THURSDAY, FEBRUARY 28, 1901.

THE ORIGIN OF WORLDS.

Kant's Cosmogony as in his Essay on the Retardation of the Rotation of the Earth, and his Natural History and Theory of the Heavens. With introduction, appendices, and a portrait of Thomas Wright of Durham. Edited and translated by W. Hastie, D.D., Professor of Divinity, University of Glasgow. Pp. cix + 205. (Glasgow: James Maclehose and Sons, 1900.)

IN this work Prof. Hastie has not only given us a very readable book, but has written an important chapter in the history of astronomy. His main object is to make us recognise in Kant a profound genius, and to give us reasons for this appreciation. The author was well advised, for Kant, in the domain of natural science, enjoys a somewhat nebulous reputation. Few would care to say with exactness what particular view Kant supported concerning the origin of the cosmos, to what extent he was assisted by earlier writers, or how much of his work has been approved by later physicists. It was inevitable that the work of Laplace, appearing at a later date and supported by a renown won by his successful solution of problems connected with celestial mechanics, should occupy a position of wider acknowledgment and receive the assent of those who, unable to add any support or offer effective criticism to his theory, were content to rely upon his deservedly high reputation. Thus it has come about that more than one writer has owed his knowledge of Kant to very second-hand sources, and while only very imperfectly apprehending the points of difference in the systems suggested by the two philosophers, has allowed the later to eclipse and supplant the work of the earlier writer. Perhaps it is not too much to say that until Prof. Newcomb's "Popular Astronomy" appeared, no intelligent comparison between the theories of Kant and Laplace could be found in any popular work written in English. Prof. Hastie has, however, removed any difficulty that any one might experience in endeavouring to master Kant's views at first hand, and there is no longer any excuse for incomplete knowledge. In excellent English, and we have no doubt with faithful adhesion to the original, he has given us more than all of that portion of Kant's work which the author himself considered to be supported by fair demonstrable inferences. This translation, indeed, oversteps the point at which Kant authorised the publication of his work by J. F. Gensichen in 1791. The remaining portion seems to have been too imaginative and fanciful to receive the support of Kant's maturer judgment, but Prof. Hastie has translated the whole, and the part yet unpublished may see the light if a favourable opportunity offers.

Not only has Prof. Hastie given us Kant's views in practically his own words, but by adding a sketch of the theories of other writers of the period, such as Lambert and Wright, and, later, those of Herschel and Laplace, he has reconstructed the environment in which Kant lived, and permitted us to see in some measure the extent of his acquirements and the gradual increase of later knowledge. To Wright, indeed, to whom Kant admits his obligations, the translator has rendered an act of justice by giving at very considerable length both the account of his suggestions, as they appeared in the *Hamburgische Freyen Urtheile* for 1751, and De Morgan's comments on Wright's hypothesis. Perhaps there was less reason for dealing at equal length with Lambert and the elder Herschel, but enough is given to permit the relations between these old astronomers to be readily apprehended. The result of the examination of Kant's work, and of the comparison with other writers on the same subject, has manifestly given Prof. Hastie very exalted views of Kant's power and insight; and by the use of various expressions he invites us to declare that "a greater than Newton is here."

"Newton was too resolutely opposed to hypotheses not directly founded upon empirical facts, and too anxious to keep within the limits of exact calculation, to give reins to his imagination in the physical sphere. But Kant, gifted with a rare combination of empirical observation and speculative thought, was especially equipped with a genius that could grasp and combine the 'two worlds' in one" (p. lxxxvi).

And again—

"His (Kant) evolutionary theory was thus co-extensive with the Universe, and included all its parts and all its developments. He was thus the precursor in the eighteenth century of Herbert Spencer and Darwin in the nineteenth; but he was greater than both in that he established the general principles of which they have only given particular expressions" (p. lxxxvii).

Laplace also fares badly at Prof. Hastie's discriminating hands—

"Kant, indeed, does not write with the admirable lucidity and ease of Laplace, but he has greater strength, more intensity, richer poetic vision" (p. cvii).

We doubt if this generous view of Kant's powers will meet with a ready assent from many readers. But every one will give him credit for the possession and development of one great thought. He saw and appreciated more clearly than any who had lived before him that the creation of the Universe was the result of a process, and not of an act or succession of acts, implying breaches of continuity. He unfalteringly demanded the banishment of all supernatural interferences from the ordered development of nature, and perceived the possibility of deriving the most complicated forms from the universal laws of motion regulating the simplest elements of matter. To rise above the trammels of dogmatic theology, and to give scientific expression to the evolutional processes of nature, were remarkable feats in his age and in the condition of physical science, and much may be forgiven him if in some of his details he shows a lack of accuracy, or if some of his conceptions are in formal contradiction with the principles of mechanics. And his reputation will still stand high if we freely admit that there are errors, or at least inconsistencies, in his cosmogony. There is a tendency in the very able introduction of Prof. Hastie to explain away these errors, and to contend for a closer agreement between the views of Kant and modern scientific theories than really exists. This treatment seems to us injudicious, and tends to raise a spirit of contradiction which really detracts from the very high estimate any one must form of Kant, simply considered by his work in the physical sciences.

Kant's announcement of the appearance of his cosmogony is found in a paper which he wrote, discussing a possible alteration in the time of the earth's axial rotation. We doubt if anything like justice has been done to Kant's memory in connection with this discussion. He there pointed out, in the clearest possible manner, two important facts which in recent times have received very considerable attention, and the early mention of which by Kant discloses a far-reaching apprehension of the operations of celestial mechanism. One is the view revived by Delaunay at the time of the controversy concerning the amount of the secular acceleration of the moon's motion, that the action of the tides must tend to diminish the time of the earth's rotation. The other is, that the explanation of the fact that the moon, in revolving round the earth, turns to it always the same hemisphere, can be traced to tidal influence. But if these two bold speculations have not met with the attention to which they are entitled, Kant himself was not a little to blame for this neglect. For he subsequently adopted the notion that the daily rotation of the earth was accelerated by the falling of heavy particles from the solid crust of the earth towards the centre, supposed to be fluid, and such particles carrying with them a greater velocity of rotation than the lighter particles which might be ascending from the centre. It is, perhaps, of no great consequence to point out here that modern analysis tends to the conclusion that our globe is solid throughout, but it is not a little curious to notice that Kant did not seem to apprehend that the introduction of a second hypothesis does not in any way affect the validity of the former argument. The possibility of the two causes operating together, and the ultimate effect depending upon the amount of their difference, does not seem to have occurred to him. But the paper as it stands in the text betrays a feverish, unphilosophical hurry. The argument is marred by misdescriptions that would have been eliminated by the exercise of more care, and one might well doubt whether Kant fully appreciated the importance of his own suggestions.

But in the presentation of his cosmogony, properly so-called, he lavished all the care and skill of which he was master. Laplace hid his suggestion of the nebular hypothesis away at the end of a volume as though he were ashamed of it, or was afraid that the introduction of more or less hypothetical matter might damage the effect of his rigorous demonstrations. Kant, on the other hand, believing that he was writing a classic for all time—perhaps he was—felt himself entitled to dedicate his work to his sovereign, and was content to base his reputation on the legitimacy of his hypotheses and the use he made of them. But mankind has, perversely enough, connected the nebular hypothesis with the name of Laplace rather than with that of Kant.

To Thomas Wright, of Durham, the author, according to Prof. G. H. Darwin, of a book of preternatural dulness, Kant is indebted for his general view of the construction and arrangement of the Milky Way. Whatever merit or originality the "grindstone theory" possesses, the credit of its discovery seems to be undoubtedly due to this author, and the additions that Kant attached to the description are not particularly happy. For he not only regarded the nebulæ as presenting distant views of remote galaxies and constellative systems in which the construction of our Milky Way was repeated, but he created a central sun about which each star had its appointed orbit, and around which it would run its course during endless ages. We cannot, therefore, follow Prof. Hastie in his assertion that Kant "improved and simplified Wright's theory, giving it a more exact scientific expression" (p. lxviii). Nor are we prepared to admit that "spectroscopic results are so far in entire harmony with Kant's view, and have only extended its range and certainty" (p. c). Spectroscopic observation has not supported the conclusion that nebulæ are due to the combined light of distant suns, so remote that the light from them, condensed into a small space, is visible to us as a tiny luminous cloud. In this place it is sufficient to refer either to the philosophic views held by Schiaparelli, or the more complete examination of these bodies of which an account has been given by Sir Norman Lockyer. Nor is it probable that the stars, collected as they are into irregular clusters or masses with comparatively vacant spaces between them, constitute a stable system. There is no evidence of the existence of a central body of vastly greater mass than the stars surrounding it, which is almost an essential feature to the maintenance of such a system.

