation.

SATURDAY, April 28.

Royal Institution, at 3.—Egypt in the Middle Ages: Prof. Stanley Lane-Poole.

CONTENTS.

THURSDAY, APRIL 26, 1900.

THE BIRDS OF CELEBES.

The Birds of Celebes and the Neighbouring Islands. By A. B. Meyer and L. W. Wiglesworth. Two volumes. Pp. xxxiii, 392 and 590; with 45 plates and 7 maps. (Berlin: R. Friedlander und Sohn, 1898.)

FEW regions of the world approach in interest to the naturalist the wide Archipelago strung upon the equator, between the Asiatic and the Australian continents, both of which claim a share in the broken lands between which Wallace's Line rides the marches. Of all these islands none perhaps have attracted more attention than Celebes, notably on account of its strange configuration, but especially from its central position in the archipelago which has given a remarkable character to its fauna, the affinities of which have bandied it from one to the other of the two zoological realms between which it lies. To which of them it will finally appertain must still remain an open question till it has been more fully explored, botanically as well as zoologically. Towards the settling of this question, however, Dr. Meyer, the distinguished Director of the Royal Museum in Dresden, in collaboration with Mr. L. W. Wiglesworth, has made a notable contribution in the work under notice, wherein the ornithology of the Celebesian area (as the authors name the main island plus the neighbouring islet groups in its immediate vicinity) is discussed. Both authors have brought special qualifications to their task, for both have large experience as observers in the field, Dr. Meyer having several years' personal knowledge of the area in question. That every care has been taken by them in the preparation of this monograph is testified to by the six years of constant toil which the subject has exacted from them.

The systematic account of the individual species found in the area is prefaced by a valuable introduction of 130 pages, in which the authors give a short biographical note concerning the naturalists and collectors who have worked or written upon the birds of Celebes. This is followed by an account of the seasons and winds (illustrated by two coloured maps) in the East Indian Archipelago, in their relation to the dispersal and distribution of the birds. A section is next devoted to migration in the archipelago, with reference to which the authors remark that "during our studies it has become abundantly evident to us that ornithologists are not generally aware that migration goes on in the East Indies to the great extent it does." They enumerate fifty-four "of the more prominent migratory birds of Celebes," with tables which tend to "prove that each species has its own route or routes of migration." Some of these species come from Norway *viâ* Siberia, China and the Philippines to North Celebes, and go no further; others hold on their course to New Guinea, Australia and New Zealand; while yet others fly directly from Northern Asia and Japan to the Philippines, North Celebes or the Moluccas, hugging the coast of the Western Pacific. In their return journey the migrants do not appear "always to return in spring by the route pursued in autumn, often apparently being rare or absent in districts through which they pass in abundance in other seasons," while a few remain and probably breed in their winter quarters. As to the causes of migration, however, the authors afford us no new facts or suggestions tending to bring us nearer the solution of the "mystery of mysteries" of bird life.

A further section of the introduction is devoted to the subject of "variation or modification of structure and plumage" among the birds of Celebes, under the headings of individual and of geographical variation; seasonal changes; sexual differences, and changes depending upon age. Under the last heading the authors provide "some evidence drawn from Celebesian birds that modifications of shape . . . of feathers are caused by the ever-repeated action of mechanical attrition . . . and are ultimately transmitted to offspring," and they take as one of their examples the case of the racket tail feathers of *Prioniturus*. The two middle tail feathers of these birds "are prolonged much beyond the others, and in adult birds the over-reaching portion of these two rectrices is converted into a bare shaft tipped with a spatule of ordinary web." Drawings are given from specimens in the Dresden Museum showing that the feathers come in in the adult birds with the shafts bare, a character which must therefore be congenital and hereditary. According to the authors, the course of events must have been as follows:—the two middle tail feathers becoming (for no specified or known reason) a little longer than the rest, were by attrition on the twigs of trees, walls of their nesting-holes, &c., narrowed at the tips; the friction reacting on their roots resulted in still greater lengthening of the feathers; further attrition resulted in half-formed rackets [why?]; still further continued attrition and further lengthening of the feathers resulted in the "production of other stages up to the most advanced development of the present time"—"a process of ages, more and more advanced results being obtained in successive generations and transmitted by heredity." Their "arguments in proof that these rackets are the inherited effects of attrition" are shortly: (1) that such can easily be formed artificially by scraping; (2) where the shafts are not exposed to attrition they are not bare; (3) rackets do not occur on unexposed feathers sheltered from attrition; (4) rackets are present in birds having no affinity with one another over the most varied positions; (5) remains of the web are often to be found on the shaft of the racket; (6) there appears to be no other means for accounting for their origin—they are not sexual, not useful, and not "recognition markings"; (7) the Motmots which produce these racket tail feathers by biting, now produce incipient rackets hereditarily. These arguments (?) hardly carry conviction; but if the truth be that the rackets are the inherited effects of attrition, one asks why so few feathers specially exposed to attrition by twigs and sides of holes, &c., as the external rectrices and remiges of all birds, and specially the exterior *lengthened* feathers of wedge-shaped tails (*Dicrurus*), are neither bare nor racket-shaped nor incipiently so. One points also to the middle tail feathers of the male *Paradisea rubra*, which—judging their development by the progress of their moult, as the authors do—*begin* "rather *shorter than the rest of the tail*," then are "moderately lengthened and with webs narrowed in the middle," and finally end

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in a "black horny riband, bearing at its extremity a spatulate web" (Wallace). Why have the females of *Parotia sexpennis* no spatulate occipital plumes, and those of the spatulate or bare rachised-tailed Birds of Paradise no rackets, if the character is a non-sexual one? In the case of the Motmots, may not the narrowing of the web of the tail feathers be due to some physiological, pathological, or other cause, which attracts the bird's notice to the spot, causing it to peck at the feather and eventually bite away its webs; a habit which might become as fixed as the biting of the nails is from parent to children in many families. In the specimens which lived in the Zoological Gardens in London the central tail feathers came in with the webs on and were bitten off by the birds. The spatulate feathers would not arise, or would be lost, probably, if the Motmots left their tails alone. The very varied positions in which these singular plumes appear (altogether only in a few groups of birds), seem to indicate that it is not a question of attrition or excitation on objects with which the feathers come in contact, otherwise the occurrence of similar feathers would be far more common than it is, especially in the families to which the birds sporting such ornaments belong, since their habits, flight, and movements are similar. And if the rush of air through the feathers of the wing of certain pigeons can produce attenuation of their first primary, the same, or at least some, effect ought to be produced by the same cause, not only in many other pigeons, but also in hosts of other birds.

The final section of the introduction discusses the geographical distribution of the birds of the Celebesian area, and shows that it is inhabited by 393 species, and that fifteen genera and 108 species are peculiar to it. Each species is fully treated of in the systematic part of the work, as to its synonymy and diagnosis, with interesting and often lengthy accounts of its distribution and habits. Of these, seventy-seven are figured in forty-five plates by Herr Geisler, the artist of the Dresden Museum, who has, at the request of the authors, represented "the exact hue of the specimens painted, sometimes at the cost of the artistic effect and clearness of tint seen in the English productions." The work is also embellished by seven maps—two climatological, two topographical, and three devoted to geographical distribution.

As a result of their laborious investigations, the authors find that

"one-half of the peculiar birds of Celebes have their nearest affinities in the Oriental Region, and one-fifth only in the Australian Region; but the Australian forms seem to be, on the average, rather more strongly differentiated than the Oriental forms. . . . The origin of the Celebesian avi-fauna is principally an Asiatic one, but Celebes, as a whole or as a group of islands, was separated early from the Continent, or never was intimately connected with it. . . . The special faunas of Celebes, however, . . . are far from worked out. . . . The future, therefore, only can decide whether the ornithological facts as at present known teach us correctly that Celebes belongs to the Oriental Region and not to the Australian . . ."

The authors are to be congratulated upon the production of one of the best and most exhaustive ornithological monographs of a special region that have for a long time appeared either in England or on the Continent.

PUMPING IN MINES.

Mine Drainage; being a Complete Practical Treatise on Direct-Acting Underground Steam Pumping Machinery. By Stephen Michell. Second edition. Pp. xviii + 369. (London: Crosby Lockwood and Son, 1899.)

AS a somewhat heterogeneous collection of statistics, drawings and descriptions of pumping machinery, the work before us probably stands unrivalled in our own or any other language. It is profusely illustrated by means of excellent phototypes and woodcuts of pumping engines, as well as the details of their valves and valve gear, and contains minute verbal descriptions of their construction and mode of action. According to the author, most of the drawings have been supplied by the engine-makers, a fact with which no fault can be found, since there is no better source from which illustrations for a work like this can be obtained. But when we come to a consideration of the verbal descriptions the matter assumes a different aspect. Except in those cases in which an author feels himself bound to explain the views or original work of another author with precision, so as to avoid the possibility of misconstruction, descriptions quoted verbatim are out of place. In describing appliances with which he is, or ought to be, familiar, he should do so in his own words and from his own point of view, and at the same time give the reader the benefit of his opinions and criticism. If he quotes page after page from trade catalogues as our author does, not omitting even letters of commendation from customers, he abdicates his claim to the position of an author and becomes a simple compiler.

The work before us partakes far too much of this character, being to a large extent a compilation of the contents of catalogues; and as this is a class of information that is liable to vary with the issue of each new catalogue, and can be always obtained post free, it is a pity to swell the bulk of a volume by inserting it without measure.

The first twenty-two pages of the book contain introductory matter, including a few definitions and a history of the Worthington and other pumps; then follow four pages filled with the names of pumps and their makers, and thereafter the subject-matter is proceeded with. Hydraulic and electric pumps, together with four and a half pages of "Hydraulic and other memoranda," are, for no apparent reason, relegated to an appendix; and the volume closes with a good index.

In linking up the subjects and in venturing to express his own opinions, the author is not always equally happy in his remarks. For instance:—

"Height is essential to effectiveness in an air-vessel, mere lateral extension of volume adding little to its value" (p. 72)

"The pump valves act a most important part in the action of the pump. Indeed, their function is a most important one, and they may fitly be described as the 'lungs' of the pump" (p. 82).

"A speed of 100 feet per minute is quite sufficient for small steam pumps if an excessive resistance in the rising main is to be avoided" (p. 94).

Apart from the resistance due to the head, which is the same whether the pump is large or small, a pump encounters no other resistance in the *rising main* or discharge pipe, except that due to the friction of the ascending water. The amount of that resistance is a function of the velocity of flow, the area in cross-section, and the length of the discharge pipe, and is in no other way related to the size of the pump.

"The Kaselowsky system is similar to that of Messrs. West and Darlington, originated many years ago, and developed in the last dozen years in the Scotch collieries by Mr. Moore. The chief features in which it differs therefrom are the use of accumulator pressure and a very long stroke, admitting of considerable reduction in the dimensions of the underground engine" (p. 340).

Just before summing up in this way, our author has filled two and a half pages with a description of Kaselowsky's system, furnished by the Berliner Maschinenbau Actien-Gesellshaft, which he says "may be comprehensible."

Moore and Kaselowsky both transmit power by means of a forcing pump actuated by steam at the surface through two pipes filled with water to a pumping engine situate at the point in the mine from which water is to be raised. In Moore's pump, the water in each pipe moves first in one direction, and then in the opposite direction, acting the part of a rigid rod in its downward stroke, and the pumping engine in the mine oscillates in exact synchrony with the water in the pipes and with the forcing pump at the surface. Thus, if there were no leakage of motor water, each pipe would always remain filled with the same water that was originally put into it. Neither the forcing pump at the surface nor the pumping engine in the mine requires to have any distributing valves. The principal objection to this pump is that the pipes being subject to variations of pressure, expand and contract alternately, so that part of the stroke of the forcing pump, and consequently part of the work expended in driving it, is lost.

In Kaselowsky's pump, on the other hand, the motor water flows in a closed circuit, descending in one of the pipes and ascending in the other. The excess of pressure in the former over that in the latter is created by the forcing pump on the surface, and is expended in working the pumping engine in the mine. Both the forcing pump and the pumping engine are necessarily provided with distributing valves.

The pumping engine in the mine consists of two complete engines and pumps fixed side by side on the same bed plate, each of which actuates the distributing valves of the other in exactly the same way as this is done in a Worthington pumping engine. The accumulators to which our author refers are three in number. Their purpose is to prevent the occurrence of shocks in the motor water when the distributing valves open and close. The motor water, travelling from the forcing pump towards the pumping engine, passes under the plunger of the first accumulator just after it leaves the forcing pump at the surface, under that of the second just before it enters the distributing valve chest of the pumping engine in the mine, and under that of the third just after it leaves the same valve chest. They act exactly the same part towards the motor water as an air-vessel does towards the water discharged by a pump.

The difference between Moore's pump and Kaselowsky's is therefore a very wide one, and does not consist in "the use of accumulator pressure and a very long stroke," as we are so confidently informed.

In the hydraulic and other memoranda we find:

"Dia. of circle or cylinder $+ \cdot 7854 =$ area."

This must certainly be an oversight.

The rules for finding quantities are very arbitrary, as the two following examples will show, and no explanation is offered as to how they have been concocted.

Thus:—

"Square of dia. in feet × five times the depth in feet = gallons."

"Square of dia. in inches = lbs. of water for 3 feet long ÷ 10 = gallons."

Although the book is called "A Complete Practical Treatise," there seems to be no good reason why the hydraulic and other memoranda should have been pitched upon such a low level as to appeal only to the capacity of those who can do little more than read or write. The School Boards and the Science and Art Department, now Board of Education, have for a number of years past been training many boys and men who are destined to irresistibly supplant the rule-of-thumb class for whom such rules were originally framed. The least of these would scorn to have a set of hard and fast rules thrust upon him without some kind of explanation, and no writer of the present day can afford to ignore this fact if he expects his work to be appreciated and to have a permanent value.

Mr. Michell's book is altogether too voluminous. In the first paragraph of his preface he strikes the key-note that should have been his guide in writing it, namely:—"Many of the engines in use when the work was first published have, in the severe ordeal of underground work, maintained their position as useful and effective pumping agents; others have failed, and are now only a name in the chronicle of mine pumps."

Thus, judging by the past, we may be quite sure that many more of those now in use will likewise disappear from the scene. If, instead of describing as many pumps now in use as he could find space for, our author had instituted careful inquiries to find out the most economical and trustworthy amongst them, if he had confined his attention solely to these, condensed his book to about one-quarter of its present size, and embodied a few leading formulæ in their proper places in the text for the use of the student and the educated man who is now, and is also yet to come, he would have produced a more interesting, readable and useful work than the one now before us.

We differ entirely from the views expressed by him to the effect that "In collieries with plenty of refuse coal and slack of no commercial value, much of it, perhaps, worth only a shilling or two per ton, a small initial outlay rather than economy in working, and a plant that occupies little space in the pit . . ." can ever be a consideration of such great importance in the eyes of a properly educated colliery manager as to determine him to adopt an uneconomical pump because of its cheapness in first cost. Such a man would foresee that additional boiler-power and additional labour for stoking the boilers would be required to supply steam to the wasteful pump.

He would therefore spend an additional sum on the pump itself rather than on the purchase of boilers and in stoking, and he might even be sufficiently far-seeing to capitalise the value of the coal he would save, and spend part of that amount also upon the pump.

In conclusion, the opinions expressed by our author to the effect that a pump placed in a chamber underground is for that reason necessarily neglected, and subjected to rough and unskilful treatment, that it cannot be so economical as an engine working on the surface, that steam pipes in the shaft heat the workings, and so on, all tend to betray a want of knowledge of the practice of educated and observant engineers and managers of the present day. They sound rather like an echo from the uninstructed past, or a dirge of the days that are now passing rapidly away.

W. GALLOWAY.

THE PALAEONTOLOGY OF THE INVERTEBRATA.

Text-Book of Palaeontology. By Karl A. von Zittel. Translated and edited by Charles R. Eastman, Ph.D. Vol. i. Pp. viii+706; with 1476 woodcuts. (London: Macmillan and Co., Ltd., 1900.)

ENGLISH-SPEAKING geologists and palæontologists have awaited with eagerness the long-promised translation of Prof. K. A. von Zittel's well-known "Grundzüge der Palaeontologie" which appeared early in 1895. At last we have received the first volume, which completes half the work, namely, to the end of the Invertebrata. It proves, however, to be much more than a translation of the German original. It is illustrated by the same beautiful woodcuts, with few additions; it is also similar in general plan; but most of the chapters have been entirely rearranged and rewritten, to express the views of the various American and English authors who have co-operated with Dr. Eastman. It is, therefore, virtually a new work, and the scheme of classification adopted is very different from that accepted by the eminent Professor of the University of Munich.

The only part of the "Grundzüge" which remains almost unchanged in the present translation comprises the admirable introductory chapter and the account of the sub-kingdoms Protozoa and Cœlenterata. Here the student will find Prof. von Zittel's own summary of his important researches on the structure and classification of the fossil sponges, which it is well to have left untouched. Changes begin with the Echinodermata, and attain their maximum in the Cephalopod Mollusca, becoming less noteworthy again in the Arthropoda, which conclude the volume.

Of the Echinodermata, the Crinoidea and Blastoidea were revised by the late Charles Wachsmuth. He added much new matter, and described and classified the crinoids in accordance with Wachsmuth and Springer's "Monograph on the Crinoidea Camerata of North America," which is here said to be "as yet unpublished," but really appeared in 1897. The sections on Asterozoa and Echinozoa have been extended, and in some respects much improved, by Mr. Percy Sladen, who has completely rearranged the Euechinoidea in accordance with the researches of the late Martin Duncan. The short description of the Vermes has been revised and slightly enlarged by Dr. G. J. Hinde. The chapter on Bryozoa is no longer that of Prof. von Zittel, but the work of Mr. E. O. Ulrich, who has added many new figures. It is not quite up to date, there being no references to Dr. Gregory's "British Museum Catalogue" or his memoir on early Tertiary Bryozoa, published by the Zoological Society. The Brachiopoda, revised and partly rewritten by Mr. Charles Schuchert, are arranged according to Beecher's classification, which is described in von Zittel's original as "one-sided," being based only on embryology. The rearrangement of the Mollusca has been undertaken by Messrs. Dall, Pilsbry and Hyatt, who deal respectively with the Pelecypoda, Gastropoda and Cephalopoda. Here it is difficult to recognise any of the original "Grundzüge" except the figures. In the description of the Arthropoda, Prof. Charles E. Beecher has added much important new matter to the section on Trilobita, which students will be glad to have. The treatment of the higher Crustacea and Merostomata is also much changed by the revision of Profs. Clarke and Kingsley; but the Arachnida, Myriopoda and Insecta, edited by Mr. Scudder, remain almost as in the original German work.