But it may be urged that Kant's greatest success is to be found in his construction of the solar system. In the bold conception

"I assume that all the material of which the globes belonging to our solar system—all the planets and comets—consist, at the beginning of all things was decomposed into its primary elements and filled the whole space of the universe in which the bodies formed out of it now revolve" (p. 74),

he anticipated Laplace in the essential portion of the nebular hypothesis, and though his conception is marred by one great dynamical error, yet possibly his origin of the cosmos comes nearest to that at present held by the greatest authorities. If Kant's theory be maintained in detail it would seem to lead, not to a planetary system, such as at present exists, but to a central sun formed by the collection of all the matter in the "meteoritic plenum." But this may be a quite possible condition at one stage of the process, just as Laplace's hot rotating nebula, with which his hypothesis starts, may represent a later stage. For Lord Kelvin is understood to trace the solar system to an originally

"cold nebula consisting of separate atoms or of meteoric stones initially possessed of a resultant moment of momentum equal to that of the solar system. Collision at the centre will reduce them to a vapour, which then expanding far beyond Neptune's orbit will give a nebula such as Laplace postulates."[1]

But Kant's great error consists in the assumption that a motion of rotation could be produced from a state of rest by repulsive forces acting upon the rarer masses of the condensing matter, which would give rise to a whirling motion. This is to ignore the fact that the sum total of rotatory motion in a system can never be increased or diminished by the mutual action of its separate parts.

It is needless to dwell on such points as the suspected increase of eccentricity in planetary orbits with increase of distance from the sun, or the explanation offered for the varying densities of the planets with the variations of

[1] G. F. Becker, "Kant as a Natural Philosopher," *American Journal of Science*, vol. v., February 1898.

the radius vector. An effort to bring into quantitative correlation such constants as density, eccentricity, or inclinations of axis, must end in failure for Kant. He will be judged, not by details, but on the general principle by which he claimed to have arrived at a just comprehension of a complete cosmogony. Similarly, one may pass over his genesis of satellites and the formation of Saturn's ring. Of the former it is sufficient to say that both Kant and Laplace saw in the existence of satellites the repetition on a small scale of the formation of the solar system. We know now the extreme probability that the moon owes its existence to a quite unique arrangement, and it would be hazardous to affirm that any one process has been operative in more than one planet. With regard to the latter, if the existence of a ring about Saturn is suggestive of the manner in which planets came into existence, neither Kant nor Laplace could give sufficient reasons to account for the stable condition of the ring in that system and the instability in others.

The problem of the ordered solar system is one around which much future controversy will arise, and possibly the ambition of neither the astronomer nor the physicist will go further than to suggest how it might have been effected on a plan that does not contradict any known physical laws or inferences. This is very different from saying how it actually "rose out of chaos." Prof. Hastie quotes with approval a remark of Kant, "that it is more difficult to explain the genesis of a caterpillar than the origin of a world." If this be true, it may be due to the fact that we know less about the fabric of the Universe than of the caterpillar, and it is consequently easier to be convicted of error in the smaller than in the greater matter. Kant, together with all makers of cosmogonies, enjoys the advantage that the accuracy of the theories cannot be submitted to any adequate test. W. E. P.

THE HERPETOLOGY OF NORTH AMERICA.

The Crocodilians, Lizards, and Snakes of North America. By E. D. Cope. Reprinted from the Report of the U.S. National Museum for 1898, pp. 153–1270. With woodcuts and 36 plates. (Washington, 1900.)

THE eminent position held by the late Prof. Cope among workers on the taxonomy of vertebrates in the latter half of the past century is chiefly due to the fact that, as has been the case with Prof. Gegenbaur in the field of comparative anatomy, he applied the teachings of the evolutionary theory from the very outset, at a time when other zoologists, imbued with the Cuvierian and Müllerian principles, were still striving at natural arrangements on physiological bases. The ideas set forth in the revolutionary essays on the classification of Batrachians and Lizards, by which he first made his name known, though at first received with little favour by his fellow-workers in Europe, have gradually made their way, and may be said to have well stood the test of time. Although considerably modified in many points both by himself and by others in the intervening thirty-five years, Cope's views hold the field to a greater extent than those of any other taxonomist of the same period. Later in his career, similar attempts at the general classification of Reptiles and Fishes have, in the opinion of the reviewer, been equally successful.

The quick perception of the importance of apparently trivial anatomical details, the veritable instinct with which he realised their phylogenetic bearing and selected them for the purpose of connecting forms widely remote in the systems of his predecessors, and led to conclusions which have, in many instances, ultimately been confirmed by palæontological discoveries, have rendered his name famous in Europe as well as in America. During the later years of his life, however, hasty and careless work, a constant striving at originality, to a certain extent marred the productions of his never-ceasing activity. This may be said of his latest attempts at improving the classification of the Lizards and Snakes, the results of which are incorporated in the thick volume of over 1100 pages now issued by the Smithsonian Institution. It is not stated by whom the work has been seen through the press, nor whether and to what extent the original MS. has been touched up, an omission through which it appears uncertain whether the late author or the editor is responsible for various startling errors which one feels disinclined to ascribe to the former.

The present volume forms part of a series of monographs intended to illustrate the cold-blooded lung-breathers of North America, a work which was devised many years ago by the late Prof. Baird, whose MS. and a number of carefully-drawn figures were placed in the hands of Prof. Cope in 1864. The Batrachians appeared in 1889, the Chelonians were to have been described by Prof. Baur, whose death so nearly followed that of the author of the present treatise, dealing with the remaining orders, viz., *Loricata* (Crocodiles) and *Squamata* (Lizards and Snakes).

As regards the first of these two orders, which includes only two North American living types, *Alligator mississippiensis* and *Crocodilus americanus*, it seems surprising that so advanced a reformer of classification should still have adhered to the inclusion of the *Parasuchia* among the Crocodilians. These Triassic types differ in so many respects from the later *Eusuchia*, and have so much in common with the Rhynchocephalians and the Sauropodous Dinosaurs, that their separation as a distinct order (*Thecodontia*) appears imperative if exact definitions of the allied groups are to be attempted.

Prof. Cope's arrangement by which the *Lacertilia*, or *Sauria* as he prefers to call them, and *Ophidia*, forming the bulk of the fauna, are brigaded under *Squamata* is well in accordance with the present state of knowledge, the supposed characters on which the two groups were formerly allowed ordinal rank being quite insufficient for that purpose. But, in the opinion of the reviewer, a classification in which the *Rhiptoglossa* (Chameleons) are regarded as a mere super-family of Lizards, equivalent with the *Pachyglossa* (*Agamidae*, *Iguanidae*), *Nyctisaura* (*Geckonidae*, *Eublepharidae*), *Uroplatoidea*, *Thecaglossa* (*Varanidae*), *Helodermatoidea*, *Diploglossa* (*Zonuridae*, *Pygopodidae*, *Anguidae*, *Xenosauridae*), *Leptoglossa* (*Teiidae*, *Xantusiidae*, *Lacertidae*, *Gerrhosauridae*, *Scincidae*, *Acontiidae*, *Dibamidae*, *Anelytropidae*), *Annielloidea* and *Annulati* (*Amphisbaenidae*), absolutely fails to express the degree of relationship between them and the members of other families; and if one turns to the synopsis on pp. 200 and 201, in which the distinctive features of the primary groups, here inadvertently termed "orders" and "suborders" (*cf.* p. 178, where the *Sauria* are described as a suborder), are set forth, one cannot fail to be struck by the want of logic and of perception of proportions which characterises the new arrangement. It may also be pointed out that the group *Annielloidea* has been omitted from the synopsis; this is but one out of many clerical oversights of a similar kind which a rapid inspection of the volume reveals.

A glance at the definitions of the species in the difficult genera, such as *Sceloporus* and *Cnemidophorus*, shows that the subject has not been mastered. An attempt to name an extensive series of *Scelopori* with the aid of the key given would, it can be predicted, result in failure.

In the classification of the snakes, the author agrees with the reviewer in the main divisions. The innovations are mainly due to the consideration of the structure of the intermittent organ or "hemipenes" of the male, by the use of which character many changes have been introduced in the limits of the genera and in their groupings, changes which are not likely to meet with general acceptance. Far too few species have as yet been tested with regard to this character, and Cope himself admits of occasional exceptions, which have turned up in the course of his investigations, such as when one of the paired organs has proved to belong to a division of his system different from that of its fellow on the same specimen. *A priori*, it does not seem that the development of folds and spines on such an organ is at all likely to have so deep a signification as to assist in establishing subfamilies and genera; to adduce a somewhat parallel example, we might as well attempt to employ the differences in the nuptial excrescences of male Batrachians for the definition of genera and even higher groups. And if we are to judge of the value of the character by the changes which its consideration warrants in the groupings of the genera, its introduction in the system does not appear as anything in the way of an improvement.

The investigation of the lung characters, to which the author has devoted so much attention, is a more useful piece of work, so far as taxonomy is concerned, and it may be mentioned that through it the view once propounded by the writer of this notice that the Amphisbænids may be directly derived from degraded types of Teiids, has proved to be untenable.

Allusion has been made above to some extraordinary errors which have crept into this work. Two may be mentioned, *à propos* of snakes, as illustrations:—P. 1127, the *Hydrophiinae* are stated to "leave the water to deposit their eggs"; p. 1129, *Echis carinatus* is described as the "Krait" of India.

The illustrations are numerous and for the most part excellent, and an interesting essay on the geographical distribution of Batrachians and Reptiles concludes this monograph, which, in spite of its imperfections, such as it is a reviewer's duty to point out, will prove of great service to the student of a highly interesting but most difficult group of animals, our knowledge of which has been so greatly advanced by the genius and industry of Prof. Cope. The work is also useful as a catalogue of the specimens preserved in the United States National Museum in Washington.

G. A. B.

PRACTICAL PHOTOMETRY.

Photometrical Measurements. By W. M. Stine, Ph.D., Williamson Professor of Engineering, Swarthmore College. Pp. xi+270. Illustrated. (New York: The Macmillan Company. London: Macmillan and Co., Ltd., 1900.) Price 6*s*. 6*d*. net.

AS a "manual for the general practice of photometry, with especial reference to the photometry of arc and incandescent lamps," this work will be found useful. Most of the descriptions of photometers are clear and well illustrated, and much practical information about standards of light is collected together. That strange medley of apparatus enshrined in an expensive tabernacle of mahogany and velvet called by gas engineers a "photometer" is not even mentioned, possibly because the book is of American origin. Photometers, and those parts of the art of photometry which are of use to engineers, may be defined without much difficulty, and the apparatus and methods suitable for the research laboratory may be grouped together; when to these is added the theory of the subject, the whole ground of photometry is covered. But the author makes no such distinctions, and the value of his work suffers. While his reference to spectro-photometry is meagre, and the bolometer is dismissed in less than six lines, he drags in double integration to determine the mean spherical intensity of a purely academical case of distribution. On the other hand, he treats possible cases of distribution in a clear and practical way. The description of a Bunsen photometer in the crude form of a screen without mirrors or prisms, and an ancient algebraical theory of the Bunsen screen, containing no reference to the angle of emission or direction of view, marks the author, as do many other passages, as a science teacher. He is in good company; there is hardly a text-book of physics in English in which that useless affair is not represented as a Bunsen photometer. In common with most science teachers, he assumes that the shadows of a Rumford photometer must be widely separated, and he very properly alludes to the lack of sensitiveness which results. When Lord Kelvin said that no one could need a better photometer than a pencil and a white card he knew that the edges of the shadows should meet, and, it may be added, that the shadows should completely cover the card. The little-known, but valuable, Conroy, Ritchie and Thompson photometers, varieties of the Rumford, are described, and the somewhat over-rated Lummer-Brodhun apparatus is criticised. To describe the use of the rotating sector without allusion to Abney, the light of the arc without reference to Fleming, S. P. Thompson or Mrs. Ayrton, and measurement of the mean spherical candle power of arcs without reference to Blondel, can hardly be excused by the attempt to compress the whole book into 261 pages. That the author is a professor of engineering may account for the excellence of the practical parts of the manual; but that, being a professor, some of the theoretical parts are so obscure is strange.

He must needs allude to "the logarithm of the ratio" in defining Fechner's law, because he is a professor; he goes on to give a lucid arithmetical example, because he is an engineering professor, but after a page relapses hopelessly into totally unnecessary integration in order to get back to the professorial logarithm.

The nomenclature of photometrical quantities is dismissed in a few lines with the very true remark that "the tendency toward particular nomenclature of physical quantities has been carried to a burdensome excess in many cases, until it has assumed the nature of scientific fetichism." "The attempts" of Hospitalier are alluded to, but the author has paid so little attention to the matter that he falls into sad confusion in the use of the expression "illumination." The word is used in half a dozen senses—as a sensation, as a flux, as a quantity of light, and so on. It is true that the "lux" of Preece or Hospitalier are no guide, but the "carcel-metre" or the unscientific "candle-foot," when once understood, leave not the slightest ambiguity about the meaning of "illumination."

The chapter on standards of light is excellent, but the table of comparisons of standards, taken from Laporte, does not include the British candle. Only two items out of a dozen appear to agree with the more complete table of Palaz. The British candle, with all the refinements of the gas referees, is not a unit which does credit to physical science, but it is at least as definitely known, reproducible and measurable as any other standard of light.

The arrangement, illustrations and index are good; the spelling is English. A. P. T.

OUR BOOK SHELF.

The Nature and Work of Plants: an Introduction to the Study of Botany. By D. T. MacDougal, Ph.D., Director of the Laboratories, New York Botanic Garden. Pp. xvii+218. (New York: The Macmillan Co. London: Macmillan and Co., Ltd., 1900.)

THIS is a bright and readable little volume, in which plants are treated of mainly from a natural history and physiological point of view. It deserves to be successful, if only as showing that it is possible to gain a fairly considerable, and certainly intelligent, insight into the ways of plants, and that without first mastering the mass of technical detail which too often renders elementary books on botany so repulsive to beginners.

The author commences with a general account of the materials of which plants are composed, and of the structures of which they are built up, the student being led to investigate for himself the different facts and principles enunciated. The phenomena of reproduction, irritability and the like are introduced as objects of observation, and in such a way as to arouse, rather than by satiating to quench, curiosity. The seed and fruit are more fully dealt with, as they afford examples in which adaptations to special purposes can be made out with some degree of clearness, and their individual peculiarities are well explained. If one feels some doubt as to the wisdom of selecting the coconut as an introductory example of a fruit, one cannot complain of the mode in which its structure is treated. The very interesting case of *Xanthium*, in which two fruits are contained in a common sheath, one seed of which germinates in one year whilst its fellow remains dormant till the following season, will probably be new to some readers on this side the Atlantic.

A short chapter on plant societies closes the volume, which may be warmly commended as one likely to excite an interest in many people who fancy that the acquirement of a more or less complicated vocabulary is an essential preliminary to a scientific study of plants.

Naturally, the book is not without its faults. Some of these seem to be those of carelessness, of which there is an example on p. 11 in the implication that a dried plant consists of charcoal (!) and ash. But these defects are not numerous, and do not seriously affect the general excellence of the book

Practical Coal Mining. By George L. Kerr. Pp. x + 462. (London: Charles Griffin and Company, Ltd., 1900.)

IN the vigorous outburst of technical literature that the last few years have witnessed, the subject of mining has not been forgotten, and the student of this subject has his choice of a fair number of works of a high degree of merit, amongst which those published by Messrs. Griffin and Co. take foremost rank. It was therefore to be expected that a new book on coal mining, issued by these same publishers, ought to surpass anything previously written on this subject, or at any rate to present features of especial importance. It is to be regretted that these anticipations have been very far from being realised, and, indeed, that it is difficult to discover anything in the work now under review that justifies its publication. It is very largely made up of extracts from the works already referred to, as well as from others, nor are these extracts by any means the worst part of the book. The author's style is far from clear, and many passages might be quoted that would be quite unintelligible to any one who was not acquainted beforehand with the subject-matter; this obscurity of languages often merges into inaccuracy and want of precision—the latter fault being one of the most dangerous that could well be found in a book intended to be placed in the hands of a student. A couple of examples of this fault may be cited: on p. 3 the author writes that "the line at right angles to the direction of 'dip' is called the 'strike,'" a definition that is not true unless qualified by the statement that the line referred to is a line within the bed; it is obvious that there may be an infinite number of lines at right angles to the direction of dip, but only one of these is the strike. Again, on p. 326, we find the following: "When two shafts are sunk and connected by a passage, and the density (weight) of air in the two shafts is equal, no current of air will circulate, no matter what their respective sizes may be." This, again, is only true if it be postulated that both shafts are of precisely the same depth, otherwise an air current may circulate.

The author is weak whenever he touches upon scientific ground; he uses mechanical formulas without apparently appreciating their limitations, as, for instance, when he applies formulas for the bending of columns, ignoring the fact that these are only applicable within the elastic limit. Similarly, his mechanical conceptions of the work done by the winding engine (p. 221) are incorrect. That his chemistry is not much more satisfactory may be judged from the occurrence of such phrases as "glycerine nitrate" for nitro-glycerine, &c.

The best chapter in the book is that on "Modes of Working," the methods of coal-getting in use in Scotland being well described. Indeed, had Mr. Kerr confined himself to a small book describing merely those points in which Scotch practice differs from the English, notably in shaft-sinking, coal-getting and haulage, he would have produced a contribution of distinct value to the literature of coal mining, a phrase that can, unfortunately, not be applied to his present more ambitious attempt. H. LOUIS.

Bookkeeping for Business Men. By J. Thornton and S. W. Thornton. Pp. vi + 185. (London: Macmillan and Co., Ltd., 1900.) Price 3*s*. 6*d*.

BOOKKEEPING is only the application of common-sense principles to the classification and systemisation of accounts. Its purpose is to show how the financial facts of a business may be expressed in the clearest and shortest way, so that the financial position can be readily understood. A pupil who has been taught arithmetic in a reasonable way can adapt his knowledge to the forms of bookkeeping in a few weeks when placed in an office. For people who have not had the advantage of a rational education, it is necessary to draw up hard and fast rules, which must be obeyed in order to keep accounts intelligibly. The volume under notice does this, by showing as simply as possible how a trader unfamiliar with bookkeeping may construct, keep and balance a set of account books suited to his own business. A set of "Automatic Balancing Charts" is published separately as a supplement to the book, and they are drawn up in such a way that it is almost impossible for a person of average intelligence to make an incorrect entry upon them. Both the book and the charts should prove of service to business men unfamiliar with the intricacies of bookkeeping.