With so many collaborators, it has naturally been impossible for Dr. Eastman to obtain uniformity of style throughout the volume; and the judgment which teachers and original workers will pass upon it depends largely on the section which they happen to consult. On the whole, we are disposed to prefer the original volume in the form in which it was issued by the distinguished teacher who prepared it. With all due deference to the eminent specialists who have devoted so much labour to the translation and revision, we cannot refrain from expressing our opinion that they have converted an admirable student's manual into little more than an index to certain technical memoirs, which are as yet by no means accepted classics in palæontology. As Prof. von Zittel himself remarks in his preface, many of these memoirs are founded on certain embryological and phylogenetic considerations, which may soon prove to be baseless assumptions; while the old methods of comparative anatomy are often almost abandoned in favour of some one-sided hypothesis. We would also note that a large proportion of the generic names adopted are quite unknown in the original works on geology and palæontology which the average student will have to consult at the beginning of his career. In short, if the translators and revisers had devoted more attention to the correction of errors or the incorporation of new facts, and displayed less eagerness to infuse their own personal idiosyncrasies into the work, they would have done much more valuable service than they have actually accomplished.

The subject is too technical to enter into detailed criticism, and it must suffice merely to allude to three points in illustration of the difficulties which are placed in the way of the student.

One of the first fossils which every student must learn to know is the brachiopod *Terebratula.* Accordingly, Prof. von Zittel, in his "Grundzüge," gives a concise description of this shell as ordinarily understood in standard literature. Mr. Schuchert's translation, on the other hand, has :—" *Terebratula*, Klein, 1753 (Fig. 551). Genus not well known. Mesozoic or Tertiary." He merely gives a list of ill-defined generic names of no value whatever, except as an index to certain special memoirs which he happens to approve.

In the Mollusca Pelecypoda, Dr. Dall must have devoted great labour to his exhaustive revision; but, from the student's point of view, it would have been much better if he had bestowed it on the correction of mistakes. In the description of *Pseudomonotis*, for example, "left valve" is copied from the original German, although even the accompanying figure must have shown the translator that it was a mistake for "right valve."

Finally, every student must know something of the common *Nautilus*. If he looks at Prof. Hyatt's description (p. 526), he will learn that it is a recent genus, and may perhaps range backwards to the Tertiary; but if he turns to Figs. 1075 and 1076, he will read that species of the genus occur in the Middle Lias and the Tithonian. Which of these two contradictory statements does Prof. Hyatt intend the unfortunate student to accept? We presume he intended to re-name the illustrations *Cenoceras*, and, like Dr. Dall, was too much occupied with the greater rearrangements to take note of the minute points on which the real value of a text-book depends. In fact, not only in this instance, but throughout Prof. Hyatt's section on Cephalopoda, the student will find hopeless confusion and receive practically no aid in plodding through the current literature of geology and palæontology. Nearly a hundred new generic names, introduced without definition, add in no small degree to the difficulties.

While, however, the elementary student, for whom the "Grundzüge" was written, will meet with disappointment when he attempts to use its English counterpart, the more advanced student engaged in original research will welcome the handsome volume which Dr. Eastman has produced. It is a valuable work of reference, which ought to find a place in every geological and biological library. We hope it will soon be followed by the second volume, containing the Vertebrata, which will make the English "Zittel" the most exhaustive and valuable treatise on palæontology in our language.

INADEQUACY OF THE CELL-THEORY.

Les Êtres Vivants. Organisation—Evolution. By Paul Busquet. Pp. 181; 141 figures. (Paris: Carré and Naud, 1899.)

WHAT the particular secret of this volume is, we have been unable to discover, except that it is intended as an argument for a franker recognition of the unity of the organism, and as an argument against the view which regards the multicellular creature as a "cell-state" or as a colony. To discuss these difficult matters profitably requires great competence, and we do not think that this is shown by the author, who, for instance, cites the old report that the ectoderm of a Hydra turned inside out becomes endoderm, and so on, and uses this as an argument against the original distinctiveness of the two germinal layers. Furthermore, while an attack on a position often means progress, one must master the previous moves, and we see no evidence that Dr. Busquet has done so. Has he seriously considered, for instance, Whitman's notable essay on "The Inadequacy of the Cell-Theory of Development"?

A pleasing feature of the book is the author's grateful tribute to his master, Prof. Kunstler, whose views he expounds and elaborates. Thus he begins with a defence of Kunstler's conclusion that protoplasm is composed of series of minute elements, more or less globular, either placed in apposition or separated by fluid. This alveolar or "spherular" structure of protoplasm was described by Kunstler in 1881, and has been familiarised by the researches of Bütschli (not Butschli, as the author persistently calls him, just as he calls Kölliker—Kolliker, which is absurd). We do not notice any mention of Flemming, though his lifelong observations on reticular structure, and his criticism of the demonstrations of alveolar structure, must be taken account of if one wishes to be treated seriously in discussing such matters.

The author points out that just as Dutrochet (1824) and Turpin (1826) may be said to have priority over Schwann and Schleiden in formulating the "Cell-Theory," so Kunstler must be credited with priority over Sedgwick, Whitman and Delage in demonstrating its inadequacy. For Kunstler maintained long ago that the cell is no primitive morphological unit, but an acquired mode of organisation, and that the cellular structure of the Metazoa is a secondary result adaptive to functional convenience. The frequent vagueness of cell-limits, the abundant illustrations of inter-cellular bridges, and the occurrence of indisputable syncytia are forcibly indicated by the author.

It is argued that to think of a Metazoon as derivable from a colony of Protozoa is misleading; and that although there are some true colonies among Metazoa, *e.g.* in Cœlenterates and Tunicates, the colonial or polyzoic hypothesis, especially elaborated by Perrier, is a specious fallacy. We are asked to choose between two alternatives—the Metazoa are colonies of individualities of a lower order, or they are individualised irreducible unities. But it is not made plain why we may not suppose that the ancestral forms of various stocks passed through an imperfectly integrated colonial or polyzoic stage.

The author takes a survey of the animal kingdom, and seeks to substantiate a number of general conclusions, which we shall try to summarise. Living matter shows "a general and universal tendency to proliferation or repetition of similar parts." "These phenomena of repetition appear at first in the adult, where they constitute an acquired character; in the embryo they are but the reproduction more or less modified, by coenogeny, of what exists in the perfect individual." But in certain circumstances the repeated parts may coalesce, exhibiting a secondary and acquired simplification, and bringing about a recondensation of the organism, preparatory to a recommencement of the evolutionary process on some new line. Types do not arise by a slow and direct transformation of pre-existing forms, but each is a new genesis. "The law of the formation of new types is a fragmentation of the tissue of more primitive organisms, and the arrangement of these new formations in new groups." "Neither selection nor adaptation can explain the specific peculiarities (particularités) of the structure of organisms, which are due to new spontaneous productions."

Thus the reader is insidiously led from harmless admissions as to the structure of protoplasm to grave heresies in regard to the efficacy of natural selection; but if he is convinced, we confess our inability to understand how the trick is done. We think that the sound part of the book may be summed up in a sentence of E.B. Wilson's: "Broadly viewed, therefore, the life of the multicellular organism is to be conceived as a whole; and the apparent composite character, which it may exhibit, is owing to a secondary distribution of its energies among local centres of action." J. A. T.

OUR BOOK SHELF.

Notions de Minéralogie. Par A. F. Renard et F. Stöber. Ier. fascicule. Pp. iv + 189; 398 figures. (Ghent: Ad. Hoste, 1900.)

A TEXT-BOOK of mineralogy, written by the Abbé Renard, with the co-operation of his assistant, F. Stöber, who has published important mineralogical papers, excites high expectations; and, in spite of its modest title, this work is really a text-book. The present volume contains only the introductory portion, dealing with the geometrical, physical and chemical properties of minerals. A second part is promised, which will contain the description of various species and a notice of those found in Belgium.

The excellent historical survey with which the book opens is modelled upon Fletcher's well-known "Introduction to the Study of Minerals"; it is only brought down to the year 1833. In the following section (geometrical crystallography) some of the principal types of crystals, and their planes of symmetry, are indicated by projections of the "elementary spaces" (the systematic triangles of Maskelyne) similar to those used by Liebisch in his "Grundriss der Krystallographie"; axes of symmetry are not employed, but the familiar conception of hemihedrism is retained; and the facts are stated in a manner which involves no special mathematical knowledge. Indices are used throughout. The subject of twinning is briefly treated, and only by reference to twin planes. In the optical section use is made of the wave-surface and the ellipsoid of optical elasticity.

Since out of 189 pages eighty-eight are devoted to the geometry, and fifty-seven to the physics, of crystals, the chemical section is very brief, but considerable attention is, as might be expected, devoted to microchemical analysis, and also to crystal etching.

The reader will not expect to find much that is novel; neither will this book give him an insight into modern theoretical aspects of the subject; but he will find, what is more important, a very lucid statement of the essential facts, and a clear description of the practical methods in use by mineralogists; to illustrate this, special attention may be called to the paragraph on the angle of minimum deviation on p. 116, and to the interpretation of interference figures by the diagrams on pp. 138–9.

It must not be imagined from what has been said that the book ignores new advances in the science; there is, for example, a paragraph on the use of X-rays.

The figures are adequate, but not very well printed.

When the second part appears, we shall expect to find that it completes a very readable and useful student's handbook. H. A. M.

Muret-Sander's Encyclopaedic English-German and German-English Dictionary. Pp. xlviii + 1733. (London: H. Grevel and Co., 1900.)

BEFORE buying a dictionary of words of a foreign language the purchaser has to make up his or her mind as to what *kind* of a dictionary is required. There are, for instance, dictionaries which can easily be placed in the waistcoat pocket: these necessarily contain a very restricted number of words. From this they gradually increase in size, weight, and quantity of information given, until they assume such proportions that they are best kept in one place and referred to there, as their bulk renders them somewhat inconvenient to move.

The volume before us, which is described as an abridged edition, may be said to be verging on the larger size of dictionaries, as its dimensions are 11 × 8 × 3 inches, and it contains nearly 1800 pages.

The plan and arrangement of the work are uniform with the well-known French-German dictionary of Sachs-Villatte, and the pronunciation adopted is based on the phonetic system employed in the method of Toussaint-Langenscheidt.

The volume should find special favour with students of science, for, although it is in no sense technical, there is a sufficient sprinkling of scientific terms throughout its pages which should render it most useful to this large class of readers. To find out the extent of the insertion of technical terms, we have chosen at random some chemical terms such as ozone, hydroxide, vanadium, fractionation, nitrate, and find that all except one are included. Repeating the same for physical terms, we find ampere, watt, electrolysis (absent, but electrolyse inserted), galvanism, achromatic, all but one mentioned.

Some readers may dislike the use of the German type when German words are printed, since most of the German scientific publications are now printed in Roman type; any one, on the other hand, familiar with the German language, will probably prefer the usual German letters. In addition to being clearly printed, the volume is strongly bound, and is issued at the moderate price of fourteen shillings.

Die Elemente der Entwickelungslehre des Menschen und der Wirbelthiere. By O. Hertwig. Pp. vi + 406; 332 figures. (Jena: Gustav Fischer, 1900.)

THIS work is a condensation of the sixth edition of Hertwig's well-known "Lehrbuch," brought out in a form more suited to the needs of beginners and students, especially of medicine. It is intended "to serve as an introduction to the field of embryological science, and to put forward only its leading facts in a shorter form." Hence the discussion of controversial problems is omitted, as well as historical reviews or references to literature, for which the more advanced student must consult the larger work. Each chapter concludes with a "repetitorium," by which is meant a numbered series of categorical statements, summing up briefly the results obtained in the foregoing chapter. There are numerous illustrations, the pick of those in the "Lehrbuch." The book is doubtless one which will be very useful to the German student, but unless it is translated, it may be doubted if it will have a very large sale in this country, since the English student of the class for which it is intended is not able, as a rule, to read easily books in a foreign tongue, while those who take their science enough in earnest to acquire this faculty, will probably purchase the larger work. For the teacher, however, the book offers a brief and convenient summary, very handy for reference. E. A. M.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Recent Exploration in the Upper Air and its Bearing on the Theory of Cyclones.

ABOUT ten years ago there was an interesting discussion in regard to the theory of cyclones, by such leaders in meteorology as Ferrel, Blanford, Hann and Davis (see NATURE, vol. xliii. p. 82 and p. 470). Since then, considerable new material has been accumulated by research in the free air with kites and balloons, and it seems appropriate to consider its bearing on current theories.

In America the work with kites, by Mr. Rotch, has resulted in the discovery of the following facts:—

(1) The atmosphere is separated by sharply marked inverted vertical gradients of temperature into superposed strata, each stratum potentially warmer than the one beneath. By potentially warmer is meant that if any stratum were brought down, it would be heated by compression and become warmer than the stratum it replaced. There are usually two, and sometimes three, strata between the ground and the altitude of 3000 metres. The boundaries between these strata are regions of sharp contrast in a vertical direction of temperature, of humidity (both absolute and relative), and sometimes of wind direction. These boundaries are also regions of maxima in wind velocity, and the regions where clouds are chiefly found.

(2) In the changes of condition of the atmosphere from day to day, the minima of temperature and humidity occur simultaneously at all levels, except that in a superficial stratum within about 300 metres of the ground, the minimum sometimes occurs later as a result of surface cooling.

(3) The air column up to 3000 metres above barometric minima at sea-level averages about 10° F. warmer than the air column up to 3000 metres above barometric maxima at sea-level.

(4) All the conditions which characterise the surface cyclone and anticyclone, such as the circulation of the wind around a central area, the clouds and the rainfall, usually do not exceed the height of 3000 metres. Above that height there is an entirely different distribution of pressure and wind circulation from that observed at the earth's surface.

(5) In the areas of low pressure in the upper atmosphere the air is cold, extremely dry and clear. In the areas of high pressure in the upper atmosphere the air is warm and frequently moist.

In kite-flights made on November 24 and 25, 1898, at Blue Hill, there were evidences of three distinct wind circulations. The surface cyclone did not exceed 800 metres (or half a mile) in thickness, and above this was a warm-centre cyclone with dense clouds and precipitation about 2000 metres in thickness. At the height of 3000 metres (or about two miles) the wind, on November 24, was found blowing from the south and circulating around an area of low pressure with a cold, dry central area; while at the same time at the surface of the earth the wind was from the north and circulating around a warm-centre surface cyclone. (See *Bulletins* No. 1, 1899, and No. 1, 1900, of the Blue Hill Meteorological Observatory).

In France, M. Teisserenc de Bort has made a study of the air by means of *ballons sondes* launched at frequent intervals from Trappes. His results show that the annual period in the temperature of the air is well marked up to and exceeding ten kilometres. They show further that during the irregular warm and cold periods in the atmosphere the isotherms rise and fall simultaneously at all heights up to at least ten kilometres. In other words, the warm and cold waves aloft occur simultaneously with those near the surface (see *Comptes rendus*, August 21, 1899).

Dr. Hergesell, of Strassburg, has discussed the records of the international balloon ascents, and derived a number of important conclusions. Among these are: (1) In the highest strata of the atmosphere attainable by balloons the temperature change from day to day, and the temperature gradients in a horizontal direction, are very marked. Within distances of only a few hundred kilometres are sometimes temperatures at the same level which differ as much from each other as 30°–40° C. (2) Such temperature distributions as that which brought frosts in Europe on May 13, 1897, are not local and confined to the earth's surface, but meteorological phenomena of great extent and importance which embrace the entire atmosphere above Europe. (3) By computing and plotting the air-pressure for the heights of 5000 and 10,000 metres, it was found that the areas of low pressure at these heights coincide approximately with the areas of low temperature, and in most cases are many hundreds of kilometres from the surface cyclone. Thus, on March 24, 1899, the surface cyclone or area of low pressure was along the north coast of the Mediterranean, near Italy, while the minimum pressure at 5000 and 10,000 metres was in Finland, or even further north (*Meteorologische Zeitschrift*, January 1900).

To compare these facts with theory, I have looked up the views expressed in modern text-books and recent literature. I find a number of different opinions in regard to the causes of cyclones, and have classified them as follows:—

(1) Instability produced by a rapid decrease of temperature with increase of height; that is, by a vertical gradient equalling or exceeding the adiabatic rate. This may be called *the theory of vertical instability*.

(2) Instability produced by differences of temperature in a horizontal direction. In such a case, in consequence of the the difference in density, there is established a convectional interchange of air between areas of different temperatures, and there result differences of pressure, and consequently cyclones and anticyclones. This theory I call *the convection theory*.

(3) If a current of damp air is deflected upward by any means, mechanical or otherwise, it cools by expansion, and its moisture begins to condense. This condensation retards further cooling, so that the air in rising may cool at a rate less rapid than that ordinarily existing in the atmosphere. In such a case, the air would continue to rise, and the conditions would be favourable for storm formation, as long as the supply of moisture lasted. This has been called *the condensation theory*.

(4) When bodies of water, moving in different directions or with different velocities in the same direction, come in contact, whirls and eddies are set up between them. It is therefore conceivable that the large masses of air moving between the equator and the pole, may, at their places of meeting, produce similar large eddies, such as the cyclones of the weather map. These have been called *dynamic cyclones* and also *driven cyclones*.

Probably no meteorologist believes that any one of these causes acts entirely alone in cyclone formation. But a difference of opinion arises as to which is the principal cause, and to what extent the others are subsidiary causes. All theories agree in ascribing the primary cause to differences of temperature, either local or between equator and pole.