Reports from the Laboratory of the Royal College of Physicians, Edinburgh. Edited by Sir Batty Tuke, M.D., and D. Noel Paton, M.D. Vol. vii. (Edinburgh: Oliver and Boyd, 1900.)

THIS volume consists of a series of original papers which, since the end of 1897, have emanated from the laboratory of the Royal College of Physicians of Edinburgh. Practically all these papers have been published previously in the medical or scientific journals, and in this form have no doubt been read by those interested in their subject-matter. This is, however, perhaps only partially true of two reports which were presented respectively to the Fishery Board for Scotland and to the Prison Commission for Scotland. The first report consists of sixteen monographs on the life-history and the physiology, under varying conditions, of the salmon; and concludes with a monograph, by Dr. Dunlop, upon the food value of the salmon at different seasons, and obtained from different sources.

Dr. Dunlop is also the author of a report to the Prison Commission for Scotland upon prision dietaries. The report seems to be an exhaustive one, and contains many suggestions with regard to the adaptation of the diets in prisons to the varying conditions and labour employments of the prisoners.

Mother, Baby and Nursery. By Gènevieve Tucker, M.D. Pp. xvi + 193. (London: T. Fisher Unwin, 1900.) Price 1*s.*

THIS is one of the many manuals written for the guidance of young mothers. The writer is an American doctor, but suitable to every mother are the clear and practical directions on the management of herself and her infant. The earlier chapters are concerned with heredity and the conditions favourable for the unborn child. The practical advice is valuable, but it is misleading that the author's opinions on questions of heredity are stated as generally acknowledged facts. The chapters on the care of the infant are suggestive and helpful, and the importance of early training in good habits beginning during the first month of life is insisted upon duly and wisely; but the following advice is extraordinary and *not* to be recommended: "Take a good-sized raisin, cut open, taking out the seeds, put it on the umbilicus." A chapter containing a classification of the diatheses of infants (scrofulous, tuberculous types, &c.) seems out of place in a manual of this description. At the end of the book there is a short and emphatic summary of what is and what is not to be done in the nursery; but among the "nursery don'ts" we notice the omission of a warning against a practice too common, at any rate, in this country, namely, the use of so-called baby-soothers.

Interest is added to the book by the introduction of photographs of young children, but we dislike to see advertisements embodied in the text.

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.*]

Vortex Rings.

IN the course of some experiments preparatory to a lecture on vortex rings, I have introduced certain modifications which may be of interest to teachers and students of science.

The classic vortex-box is too well known to require much description. Our apparatus, which is rather larger than those in common use, is a pine box measuring about a metre each way, with a circular hole 25 cms. in diameter in one end. Two pieces of heavy rubber tubing are stretched diagonally across the opposite or open end, which is then covered with black enamel cloth tacked on rather loosely. The object of the rubber chords is to give the recoil necessary after the expulsion of a ring to prepare the box for a second discharge. Such a box will project air vortices of great power, the slap of the ring against the brick wall of the lecture hall being distinctly audible, resembling the sound of a flip with a towel. An audience can be given a vivid idea of the quasi-rigidity of a fluid in rotation by projecting these invisible rings in rapid succession into the auditorium, the impact of the ring on the face reminding one of a blow with a compact tuft of cotton.

For rendering the rings visible I have found that by far the best results can be obtained by conducting ammonia and hydrochloric acid gases into the box through rubber tubes leading to two flasks in which NH_4OH and HCl are boiling. Photographs of large rings made in this way are reproduced in Fig. 1, the side view being particularly interesting, showing the comet-like tail formed by the stripping off of the outer portions of the

FIG. 1.

ring by atmospheric friction as it moves forward. It is needless to say that the experiment with the visible rings should be left until the end of the lecture. The power of the air-rings can be shown by directing them against a flat pasteboard box, stood on end at some distance from the vortex apparatus, the box being at once overturned or even driven off on to the floor. A large cluster of burning gas jets can be extinguished by the impact of a ring, a modification of which experiment can be shown on a small scale by shooting a capped shell in a shot-gun at a candle several paces off. If one's aim is good the candle will be extinguished by the invisible vortex.

For showing the elasticity of the rings by bouncing one off the other, I find that the best plan is to drive two in rapid succession from the box, the second being projected with a slightly greater velocity than the first, all experiments that I have made with twin boxes having yielded unsatisfactory results.

Though the large vortices obtained with an apparatus of this description are most suitable for lecture purposes, I find that much more beautiful and symmetrical rings can be made with tobacco smoke blown from a paper or glass tube about 2·5 cms. in diameter. It is necessary to practice a little to learn just the nature and strength of the most suitable puff. Rings blown in this way in still air near a lamp or in full sunlight, when viewed laterally, show the spiral stream lines in a most beautiful manner. I have succeeded in photographing one of these rings in the following way. An instantaneous drop shutter was fitted to the door of a dark room, and an arc-lamp focussed on its aperture by means of a large concave mirror. The shutter was a simple affair, merely an aluminium slide operated with an elastic band, giving an exposure of 1/300 of a second. A photographic plate was set on edge in the dark room in such a position that it would be illuminated by the divergent beam coming from the image of the arc when the shutter was opened. A ruby lamp was placed in front of the plate, and rings were then blown from a tube in front of the sensitive film. As soon as a good ring, symmetrical in form and not moving too fast, was seen to be in front of the plate, a string leading to the shutter was pulled and the plate illuminated with a dazzling flash. The ring casts a perfectly sharp shadow owing to the small size and distance of the source of light; the resulting picture is reproduced in Fig. 2. The ring is seen to consist of a layer of smoke and a layer of transparent air, wound up in a spiral of a dozen or more complete turns.

The angular velocity of rotation appears to increase as the core of the ring is approached, the inner portions being screened from friction, if we may use the term, by the rotating layers surrounding them. This can be very nicely shown by differentiating the core, forming an air ring with a smoke core. If we make a small vortex box with a hole, say 2 cms. in diameter, fill it with smoke and push very gently against the diaphragm, a fat ring emerges which rotates in a very lazy fashion, to all appearances. If, however, we clear the air of smoke, pour in a few drops of ammonia and brush a little strong HCl around the lower part of the aperture, the smoke forms in a thin layer around the under side of the hole. Giving the same gentle push on the diaphragm, we find that the smoke goes to the core, the rest of the ring being invisible, the visible part of the vortex spinning with a surprisingly high velocity. Considerable knack is required to form these thin crescent-like vortices, the best results being usually attained after quite a number of attempts have been made. A drawing of one of these smoke-cores is shown in Fig. 3. The actual size of the vortex being indicated by dotted lines, it is instructive as showing that the air which grazes the edge of the aperture goes to the core of the ring. The experiment does not work very well on a large scale, though I have had some success by volatilising sal ammoniac around the upper edge of the aperture by means of a zig-zag iron wire heated by a current.

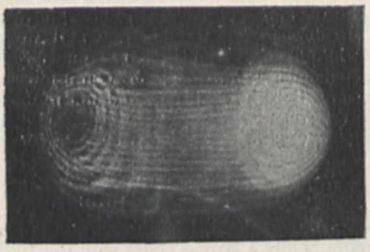


FIG. 2.

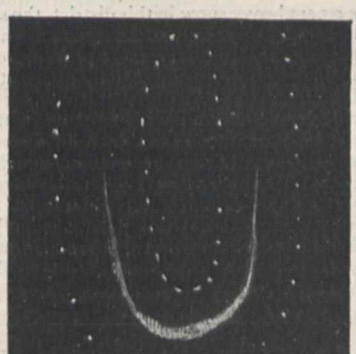


FIG. 3.

By taking proper precautions we can locate the smoke elsewhere, forming a perfect half-ring, as is shown in Fig. 4, illustrating in a striking manner that the existence of the ring depends in no way on the presence of the smoke. The best way to form these half-rings is to breathe smoke very gently into a paper tube, allowing it to flow along the bottom, until the end is reached, when a ring is expelled by a gentle puff. A large test tube with a hole blown in the bottom is perhaps preferable, since the condition of things inside can be watched. It is easy enough to get a ring with most of the smoke in the lower half, but to get a ring, one half of which is wholly invisible, the smoke ending abruptly at a sharply defined edge, as shown in the illustration, requires a good deal of practice. I have tried fully half-a-dozen different schemes for getting these half-rings on a large scale, but no one of them gave results worth mentioning. The hot wire with the sal ammoniac seemed to be the most promising method, but I was unable to get the sharp cut edge which is the most striking feature of the small rings blown from a tube.

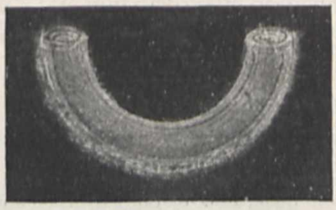


FIG. 4.