Vertical instability can scarcely be considered the primary cause of cyclones, because, as stated above, the atmosphere is found normally separated into strata, each one potentially warmer than the one beneath. The fatal objection to the condensation theory, as pointed out by Dr. Hann, is that cyclones in temperate latitudes are more violent in winter than in summer. Latent heat is not so effective an aid to storm action in winter as in summer, and yet it is in winter that our cyclones possess their greatest violence. According to the theory of driven cyclones, "The masses of air set in motion polewards by the upper gradients are resolved, in part, into great whirls, the principal progressive motion of which is controlled by the prevailing west component of the former. The influence of the inequalities of the earth's surface, the different heating and cooling of the land and ocean, and the bringing in of aqueous vapour and its condensation, come thus into account, as matters of secondary importance," (NATURE, vol xliii. p. 470). "If . . . cyclonic and anticyclonic disturbances are produced by the irregular flow of the general winds, it is probable that these disturbances would originate in the higher regions of the atmosphere, where the winds blow much faster than near the earth's surface. The differences of pressure produced at high altitudes would be felt down to sea-level; and, as the lower winds move with comparative slowness, they would be governed by the gradients thus imposed on them by the irregular movements of the upper winds. According to this theory, an area of high pressure would be perceived at sea-level beneath a district where the upper currents crowd together; and an area of low pressure, or a cyclonic storm, would be developed beneath a region where the upper currents are somewhat divergent." (Davis's "Elementary Meteorology," 1894, p. 219.)

As stated above, observation does not show areas of minimum pressure in the upper air above areas of minimum pressure at sea-level. Furthermore, according to the theory of driven cyclones, the progressive motion of the cyclone is supposed to be determined by the "prevailing west component" of the upper currents. At Blue Hill the mean westerly component of the upper current is 35 metres per second at 9000 metres, about 17 metres per second at 4000 metres, and 1 metre per second at 200 metres (*Harvard Observatory Annals*, 1890, vol. xl. p. 447). It is natural to suppose that a driven whirl, in such conditions, would be rapidly toppled over and destroyed. Yet storms persist for days. If, however, a driven whirl did persist in such conditions, its axis if tilted at all would, according to all analogy, be tilted in the direction of progressive motion. Yet the direct observations with kites at Blue Hill, and the observations of clouds by Ley in England, prove that the axis of the cyclone is tilted backward. Moreover, it is reasonable to suppose that the air in the rear of a driven whirl would partake of the progressive motion of the whirl, and this, added to the indraught, would make the wind velocity in the rear of the whirl very much greater than that of the winds in front, yet such is not generally found to be the case. For these reasons I think the observations do not favour the theory of driven cyclones.

The theory of cyclones with which the observations in temperate latitudes seem best to agree, is the theory which supposes the cyclone to result from contrast of temperature in a horizontal direction. This I have called the *convection theory*. In this theory there are two types of cyclone. The warm-centre cyclone of the lower atmosphere, and the cold-centre cyclone of the upper atmosphere. The best type of the cold-centre cyclone is the polar cyclone; but there also exist in the upper air in temperate latitudes small travelling cyclones or *hemi*-cyclones of the same nature. Horizontal contrasts of temperature are most marked in winter, hence the theory explains why cyclones are most violent in winter. The origin of the horizontal contrasts of temperature is not shown by observation. They probably arise by the interchange of air between higher and lower latitudes. A body of air moving from the equator toward high latitudes would come into a region where it would be nearly surrounded by colder air, and the conditions would favour the production of a warm-centre cyclone. A body of air moving toward the equator would produce conditions favourable to a cold-centre cyclone. H. H. CLAYTON.

Blue Hill Meteorological Observatory, March 30.

Rock-structures in the Isle of Man and in South Tyrol.

IF the intercrossing of two separate systems of folding be the essential condition in the complicated rock-structures so ably worked out by Mrs. M. M. Ogilvie Gordon in South Tyrol, I scarcely think the parallelism with the conditions in the Manx *Carboniferous* rocks can be so close as Mrs. Gordon suggests in her recent letter (NATURE, March 22, p. 490).

So far as I have been able to judge, the disturbances in the Carboniferous volcanic rocks of the Isle of Man were the result of a movement which was single both as regards direction and time. It is true that this conclusion was reached in 1897, before Mrs. Gordon had taught us the importance of torsion-structure in areas of disturbance; but I re-examined the sections last autumn, after having studied Mrs. Gordon's paper, without finding any reason to alter my former opinion on this point. The interpretation given in my recent paper (*Q.J.G.S.* vol. lvi. p. 11) is therefore in all respects the same as that published in brief in the official Summary of Progress of the Geological Survey for 1897 (pp. 110–112).

It seems necessary, also, to call attention to the small scale of the structures in question in the Manx Carboniferous rocks. Their most striking feature is their sudden local development in a limited tract where the strata are rendered by diverse lithological composition peculiarly susceptible to differential displacement. Under such conditions, it appears that even a small degree of lateral movement may be so focussed as to cause great disturbance at certain places without much disturbance of adjacent tracts. The post-Carboniferous movement in the Isle of Man can scarcely have been even approximately of the magnitude of the disturbances in South Tyrol described by Mrs. Gordon.

It was in pre-Carboniferous times that the Manx region underwent earth-movements of really grand intensity; and Mrs. Gordon may have had this fact in mind in referring to the subject. In the Older Palæozoic (probably Cambrian) slate-rocks of the island, "crush-conglomerate" has been developed on a very extensive scale by differential shearing, as described by Prof. W. W. Watts and myself five years ago (*Q.J.G.S.* vol. li. p. 563). These rocks, moreover, show evidence of successive epochs of disturbance, varying slightly in direction but apparently all pre-Carboniferous. The production of the "crush-conglomerate" appears to have occurred during only one of these stages. It is not improbable that an observer acquainted with the "torsion-structures" of the Dolomites might be able to find parallel phenomena among the highly complicated pressure-structures in the Manx Slates; but I think that a sharp distinction should be drawn between these structures and those of the Carboniferous rocks of the island. G. W. LAMPLUGH.

Tonbridge, April 8.

Electric Light Wires and Dust.

I BELIEVE that the collection of dust upon electric light wires and fittings is generally attributed to air currents, due to thermal causes, the same thing occurring, to some extent, with hot-water pipes. Recent experience has, however, convinced me that in the case of electric light conductors, electrostatic attraction is really the chief factor, particularly where the supply is at 200 volts from the street mains. In my office here I have several electric light cords strung across the ceiling. They are all exactly similar and under the same conditions, except that some of them have the switch in the negative and some in the positive conductor. The former gather dust to an extraordinary degree, and now, after a few months' use, have become quite an eyesore. The latter are practically as clean as when first put up. As is well known, the negative conductor of a street supply tends always to earth itself, and, as a matter of fact, in my case I find that the negative of my supply from the Westminster Co. is almost at earth potential. The positive, on the other hand, is nearly 200 volts above the potential of the earth. In this lies obviously the cause of the phenomenon. The wires which have the switch in the negative are nearly at 200 volts potential above the earth whenever the switch is off, while those which have the switch in the positive are at zero potential in these circumstances. Of course, when the switches are on, all the cords are under similar conditions, one conductor in each being nearly at 200 volts above earth, and the other at about earth potential. No doubt it is when the switch is off, in the case where it is in the negative conductor, that the accumulation of dust takes place. Having regard to the comparative lowness of the 200 volts potential, from an electrostatic point of view, the rate at which the dust accumulates on the cords is most surprising, and this is my reason for thinking it worth while bringing the matter to notice. A. A. C. SWINTON.

66 Victoria Street, Westminster, April 23.

ON THE SIZE AT WHICH HEAT MOVEMENTS ARE MANIFESTED IN MATTER.

IN the molecular theory of heat it is assumed that the motions of atoms and molecules are the motions upon which the phenomena of temperature depend. These motions are assumed to be very irregular, and the apparent uniformity of structure of a gas, for example, is attributed to the very small size and irregularity of the motions, which within any region of sensible size are the same, *on the average*, as within any neighbouring region. Within regions of molecular dimensions the distribution of motion is extremely irregular; neighbouring molecules are not in general moving at the same speed or possibly vibrating in the same way. Hence in this view the size at which heat movements are manifested in matter are of molecular sizes, *i.e.* from 10^{-7} to 10^{-8} cm.

In addition, however, to all this matter, motion and vibration, there are present ether motions of an irregular kind. Within any closed envelope at constant temperature the ether motions must be in statistical equilibrium with the motions in the envelope. The energy per c.c. of these ether motions will be considerable at high temperatures, and small at low ones. Many years ago I called attention to the energy per c.c. required in order to, in this sense, warm up ether, and showed that it was quite comparable with that required to warm up a rare gas. Now the size at which these motions are developed are comparable with the wave-length of the ether disturbances of the period of the motion. In the case of irregular disturbances, such as cause temperature phenomena in solids and liquids, one cannot define precisely the size of the ether disturbances, because they are of all sorts of sizes, being irregular in the same way as the matter motions are irregular; but it is known that at each temperature there is a particular wave-length, round which the ether vibrations may be grouped, and that this average wave-length is shorter the higher the temperature. The wave-lengths of these vibrations, so far as they have been observed, vary from $2 \cdot 4 \times 10^{-3}$ to 10^{-5} cm.

It is at once evident that the average size of the ether motions is *very* much greater—quite a thousand times greater—than the size of the molecular motions. In the molecular motions we could not expect to find any irregularity of distribution within distances such as we can see with a microscope, because within a visible volume there will be millions of molecules, and the average motion will be all that we can expect to see. Is it necessarily so as regards the ether motions which exist on so much a greater scale? Is there any way in which these very much larger scale phenomena may be expected to affect matter on a scale comparable with their own size, and which consequently we might expect to be able to see, and which might produce effects on masses of matter consisting of millions of molecules?

We may consider in this connection an analogy from sound. In sound we can have small solid objects, such as masses supported by springs, which give out waves in air very much longer than the sounding object. A tuning-fork, for example, may be only a few centimetres long, and may give out waves a metre long. The balance wheel in a watch vibrating quarter seconds would generate waves—feeble ones no doubt, but still waves—80 metres long, or some 8000 times the linear dimensions of the vibrating object. Similarly the vibrations of molecules generate ether waves many thousands of times as long as the linear dimensions of the molecules. On the other hand, solid bodies may be much longer than the air waves they produce. A bar of steel vibrating longitudinally would be fifteen times as long as some of the air waves it would generate. A pipe full of air would be of about the same length as the air waves to which it would resonate, not less than about a quarter as long. If, then, we had a large number of sounding bodies, some small ones like small tuning-forks, balance wheels, and such like, and others like pipes of a size comparable with the air waves, we would expect that when the small ones were all sounding, the larger ones would resonate to their corresponding waves, and thus be set in vibration by the waves originated in the smaller bodies.

In the case of electromagnetic waves we should expect the same result. If there are bodies comparable in size with the heat waves in the ether which can have electromagnetic vibrations produced in them of the same periods as those emitted by the molecules, these bodies should resonate to these heat waves. Now, by utilising the ordinary process of conduction in metals, we know that it is possible for electromagnetic vibrations to exist in conductors of a small size, down to a few millimetres in diameter; and there is no reason to doubt that by means of conduction very much smaller bodies can have electromagnetic vibrations in them. Dr. Lodge, indeed, has suggested that the structures in the retina are of about the right size to resonate electromagnetically to waves of the frequency of the light waves that affect our eyes. Larger objects would resonate to the electromagnetic vibrations corresponding to the ordinary air temperatures. A sphere 10^{-3} cm. in diameter would, for instance, resonate to waves of about the greatest length that have been measured by Rübens and Nicholls, and a much larger one could have a harmonic of its fundamental tone excited in it by these waves. In addition to these vibrations in conductors, non-conductors of one specific induction capacity immersed in a medium of a different specific inductive capacity could also have syntonic vibrations excited in them. From all this it seems quite certain that in small particles of matter there must exist, at all temperatures, electromagnetic vibrations of a size comparable with the wave-lengths existing in the surrounding ether.

What sort of effects might we expect to be produced by these electromagnetic vibrations? Is there any prospect of our being able to detect them? What amount of energy may there be in this form of vibration on each particle? These are questions to which I am afraid I can only give very vague answers. To the first question, as to what effects may be expected to be produced by these vibrations, I can only suggest in the first place an unequal heating of the particle. The parts of the particle which are the electric nodes, where the electric current alternates and where there are no electric charges, these parts should be kept at a slightly higher temperature than the electric loops. If the particle were not perfectly symmetrical, this would lead to an unequal heating of the particle as a whole, and this may be a cause of those so-called Brownian motions of small particles immersed in a liquid which are so very difficult to explain. In the second place, it may lead to a grouping together of molecules into masses of a size depending on the temperature of the liquid, and to a going about of these groups of molecules and a similarity of the vibrations of the component molecules which complicates the theory of temperature in a way that may ultimately, as I have before now pointed out, explain to some extent the difficulties at present surrounding this theory. In the third place, this may be connected with the conditions for the breaking down of simple viscous motion and the production of vortices in a liquid, though I hardly think an explanation on these lines is required; and, finally, it may be connected with crystalline forces, the structures in the eye, vital actions in small cells and on a small scale, as in the patterns on diatoms, and possibly with the temperature at which vital actions of certain kinds, such, for example, as consciousness, are possible. These are the merest guesses of a wild kind as to the possible results of what seems to be a *vera causa* for structures and actions in matter of a size comparable with the wave-lengths of light, and must be taken as merely wild guesses.

As to the second question, of the prospect of detecting these electromagnetic vibrations in particles of matter, its answer depends so entirely upon the first that I can only leave it to the investigators of the future to try and detect them. That such electromagnetic vibrations exist, I think, can hardly admit of doubt, any more than that the strings of a piano are kept in vibration when loud and irregular noises are produced in its neighbourhood.

As to the energy of the vibrations upon each particle, I cannot give any satisfactory answer. If the particle were in a region through which a series of plane waves of a constant type were being transmitted, it would no doubt be possible to solve the problem of determining the amplitude of its vibrations in particular cases of assumed shapes of particles. In the actual case of irregular disturbances I do not see, at present, any direct way of attacking the problem. It would apparently require to be attacked statistically, but I doubt whether this would lead to a true result, because there seems some reason to think that trains of uniform waves of considerable length do exist in the ether, and if there is any regularity of this kind in the ether motions, a purely statistical treatment, in which the vibrations were assumed to be quite irregular, would fail to lead to a true result. If the energy of these electromagnetic vibrations of its fundamental period on a particle is no greater than corresponds to its one degree of freedom on Boltzmann's theory of partition of energy, I am afraid the amount of energy of this kind on each particle is hardly sufficient to account for any observable phenomenon. That it may, however, be much greater seems justified by the failure of this theory, so far as is known, in other cases, and this must be my excuse for calling attention to what seems certainly a *vera causa* for structures and actions in matter of a size comparable with the heat vibrations in the ether, even though the amount of this cause may, when fully investigated, turn out to be so small as to be insufficient to produce observable effects.

GEO. FRAS. FITZGERALD.

REPORT OF THE MALARIA EXPEDITION TO SIERRA LEONE.

FOLLOWING close on the "Instructions for the Prevention of Malaria," the Liverpool School of Tropical Medicine have issued the report of the malaria expedition sent out to Sierra Leone by that body in August last. Their objects, as stated in the report, were :—

(1) To find one or more species of insects hospitable to the human Hæmamœbidæ on the West Coast of Africa.

(2) To study the bionomics of these insects, with a view to suggesting better modes of prevention of malarial fever than those hitherto known to us.

The terminology adopted is that used by Major Ross in consultation with Prof. Herdman, already noticed in NATURE (August 3, 1899). It is proposed to abolish the word mosquito, and use the old English equivalent, gnat, as there is no difference between the two, and because the terms malaria and malarial fever no longer hold—they propose the term hæmamœbiasis, or gnat fever.

The genus Anopheles was chiefly looked for, because these had been shown to be concerned in the transference of the parasite. In the barracks at Wilberforce, Sierra Leone, 25 per cent. of the soldiers suffered from all three forms of malaria or gnat fever. All the gnats caught in the barracks were *Anopheles costalis* except one, and out of 109 of those examined, parasites were found in 27.

Some experiments on feeding Anopheles on a patient with *H. malariae* gave positive results, several young zygotes being found in the gnat. These gnats were caught in a building where there were no fever patients, and numbers of them had been examined and found free from parasites. When, however, Anopheles bred from the larvæ and kept in test tubes were applied to the skin of a patient, they were found not to feed copiously, and negative results, as regards zygotes, were obtained on dissecting them. It is suggested that the explanation of the failure was the non-fertilisation of the females ; it seems that the female gnat requires blood for the nutrition of the eggs. If the ova are not fertilised, the blood is possibly evacuated without some digestive process being performed which may be necessary to the vitality of the zygotes.

Measures of precaution against the bites of gnats, and measures for reducing their numbers, are discussed in the chapter on prevention. It is remarked that neither Europeans nor natives made any effort to keep down the numbers of gnats, which constitute a very serious pest in Sierra Leone, as they do in all tropical towns. Both this report and the "Instructions for the Prevention of Malaria" should be invaluable to residents abroad, as indicating how they may protect themselves from the annoyance from gnats, and from the evil results that may arise from their "bites."

Experiments were instituted with a view to destroying the adults or larvæ, and to prevent the insects from breeding. It was not always possible to discover the breeding pools of the Anopheles infecting a particular spot ; for instance, none could be found at Wilberforce, the nearest pools where larvæ were found being nearly a mile away. Dr. Fielding Ould tried experiments with tar, and found the film on the surface of the pool lasted longer than a film of kerosene oil ; while both killed the larvæ and prevented them from hatching so long as the film lasted.

In the addenda are some good micro-photographs of both zygotes and blasts from the gnat.

JOSEPH BERTRAND.

AMONG the heavy losses which science has suffered during the past few months, few will be the subject of such universal regret as the death, on April 3, of M. Joseph Bertrand. The loss will be felt, not only by mathematicians, but also by the great body of scientific men with whom Bertrand was brought into contact in his capacity of life-secretary of the Paris Academy of Sciences.

Joseph Bertrand was born at Paris in 1823, and at an early age commenced his mathematical studies under the guidance of his father, who had been a pupil of the École Polytechnique. Subsequently Bertrand entered the Collège de St. Louis, and at the age of eleven he succeeded in passing the examination for entrance into the École Polytechnique, although it was not till six years later that he actually entered the college, when he headed the list of candidates. As a boy, Bertrand would nowadays be styled an "infant prodigy," by analogy with the youthful musicians who created such a *furore* at London concerts a few years ago ; and it is interesting to learn from M. Maurice Lévy that this title (*enfant prodige*) was actually bestowed on him by the scientific men who welcomed Joseph as a young colleague at an early stage of his existence. The analogy between music and mathematics seems, moreover, to have suggested itself to M. Jules Lemaitre, Director of the French Academy, who remarks that such precocity of genius is sometimes found in mathematics and in music, but is never seen in literature. We find Bertrand publishing a paper on the theory of electricity in 1839, when he must have been about sixteen years old, and it is hardly surprising in view of this to learn that his precocity amazed his masters. In 1841 he wrote papers on indeterminate forms, Jacobi's theorem and differential equations, and from that time onward he was fairly launched on his career as a writer of mathematical papers, his output being five papers in 1842 and seven in 1843. But whereas most of the young musical *débutants*, to whom reference has just been made, have enjoyed only ephemeral reputations, and have exhausted their energies in their premature efforts to an extent which must have prejudiced their future careers, Bertrand succeeded in achieving all that was predicted of him ; he showed no diminution of energy in advancing years, and, moreover, to judge from all accounts, he developed into a good man of business, a quality which is commonly regarded by "the general public" as incompatible with being a genius.