In accounting for the formation of vortex rings, the rotary motion is often ascribed to friction between the issuing air-jet and the edge of the aperture. It is, however, friction with the exterior air that is for the most part responsible for the vortices. To illustrate this point I have devised a vortex box in which friction with the edge of the aperture is eliminated, or rather compensated, by making it equal over the entire cross-section of the issuing jet.

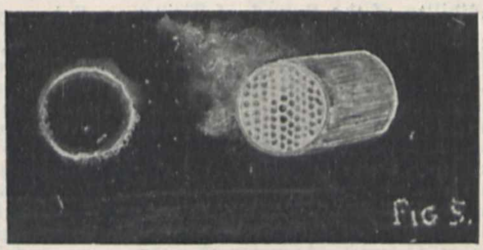


FIG. 5.

The bottom of a cylindrical tin box is drilled with some 200 small holes, each about 1·7 mm. in diameter. If the box be filled with smoke and a sharp puff of air delivered at the open end, a beautiful vortex ring will be thrown off from the cullender surface (Fig. 5). We may even cover the end of a paper tube with a piece of linen cloth, tightly stretched, and blow smoke rings with it.

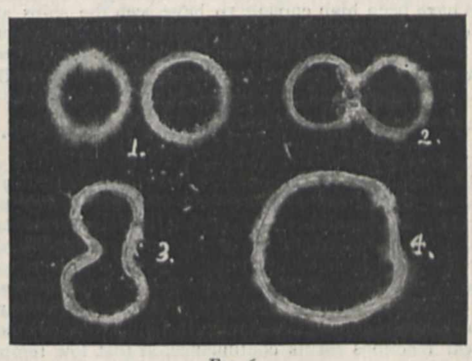


FIG. 6.

In experimenting with a box provided with two circular apertures I have observed the fusion of two rings moving side by side into a single large ring. If the rings have a high velocity of rotation they will bounce apart, but if they are sluggish they will unite. At the moment of union the form of the vortex is very unstable, being an extreme case of the vibrating elliptical ring. It at once springs from a horizontal dumb-bell into a vertical dumb-bell, so rapidly that the eye can scarcely follow the change, and then slowly oscillates into the circular form as shown in Fig. 6. This same phenomenon can be shown with two paper tubes held in opposite corners of the mouth and nearly parallel to each other. The air in the room must be as still as possible in either case. R. W. WOOD.

University of Wisconsin, Madison.

Dust-tight Cases for Museums.

THE new geological museum now being erected here will have high windows and a long south aspect. The effect of this will be that the sun will fall suddenly on glazed cases and as suddenly pass off them, thus by the expansion and contraction of the air causing dust-carrying currents to force themselves through every chink. From this cause it costs about three times as much to keep cases and specimens clean on the side exposed to the sun as it does in the shaded part of a museum. This may be obviated by elastic diaphragms (which would hardly allow sufficient movement for such large cases as ours) or by small sliding shutters packed with cotton-wool something like Tyndall's respirators.

Can any of your readers refer us to museums in which such a system has been tried, or give us any advice on the subject before our cases have been built? T. MCKENNY HUGHES.

Woodwardian Museum, Cambridge, February 19.

Audibility of the Sound of Firing on February 1.

SIR W. J. HERSCHEL'S letter is very interesting, and I should like to make a few remarks upon it. To begin with, it must, I think, be granted that the discharge of the guns was almost simultaneous. The special correspondent of the *Times* on board the *Majestic* says, "and then simultaneously all the vessels in the long lines joined in, like the tolling of the passing bell." And the special correspondent of the *Times* at Osborne says: "A minute's interval . . . again the quick red flashes down the line, and again the dilatory roar." But why do we find the full minute's interval at Eastbourne, and three reverberations a minute at Oxford? Assuming that there was no firing at Windsor, the reason, I think, must be sought for in the very different character of the roads the sound had to travel over to reach these respective places. In our case the road was all over the sea with the exception of a few miles of low-lying land at Selsey Bill. On the other hand, to reach Oxford the sound would be greatly impeded by the contour of the land, to say nothing of some possible echo from the high ground of the Isle of Wight. Independently of Sir W. J. Herschel's letter, I have grounds for thinking that the sound followed the course of the valleys, and it is possible that the separate reports per minute emerged by as many different channels of passage and of echo. To have received the sound in a straight line, that is to say, to have been high enough to have seen the ships at Spithead, one would have had to have been at an elevation of somewhere about 2800 feet at Eastbourne and 3200 feet at Oxford.

Eastbourne. H. D. G.

Influence of Physical Agents on Bacteria.

IN your report of Dr. Allan Macfadyen's lecture on the influence of physical agents on bacteria (p. 359), I should like to call attention to one point. Dr. Macfadyen suggests that since phosphorescent bacteria regain their power of emitting light after being cooled to the temperature of liquid hydrogen, it may be the case that life is not dependent for its existence on chemical reactions. Because, says he, at the temperature of liquid hydrogen, *e.g.* -250° C., all chemical reactions are well-nigh, if not absolutely, at a standstill, if life were dependent on chemical reactions for its continuance, at that low temperature life would be destroyed. I would submit that this is a case of *non sequitur*. It appears exceedingly probable that the action of excessive cold in *suspending* and stopping vital phenomena, while not *destroying* the capacity of organisms to resume their vital activities, supports the prevalent view that life is dependent on chemical processes. For may it not be that excessive cold, while preventing the vital processes from taking place, by no means alters the chemical constitution of the complicated molecules, the interactions of which normally produce vital phenomena, and leave these molecules, which one may call biogens or anything else, in exactly the same state as they were immediately before the onset of excessive cold, ready as soon as the conditions become suitable once more to resume those vital processes which are known as metabolism.

As an illustration of what I mean I will quote a case of inorganic phosphorescence. It is well known that phosphorus is slowly oxidised in air and emits light at the same time. This reaction takes place when the air is at the pressure of the atmosphere, and the partial pressure of the oxygen is one-fifth of an atmosphere. If, now, the pressure of the air be made equal to five atmospheres, or if the air be replaced by pure oxygen at a pressure of one atmosphere, in both of which cases the pressure of oxygen is five times as great as before, the oxidation ceases and the phosphorescence vanishes. But this is only because the conditions are unsuitable, the constitution of the phosphorus and the oxygen is unaltered, and as soon as the pressure of the oxygen is lowered the phosphorescence begins once more. In both cases, the bacteria and the phosphorus, the action of the physical agent—in the one case cold, in the other pressure—is merely to render the conditions unsuitable for the appearance of the phenomenon, and not to destroy the possibility of its subsequent revival. H. D. D.

Balliol College, Oxford, February 10.

Malaria and Mosquitoes.

I WAS stationed in Karachi, Sind, for more than twenty years. There was undoubtedly a strong belief with the Indians that the disturbance of ground for building led to fever; building operations may be estimated by the fact that I went to a city of 45,000 inhabitants and left 130,000. Not long before I left, the ground of the native town was disturbed by the installation for the first time of a system of underground drainage. I think, but am not sure, this was followed by an outbreak of fever.

Qua mosquitoes, may there not be a distinction between malarious and ordinary fever. F. C. CONSTABLE.

Wick Court, near Bristol, February 24.

Snow Crystals.

AFTER the recent heavy snow in this district, the slight fall yesterday afternoon did not, at first, attract much attention, appearing like sleet to the casual observer. It proved, however, to be of an unusual character, consisting chiefly of beautifully-formed single crystals. It was remarked that "it was snowing stars;" and the ground became covered with myriads of them, varying in size, some being a quarter of an inch in diameter. These "frost flowers" appear to have been common enough in Tyndall's Alpine experiences, but are, I imagine, rarely seen in England upon this scale. The thermometer registered 30° Fahr., and it would be interesting to know if this phenomenon was peculiar to the High Peak district, and what are the conditions conducing to such a display. WM. GEE.

Buxton, February 19.

A "NEW STAR" IN PERSEUS.

WE have received the following:—*Edinburgh Circular*, No. 54. A new star was discovered in Perseus, by Dr. T. D. Anderson of this city, on February 21, 14h. 40m. G.M.T. The star was then of the 2·7 magnitude, and shone with a bluish-white light. Dr. Anderson gave as its approximate place for 1901·0:—

R.A. 3h. 24m. 25s. Decl. + 43° 34'.

At 6h. 58m. G.M.T., on the 22nd, the undersigned estimated the Nova as 0·3 magnitude brighter than α Tauri, and at 8h. 10m. considered it equal to Procyon, which it closely resembled in colour.

On the 23rd, at 8h. 10m. G.M.T., Dr. Halm and Mr. Clark found the new star 0·2 magnitude brighter than Capella.

A direct-vision prism on the 6-inch refractor showed nothing beyond a perfectly continuous spectrum. With the large Cooke spectroscope on the 15-inch equatorial the first impression was the same as with the smaller apparatus; but on closer examination about half a dozen delicate dark (Fraunhofer) lines were made out by Dr. Halm, extending from a little below D to about F. The spectrum of the Nova, at its present stage, is therefore of a distinct but feebly developed solar type. The existence of these lines I was able to confirm, but the sky became gradually obscured before their positions could be satisfactorily determined.