In 1842 he had a narrow escape from being killed in a railway accident near Meudon. In company with his brother, Alexandre Bertrand, now distinguished as an archæologist, he had gone to Versailles to see the fountains, and on the return journey the accident occurred in which Admiral Dumont d'Erville was killed. Both of the Bertrand brothers suffered, Joseph losing the bridge of his nose—a misfortune which disfigured him for life—while Alexandre's leg was fractured. Joseph rescued his brother by dragging him through "the skylight," the carriage doors being locked. A few months later he married the sister of one of the injured, a Mademoiselle Acloque. At the Polytechnique, Bertrand acquired a knowledge of mining, and on leaving he became an inspector of mines. He was subsequently appointed professor at the Lycée St. Louis.

In March 1844 he became teacher of analysis (*répétiteur d'analyse*) in the École Polytechnique; from 1847 to 1851 he was examiner for admission to the same institution, which raised him to the rank of professor of analysis in 1856, a post which he held till 1895, just after he had completed his jubilee as a member of the teaching staff, an event which was commemorated on May 27, 1894, by a committee of his old students, who presented him with a medal engraved by Chaplain. In 1847 he was appointed deputy professor to Biot in the department of physics and mathematics at the Collège de France, and on the death of Biot, in 1862, he was appointed to the chair. From then up till 1890 he lectured regularly, with the exceptions that his work was taken by Darboux in 1867, by Maurice Lévy in 1874–76 and 1878–85, by Laguerre in 1885–86; since 1890 Marcel Deprez has acted as his deputy. We have it on the authority of M. Gaston Paris, that his first course of lectures was on a comparative study of the theories according to which geometers had attempted to account for capillary phenomena, his latest lectures being on electricity, thermodynamics and theory of errors. From 1858 to 1862 he was professor of higher mathematics at the École Normale Supérieure, and he also is stated to have held a professorship of special mathematics in the Lycée Napoléon. In 1856 Bertrand was elected a member of the Académie des Sciences at the early age of thirty-four, in place of Sturm; and on the death of Élie de Beaumont, in 1874, he was elected permanent secretary, in which office he had Berthelot as a colleague. He was made officer of the Légion d'Honneur in August 1867, and commander in December 1881. In 1884 he succeeded Jean Batiste Dumas in the French Academy.

Bertrand's larger works—namely, his "Traité d'Arithmetique," published in 1849; his "Traité d'Algèbre," published in 1856; and his "Traité du Calcul differentiel et integral," brought out during the years 1864–70—are accepted as standard treatises by mathematicians in all countries, the last named of the three being perhaps the most widely read of all. His treatise on Arithmetic contains, for the first time, a clear definition of incommensurable quantity. His treatise on the Calculus contains a large number of geometrical applications embodied in his divers memoirs; and special mention may also be made of his exposition of the theory of functional determinants and the close and useful relation which he established between these determinants and the simple derived function of one variable. It is greatly to be regretted that the manuscript of the third volume of this work was destroyed in a fire. A similar misfortune befel the manuscript of his original treatise on Thermodynamics, completed in 1870. In this case, however, the loss has been repaired by the publication of a book on the same subject at a later date, based on a course of lectures given at the Collège de France. Those who have grappled with such a subject as thermodynamics will appreciate his naïve observation that he has not attempted to make a complete treatise, and that he has only expounded what he has understood. But, as M. Lévy justly goes on to remark, on those points which he pretends not to have understood, notably on irreversible phenomena and the application of the Second Law to bodies of non-uniform temperature, he has made a series of critical remarks of great importance, which have already borne fruit. This treatise, moreover, is remarkably rich in illustrative examples all more or less original, those dealing with saturated vapours coming well within the range of *practical* applications. Other works emanating from his pen are an edition of Lagrange's "Mécanique analytique," with copious notes, and a small volume of lectures on electricity, in which Bertrand gives the true origin and reason of Faraday's notion of "electric flux," although, being a mathematician, he naturally favoured the rigorous methods of Ampère, for whom he expressed great admiration.

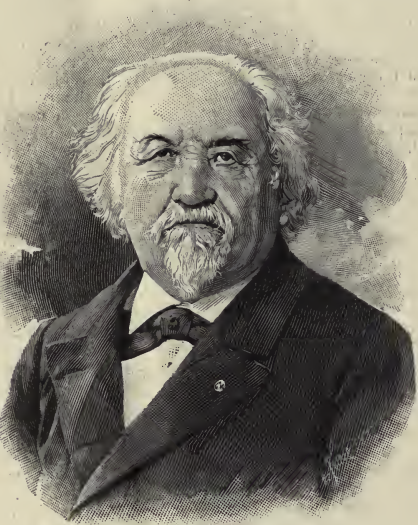
Passing from these standard treatises to the numerous papers published in scientific journals, a glance down the list of these shows that, from the outset, Bertrand devoted his attention largely to applied mathematics, and to those portions of pure mathematics required in the solution of problems in applied mathematics. His early papers deal chiefly with the differential and integral calculus, differential equations, the calculus of variations, analytical mechanics, and in particular the integration of the equations of dynamics. His papers on the theory of surfaces, dating from 1843, on the principle of similitude in mechanics, on the propagation of sound and on capillary phenomena, are among the best known of his minor writings. After 1864, we find him writing biographical memoirs, commencing with Copernicus, Tycho Brahé and Fresnel, and followed up in later years with Comte, Lavoisier, D'Alembert (1889) and Pascal (1890). In 1868, Bertrand commenced a series of papers on hydrodynamics; flight of birds came under his "ken" in 1871, and in the same year he turned his attention to lunar theory. In the three years 1871–73, he contributed quite a number of papers dealing with electricity and magnetism, including the mutual action of currents, &c. In the period 1874 to 1883, the subjects treated included the sun, figure of the earth, electricity and magnetism, electric transmission of power, the Foucault pendulum, the theory of probability. Probability was always a favourite subject with Bertrand. The numerous pitfalls connected with the solution of problems, the remarkable power of prediction which the theory appears to afford, had a great fascination for him, and many were the courses of lectures which he delivered on this subject, not only at the Collège de France, but even in the less advanced classes at the École Polytechnique, where the subject was introduced by him chiefly in connection with its bearing on astronomy and the applied sciences, such as civil and military engineering.

We have spoken, too, of Bertrand's papers on Foucault's pendulum. How far Foucault owed the success of this and his other discoveries to the influence of Bertrand may be judged from M. Lévy's own words. Nearly at the beginning of his (Bertrand's) career, when he was but a mere professor at the Lycée, he discovered Foucault, became attached to him, helped him with the mathematical science which Foucault was lacking, contributed thus to his discoveries without in any way thrusting himself forward; and afterwards, hardly had he been elected into the Academy of Sciences, before he pressed forward the candidature of the great physicist, then little known or unappreciated, against the opposition of many of the highest authorities of that time—a contest which has remained famous. The struggle was not without its risks, nor the success without its honour. One vote turned the scale. But the Institut de France added one more man of genius to its scientific roll.

By the end of 1883 Bertrand had written about 121 papers. Many of these were published in the *Comptes rendus*; others, mostly written in a lighter style and oftentimes with a vein of irony running through them, appeared in the *Revue des deux Mondes*, and included criticisms on "pseudo-mathematicians," as well as numerous biographies of genuine men of science.

Of late years Bertrand communicated but few papers to the Paris Academy. He appears to have devoted himself chiefly to the administrative work of the Academy. In connection with the annual awards of prizes, we find his name almost invariably appearing on the lists of judges, and he appears to have been no less energetic in drawing up biographical notices of deceased members. Nevertheless, we find him in 1895 writing on a geometrical theorem, and in 1896 breaking a lance with Boltzmann on that ever-fascinating and never-satisfying theory, the Kinetic Theory of Gases. This is the last time that we have been able to find Bertrand's name in the *Comptes rendus* as the writer of a paper, though it repeatedly figures in other connections.

Bertrand's countenance and carriage are described as "characteristic." He was "short, thick-set, lively, vigorous, and very kind-looking. His face was covered with scars, and his nose had lost its bridge," as we have seen, as the result of the Meudon railway accident, but the imprint of misfortune would appear to have given a tender pathos to his appearance, which seemed to draw his friends nearer to him. As a relaxation from work, he is said to have never tired of reading the novels of Sir Walter Scott, whom he described as "the greatest



Joseph Bertrand.
(From *La Nature.*)

novelist that ever lived." He leaves several sons, one of whom, M. Marcel Bertrand, a mining engineer, is himself a member of the Academy of Sciences, and rather well known.

If Bertrand's mathematical work earned for him the respect and admiration of men of science far and wide, his philanthropy endeared him to the smaller circle with whom he was more intimately known. The enjoyment he derived from his own studies was fully equalled by his delight at reading the works of others. He constantly sought to bring to light fresh workers, and the few words of kind reassurance and appreciation, not to mention the passing on of an idea or the lending a helping hand over a difficulty, so much valued by the budding mathematician, were never wanting at the critical moment. In endeavouring to help those less favoured by fortune than himself, Bertrand would give much time and thought as to the best way of rendering them assistance. In 1857 Baron Thénard founded the "Société des Amis des Sciences," an institution the object of which is to assist scientific men and their families when in need. Bertrand was one of the first to support the Society, and his signature figures along with those of Boussingault, Quatrefages, Becquerel, Sénarmont, Balard, Daubrée, Frémy, Deville, Berthelot and Pasteur in all its early records. In 1864 Bertrand was elected on the council, in May 1895 he was nominated vice-president, and in November of the same year he succeeded Pasteur as president. The Pasteur Institute also owes much to his energetic support.

Mathematical investigation is essentially a search for truth; but with Bertrand the love of truth and hatred of all that is false, was not confined to the mathematical side of his character; this trait was indeed deeply engrained into his whole existence. While there was nothing he would not do for those he knew to be deserving, he seems to have possessed a happy knack of effectually disposing of his enemies by a few strokes of sarcasm, which must have been the more withering because they so completely placed his adversaries in the wrong.

Had Joseph Bertrand's life and health been spared a little longer, there can be no doubt that he would have taken a foremost part in the liberal programme of congresses with which Paris hopes to attract a distinguished assembly of *savants* from all quarters of the globe, and we are sure that many English readers of his "Differential and Integral Calculus" would gladly have availed themselves of the opportunity of coming into personal contact with the well-known French mathematician. The loss of so prominent a figure in the Parisian world of science would at any time be deeply deplored, and his absence from the brilliant gatherings that are to be, only adds to our regret at losing one who has done much to simplify and popularise the study of mathematics.

At the funeral, discourses were delivered by M. Jules Lemaitre, director of the Académie Française; by M. Maurice Lévy, president of the Académie; by M. Berthelot, his fellow secretary of the Académie des Sciences; by M. Gaston Darboux, representing the Société des Amis des Sciences; by M. A. Cornu, representing the École Polytechnique; by M. Duclaux, director of the Institut Pasteur; by M. Gaston Paris, administrator of the Collège de France; and by M. Georges Perrot, director of the École Normale. In endeavouring to portray the life of a man of many and varied parts like Bertrand, we have largely drawn on the information contained in these orations, which are published in the *Comptes rendus*; but while it has thus been possible to enter into many of the details of Bertrand's life, his character as an individual can only be appreciated by reading separately the thoughts expressed by those who have known him intimately in his many capacities. Of these expressions, we can do no better than conclude with the words of M. Georges Perrot:—

"Il n'a pas été moins grand par le cœur que par l'esprit."

G. H. Bryan.

NOTES.

We notice with regret the announcement that the Duke of Argyll died on Tuesday morning, at the age of seventy-seven years. No definite arrangement has yet been made with regard to the funeral, but it is believed the interment will take place next week.

The international conference for the protection of wild animals in Africa, announced last week, was opened at the Foreign Office on April 24, and was attended by plenipotentiaries of France, Germany, Great Britain, Congo Independent States, Italy, Portugal and Spain. Readers of Nature hardly need to be reminded that such a conference is of deep importance, and it is sincerely to be hoped that a definite plan of action will be decided upon as a result of its deliberations. A leader in Tuesday's *Times* directs attention to the necessity of an international agreement to restrain the extermination of many of the mammals, birds and fishes in Africa. It is useless to preserve wild animals in one part of Africa while they are killed off without restriction in neighbouring districts by people accredited as citizens of another European State. This is why an international agreement is sought for. It is needless to dwell upon the unnecessary slaughter of elephants, rhinoceroses, hippopotami, and the larger kinds of antelopes, elands, koodoos, sables and others since the Cape Colony, the Boer States, and the Rhodesian territories have been opened up to colonisation. Half a century ago, as the *Times* points out, the whole of South Africa below the Zambesi swarmed with antelopes and other game, including lions and leopards. Now, except in a few rare districts, there is nothing more of the kind to be found than in Hampshire or Devonshire. To remedy this state of things, the *Times* advocates the establishment of large reserves, like the Yellowstone Park in the United States, where wild animals can be allowed to live their natural life. It is easier to bring this to pass in Central Africa, where so much land is practically waste, than in countries where civilisation has made its way. The experiment has been tried, on a small scale, in many places, and with considerable success. In a narrow strip of forest country on the South Coast the Government of the Cape Colony preserves some herds of elephants. Mr. Rhodes has done much for the preservation of antelopes both on his property near Cape Town and in Rhodesia. There appears to be no reason why very large areas in Central Africa should not be set apart as refuges in which all the rich animal life of the continent might be permitted to propagate and develop under something approaching to natural conditions. Ten or twelve of these great reserves would keep alive, for a time at least, the striking types of animal life in which Africa is so extraordinarily fertile.

IN connection with the subject of the foregoing note, some remarks made by Prof. S. P. Langley in the latest report of the Smithsonian Institution are of interest. It is pointed out that the National Zoological Park at Washington was established with the object of preserving the fast vanishing species of American animals. The changes which were noticed in the western part of America some years ago are now occurring in Alaska. With the advent of the settler and the railroad in the West, the great herds of animals which ranged over the western territory of the United States were practically exterminated, though by strenuous efforts here and there small collections of the buffalo and other large interesting mammals, like those in the National Zoological Park, have been kept alive. Whether a race can be made to survive in this way is open to question, but the effort at least should be made, and the Smithsonian Institution is trying to promote this survival. The United States still possesses at Kadiak Island, on the south-east coast of Alaska, a few living specimens of the largest carnivorous animal now in the world—a monster bear—which has not at any time been brought into captivity. Prof. Langley has been trying for two years, through American companies on the island, to obtain live specimens of this and other great mammals of Alaska with the hope of preserving the species before the inevitable opening of all that distant territory of the United States to civilisation and settlement will have resulted in the extermination of its large fauna, but these efforts have hitherto been wholly unsuccessful.

THE summer meeting of the Institution of Mechanical Engineers will be held in London during the last week in June.

THE Bruce gold medal of the Astronomical Society of the Pacific has been awarded to Dr. David Gill, C.B., F.R.S.

THE *Daily News* announces the death of Prof. A. Milne-Edwards, director of the Natural History Museum at Paris.

SIR J. BARRY TUKE, well-known for his works on mental diseases, has consented to become a candidate for the vacancy in the parliamentary representation of the Universities of Edinburgh and St. Andrews, caused by the death of Sir William Priestley.

WE learn from the *Chemical News* that an international banquet will be held by the Chemical Society of Paris in honour of those gentlemen who, by their presence at the Universal Exhibition, will represent pure and applied chemistry. The date fixed for the banquet is Thursday, July 19, when the chair will be taken by M. Berthelot, honorary president.

THE economic position of the German Empire in 1900 forms the subject of a report by Mr. Gastrell, commercial attaché to Her Majesty's Embassy at Berlin, which has been issued by the Foreign Office. It is instructive to trace the steps in the progress of the German Empire towards the important position it holds to-day. Mr. Gastrell points out that, in industrial and commercial matters, the first twenty years of the existence of the German Empire—from 1871 to 1890—were devoted to the elementary education of its people; the following ten years—1891 to 1900—have been spent on their higher education; and the end of the century sees in them a body of men each an expert in his own trade or profession. The bases on which Germany's power stands are primarily its trade and, in a minor degree, its agricultural resources. The population of Germany to-day is probably larger than that of the United Kingdom by some 15,000,000, and greater than that of France by about 17,000,000.

THE facilities which will be granted by the Portuguese Government to foreign astronomers visiting Portugal in May, for the purpose of viewing the total eclipse of the sun, have been made the subject of an official announcement by the Foreign Office. Astronomers from abroad will be exempt from payment of the usual Customs duties on production at the Custom House, on arrival, of a certificate drawn up by the astronomical society to which they may belong, setting forth their names, and describing the instruments and books which are to be imported. This certificate, however, should be legalised by the nearest Portuguese Consulate before starting. Further, it is announced that the Ministry of War has informed the Ministry of Education that all the military authorities of the districts of Vizen, Aveira, Guarda, Castello Branco and Coimbra will afford any possible assistance to astronomers during the observations, and that tents will be lent to observers, on a request being addressed to the Ministry of War in Lisbon to that effect. A Government notice has now been published in the *Official Gazette*, stating that the King has nominated a Royal Commission for the purpose of assisting in every way those who may come from abroad for scientific observations, and for superintending astronomical arrangements generally. This commission will sit either at the Royal Observatory, Lisbon, or at the Geographical Society, Lisbon; its president is his Excellency Senhor Marianno de Carvalho. If any British astronomers going to Portugal will communicate with her Majesty's Minister shortly before their arrival, he will be able to take steps to facilitate the object of their visit.

THE annual meeting of the Iron and Steel Institute will be held on Wednesday and Thursday, May 9 and 10, under the presidency of Sir William Roberts-Austen, K.C.B., F.R.S.:

On the first day, the Bessemer gold medal for 1900 will be presented to Mr. Henri de Wendel, president of the Comité des Forges de France. During the meeting, papers will be read and discussed on ingots for gun tubes and propeller shafts; the manufacture and application of water-gas; the equalisation of the temperature of hot blast; blowing-engines driven by crude blast-furnace gas; the solution theory of iron; the use of fluid metal in the open-hearth furnace; the manganese ores of Brazil; the utilisation of blast-furnace slag; iron and phosphorus; and the continuous working of the open-hearth furnace. The annual dinner of the Institute will be held at the Hotel Cecil on May 9.

IT may be remembered that in France, last year, the *Matin* organised a race of about 1400 miles, known as the "Tour de France," which effectually brought the powers of automobile vehicles to the notice of all sections of the population. In some of these contests very surprising results have been attained. The winning car in a recent race at Pau, says the *Times*, accomplished a distance of 208 miles without a stop, at an average speed of $44\frac{3}{4}$ miles an hour, covering the first $34\frac{1}{2}$ miles in the remarkable time of $33\frac{1}{2}$ minutes. Stimulated by the success of last year's "Tour de France," both in promoting the use of motor cars and in revealing the types of car best suited for the purposes in view, the Automobile Club of Great Britain and France has arranged a trial of over 1000 miles, to be carried out on a route passing through the following centres of population:—Bristol, Birmingham, Manchester, Edinburgh, Newcastle-on-Tyne, Leeds and Sheffield. The procession of cars started from Hyde Park Corner on Monday, and the survivors will return to London on Saturday, May 12. Eleven days will be devoted to covering the distance, and at each of the above-named places the vehicles will be on exhibition for one clear day. They will also be exhibited for a few hours at Cheltenham, Kendal, Carlisle, York, Lincoln and Nottingham, and at the conclusion of the trial there will be a week's exhibition at Prince's Club, Knightsbridge. Over eighty vehicles are taking part in the trial, of which fifty-three have been entered by manufacturers and agents, and the remainder by private owners.

THE death is announced of Prof. Silas W. Holman, emeritus professor of physics at the Massachusetts Institute of Technology.

AN appreciative notice of the life and scientific career of the late Mr. J. J. Walker, F.R.S., who died on February 15, is contributed to the *University College School Magazine* by Mr. R. Tucker. Mr. Walker was appointed lecturer in applied mathematics and physics at the school in 1865, and in the same year became a member of the London Mathematical Society. He was a member of the council of the society from November 1869 to November 1874, and then again from November 1876 to November 1894; he was vice-president for two periods of two years, and president from November 1888 to November 1890. He contributed some twenty-four papers to the *Proceedings*, the longest of which were a method in the analysis of plane curves and on the satellite of a line relatively to a cubic. His presidential address was "On the influence of applied on the progress of pure mathematics." This, as remarked by his successor in office, Prof. Greenhill, "showed us how many of the most abstruse theories of pure analysis owe their origin to ideas which arose in connection with concrete and even practical requirements." His range of mathematical reading was very extensive, and he contributed papers to the Royal Society and most of the mathematical journals. From 1868 to 1882 Mr. Walker was vice-principal of University Hall. He was a member of the Physical Society, and was elected F.R.S. in 1883.

THE death of M. Gustave Planchon has removed from our midst perhaps the most active scientific pharmacist of the present day. Although typically French, Planchon's works, so far as their matter is concerned, are cosmopolitan, his "Simple Drugs of Vegetable Origin," for instance, being known to all students of pharmacy. Planchon was a graduate of Montpellier, and the first part of his career was spent in teaching pharmacy in the Montpellier Faculty of Medicine. In 1866, however, he was called to Paris as Professor of the Natural History of Medicaments. He was appointed Director of the Paris School of Pharmacy in 1886, and continued to hold that position until his death a few days ago. Most prominent among his contributions to pharmacy are his, the work mentioned above, and, brochures upon quinine, ipecacuanha and jaborandi. He was also a great authority upon the history of pharmacy and medicinal plants lore. He was quite recently elected President of the International Congress of Pharmacy, which is to take place in Paris next August, and it will be a matter of most sincere regret that one who would have filled the duties of this position so ably has been so unexpectedly cut off. Besides those who admire his work, and him on account of it, he leaves behind a large circle of close friends who will all their lives miss his kindly personality.

THE Paris correspondent of the *Times* reports that a geologist, M. Neuburgher, has just been examining, on behalf of the French Government, the mineral oil country of Oran, Algeria. It is stated that there is a tract, of at least 120 miles in length, exceedingly rich in petroleum, resembling the rich districts of Baku and Galicia.

THE death of an aëronaut at Paris from poisoning by hydrogen arsenide shows the necessity of taking precautions to purify the gas used for filling balloons. From a note in *La Nature* it appears that upon the occasion on which the accident occurred the balloon was filled in the ordinary way, and nothing peculiar was noticed in the character of the gas; but some hours afterwards the persons who had assisted in the operation were taken seriously ill, and one of them did not recover. The accident directs attention to a danger frequently overlooked.

ANOTHER effort to discover some clue to the fate of Andrée will be made this summer. The *National Geographic Magazine* states that the Swedish-Russian Expedition, which will leave about June 1 for Spitzbergen to relieve the party that is at present engaged in the work of measuring an arc of the meridian in that latitude, plans to make a detour to King Charles Land and carefully search the entire neighbourhood. It will be remembered that in September of last year a buoy was picked up on the north coast of King Charles Land, at 80° north latitude and 25° east longitude, marked "Andrée's Polar Expedition." When taken to Stockholm and opened, it proved to be what Andrée had called "the North Pole Buoy," and in which he was to place a message when he passed the North Pole. However, a microscopical examination of the interior could discover no message. As the buoy could not have drifted to King Charles Land from the neighbourhood of the Pole, the only conclusion possible is that it was a part of the wreckage of the expedition, and that possibly more wreckage may be found near by.

SWISS engineers, though so successful in the manufacture of various classes of machinery, labour under the disability that practically the whole of the iron employed, valued at over two million pounds annually, has to be imported from Germany and elsewhere. This is due, not so much to the absence of iron ores within their boundaries as to the want of coal wherewith to smelt it. We learn from the *Electrician* that recent researches in electro-metallurgy promise a means of overcoming the defect, and a scheme for the application of the electric furnace to the smelting of iron on the large scale is being developed by Herr Müller Landsmann in the Bernese Oberland, near Meiringen. A concession has been obtained from the State for the working of an outcrop of hæmatite. The vein has a thickness of 7 feet, and is visible for a length of two miles along the mountain face. Thence the ore will be transported by an aërial ropeway to Innertkirchen below. The concession obtained for the water power available from the Aar in the immediate neighbourhood, amounting to 60,000 h.p., will be used to drive the machinery required, and to supply the power for the electric smelting furnaces.

AGRICULTURAL experiment promises to become an important branch of technical education in rural districts. Prof. W. Somerville's eighth annual report on experiments with crops and stock in the counties of Cumberland, Durham and Northumberland is an instance in point. It contains the results of well-arranged experiments of direct value to the farmers of the districts in which they were made; and by encouraging work of this kind the councils of the counties mentioned are doing a service both to technical education and the agricultural community. Many of the investigations described deal with the values of natural and artificial manures for different crops. A note on the eradication of charlock amongst corn crops by spraying with solutions of sulphates of copper and iron is of wide interest. The corn crop was in no case permanently injured by the treatment, though in some cases it was temporarily harmed. In no case was clover at all injured. On the whole, a 4 per cent. solution of copper sulphate is recommended for application at the rate of 25 to 40 gallons per acre, the dressing being repeated after the interval of a week if necessary.

AT a meeting of the Academy of Science of St. Louis, on April 2, Dr. W. H. Warren read a paper giving an outline of recent progress in the chemistry of perfumes. For the most part, these substances are high boiling oils. Formerly these oils, which are complex mixtures of several compounds, were obtained exclusively from flowers, but recently some of the essential principles have been produced by chemical means, whereas other artificial perfumes are mere imitations. With a few exceptions, the essential principles which give the perfumes their value belong to the complex class of organic compounds known as the terpenes. Nearly every substance having the properties of a perfume has in its molecule certain atomic groups the presence of which exerts a marked influence on the odour. Among the more important of these may be mentioned the aldehyde, ketone, ester, ether and alcohol groups. Wonderful progress has been made in the knowledge of the terpenes and of their derivatives during the past ten or fifteen years, among the chemists who have taken a prominent part in the labour being Wallach, Baeyer and Tiemann.

PARTICULARS concerning the establishment of the Hamburg Institute for the study of nautical and tropical hygiene are given in the *Board of Trade Journal*. The Institute, like those of Liverpool and London, is a natural outgrowth of new conditions. The rapid transition from sails to steam, as a means of propulsion, the almost universal substitution of steel for wood in the construction of sea-going vessels, and the improvement in the food provided for seamen, have brought about a marked change alike in the ailments and the nature of the accidents occurring to members of the crews. Scurvy, night blindness, the so-called ship anæmia, chronic ailments of the digestive organs and canals, as well as lead-poisoning, even if not yet absolutely extinct, have become rare in a very marked degree. In their place, however, a series of new diseases has demanded the closest attention of the medical faculty. To deal with these diseases, and cases of malaria, beri-beri, black water fever, and other tropical disorders, special hospitals or institutes at large ports are needed. The Hamburg Institute is to comprise a division for patients, provided with sixty beds and a laboratory, which will be fitted for bacteriological as well as for chemical research, space being provided for twelve investigators. Five tables for research will be reserved for qualified military medical aspirants for service with the German Colonial troops or under the German Colonial Department. Their course of study of the etiology, symptoms and treatment of malaria and other grave tropical diseases, of tropical physiology and tropical hygiene, will extend over several months. Attention will also be given to the more general methods of hygienic investigation, so that the students in question, when opportunity should be forthcoming, may possess the requisite training for extended research abroad, combined with the ability to report technically thereon. The additional tables in the laboratory will be placed at the disposal of the naval and mercantile services, as well as of medical men, who, having returned from the tropics, are desirous of pursuing special branches of research. The participation of Prof. Koch in the investigation of tropical diseases has greatly assisted the decision of the German authorities in establishing the Hamburg Institute.

THE complete history of the great Japanese earthquake of 1891 is still unwritten; but Prof. Omori has contributed an interesting note upon it to the last volume of the *Publications* of the Earthquake Investigation Committee. The total disturbed area is estimated at about 900,000 sq. km. The maximum acceleration at various places was calculated from a large number of overturned bodies; that at Nagoya being 2600, and at two other places more than 4300 km., per second. The range of the motion at Nagoya must have been about 233 km. Many observations were also made on the direction of overturned bodies, from which it appears that in and near the Mino-Owari plain, the principal direction of the earthquake motion was approximately normal to, and directed towards, the meizoseismal zone.

FOR several years Prof. Omori has studied the subject of earthquake measurement in a brick building. One of Prof. Ewing's horizontal pendulum seismographs was fixed near the top of an external wall of the Engineering College at Tokyo, whilst another was erected on the ground below. During the years 1894–98, ten moderate earthquakes were recorded, and it was found that if the earthquake consisted of comparatively slow vibrations (say, above half a second in duration), the motion was practically the same in both places; but if of quick-period vibrations, the motion of the top of the wall was about twice as great as that of the ground. Prof. Omori notices that, with destructive earthquakes, the damage of two-storied buildings is generally confined to the upper storey.

WE have received a reprint, from the *Transactions* of the Royal Society of Canada, of a note, by Mr. W. Bell Dawson, on some remarkable secondary tidal undulations registered at Halifax, N.S., Yarmouth, St. Paul Island, and St. John, N.B., on January 1 and 2 of this year. The secondary movements ranged from 10 per cent. of the whole amplitude of the tide at St. Paul Island, to no less than 45 per cent. at Yarmouth. The pilot chart of the North Atlantic shows that at least three storms, two of which developed hurricane force, passed over or near the region between December 26 and January 2. Mr. Dawson does not attack the general problem of the causes of secondary undulations, which are of very frequent occurrence off the eastern seaboard of Canada, but he draws attention to the favourable conditions which exist there for observing them. The most important feature as yet determined is that the secondary undulations do not become magnified in range in the same ratio as the main tidal undulation does, under the influence of the general form of the coast.

The sudden rise of temperature over the British Islands towards the close of last week, when the temperature in the neighbourhood of London reached 78°, owing to the presence of a large area of high barometric pressure, was a very welcome change from the recent exceptionally cold period to which the latenesss of the spring in all parts of the country was due. This reading has only been once exceeded in April during the last twenty-five years. For the greater part of the month the mean of all the highest day readings was about 1° below the average, and it was not until the 19th that the temperature at Greenwich exceeded 64°; in many recent years a higher temperature has occurred in March. The returns published by the Meteorological Office show that the rainfall over England since February had been much below the average, and that the amount of bright sunshine had been deficient in most parts

To the March number of the *Agricultural Gazette* of New South Wales, Mr. W. W. Froggart, the Government Entomologist, communicates an important paper on the "plague" of locusts to which the country has lately been subjected. Although Australia has been visited by swarms of locusts from a very early period, it does not appear that these did much damage till the seventies, when farms had begun to occupy much of the open plains of Victoria and other districts. Between that period and 1891 New South Wales was devastated by swarms of the species known as *Pachytylus australis*; but in the serious visitation of 1899 the place of that kind was taken by *Epacromia terminalis*, which is believed to have moved into the colony from South Australia. Not only did the swarms destroy all the sheep-feed in the districts visited, but they likewise ruined some 20,000 acres of young wheat. Mr. Froggart concludes that an effectual remedy would be either to destroy the eggs, or to expose them in such a manner that they would be readily accessible to the attacks of birds. But he has also hopes that inoculation of the immature insects with the so-called African locust-fungus would have good results.

The March number of the *American Naturalist* contains some interesting remarks on the habits of the American gilled and blind salamander described some time ago by Dr. Stejneger under the name of *Typhlomolge*. A number of living specimens were obtained from subterranean waters at a depth of 181 feet below the surface, but only one of these survived for any length of time above ground. Unless disturbed, these salamanders spend their time in resting or in walking very slowly; when walking, they move a few steps at a time, pause awhile, and then once more advance. From the extreme slenderness of their limbs, Dr. Stejneger came to the conclusion that these were employed solely as feelers, and that progression was effected by means of the tail; but this conjecture is now shown to be incorrect.

From Mr. J. C. Thompson we have received a copy of his paper on tropical and northerly "plankton," published in the *Transactions* of the Liverpool Biological Society.

We have to thank Messrs. Eigenmann and Schafer for a copy of their paper on the mosaic of single and twin cones in the retina of fishes, published in the February number of the *American Naturalist.*

The *Irish Naturalist* for April contains an interesting account by Dr. R. F. Scharff upon all the species of whales and dolphins known to have visited the Irish coast, illustrated by good figures of their skulls, with the outline of the heads.

In a paper on some abnormally-coloured Australian birds, in the *Victorian Naturalist*, Mr. R. Hall calls attention to the fact that while in New Zealand and South Australia birds display a tendency to albinism, in North Australia, as in India, the variation tends to the development of melanism.

Hitherto the genus of vampire bats known as *Monophyllus* has been represented only by a single species from Jamaica. In a recent issue of the *Proceedings* of the Washington Academy of Sciences, Mr. G. S. Miller describes three new representatives of the genus, at least one of which is from the mainland.

The *Journal* of the South-Eastern Agricultural College, Wye, Kent—issued under the joint auspices of the Kent and Surrey County Councils—contains much valuable information in regard to pests and diseases which infect or afflict cattle and crops; the one of most local interest being an essay on "red mould" in hops.

Monsieur C. Janet, President of the Zoological Society of France, has favoured us with a copy of his "Essai sur la constitution morphologique de la Tête de l'Insecte," Paris, 1899. In this brochure, which is admirably illustrated, the author adopts the view that the true head of all insects is primarily composed of five segments.

We have received from the Trustees of the British Museum the portion of vol. ii. of the "Catalogue of the Lepidoptera Phalænæ" containing the plates, by Sir George Hampson. The execution of the coloured illustrations of these "Microlepidoptera" is all that can be desired; but we notice that the author has departed from recognised usage in calling the family *Arctiadae* instead of *Arctiidae.*

The "Psychological Index," published annually by the *Psychological Review*, is well-known to be a comprehensive and orderly bibliography of original publications in all languages, on psychology taken in its widest sense. The "Index" for 1899 has just been published, and it occupies no less than 174 pages of the *Psychological Review.*

Engler's *Botanisches Jahrbuch für Systematik, Pflanzengeschichte, und Pflanzengeographie* continues to be characterised by the value and excellence of its papers in the domain of systematic botany. The parts most recently received (vol. xxvii. Heft 5 and vol. xxviii. Heft 2) contain, among other contributions, the conclusion of the Editor's series of papers on the flora of Africa; a paper on experiments on variation in plants, by Krasan; an exhaustive paper on the genus *Thea*, and the anatomical and morphological characters of the teas of commerce, by J. Kochs; a monograph of the genus *Mollinedia* (Monimiaceæ), by Janet R. Perkins.

The report of the Epsom College Natural History Society reminds us that the study of natural objects and phenomena which the Board of Education is endeavouring to develop in rural schools, is already carried on in an admirable way by the boys in many of our public schools and colleges. We find in the present report abstracts of lectures, descriptions of work done in the astronomical, botanical, entomological, geological, photographic and zoological sections, a summary of meteorological observations, and tables of anthropological measurements of boys in the college. The lists of plants observed and dates of first blooms, of insect captures, and of the dates when various birds were seen, or their nest, eggs and young, are particularly interesting from the point of view of phenology. The evidence given by the report of interest in natural things and characteristics is gratifying to every lover of natural history, and a credit to Epsom College.

The *Athenæum* makes the following announcement:—The "Diary of White of Selborne" is to be published. He kept it, as is well known, for more than twenty-five years, and used for the purpose a form "invented" by Daines Barrington, entitled "The Naturalists' Calendar," constructed for recording on each day, in proper columns, the readings of the thermometer and barometer; the direction of the wind; the measurement of the rainfall; the weather; the appearance of leaves and flowers of plants; the appearance or disappearance of birds and insects; observations with regard to fish and other animals; and miscellaneous observations. But Gilbert White enriched his "Calendar" with much other matter. There are not only numerous disquisitions on points of natural history, but notes of events of public interest and of personal or domestic concern. These are written on interleaves, or such spaces as may happen to be available. It is proposed to arrange for the publication of the diary in the manner of the original in every substantial particular. There will be no editorial notes, except in elucidation of a few points of real obscurity. It will fill two large quartos of about 700 pages each, and Messrs. Constable and Co. are to be the publishers.