At about the same hour a photograph of the Nova was secured by Mr. Heath at a time when all the neighbouring stars were obscured by haze. Except a very short interval on the 23rd, the sky here has been completely overcast since the 22nd.

The Nova was independently discovered by Mr. J. E. Gore at Dublin at 11h. 15m. Dublin time on the 22nd, and by Mr. W. B. Dodd and Mr. H. Wake, of Whitehaven, on the 23rd inst. RALPH COPELAND.

Royal Observatory, Edinburgh, February 25.

On the night of the 25th observations were made at the Solar Physics Observatory, South Kensington, the general results of which have been stated by Sir N. Lockyer as follows in a letter to the *Times*:—

(1) The spectrum strongly recalls that of Nova Aurigæ.

(2) There are at least two light sources involved; one with a dark-line spectrum, the other giving chiefly the bright lines of hydrogen, helium, asterium and calcium.

(3) Some of the bright lines are probably reversed.

(4) The broadening of the bright lines is considerably greater than that observed in Nova Aurigæ.

(5) It has been determined by a comparison spectrum of Bellatrix, on the same plate, that the middle of the bright lines occupies nearly the normal position in the spectrum; the greatest breadth of lines observed extends over some 30 tenth-mètres.

(6) The centres of the bright and dark lines are separated by about 15 tenth-mètres, showing a differential velocity of somewhere about 700 miles per second between the colliding light sources.

(7) The star is keeping up its magnitude so far as may be gathered from a very brief observation made between clouds on Friday. To-night (February 25) it has been brighter than Aldebaran, slightly less bright than Capella.

PHOSPHORESCENCE AS A SOURCE OF ILLUMINATION IN PHOTOGRAPHY.

IN certain libraries there exists a fixed rule that no books may be removed. This being so, all extracts and copies of plates and engravings have to be made in the libraries. Reproduction by the methods of ordinary photography is most inconvenient, since the employment of artificial light is strictly prohibited; also the introduction of a camera, and its manipulation in a library, are surrounded by many difficulties. These circumstances led me to devise the following method for obtaining copies of plates, engravings, printing and writing. A piece of cardboard is coated with a phosphorescent substance, and, after sufficient exposure to the light of the sun or of an arc lamp, it is placed at the back of the engraving or writing to be copied; on the face of the engraving or writing a dry photographic plate is placed, and then the book is closed for a certain time, depending on the nature and thickness of the paper used in the book. I find that the period of time lies between eighteen and sixty minutes. The plate is then withdrawn and stored in a dark box for development. The dry plate is easily manipulated under a cloth, which shuts off all light and covers the book during the operation. The results are sufficiently good for most purposes—in the case of some papers the fibrous structure is shown; this very slightly detracts from the clearness of the copies made by this process. Neither the luminous substance nor the dry plate injure the book in any way, so that the method may be employed in the case of valuable prints and engravings (Fig. 1). If films be used instead of plates, a large number of copies of different engravings in the same book may be made at the same time. The time of exposure to the phosphorescent backing is shortened considerably by placing the phosphorescent card on a warm surface, such as that of a metal vessel heated to about 20° C. with hot water;

FIG. 1.

when films are employed, this temperature should not be exceeded. In an experiment made in the laboratory I found that the phosphorescent substance under normal barometric pressure became brightly luminous when subjected to the brush discharge of a Tesla inductor; the discharge from an ordinary induction coil fails to produce the same effects. F. JERVIS-SMITH.

THE ROYAL SOCIETY'S ADDRESS TO THE KING.

ON Saturday last His Majesty the King received deputations with addresses from the Universities of Oxford and Cambridge, General Assembly of the Church of Scotland, the Corporation of the City of Liverpool, and the Royal Society.

The Royal Society was represented by Sir William Huggins, K.C.B. (president), Mr. A. B. Kempe, treasurer (mover), Sir Michael Foster, M.P., secretary (seconder), Dr. T. E. Thorpe, C.B. (foreign secretary), Lord Lister, Lord Kelvin and Sir J. D. Hooker (past presidents), and Mr. W. H. M. Christie, C.B., Astronomer Royal (vice-president). The following was their address:—

TO THE KING'S MOST EXCELLENT MAJESTY.

The Humble Address of the President, Council, and Fellows of the Royal Society for Promoting Natural Knowledge.

Most Gracious Sovereign,—We, your Majesty's most dutiful and loyal subjects the President, Council, and Fellows of the Royal Society of London for Promoting Natural Knowledge, humbly beg leave to offer our deepest and most heartfelt sympathy with your Majesty in the great sorrow which has befallen you in the death of your beloved mother, our late Sovereign Lady the Queen. Your Majesty's loss is our loss, a loss not only to ourselves, not only to all your Majesty's subjects throughout the Empire, but to the whole world. During your beloved mother's wise and beneficent reign under her thoughtful fostering care that natural knowledge which the society was founded to promote has been promoted to an extent and in ways never known before, and we feel sure that not in our time only, but in the years to come, to the story of the advance of science in the past century will be most closely linked the memory of the goodness, the wisdom, the peerless worth of the august and beloved lady whose death has now plunged us into the deepest grief.

While thus uttering words of sorrow we ask leave, sire, at the same time, to lay at your Majesty's feet our unfeigned and heartfelt congratulation upon your Majesty's accession to the Throne of your ancestors to reign over a people to whom happily your Majesty is no stranger, but who have by many experiences learned to recognise your great worth, and have been led to the sure hope that under your gracious rule the nation will continue to hold the proud position which it has gained under the guidance of your beloved mother.

That your Majesty's reign may be long, happy, and glorious, and that you may ever rule in the hearts as well as over the persons of a loving, dutiful, and grateful people is the earnest wish and ardent prayer of your Majesty's loyal and dutiful subjects, the President, Council, and Fellows of the Royal Society of London.

The King's reply was as follows :—

I am much gratified by the warm expression of your loyalty and affection, of your profound sympathy with our present grief, and of your loving appreciation of the goodness and great qualities of my dearly beloved mother. I thank you for your dutiful good wishes, and I share your hope that my reign also may be blessed by a continuous growth of my people in enlightenment, refinement, and power for good. The intellectual attainments and energies which your society so conspicuously represents are among the most precious possessions of the nation as aids in securing those high ends, and I remember with gratification the close connection of the society with its Royal founder and my other predecessors on this Throne, and the fact that I am a Fellow, as was also my dear father. You may feel assured of my constant interest in and protection of your work, and in token of my good will I shall be pleased to inscribe my name as patron in the charter book.

NOTES.

WE deeply regret to announce that Prof. G. F. Fitzgerald, F.R.S., died on Thursday, February 21, at the age of forty-nine years.

SIR ARCHIBALD GEIKIE retires to-day, February 28, from the office of Director-General of the Geological Survey of the United Kingdom and Director of the Geological Museum, after a service of nearly forty-six years. He has remained at his post after the usual age-limit in order to complete the annual summary of progress of the institution under his charge. It is understood that, being now freed from administrative duties, he intends to devote himself to the completion of several important Memoirs of the Geological Survey. He is succeeded in his appointment by his colleague, Mr. J. J. H. Teall, F.R.S., who is at present president of the Geological Society.

A VERY interesting announcement referring to the Leonid meteors has been received from the president of the Toronto Astronomical Society. He informs us that Mr. R. F. Stupart, vice-president of the Society, director of the Toronto Observatory and superintendent of the Meteorological Service of Canada, has sent him a copy of the following notes made by an observer at York Factory, Hudson's Bay :—" November 15, 1900. Very general display of shooting stars. Some very big ones N.W. to S.E. Sky full in shoals. November 16.—Shooting stars seen until daylight. Scared the people—they thought it was the end of the world." From these records it appears that a shower of Leonid meteors actually did occur last November.

IT is announced that a strong and influential committee has been formed with a view of erecting a triple monument in Heidelberg, by which the names of Bunsen, Kirchhoff and Helmholtz, whose lives and works are inseparably associated with the scientific progress and the rapid social and intellectual development of the alma mater of that city, should be thus lastingly and fittingly commemorated. It is proposed that special appeals for contributions should shortly be issued to some of the learned societies and academies in the German Empire as well as to some personal friends and admirers of the late three famous men of science, whose friendship they are known to have enjoyed and by whose influence they have benefited in their subsequent scientific attainments. It is understood, however, that the general public will not be invited to contribute towards this Bunsen-Kirchhoff-Helmholtz memorial fund. The chairman of the committee is Dr. Adolf Kussmaul, Emeritus Professor of Medicine in the University of Strassburg, to whose suggestion the movement owes its origin.

THE current issue of the *Journal* of the Franklin Institute contains an interesting account of a discussion on the electric distribution of power in workshops, which brings out very clearly the numerous advantages to be gained by the adoption of this method of distributing power. The rapid success which the system has achieved in America points conclusively to its convenience and economy. As one of the speakers pointed out, electric power originally based its claim to attention on the ground that there was much less loss in distribution, and that a saving of 20 to 60 per cent. of the total power used might therefore be effected by substituting electric for shaft driving. This saving, although at first sight it appears great, may, however, be quite small when considered in relation to the total cost of turning out the finished article which the factory produces, amounting, perhaps, to but a small fraction of a per cent. But electric power, it was soon found, effects saving in many other ways, one of the chief of which is that it enables the positions of machinery to be decided with reference to the machine rather than to the shafting. This means that the available floor space can be much more thoroughly utilised. It was stated in the discussion that in the case of the Baldwin Locomotive Works, the adoption of electric driving has saved so much floor space that the works would have to be made about half as big again to give the same output with shaft driving. In addition to these advantages, electric power has proved more convenient, healthier and less dangerous. With all these recommendations it ought not to be long before it entirely displaces the old-fashioned systems.

A BILL intended to organise the National Observatory of the United States has been introduced into the Senate by Mr. Morgan. The object is to convert the U. S. Naval Observatory into a National Observatory, and the following sections from the text of the bill, given in *Science*, describe the proposed organisation :—" That the Director of the National Observatory shall be an eminent astronomer, appointed by the President, by and with the advice and consent of the Senate, at a salary of five thousand dollars per annum, and shall be selected from the astronomers of the National Academy of Sciences unless, in the judgment of the President, an American astronomer of higher scientific and executive qualifications shall be found. That the Secretary of the Navy may detail for duty as astronomers at the National Observatory such professors of mathematics and other officers of the Navy as he shall deem necessary in the interests of the public service ; but on and after the passage of this Act no appointments shall be made of such professors unless required for service at the Naval Academy."

THE departmental committee appointed by the Board of Agriculture, and presided over by the Earl of Onslow, to inquire into the conditions under which agricultural seeds are at present sold, has completed the report upon the subject. The committee conclude that the seed trade in England is, on the whole, well conducted, and has of late years improved with the advance of science. Nevertheless, the majority of the committee recommend that one central station should be provided in the United Kingdom for the purpose of testing the purity and germinating power of seeds sent to it for official examination.

THE Berlin correspondent of the *Times* gives some of the results of the German census of December, 1900, which have just been published. The population of the German Empire has increased from 52,279,901 in 1895 to 56,345,014. Of this population 27,731,067 are males and 28,613,947 females. Over 83 per cent. of the whole population is contained in the four kingdoms; of these Prussia comes first with (in round figures) 34,500,000 inhabitants, and Bavaria second with 6,200,000. The figures for Saxony and Württemberg are 4,200,000 and 2,300,000 respectively. More than 16 per cent. of the population is resident in the thirty-three towns of over 100,000 inhabitants. Of these thirty-three towns the largest is Berlin, with a population of 1,884,151.

A REUTER telegram from Calcutta states that at a meeting of planters and agents interested in the indigo trade, held on February 20, it was decided to appoint a committee to wait on the Lieutenant-Governor in order to request him to grant a subsidy for further researches, as the results reported by the experts, Messrs. Hancock and Rawson, were highly promising. In the course of the meeting Mr. Karpeles said that Dr. Brunck's advice to Indian planters to give up the indigo trade was not likely to be followed. No reduction in planting was contemplated, and an increased output was expected from the manuring and blower processes.

AT the Wilts County Council's meeting on Friday last, reference was made to the fall of stones at Stonehenge, and a discussion ensued as to the taking of steps for the preservation of the remains. Prof. Story Maskelyne suggested the appointment of a small committee, not necessarily composed entirely of members of the council, but Lord Edmund Fitzmaurice, M.P. (the chairman of the council), explained that the matter was already being dealt with by the Charities and Records Committee, to whom the question of ancient monuments had been referred. It was also stated that the committee was in communication with the landowner and with the Society of Antiquaries, and hoped to report definitely at the next meeting.

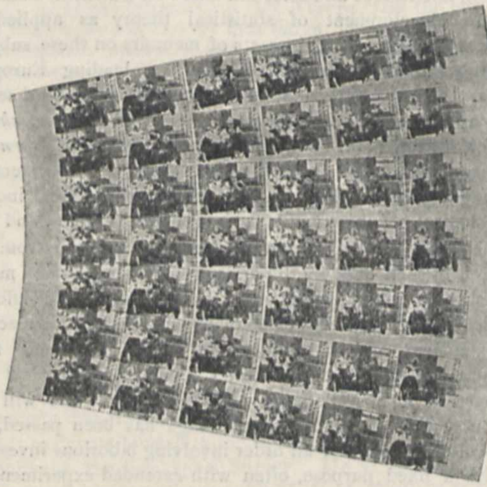
WE have to regret the death, on February 15, at twenty-six years of age, of Mr. Fred. Pullar, son of Mr. L. Pullar of Bridge of Allan. In conjunction with Sir John Murray he had recently published an admirable survey of the depths of many Scottish freshwater lochs, illustrated with beautifully engraved charts. The manner of his death was heroic. While skating on Airthrey Loch, near Bridge of Allan, a young lady fell through the ice, and he at once skated to her assistance and plunged in with his skates on. He kept her afloat for ten minutes, but in spite of determined efforts to save them, both perished. Eye-witnesses testify that he might have saved himself but for his devotion to duty. He was an only son, and the warmest sympathy is felt and expressed for his family.

THE Reale Istituto Lombardo has made the following awards of prizes:—Under the Brambilla foundation for improvements in industries or manufactures in Lombardy, a gold medal and 1000 lire to Gadda and Co., of Milan, for electrical machinery; a gold medal and 500 lire to Reiser, Cattoretti, Gola, Norsa and Co., for their manufacture of embroidery with new shuttle machinery; and the same to Carlo Fino for the preparation of cattle food in which blood and molasses are used; and a premium of 300 lire to Virginio Rimoldi for machinery for sewing gloves. Under the Fossati foundation a prize of 2000 lire has been awarded to Prof. A. Stefani for his papers on the regeneration of the peripheric nervous fibres. A number of other prizes remain unawarded. The prizes now offered include a prize of the Institution for the best essay on the differential equations of applied electricity to be sent in by April 1, 1901; a similar prize for 1902 for a toponomastic exploration of a district of Lombardy; two triennial medals for agricultural and industrial improvements in Lombardy; a Cagnola prize and gold medal for the best report dealing with hailstorms on the two sides of the Alpine chain, due April 1901; and a similar prize and medal for 1902, for an essay on the effects of gaseous emanations from manufactories on cultivated plants; another Cagnola prize for a discovery dealing with the cure of pellagra, the nature of miasms and contagion, the direction of balloons, or the prevention of forgery; a Brambilla prize for industrial improvements in Lombardy; Fossati prizes for 1901 and 1902 for essays on the anatomy of the encephalus of the higher animals; and for 1903, on the so-called nuclei of origin and termination of cranial nerves; a Kramer prize awarded to Italian engineers; a Secco-Comneno prize on the Italian phosphatic deposits; a Zanetti prize, open to Italian pharmaceutical chemists; and Pizzamiglio and Ciani prizes for educational and literary writings.

A CIRCULAR letter has been sent out seeking an expression of opinion from experts as to the advisability of founding a journal for the statistical study of biological problems. The letter is signed by Profs. Karl Pearson and Weldon, pioneers in this country in the line of work it is desired to encourage. *Biometrika* is the proposed title of the journal; thirty shillings the estimated cost of the first volume, to consist of four parts; and the proffered programme is an embodiment of memoirs on variation, inheritance and selection based on statistical examination, the development of statistical theory as applied to biological problems, and abstracts of memoirs on these subjects appearing elsewhere in each of the four leading European tongues. The proposal to found this journal is a natural sequel to the appearance during the last few years of the *Archiv f. Entwicklungs Mechanik* and, later, of the *American Journal of Physiology*, so largely devoted to the work of experiment on the living organism. The founders claim for statistical inquiry into biological phenomena a now established position, and give it as their opinion that "many persons are deterred from the collection of such data by the difficulty of finding such a means of publishing their results as this journal would afford." Statistical work in biology, to be of service, must be far-reaching and extensive, and it cannot be well dissociated from morphological inquiry of the better kind. A mere shot here and there at a miscellaneous collection of objects will not suffice now that the experimental stage has been passed, but upon prolonged work of an order involving laborious investigation with a fixed purpose, often with extended experiment, to be made, when possible, over a large area, can reliance alone be placed. Progress must necessarily be slow, and the accumulation of results worth publishing can only be expected after protracted research; and in these circumstances we are doubtful if the desire to burden the already over-crowded literature of biology with a new serial is not somewhat premature. It may be borne in mind that existing periodicals and the organs of societies are available for purposes of publication; and we could well desire for some of these that much of the so-called "systematic" work and quibbling over priority in nomenclature, fast becoming intolerable, might be replaced in work of the statistical and experimental order.

MR. W. A. HICKMAN, New Brunswick Government Commissioner, delivered a lecture on "New Brunswick" at the Imperial Institute on Monday. Like the rest of the maritime provinces of Canada, New Brunswick is situated much nearer Great Britain than any other of the important food-producing areas of the Empire. St. John, the capital, situated at the head of the Bay of Fundy, is the chief winter port of Canada, and the first lumber-shipping port in the world. The province contains 10,000,000 acres covered with heavy forests valuable for lumber or wood pulp. The manufacture of this pulp from spruce is an industry yet in its infancy, only a few mills being in operation. The demand for the product for paper-making is practically unlimited, and the supply in New Brunswick very great, while the transport facilities of the province for shipment either to British or Eastern American ports are excellent. In 1891 there were no Government-supervised butter and cheese factories, now there are about 100; in 1895 there were no modern roller wheat mills, in 1900 about 80,000 barrels of flour were manufactured. The dykelands round the Bay of Fundy are the most fertile agricultural lands in the temperate zone, and perfectly self-sustaining; as also is the majority of the land situated along the shores of the rivers and lakes.