IN the current number of the *Bulletin de la Classe des Sciences* of the Royal Belgian Academy is a paper by M. Henry, on some new reactions of formaldehyde. Phosphorus pentachloride and pentabromide give methylene dichloride and dibromide respectively, the latter in so good a yield as to be an advantageous method of preparation. Formaldehyde also reacts readily with acetyl chloride to give chlormethyl acetate, acetyl bromide giving the corresponding bromine compound. The yields are better than those given by the interaction of the halogen and methyl acetate.

THE same number of the *Bulletin* contains an exhaustive study, by M. Gillot, of the hydrolysis of raffinose by *Penicillium glaucum*. In solutions containing a mineral acid the mould is able to secrete a zymase capable of inverting raffinose, and this ferment is still produced, although more slowly, when the solution is neutral. In alkaline solutions the germination of the spores is retarded, the solution losing its alkalinity as the development of the mould proceeded, finally becoming acid. The zymase from a pure culture of the *Penicillium* was isolated, and raffinose inverted by its aid.

THE additions to the Zoological Society's Gardens during the past week include a —— Baboon (*Cynocephalus*, sp. inc.) from Zanzibar, a Suricate (*Suricata tetradactyla*) from South Africa, a Common Boa (*Boa constrictor*), an Anaconda (*Eunectes murinus*) from South America, a Pin-tailed Sand-Grouse (*Pterocles alchata*), South European, deposited; a Panolia Deer (*Cervus eldi*, ♀) from Burmah, five Common Wigeon (*Mareca penelope*), three Pochards (*Fuligula ferina*), three Tufted Ducks (*Fuligula cristata*), four Goldeneyes (*Clangula glaucion*), European; a Common Boa (*Boa constrictor*) from South America, purchased; a Barbary Wild Sheep (*Ovis tragelaphus*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN MAY.

May 1. 8h. 58m. to 9h. 48m. ι Tauri (mag. 4·7) occulted by the moon.
1–6. Epoch of the Aquarid meteoric shower (radiant 338°–2°).
2. 5h. Venus in conjunction with moon. Venus 4° 55′ N.
5. 11h. 48m. to 12h 42m. A¹ Cancri (mag. 5·6) occulted by the moon.
6. 11h. 1m. to 11h. 51m. ω Leonis (mag. 5·6) occulted by the moon.
7. 10h. 43m. to 11h. 49m. 19 Sextantis (mag. 6·0) occulted by the moon.
15. Venus. Illuminated portion of disc, 0·402; Mars, 0·975.
22. 10h. 8·7m. Jupiter's Sat. IV. in conjunction N. of the planet.
27. 7h. Jupiter in opposition to the sun.
28. Total eclipse of the sun, partially visible at Greenwich.

Times of Occurrence and Magnitude for places in the British Isles.

Place.		Eclipse begins. h. m.		Middle of eclipse. h. m.		Eclipse Ends. h. m.		Magnitude.
Greenwich	...	2 47·0	...	3 54·9	...	4 57·5	...	0·681
Cambridge	...	2 46·7	...	3 53·9	...	4 56·0	...	0·664
Oxford ...	...	2 45·3	...	3 53·6	...	4 56·7	...	0·683
Liverpool	...	2 42·1	...	3 49·9	...	4 52·9	...	0·655
Edinburgh	...	2 40·8	...	3 46·1	...	4 47·4	...	0·5[illegible]
Dublin ...	...	2 37·9	...	3 47·4	...	4 52·0	...	0·676

This is the largest solar eclipse visible in England since that of 1870 December 22, when about eight-tenths of the sun were obscured.

31. 18h. Venus at her greatest brilliancy.

PHOTOGRAPHS OF THE AURORA SPECTRUM.—M. Paulsen describes in *Comptes rendus*, cxxx. pp. 655–656, 1900, his successful attempts to obtain a photographic record of the spectrum of the aurora borealis. His station was in Iceland, where he states the displays were very vivid during the period December 31, 1899, to January 25, 1900, and photographs were obtained with two spectrographs, one having a quartz train for recording especially the ultra-violet, the second with glass components. In all twenty-two lines have been recorded, of which sixteen are new. Their wave-lengths have been provisionally determined by means of comparison photographs of the spectra of air and metals, and are as follows:—

Strong lines: 337, 358, 391, 420.
Faint lines: 353, 371, 376, 381, 393, 397, 402, 406, 412, 417, 422, 432, 436, 443, 449, 456, 463, 470.

The four strong lines were obtained from even feeble streamers, but for the others it was necessary to keep the spectroscope in the brightest regions. Besides the lines given, several others can be seen between λλ 357 and 250, but are too feeble for reduction.

NEW VARIABLE STAR IN TAURUS.—Dr. Anderson, of Edinburgh, announces in the *Astronomische Nachrichten* (Bd. 152, No. 3634), that he has detected variability in the star having the following position for 1855:—

R.A. = 5h. 44·1m.
Decl. = + 15° 45′.

This star is not in the B.D., and some years ago he found it about magnitude 9·25, while on 1899 November 8 it was invisible in a 3-inch refractor, which plainly showed a neighbouring star of 11 mag. On 1900 March 26 it was about 9·7 mag.

NEW VARIABLE IN CASSIOPEIA.—In the *Astronomische Nachrichten* (No. 3634), Dr. Anderson also announces the variability of a star in Cassiopeia, whose position for 1855 is

R.A. = 23h. 48·4m.
Decl. = + 52° 55′.

On 1900 February 10 the star was 9·6 mag.; but on March 17 and 25 it was less than 10·5 mag.

FORMULA FOR ATMOSPHERIC REFRACTION.—In the *Comptes rendus* (vol. cxxx. pp. 1060–1061, 1900), M. L. Cruls gives a simple formula for calculating the astronomical atmospheric refraction, which is found to give results very closely in agreement with those calculated from Laplace's formula.

The equation is

$$R = (60'' \tan z - 1'' \tan^2 z)\left(0{\cdot}00138B - 0{\cdot}00001\frac{Bt}{2}\right),$$

in which R is the refraction, z the zenith distance of the object, B the barometric pressure, and t the temperature in degrees Centigrade at the time of observation.

A table of comparisons is given, showing that the difference in the refraction, as obtained from the above formula and that of Laplace, is only 0″·2 at 10° zenith distance, the error gradually increasing as the horizon is approached; but even at 70° zenith distance the two formulæ give results differing only by 1″·6 of arc.

DETERMINATION OF AXIS AND COMPRESSION OF NEPTUNE.—The *Astronomical Journal*, No. 479 (vol. xx. pp. 181–185), contains an article by Prof. S. J. Brown, of the U.S. Naval Observatory, on the determination of the position of Neptune's axis, and the degree of its polar compression from an investigation of the perturbations of the orbit of its satellite. Eighteen determinations of the orbit of the satellite to this planet have been made during the period 1848–1898, but, owing to the position of the planet and the plane of the orbit, many of the earlier observations are very discordant, and it was only on publication of the results obtained with the 26-inch at Washington that the certainty of change in the position of the orbit plane was manifest (*Washington Observations*, 1873, 1881, Appendix i.). Marth first drew attention to the changes as being too great for systematic errors, but attempted no explanation as to their cause (*Monthly Notices*, vol. xlvi. p. 504), and finally Tisserand used his data to show that the phenomenon could be explained by the assumption of a moderate polar compression of the planet (*Comptes rendus*, vol. cvii. p. 804). In calculating the perturbation Prof. Brown neglects the action of the sun and other planets, as the chief effect is undoubtedly due to the equatorial protuberance on Neptune itself. He therefore analytically obtains the elements of the satellite's orbit with respect to the invariable plane of the planet's equator, along which the node of the former moves with a uniform *retrograde* motion, the *inclination* of the two planes remaining constant.

The variations of these elements at the various epochs then furnish data for computing the annual motion of the node of the orbit of the satellite on the equator of Neptune as seen from the earth. The elements finally obtained indicate a period of revolution of the node in 531 years. At the epoch 1900·0 the position angle of Neptune's polar axis will be 158°·4, and the plane of its equator will make an angle of −21°·6 to the line of sight.

Taking the value 1″·10 as the most probable radius of the planet from recent observations, and the mean distance of the satellite as 16″·308, the flattening of Neptune is found to be about 1/43. This would indicate a low mean density for the planet, the value given being 1·83 times that of water.

THE RELATIONS BETWEEN ELECTRICITY AND ENGINEERING.[1]

THE nineteenth century is distinguished in our profession chiefly by the knowledge we have obtained of the constitution of *matter* and of the qualities of the materials we utilise for the service of man, of the presence and the characteristics of that medium—*the aether*—which fills all space, and of the existence, indestructibility and protean character of that great natural source of force, motion, work and power which we call —*energy*.

Electricity is only one of many forms of this energy. It is measureable in well-defined and accurately-determined units. It is produced and sold, utilised and wasted. It is, therefore, something distinctly objective. It has even been defined by Act of Parliament. There are four great principles underlying the practical applications of electricity:—

(1) The establishment of a magnetic field.
(2) The establishment of an electric field.
(3) The disturbance or undulation of the æther.
(4) The work done by the generation and maintenance of electric currents in material systems.

Electricity as a science is fascinating to every one, but it is deeply fascinating to the engineer. The trustworthiness of its laws, the accuracy of its measurements, and the completeness and definiteness of the units to which its measurements are referred give him confidence in his estimates and a certainty of the performance of his preconcerted operations. It places in his hands the means of directing the energy out of sight in positions known only to himself, and of applying it with great efficiency at the exact spot desired. No magician or poet ever conceived so potent a power within the easy reach of man.

The Doing of Work.

The maintenance of an electric current through a conductor means the expenditure of work upon that conductor, and this expenditure of internal work means molecular motion. In solid conductors the result is *heat*. If the current be gradually increased, this motion is similarly increased. The result is successively incandescence, white heat, fusion and disruption.

In liquid conductors the motion probably becomes revolution. The result is decomposition by the activity of the centrifugal force overcoming chemical affinity. The atoms fly away in fixed determined lines, and collect at opposite poles.

In gases the transference of electric energy in the form of sparks means dissociation. Compound gases are broken up into their component elements under the same directing influences. Work is done upon the gas as in the previous instances.

The principle of work that lies at the very root of the profession of the engineer enables all these operations to be measured in definite mechanical units, reducible to the common English standard, the *foot-pound*, but which the electrical engineer, with greater precision, refers to the scientific unit of work—the *Joule*.

The Purification of Matter.

The elements and their useful compounds are rarely, if ever, found pure. Impurities have to be sifted away. Ores, raw produce, rocks and earths have to be subjected to various processes of refining and conversion to extract from them that which is wanted. The electric current by the above operations has proved to be a powerful agent to break up crude materials into their useful and useless constituents. The electro-chemical industries of the world are very extensive.

According to Prof. Borchers, the eminent electro-metallurgist, the world manufacture of calcium carbide for the production of acetylene gas is utilising a power equal to 180,000 HP.; that of the alkalies and the combinations of chlorine for bleaching, 56,000 HP.; of aluminium, 27,000 HP.; of copper, 11,000 HP.; of carborundum, 2600 HP.; and of gold, 455 HP. Electroplating is one of the staple manufactures of Sheffield and of Birmingham. There are nearly 200 firms working at the former place, and over 100 at the latter.

The decomposing bath and the arc furnace are revolutionising many industries. Phosphorus is now being produced in England in large quantities from corundum, and aluminium from bauxite is extending in use and being reduced in price. The Post Office is using aluminium for telephone circuits. I have recommended its use on a very large scale in the interior of Africa, where transport is so costly. We can get the same conductivity as with copper with half the weight, and at a less price, and we can put up a line telegraphically ten times better than of iron for less money.

The Annihilation of Space.

The elements of Volta and the battery of Galvani—zinc, copper and a solution of sulphuric acid—gave a convenient generator of electric currents which could be directed along wires to great distances, and thus, by establishing magnetic fields, could deflect needles in such a way as to form the alphabet and so transmit words and, therefore, thought. In wires of great length, while the initial speed is that of light, it takes time for the electric waves to rise and fall, so that the number of currents which can be sent per second is limited. Between London and Liverpool the speed of speaking is virtually unlimited, but between Ireland and America it is restricted by the so-called *capacity* of the cable submerged in the ocean. This capacity absorbs energy and retards the rate of rise and fall of currents. While a thousand currents per second can be sent in the former case, only six per second are available in the latter.

Nevertheless, sitting on the shore of the Atlantic in Ireland, one can manipulate a magnetic field in Newfoundland so as to record simultaneously on paper in conventional characters slowly written words. Thus we have bridged the ocean and annihilated space.

The regulation of the ever-growing traffic on our railways and the safety of passengers is secured by similar means. The telegraph not only places the manager of the line in communication with every station upon his system, but electric signals control the motion of every train. A railway signal-box is an electrical exhibition. Every line is protected by its own electric signal. Every distant outdoor mechanical signal is repeated back. The danger signal is locked, and cannot be lowered to "line clear" until it is unlocked by the train itself or by the distant signalman. Mr. F. W. Webb is not only working the outdoor signals themselves by electrical energy, but he is moving the points and switches by the same means. So far, the experience gained at Crewe during a period of about twelve months, from the working of a signal cabin containing about sixty levers, has been such as to justify confidence and the extension of the system, and some

[1] Abridged from the "James Forrest" Lecture delivered at the Institution of Civil Engineers, on April 23, by Sir William Henry Preece, K.C.B., F.R.S.

ten cabins containing about 1000 levers will be provided. The apparatus has been designed to work in with, as far as possible, the standard signalling apparatus of the London and North-Western Railway. The interlocking frame may be said to be the ordinary mechanical frame in miniature, occupying one-third of the space. The levers—about 6 inches in length—are placed in two tiers, and are manipulated in the same way as the levers of a mechanical frame; consequently the signalman accustomed to the old type has nothing to learn in the new. The levers are mechanically locked by means of tappet locking, and they control carbon switches by which the 110-volt electric current is transmitted to the motors.

The object of this electric working is primarily to reduce the manual labour of the signalman, and enable him to pay more attention to the movements outside his cabin; increased speed of working; the removal of obstructions on the ground caused by the numerous wire and rod connections necessitated by the present system; and, finally, a reduction in the number of signalmen employed. Thus electricity adds to the security of life. It supplies the railway man with a new sense, and the engineer with a new power.

The abridgment of time necessarily follows from the annihilation of space, but the chief element which saves our time so much is the fact that we can, by electricity, do so much more from one spot. Indeed, in the United States the railway companies complained that their revenue between New York and Chicago suffered through the introduction of the telephone. People remained at home and did their business by wire.

It is very curious when visiting the United States to find that their morning papers contain extracts from our London evening papers of the same day. One frequently receives messages in England that were sent off to-morrow. This is due to the difference of longitude.

Wireless telegraphy, or, as it is better termed, ætheric telegraphy, has made but small progress, owing to the simple fact that the demands for its services are so very few.

Transmission of Power.

The sun is the *fons et origo* of all the available energy upon the surface of the earth. Coal and oil are extracted from its crust; oxygen is found in its atmosphere. Grasses, corn, fruits and vegetables become food and fuel for beast and man. Waters are converted into vapour, forming clouds, rain, brooks, rivers, torrents and falls. The atmosphere is disturbed by wind, and the waters of the ocean by tides. Energy is thus found available for useful work in many different forms. The problem before the engineer is how to select the best form of energy for his purpose, and how to utilise these waste energies of Nature so as to secure the best economical result. Falling water can, by a turbine or impulse wheel, convert the energy it possesses in virtue of its fall into the form of electricity. By the aid of transformers it can be raised to very high voltages; 40,000 volts is employed in California, 11,000 in Niagara. We use 10,000 between Deptford and Trafalgar Square. It can thus be transmitted to any reasonable distance, and there it can be utilised to do useful work. The waste forces of Nature are thus within our reach. The waterfalls of the Highlands may work the tramways of Glasgow; Niagara already works those of Baltimore.

The economy of this system for large industries is a question of the relative cost of the generation of energy by other means. Energy on the coal-fields can be produced cheaper by burning coal than by any water scheme that I have yet examined in this country. The price and abundance of coal renders the transmission of energy to great distances at present a very limited question indeed. Where coal is scarce and dear and water abundant, as in Switzerland, water-power is very much utilised. Where coal is abundant and cheap, as in England, it is uneconomical to adopt it. The transmission of power within limited areas by electricity in our cities is now within the range of practice. In Edinburgh it is supplied at the rate $1\frac{1}{4}d.$ per unit; this is $0{\cdot}83d.$ per HP.-hour. It is invaluable for small industries. It is there ready to be used when it is wanted; it wastes nothing while idle.

The economy and efficiency of distributing power over mills, factories and workshops by electricity instead of by shafting, gearing and belts, is so pronounced that the change is being effected in every country with great rapidity. If it were a question of the mere efficiency of the two systems, the advantage of the change would not be so obvious; but it is shown by the HP.-hours expended, which means the coal bill. The efficiency of an electrical system is rarely less than 75 per cent., while that of shafting is frequently as low as 25 per cent.; but the economy is the continuous waste of the latter that tells on the coal bill, while in the electrical system there is no such waste. The motor runs when it is wanted, and expends only what energy is wanted for the particular work to be done. Electrical measurements are so exact and so easily applied that automatic records can be obtained of the work done by each machine.

Every up-to-date shop should have its electric plant for healthy light, cheap power and handy distribution of material. Its economy is demonstrable in the smallest, but in the largest shops it is at once most marked. It is always available, and it costs little. Ignorance or timidity restricts its use very much. The number of works that are run by electric motors in different parts of the country is very large indeed. The efficiency, handiness and economy of doing so is so marked that the practice is extending with great rapidity. Motors themselves are being daily improved.

On the Clyde and the Tyne, and indeed wherever shipbuilding is flourishing, there we find electrical energy driving machine tools, holding up plates, and assisting in various processes. In many large machine works, cranes and traveliers are worked by it.

At Boston, U.S.A., crossing the Charles River and uniting Charlestown, the scene of the famous battle of Bunker's Hill, with its head-quarters, is a new bridge 100 feet wide and 1920 feet long, having a draw of 240 feet span, weighing 1200 tons. This draw is opened and closed by electric motors.

In the Post Office we have introduced electric motors very largely. At Leeds they are used for driving pneumatic pressure and vacuum pumps, employed there to work the pneumatic tube system. They are also used for working automatic stokers, ventilating fans and lifts.

Traction.

It is for traction purposes that electricity is making such gigantic strides. In the United States tramway working by its means has become practically universal. In the United Kingdom it is making rapid way, and in connection with electric lighting it is giving great economical results.

Electric railways are also growing apace. A bold attempt is being made by the Metropolitan Railway to work the existing line in such a way as not to interfere with the existing traffic or even with the permanent way. A new train of six coaches weighing 180 tons, having a motor car at each end weighing 54 tons, is about to run between Earl's Court and High Street, Kensington. Electric traction has an immense advantage over steam traction in impressing a continuous and uniform torque or turning moment on the shaft, and consequently a continuous and uniform effort on the trend of the wheel. The action of the steam locomotive is intermittent and the bite not continuous. Hence such frequent slipping on greasy rails. Again, the maximum torque can at once be applied by the current, and in combination with the constant effort it increases the acceleration so that a train acquires its maximum speed much more quickly. We shall increase the mean speed of the Metropolitan trains from 11 miles per hour to 15, and thereby increase the capacity of the line over 30 per cent. The stoppages on the underground railways are so frequent that the trains are always either accelerating or stopping. They never reach their top speed as they do on main lines. Electric traction enables them to start quicker and stop more promptly. On the Metropolitan the 180-ton train acquired 20 miles an hour in 200 feet, and, when going at the same speed, it was stopped in 130 feet—half its length. Smart work on such a railway depends on the rate at which trains can be emptied and filled. The English system of compartments and side doors facilitates this. It would be still further expedited if we could have one platform for entry and one for exit, and one class only.

The Liverpool and Manchester Lightning Express Railway, promoted by a very powerful representative syndicate of those two great commercial centres to carry out the scheme of Mr. Behr, is a very bold and promising venture. The line is to be monorail, 34 miles long, direct between the two cities, without any intermediate station and with no crossing. There are to be cars every 10 minutes. The speed is to be 100 miles per hour, and the time of transit 20 minutes. I know of no reason why this should not be done with safety and comfort.

The automobile car of the future has not yet seen the light. It will be electrical. Immense progress has been made in motors and in batteries. Lundell has shown how to store up the energy now wasted in descending hills, and to recover some of that absorbed by the inertia of the car. Although a battery has already been able to drive a car 100 miles with one charge, we are waiting patiently for the real automotor storage cell.

Electricity in War.

A strong contingent of electrical engineers, under the command of Major Crompton, has volunteered for service in South Africa. They are all scientifically-trained practical young engineers. Bicycles, field telegraphs, telephones, arc and glow-lamps, cables, search-lights, traction-engines and generating plant will be under their care. It is strongly hoped that we may soon hear good accounts of their performances at the front.

Electricity has been extensively applied to the development and utilisation of explosives in both the civil and military divisions of our profession. Charges are safely fired under water and blasted in mining and demolition operations by small exploding dynamos, magnetic-electric machines or induction coils acting upon high tension fuses. Sir Frederick Abel has especially distinguished himself in this direction. His fuse, composed of phosphoride and subsulphide of copper, is universally used by our War Department. Time guns are thus fired at stated hours at different sea-ports by currents originating in Greenwich Observatory. Broadsides in battleships and guns in turrets are similarly discharged. Torpedoes are even directed by currents from the shore. The defence of our coasts by submarine mines and their explosion by currents when the enemy's ships are properly located by position-finders is the last development of the application of electricity to war.

Electrical blasting has revolutionised the operations of tunnelling and driving galleries. It is much used in quarrying with great security to the men. The deepening of harbours and channels, and the removal of obstructions such as wrecks and rocks, are facilitated. On September 23, 1876, 63,135 cubic yards of solid rock were completely demolished by one discharge at Hell Gate in East River, New York. The preparation for this great blast took four years and four months. There were 4427 charged holes, each containing its mercury fulminate fuse and charges of dynamite. There were 49,914 explosions used in that one blast. Batteries were used to generate the currents, and they were arranged in large groups. Each battery exploded 160 charges. This was the record blast,

The battleship is the home of electricity. It controls the rudder, it ventilates the interior and the living space of the ship, it forces the draught and assists the raising of steam, it revolves the turrets, it trains and controls the fans, it handles the ammunition, it purifies the drinking water, it lights up the ship internally, it enables the captain to sweep the horizon with the brilliant rays of the search-light, and to communicate with his tender or with his commanding officer across space independent of weather, night, season, fog or rain.

Sanitation.

No branch of our profession fulfils the true function of the engineer more efficiently than that which deals with sanitation. Pure air, pure water, pure food, pure soil, pure dwellings, and pure bodies are the panacea for health and comfort. Electricity helps us very much in attaining some of these qualities An electric glow-lamp does not vitiate the air. It does not throw into circulation in the air any product of combustion. The question of ventilation is very much reduced in importance and rendered more simple to effect. Much less air need pass through our sitting-rooms and meeting-places. The air vitiated by our lungs can be easily withdrawn and fresh air can be forced in by fans worked by electric motors. Even the air during its entrance can be warmed, and impurities floating in it can be sifted out of it by the attraction of electrification. Heating by Dowsing's luminous electric radiators is very much on the increase; they consume 250 watts, which cost about a halfpenny per hour. In many post-offices sealing-wax is melted and kept in a liquid state by currents. Water can be sterilised by ozone, a product of electrification, and even by the nascent oxygen, when broken up into its constituent elements by electric currents. Sea-water thus electrolysed supplies us with chlorine, and converts the water into a powerful antiseptic, disinfectant and deodoriser.

Weaving.

The applications of electricity to other industrial processes are innumerable. I have time to mention only one. Mr. T. A. B. Carver has brought out a new Jacquard loom for weaving; 600 hooks are controlled electrically. The twill as well as the pattern is under complete management. It has been warmly taken up in Glasgow, and a factory has been started there.

The pattern on this cloth is woven directly from a photo-print of the artist's design, mounted on a metallic sheet; the threads of the warp being picked up by electromagnetic action, owing to the figure of the pattern being cut away, and thus allowing the circuit to be completed by the metallic sheet.

Distinction between Physicists and Engineers.

There is now a distinct line of demarcation separating the physicist from the engineer. The former dives into the unknown to discover new truths; the latter applies the known to the service of man. Research is the function of the one; utility that of the other. In the past the engineer had to rely on himself for his facts, but the advance of modern science, the growth of technical education, the formation of laboratories, and the endowment of chairs have changed all that.

We can scarcely hope for new sources of energy to be discovered, but there are some existing ones we have not touched yet. When the evil day arrives for our coal supplies to give out we may perhaps be able by the aid of electricity to utilise the heat of the sun and the tides of the ocean. There is, however, a vast illimitable store of energy not only in the rotation of the earth upon its axis, but in the internal heat of this globe itself. As we descend, the temperature gets higher and higher. It ought not to be difficult to reach such temperatures that by thermo-electric appliances we might convert the lost energy of the earth's interior into some useful electric form.

THE SIGNIFICANCE OF THE INCREASED SIZE OF THE CEREBRUM IN RECENT AS COMPARED WITH EXTINCT MAMMALIA.[1]

It has occurred to me that in order, at short notice, to take part in the celebration of the Biological Society of Paris—however briefly—I might place before my colleagues a biological problem and suggest a solution of it which, though not decisive, has, I think, much in its favour, and raises many interesting points for observation and discussion. It is well established that the extinct Mammalia of the Middle and Lower Tertiaries had—as compared with their nearest living congeners—an extremely small cerebrum. The exact figures are not important, but Titanotherium—a true Rhinoceros—had certainly not more than one-fifth of the cerebral nervous substance which is possessed by living Rhinoceros. Dinoceras representing a distinct group of Ungulata had even a smaller brain. Yet in bulk these animals were as large as, or larger than, the largest living Rhinoceros. Further, it appears from the examination of the cranial cavities of extinct and recent Reptiles, that the increase in the size of cerebrum is not peculiar to Mammalia, but that we may assert as a general proposition that recent forms have a greatly increased bulk of cerebrum as compared with their early Tertiary or mesozoic fore-bears.

It appears also that the relative size of the cerebrum in man and the anthrapoid apes may be cited here as a similar phenomenon; the more recent genus Homo having an immensely increased mass of cerebral nerve-tissue as compared with the more ancient pithecoid genera.

The significance of this striking fact—viz. that recent forms have a cerebral mass greatly larger than that of extinct forms (probably in every class of the animal kingdom)—has not been discussed or considered as it deserves. We cannot suppose that the extinct Rhinoceros, Titanotherium, was really defective in the essential control of its organisation by the cerebral nerve-centres. Probably could we see the two creatures alive side by side, we should not detect any defect in the manifestations of the nervous system in Titanotherium as compared with Rhinoceros; just as we do not remark any such obvious inferiority when we compare a lizard and (let us say) a mouse. The organism with the lesser cerebrum is in each case, in spite of the smaller mass of cerebral nerve-tissue, an efficient and adequate piece of living mechanism.

In what then does the advantage of a larger cerebral mass consist? What is it that the more recent Mammalia have

[1] By Prof. E. Ray Lankester, F.R.S. Reprinted from the "Jubilee Volume of the Société de Biologie of Paris, 1899."

gained by their larger brains? Why has there been this selection in all lines of animal descent of increased cerebral tissue?

I think we gain a key to the answer to this question by a consideration of the differences of cerebral quality between man and apes. Man is born with fewer ready-made tricks of the nerve centres—those performances of an inherited nervous mechanism so often called by the ill-defined term "instincts"—than are the monkeys or any other animal. Correlated with this absence of inherited ready-made mechanism, man has a greater capacity for developing *in the course of his individual growth* similar nervous mechanisms (similar to but not identical with those of "instinct") than any other animal. He has a greater capacity for "learning" and storing his *individual* experience, so as to take the place of the more *general* inherited brain-mechanisms of lower mammals. Obviously such brain-mechanisms as the individual thus develops (habits, judgments, &c.) are of greater value in the struggle for existence than are the less specially-fitted instinctive in-born mechanisms of a race, species or genus. The power of being educated—"educability" as we may term it—is what man possesses in excess as compared with the apes. I think we are justified in forming the hypothesis that it is this "educability" which is the correlative of the increased size of the cerebrum. If this hypothesis be correct—then we may conclude that in all classes of Vertebrata and even in many Invertebrata—there is and has been a continual tendency to substitute "educability" for mere inherited brain-mechanisms or instincts, and that this requires increased volume of cerebral substance. A mere spoonful of cerebral tissue is sufficient to carry abundant and highly efficient *instinctive* mechanisms from generation to generation; but for the more valuable capacity of elaborating *new* brain-mechanisms in the individual as the result of the individual's experience of surrounding conditions, a very much larger volume of cerebral tissue is needed.

Thus it seems probable that "educability" has increased in those Mammalia which have survived. The ancient forms with small brains though excellent "automata" had to give place, by natural selection in the struggle for existence, to the gradually increasing brains with their greater power of mental adaptation to the changing and varied conditions of life: until in man an organism has been developed which, though differing but little in bodily structure from the monkey, has an amount of cerebral tissue and a capacity for education which indicates an enormous period of gradual development during which, not the general structure, but the organ of "educability," the cerebrum, was almost solely the objective of selection.

Two lines of speculation and inquiry are strongly affected by the hypothesis thus sketched.

Firstly, as to the general laws of progressive development of bodily structure by the operation of natural selection—is it not probable that in various groups of animals, just as in the case of man among the Primates, the operation of natural selection on bodily structure (limbs, teeth, hair, horns, &c.) must have been checked, or even altogether suspended, by the transference of selection to the all-important organ of educability, the cerebrum or corresponding nerve-centres? Adaptation by means of the mental powers must take the place of adaptation of bodily structures. The educable animal leaves the ground and learns to climb trees in order to gain its food, whilst in another race the slower process of alteration of bodily form is evolving a long neck to reach the green twigs, or a ponderous strength of limb which can pull trees to the ground. Many similar cases will suggest themselves to the reader in which, even in lower animals, the capacity of learning by experience must (as it were) defeat and turn from its route the otherwise triumphant transformation of bodily structure.

Secondly, the question of the transmission of acquired characters is largely touched by these speculations. The character which we describe as "educability" can be transmitted, it is a congenital character. But the *results* of education can *not* be transmitted. In each generation they have to be acquired a-fresh, and with increased "educability" they are more readily acquired and a larger variety of them. On the other hand, the nerve-mechanisms of instincts are transmitted, and owe their inferiority as compared with the results of education to the very fact that they are *not* acquired by the individual in relation to his particular needs, but have arisen by selection of congenital variation in a long series of preceding generations.

To a large extent the two series of brain-mechanisms, the "instinctive" and the "individually acquired," are in opposition to one another. Congenital brain-mechanisms may prevent the education of the brain and the development of new mechanisms specially fitted to the special conditions of life. To the educable animal—the less there is of specialised mechanism transmitted by heredity, the better. The loss of instinct is what permits and necessitates the education of the receptive brain.

We are thus led to view that it is hardly possible for a theory to be further from the truth than that espoused by George H. Lewes and adopted by George Romanes, namely that instincts are due to "lapsed" intelligence. The fact is that there is no community between the mechanisms of instinct and the mechanisms of intelligence, and that the latter are later in the history of the development of the brain than the former, and can only develop in proportion as the former become feeble and defective.

These few lines—for the abruptness of which I apologise—will, I trust, serve to show the interesting nature of the speculations connected with the significance of the size of the cerebrum in various Mammalia and other animals. Some of the suggestions obtained from a consideration of the subject will, if carried out in detail, be found of first-rate importance in building up the science of comparative psychology.

ZONES IN THE CHALK.

THE philosophical observations on the genus *Micraster*, which were communicated by Dr. A. W. Rowe to the Geological Society in 1899, have been followed by the publication of his special researches on the zones of the white chalk on the coasts of Kent and Sussex. This second most valuable essay has been communicated to the Geologists' Association (*Proceedings*, vol. xvi. March 1900), who are to be congratulated on having such an addition to their published works. The paper follows along the lines so ably sketched out more than twenty years ago by Dr. Barrois; and Dr. Rowe, in nearly all cases, confirms the previous zonal distinctions and largely increases our knowledge. He shows how invaluable it is to collect stage by stage, and to pay the closest attention to the minute changes which the fossils, and particularly the Micrasters, undergo. The paper is essentially a zoological one, invaluable in indicating the succession of life, and as a contribution towards the genesis of species.

The ordinary subdivisions of lower, middle and upper chalk, which are important when we deal with purely geological problems, are not here dealt with; but the author, who apparently takes little interest in stratigraphy apart from fossils, admits that "we can generally recognise the zones from the appearance of the chalk alone, and that the fossils act as confirmatory evidence." This, indeed, is the experience of those who have worked at zones, and it is only by utilising properly all the evidence that satisfactory results can be obtained. Lithological evidence, often invaluable, is essentially local; the palæontological evidence, so ably and exhaustively dealt with by Dr. Rowe, is clear and uniform throughout the areas with which he deals The fossils, as he remarks, "never fail us,"—that is to say, when you find them, their testimony is safe after the experience he has gained. He has been fortunate in having such an excellent series of sections to work at, and these are well depicted in two folding plates, drawn by Mr. C. Davies Sherborn. Inland, of course, the observer has only a pit-section or road-cutting here and there to act as a guide to the zonal divisions, but no doubt with the aid of the clear descriptions given by Dr. Rowe, and of the ascertained thicknesses of the several zones, it might be possible and even desirable to trace inland their approximate boundaries, if any useful purpose were thereby gained. In any case, Dr. Rowe's work will be appreciated alike by field-geologists and palæontologists. Prof. J. W. Gregory describes a new Echinoderm, and Dr. F. L. Kitchin describes a new species of *Terebratulina* from the chalk.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Mr. R. H. Yapp has been appointed assistant curator of the Herbarium under Prof. Marshall Ward.

Prof. Clifford Allbutt was on April 23 appointed physician to Addenbrooke's Hospital, in accordance with the recent agreement between the University and the governors.

Dr. Adami and Mr. de Soyres have been appointed delegates to represent the University at the approaching Centennial of the University of New Brunswick.

The honorary degree of D.Sc. is to be conferred on Mr. Charles Hose, of Saráwak, to-day (April 26).

At the spring graduation ceremony of Edinburgh University, the honorary degree of LL.D. was conferred upon Miss E. O. Ormerod, Dr. C. D. F. Phillips, and (*in absentia*) Dr. A. Stuart, professor of physiology in the University of Sydney.

It is hoped (says the *Athenæum*) that the Prince of Wales will preside at the next Presentation ceremony of London University, which will be held in the new home of the University at South Kensington on May 9.

The governors of the Goldsmiths' Company Technical and Recreative Institute, New Cross, again report a decline in the number of students, owing to the establishment of free evening continuation classes close to the Institute by the London School Board. It will be remembered that the extension of the work of the School Board to technical education has been called into question, and that the official auditor has disallowed items in the Board's accounts referring to such expenditure. The School Board has appealed against his decision, and the whole matter will shortly be argued in the Queen's Bench Division. The engineering department of the Goldsmiths' Institute shows an increase of members, in spite of the competition of free continuation classes. It is satisfactory to notice that the governors are taking steps to encourage students to undertake systematic courses of study, extending over three or more years, and propose to periodically test the efficiency of such courses by appointing independent examiners in grouped subjects, and to award special certificates for such examinations. Mr. J. Carrington having given 100 guineas towards the encouragement of systematic study, a portion of that sum will, during the current year, be devoted to prizes in connection with these special courses. The governors report that the quality of the work done in the advanced classes in chemistry is excellent, and some useful research work is being carried on by the students.

The annual income of the Technical Education Committee of the Derbyshire County Council is at present about 11,000*l.*, exclusive of Science and Art Department's grants. This income is used to supplement local effort, and not to supersede it. Promising students of elementary schools in the county are assisted to proceed to secondary schools, and really able students of secondary schools are enabled to proceed to University or Technical Colleges, or Universities. In addition to awarding these scholarships the Council assists the development of the work of secondary schools, by means of building and equipment grants, supply of apparatus, &c. Agricultural experiments are carried on in connection with the Agricultural Department of the Nottingham University College, and the Midland Dairy Institute, Kingston, Notts. All the work of these institutions is placed under the inspection of the Board of Agriculture, which aids the work by a grant of 700*l.* a year. An experiment commenced in 1897 at Egginton for the purpose of demonstrating the influence on the quantity and quality of the herbage of permanent grass land by the use of different kinds of natural and artificial fertilisers has been continued. Each year the grass upon the different plots is cut and weighed, and the proportions of the various grasses and plants constituting the herbage is estimated. A member of the University College staff experienced in such work superintends the laying out of the plots, the sowing of the manures, and the cutting and weighing of the grass. The area under experiment is two and three-quarter acres, and the size of the plots one-eighth of an acre. The results of the experiment have been published for use by the agriculturists of the counties which promoted it.

The report of the Advisory Committee appointed to inquire into the best manner of providing for scientific and commercial training respectively in connection with the new University of Birmingham has just been issued. It will be remembered that Mr. Andrew Carnegie and an anonymous donor each promised a gift of 50,000*l.* towards the establishment of these two departments. The committee have made inquiries as to facilities for the teaching of science in its application to industries, and they report that, in their opinion, no such teaching, complete as they contemplate it, and as it must be if it is to be successful, exists in any college in Great Britain. In making their recommendations, the committee have had in view the object of the teaching of science in its application to industry, coupled with such technical instruction in handicrafts as will enable the students to complete their course in the University itself. It is proposed that the facilities already provided in Mason University College should be supplemented by chairs of mining, metallurgy, engineering, and applied chemistry. The scheme submitted contemplates the introduction of a complete equipment for the treatment of metals by heat and a small plant for treatment by electricity, as well as the necessary outfit for testing metals. Shops would be provided for manual training, and it is recommended that the machines used should be of the best and most modern type of English, American, and foreign manufacture. The committee further recommend the acquisition of 25 acres of land in the outskirts of Birmingham on which to build the University, their estimate of the total cost being 155,000*l.*

SCIENTIFIC SERIALS.

American Journal of Science, April.—Skull, pelvis, and probable relationship of the huge turtles of the genus Archelon from the Fort Pierre Cretaceous of South Dakota, by G. R. Wieland. The marine turtles of the Fort Pierre Cretaceous of South Dakota not only represent the most gigantic species known, but also are of much importance as including undoubted descendants of Protostega from the underlying Niobrara Cretaceous, in common with which they may be regarded as ancient relatives of Dermochelys.—Application of the radio-micrometer to the measurement of short electric waves, by G. W. Pierce. A long loop of fine copper wire is suspended by a quartz fibre in a strong magnetic field. The lower ends are twisted together for some distance down, and carry at the bottom a mica vane on which is mounted a small resonator consisting of two vertical copper cylinders, joined by a constantan and a manganine wire which cross in the centre between the cylinders, and are attached to the ends of the copper wire. The impact of electric waves produces surgings between the two cylinders, which heat the junction and produce a thermo-electric current in the copper loop. The latter turns in the magnetic field, and thus indicates the waves. The author confirms Righi's observations of the different transparency of wood along and across the grain.—A large slab of Uintacrinus from Kansas, by C. E. Beecher. This paper contains photographs of a slab of limestone preserving on its surface a number of fine specimens of *Uintacrinus socialis*, Grinnell. It has 27 square feet of surface, and contains 220 crinoids.—Granodiorite and other intermediate rocks, by W. Lindgren. Granodiorite, a member of the great family of rocks with predominating soda-lime felspars, is distinguished by a granular texture, greyish colour, and a mineral composition of quartz, oligoclase or andesine, orthoclase or microcline, hornblende or biotite. The family represents an important and widespread type of rocks, especially common along the Pacific slopes of the Cordilleran ranges.—Two new American meteorites, by H. L. Preston. Describes the Luis Lopez siderite, characterised by the length of its bands of kamacite, and the Central Missouri meteorite, which is distinguished by the absence of etching figures, its beautiful pitting and prominent ridges of a lustrous dark steel-grey colour resembling graphite, and containing small quantities of carbon.

Annalen der Physik, No. 3.—Wave current generators, by C. Heinke. The author discusses variable currents from two different aspects. Some are generated as such, whereas others are generated by continuous currents broken up into variable currents by mechanical, liquid, or gaseous gaps in the circuit. The latter require a certain "saturation current" which is independent of the E.M.F.—Absorption of light in electrically-glowing gases, by M. Cantor. Kirchhoff's law does not hold for electrically glowing gases, though it may hold for flames. The author sent a strong beam of light through a vacuum tube from end to end and back, and compared its intensity with a beam passing through the open air. The beam of light suffered no absorption by the glowing gas. This result could only be made to agree with Kirchhoff's law of radiation by supposing the gas to possess an extremely high temperature. This, as we know, it does not possess. Hence we have a case of emission without absorption, which indicates that the light-producing mechanism is quite different from what it is in flames.—Analysis of oscillating jar discharges by means of the Braun tube, by F. Richarz and W. Ziegler. The authors note a curious appearance produced in a Braun kathode-ray tube when the fluorescent screen is moved in a direction at right angles to the oscillation of the beam influenced by the discharge. It is a kind of herring-bone structure, in which the slanting ribs are produced by the apparent coalescence of the points of reversal, where the track is brightest and the motion slowest.—A mixture of three powders for producing electric dust figures, by K. Bürker. A mixture far superior to the ordinary minium-sulphur combination may be obtained by mixing five volumes of flowers of sulphur with one volume of powdered carmine and three volumes of lycopodium seed. The colours are reversed with respect to the ordinary mixture.—Effect of ultra-violet light upon gaseous bodies, by P. Lenard. The author proves that not only kathode and Becquerel rays are able to make air electrically conducting, produce nuclei of condensation in it, and convert part of it into ozone, but the same effects are produced, though only to a slight extent, by the extreme ultra-violet rays. The source of light used was the electric spark, but the arc light, and even sunlight, contain some rays effective in this respect.—Quincke's rotations in the electric field, by L. Graetz. Instead of suspending spheres of the dielectrics by threads, the author mounts them in the electrolyte on points, so that they have freedom of rotation. The speed of rotation, when it becomes constant, gives a measure of the conductivity of the dielectric. This mode of measurement may be applied to measuring the conductivity of air ionised by Röntgen rays.—Electrolytic interruptor for feeble currents, by A. von Rzewuski. If the pressure of the acid upon the anode is increased, the current is interrupted at feebler E.M.F.'s. This is done by either making a current of acid flow against the anode, or by suspending the reservoir of the acid some distance above the anode and connecting it by a tube.

In *Symons's Monthly Meteorological Magazine* for April, Mr. A. B. MacDowall draws attention to a curious fact about London summers. Since 1841, the mean temperature of the summer months (June–August) at Greenwich has fluctuated between the extremes $57^{\circ}\cdot 4$ and $65^{\circ}\cdot 1$. If we select all the summers reaching or exceeding 63°, and all those reaching or falling below 60°, it will be observed that the hottest summers are nearly all in years ending with the figures 5 to 9, and that the coolest summers are mostly in years ending with 0 to 4. It would appear, therefore, that the earlier summers in a decade tend to be cooler, and the later summers hotter. The data previous to 1841 are not so trustworthy, but if we take Dr. Buchan's figures as the most dependable, it might be shown that as far back as 1810, at least, the same contrast is indicated. The author of the paper would be glad of any explanation of the cause of this feature in our summer weather.

SOCIETIES AND ACADEMIES.

London.

Chemical Society, March 29.—Annual General Meeting.—Prof. Thorpe, President, in the chair.—After the delivery of the presidential address, a ballot was held for the election of officers and council for the ensuing year.—At an extra meeting held in the evening, Sir H. E. Roscoe, Vice-President, delivered the Bunsen Memorial Lecture.—April 5.—Prof. J. M. Thomson, Vice-President, in the chair.—The following papers were read:—The liquefaction of a gas by "self-cooling" (a lecture experiment), by G. S. Newth. The author exhibits the liquefaction of nitrous oxide by rapidly passing the gas from the slightly-warmed storage cylinder through a fine copper tube spiral inserted in a vacuum-jacketed test-tube.—Note on partially miscible aqueous inorganic solutions, by G. S. Newth.—The decomposition of chlorates. Part ii. Lead chlorate, by W. H. Sodeau. The slow decomposition of lead chlorate by heat consists of the two independent reactions: (1) $Pb(ClO_3)_2 = PbCl_2 + 3O_2$, and (2) $Pb(ClO_3)_2 = PbO_2 + Cl_2 + 2O_2$. The reaction $PbO_2 + Cl_2 = PbCl_2 + O_2$ simultaneously proceeds to a greater or less extent.—The bromination of benzeneazophenol, by J. T. Hewitt and W. G. Aston.—A new glucoside from willow-bark, by H. A. D. Jowett. The author has isolated, from the bark of a species of *Salix*, the glucoside of metahydroxybenzaldehyde and gives to it the name salinigrin.—Alkylation by means of dry silver oxide and alkyl iodides, by G. D. Lander. Dry silver oxide and ethyl iodide react with acetanilide yielding ethyl *i*-acetanilide, $C_6H_5N : C(OEt)Me$.—The interaction of mesityl oxide and ethyl sodiomethylmalonate, by A. W. Crossley. By the condensation of mesityl oxide with ethyl sodiomethylmalonate, ethyl trimethyldihydroresorcylate, $C_{12}H_{18}O_4$, is obtained; on hydrolysis it yields trimethyldihydroresorcinol,

$$CMe_2 \begin{matrix} \diagup CHMe.CO \diagdown \\ \diagdown CH_2 — CO \diagup \end{matrix} CH_2.$$

—The products of the action of fused potash on dihydroxystearic acid, by H. R. Le Sueur.

Entomological Society, April 4.—Mr. G. H. Verrall, President, in the chair.—Mr. M. Jacoby exhibited specimens of the genus *Sagra* from Eastern Asia.—Mr. M. Burr exhibited three species of *Pseudophyllidae*, two new species of *Capnoptera* (females), and *Capnoptera quadrimaculata*, Westw. (female), collected in the Siamese Malay States by Mr. N. Annandale. The specimens illustrated the peculiar methods of protection adopted by the insect when alarmed.—Mr. H. J. Elwes communicated a paper on "Bulgarian Lepidoptera," and made some remarks on the more notable species which he had taken in the Balkan Peninsula during the months of June and July 1899. The number of species of *Rhopalocera* captured was 120, which, with a further 20 recorded by Haberhauer and Lederer, brings up the total to 140. The mountains visited were an extension of the Rhodope range where the climate was particularly rainy, a great number of ferns flourishing everywhere, in contrast to the drier Balkans, where the number of species of *Rhopalocera* is not less than 200. Some interesting forms but no new species were encountered. A variety of *Colias myrmidone* occurred much larger and brighter than the Austrian, and more nearly agreeing with the Ural, form. The form of *Coenonympha davus* met with showed an affinity with the Asiatic and not the European form. The form of *Argynnis pales* was intermediate between that found in Greece and the central European Alps, while a form of *Erebia*, var. *gorgone*, was taken similar to that in the Pyrenees—a curious instance of interrupted distribution.

Linnean Society, April 5.—Mr. C. B. Clarke, F.R.S., Vice-President, in the chair.—Mr. W. B. Hemsley, F.R.S., exhibited and made remarks on a selection of plants collected by Dr. A. Henry and Mr. W. Hancock in the neighbourhood of Mengtze and Szemao in Western China.—Dr. D. H. Scott, F.R.S., read a paper "on *Sphenophyllum* and its allies, an extinct division of the vascular cryptograms." The author explained that his purpose was not to communicate any new observations, but to give a summary of our present knowledge of the group and to discuss its affinities. He pointed out that the study of the Palæozoic Flora not only greatly widens our conception of the three existing classes of Pteridophyta, but adds a fourth—that of the Sphenophyllales—to their number. The various views which have been held as to affinities of the Sphenophyllales were discussed in the light of the results recently attained. The supposed relation to Hydropteridæ, though supported by some ingenious arguments, was rejected as baseless, and as inconsistent with the manifest Filicinean affinities of that family. The author came to the conclusion that the Sphenophyllales were most naturally regarded as the derivatives of a synthetic group, combining the characters of Lycopods and Equisetales, and indicating the common origin of these two classes.

Paris.

Academy of Sciences, April 17.—M. Maurice Lévy in the chair.—On the heat of combustion of some very volatile liquids, by MM. Berthelot and Delépine. The method for burning volatile liquids in the calorimetric bomb previously described by the authors involves the use of collodion films, and as collodion is not infrequently dissolved by the vapours of the liquid under examination, a new method has now been devised. The liquid is sealed up in a thin glass bulb, which it completely fills, and this bulb is burst in the bomb by a small piece of camphor, the weight and heat of combustion of which are exactly known. Determinations are given for aldehyde, methylal, methyl formate, ethyl formate, propaldehyde and isopropaldehyde.—A rotating contact breaker, and some arrangements for producing powerful high frequency currents, by M. d'Arsonval. A description of the apparatus used in the decoration of the front of the electricity section at the Paris Exhibition. The condenser was of a special type, micanite plate immersed in petroleum being used; glass, ebonite, celluloid and paraffined paper were all found to be rapidly destroyed by the currents in use. A new device for breaking the circuit by blowing out an arc is also described.—On the *Stigmaria*, by M. Grand' Eury. The observations of the author are opposed to the view that the *Stigmaria* are the roots of *Sigillaria*, a study of over one hundred specimens showing distinct differences between the two kinds of roots. The true *Stigmaria*, although frequently found together with the roots of *Sigillaria*, appear to have lived generally in much deeper waters.—Influence of periodic perturbations of semi-major axis upon the value of the mean motion deduced from the observations of a planet, and on the corresponding correction of the value originally adopted for the semi-major axis, by M. A. Gaillot.—On a simplified formula for calculating astronomical refractions, by M. L. Cruls.—On series of rational fractions, by M. Émile Borel.—On the characteristics of partial differential equations and the principle of Huygens, by M. J. Coulon.—Vortex motions with cellular structure. Optical study of the free surface, by M. Henri Bénard.—The increases of resistance in radio-conductors, by M. Édouard Branly. The usual effect observed in receivers for the Hertzian waves is a decrease of resistance. In certain cases, however, the opposite is the case, and the experimental results for a tube containing lead peroxide are given.—Induction and electrostatic oscillations, by M. P. de Heen.—Remarks on a recent note of M. G. le Bon, by M. P. Curie. The property of losing its luminosity possessed by a radiferous barium chloride, recently made the subject of a communication by M. le Bon, has been previously published by several authors.—A new microchemical reaction of palladium, by MM. M. E. Pozzi-Escot and H. C. Conquet. Potassium nitrite and excess of a caustic alkali give characteristic crystals with a solution of a palladium salt.—Experimental researches on the physiological phenomena accompanying chlorosis in the vine, by M. Georges Curtel. Chlorosis is accompanied in the diseased leaf with a marked decrease in the respiratory activity and diminution of the ratio $CO_2:O_2$, by a diminution or cessation of assimilation, and by a great decrease in the transpiratory function.—On a Selaginella from the coal-measures of Blanzy, by M. R. Zeiller.—Sub-divisions of the Senonian in Portugal, by M. Paul Choffat.—On the production of calcium carbide, by M. L. K. Böhn.

DIARY OF SOCIETIES.

THURSDAY, April 26.

Royal Institution, at 3.—A Century of Chemistry in the Royal Institution: Prof. J. Dewar, F.R.S.
Institution of Electrical Engineers, at 8.—The Electric Transmission of Power: Prof. George Forbes, F.R.S.
Institution of Mechanical Engineers, at 8.—Road Locomotion: Prof. Hele-Shaw, F.R.S.

FRIDAY, April 27.

Royal Institution, at 9.—Nineteenth Century Clouds over the Dynamical Theory of Heat and Light: Lord Kelvin, G.C.V.O., F.R.S.
Physical Society (Solar Physics Observatory, Exhibition Road, South Kensington), at 8.—A short account of the Physical Problems now being investigated at the Solar Physics Observatory, and their Astronomical Applications: Sir Norman Lockyer, K.C.B., F.R.S.—Weather permitting, the 36-inch, 10-inch, and 9-inch telescopes will be used for the observation and photography of celestial objects and their spectra. The Apps-Spottiswoode coil and 21-ft. Rowland grating will also be in operation.

SATURDAY, April 28.

Royal Institution, at 3.—Egypt in the Middle Ages: Prof. Stanley Lane-Poole.

MONDAY, April 30.

Royal Geographical Society, at 8.30.—Through Africa from the Cape to Cairo: Ewart S. Grogan.
Institute of Actuaries, at 5.30.—Census-Taking: Dr. Reginald Dudfield.

TUESDAY, May 1.

Royal Institution, at 3.—Studies in British Geography: Dr. H. R. Mill.

WEDNESDAY, May 2.

Entomological Society, at 8.
Society of Public Analysts, at 8.

THURSDAY, May 3.

Royal Institution, at 3.—A Century of Chemistry at the Royal Institution: Prof. J. Dewar, F.R.S.
Linnean Society, at 8.—Note on the Movements in Fishes: Prof. R. J. Anderson.—On New Species of *Halimeda*, from Funafuti: Miss E. S. Barton.—On West Indian Fungi: Miss A. L. Smith.
Chemical Society, at 8.—Brazilin, Part IV.: A. W. Gilbody, W. H. Perkin, jun., and J. Yates.—Hæmatoxylin, Part V.: W. H. Perkin, jun., and J. Yates.—The Substituted Nitrogen Chlorides and Bromides derived from *o*- and *p*-acet-toluide and their Relation to the Substitution of Halogens in Toluides and Toluidines: F. D. Chattaway and K. R. P. Orton.
Röntgen Society, at 8.—Demonstration and Exhibition of New Methods and Results.
Institution of Electrical Engineers, at 8.—If the discussion on Prof. Forbes's Paper, read on April 26, is concluded, the following Paper will be read:—The Calculations of Distributing Systems of Electric Traction under British Conditions: H. M. Sayers.

FRIDAY, May 4.

Royal Institution, at 9.—Pottery and Plumbism: Prof. T. E. Thorpe, F.R.S.
Cold Storage and Ice Association (Examination Hall, Victoria Embankment), at 11.30.—Recent Researches in Refrigeration: G. Halliday.—Insulation and Insulators: W. D. A. Bost.—At 3.—Electric Lighting of Cold Stores: W. B. Esson.—The Design and Construction of Buildings for Ice Factories and Cold Storage: P. Gaskell.

SATURDAY, May 5.

Royal Institution, at 3.—Egypt in the Middle Ages: Prof. Stanley Lane-Poole.

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