THE difficulties involved in the manipulation of a long celluloid film have prevented the extensive use of kinematographic apparatus by amateur photographers. To avoid this objection, Mr. Leo Kamm has invented a camera—the Kammatograph—in which a circular glass plate takes the place of the celluloid film. The plate can be made to rotate rapidly by means of a multiplying gear, and at the same time it travels laterally. A small lens forms an image upon the plate, and when the plate is put in motion these images are multiplied into a series of pictures arranged in a spiral. The character of the pictures and their distribution will be understood from the accompanying reproduction of a small part of a series produced in this way. The plate



is, of course, developed precisely in the same way as an ordinary negative, and a positive is then taken from it. To display the series of pictures it is only necessary to place the positive in the camera and to arrange the camera so that the beam from a lantern close to it can pass through the lens. The plate is then rotated as before, and the succession of the pictures projected upon the screen reproduces the original movements. About six hundred pictures can be photographed during the motion of a single plate, at a rate of about twelve or fourteen a second. The camera is very compact, and both as regards price and adaptability is within the reach of any photographer who wishes to secure pictures of rapidly changing scenes and moving objects. The small size of the pictures will not permit of projection upon a large screen, but the views can be shown large enough for ordinary purposes.

FROM the point of view of public health, it is undesirable to cut up open spaces used for recreation near large cities. The Commons and Footpaths Preservation Society directs attention to the fact that there are several private bills, now before Parliament, which propose to take power to interfere with commons, village greens and open spaces. The City and North-East Suburban Electric Railway will seriously affect Hackney Marshes and Leyton Marshes, and, in a lesser degree, Victoria Park. The line is to be for the most part in tunnel, but where it crosses Hackney Marshes and Leyton Marshes, two exceptionally valuable open spaces, it will emerge from the tunnels and run on an embankment varying from 5 feet to 20 feet in height. Two short branch lines will also be erected on the surface of the Marshes, and altogether about twenty-five acres of common land will be abstracted. The North-East London Railway also seek powers to run a line on an embankment, varying from 14 to 31 feet in height, over Walthamstow and Leyton Marshes. The construction of more than two miles of high embankments on a much-used and highly valuable stretch of common land would practically destroy its utility as an open space and injure its amenity. The Society has therefore resolved to oppose the bills.

WE learn from the *Scientific American* that the Niagara Falls Power Company has about completed its second power transmission line between Niagara Falls and Buffalo. The new line possesses special interest because of the fact that the cables are made of aluminium. The three-phase current is transmitted by three cables, each composed of thirty-seven strands. The old line consists of six copper cables, each of which has nineteen strands. One advantage gained in the use of aluminium is that the cables being so much lighter, the span between poles, which in the old line is about 75 feet, averages 112½ feet in the new line. On the completion of the aluminium line, the voltage of the current that is transmitted will be raised from 11,000 to 22,000 volts.

WE have received from Mr. R. F. Stupart, director, a copy of the Report of the Meteorological Service of Canada for the year 1897, a large quarto volume of 292 pages. Observations were made at 314 stations; at the chief stations, where all the ordinary observations are taken day and night at equal intervals of time not exceeding four hours, at the telegraphic reporting stations, where the observations are taken three times daily, and at some few of the special stations, the observers are paid for the time which they devote to the duties required of them, but at the bulk of the stations the work is purely voluntary, the Meteorological Department at Toronto simply supplying the necessary instruments. A liberal exchange of telegraphic reports takes place between the United States and Canada, from which data a very comprehensive daily weather chart is constructed and on the basis of these charts forecasts and storm-warning notices are issued. The storm warnings are very successful, about 86 per cent. being fully verified, while the direction from which the wind would blow was fully verified, to the extent of about 94 per cent. The daily forecasts obtain an average success of 81 per cent. They are disseminated to the agricultural community by discs on the baggage vans of outgoing morning trains. The tables of observations and results are very carefully prepared, and the whole report furnishes an important contribution to climatological knowledge.

THE Society for the Protection of Birds has issued a small pamphlet, by Surgeon-General Bidie, urging the need of effective protection for wild birds in India.

TWO numbers (18 and 19) of the *Circular* of the Royal Botanic Gardens, Ceylon, have reached us; the one giving a list of the kinds of ornamental and timber trees best suited for planting in the island, and the other describing certain caterpillars which infest the tea-plant.

MUCH interest attaches to Mr. J. P. Smith's account, in the *American Naturalist*, of the coiled larval shell found attached to the lower extremity of many specimens of Baculites from the Cretaceous beds of Dakota. This straight-shelled Cretaceous cephalopod is accordingly considered to be descended from a coiled Clymenia-like ancestor.

WE have received the *South-Eastern Naturalist* for 1900. In addition to several papers, it contains an account of the congress of the South-Eastern Union of Scientific Societies, held at Brighton in June under the presidency of Prof. Howes. Bird protection was one of the subjects discussed, in connection with which the president expressed nis opinion that the present unsatisfactory state of affairs is largely due to the apathy of local authorities in putting enactments in force.

THE systematic position of the sand-grouse forms the subject of a paper, by Dr. R. W. Shufeldt, in the January number of the *American Naturalist*. It is concluded that these birds form a subordinal group intermediate between the pigeons and the game-birds. In the same serial Mr. G. H. Parker discusses certain tortoises with abnormally formed horny shields, in which correlated abnormalities likewise occur in the underlying bony plates. And he is led from this association to conclude that in the primitive chelonians each plate was covered by its own proper shield, as in the case of the glyptodons of South America.

To the February number of the *Zoologist* Mr. G. Renshaw contributes an account of all the known specimens, whether alive or dead, by which the quagga has been or is represented in menageries or museums. About ten living examples of this extinct equine appear to have been exhibited from time to time in menageries. Three skins, a skeleton, and two skulls represent the animal in the United Kingdom, in addition to which two other skeletons have been stated to be those of quaggas. Continental museums are more fortunate, possessing among them, in addition to several skeletons and skulls, no less than eleven moumted skins, one of which is that of a fœtus. In the South African Museum this once abundant species is represented only by a foal. A skeleton at Philadelphia, said to be that of a quagga, completes the list of known remains. The author states his belief that the skin and skeleton in the British Museum belong to an individual which died in the Zoological Gardens previous to 1838, in reality they were not acquired till 1864.

IN the *Journal de Physique* for January, M. E. Mathias applies Weierstrass's signs to determine the mutual induction of two parallel circular currents. The advantage of this method is that it enables the potential energy to be expressed as a function of the radii and distance apart of the circuits in a rapidly converging series.

MR. GILBERT NEWTON LEWIS suggests a new conception of thermal pressure and a theory of solutions in the *Proceedings* of the American Academy (xxxvi. 9). The theory, according to which the thermal pressure of any phase is equal to the pressure which the substance would exert if under the same conditions as a perfect gas, suggested itself in the consideration of certain remarkable general laws which treat of heterogeneous equilibrium in which the several phases are subject to different pressures. The same assumption is alone sufficient, according to the author, to explain all the laws of dilute solutions. The relations of Mr. Lewis's theory to the theory of van der Waals are also discussed.

THE January number of *La Géographie* contains a paper by Dr. A. G. Nathorst, of Stockholm, on the distribution of the wolf and the musk-ox in high northern latitudes, and especially in Eastern Greenland. Count Henri de la Vaulx contributes a paper on his journeys in Patagonia.

THE new number of the *Mitteilungen aus den deutschen Schutzgebieten* is devoted to an account of the work of the German members of the British and German Boundary Commission between Lakes Nyasa and Tanganyika. There are special reports, on the astronomical and geodetic work, by Dr. E. Kohlschütter, and on the country and people, by Captain Herrmann. Four sheets of an excellent map on a scale of 1 : 100,000, by the members named and Lieut. Glauning, accompany the reports.

THE Eighth Annual Report (for 1899) of Dr. S. Calvin, the State Geologist, forms vol. x. of the Iowa Geological Survey. It contains a useful index geological map of the State; a report on the mineral production, which includes coal, clay, stone, gypsum, and lead, zinc and iron ores; and sundry geological reports. Mr. Stuart Weller deals with the succession of fossil faunas in the Kinderhook Beds at Burlington. These faunas exhibit a gradual transition from those with Devonian to those with Carboniferous characters. The Devonian element is for the most part exhibited by the pelecypods, while the brachiopods ars usually Carboniferous in aspect, and there is an overlapping and intermingling of these forms. The geological reports deal very fully with different counties in Iowa.

IN the *Proceedings* of the Liverpool Geological Society (vol. viii. part iv., 1900) we find an interesting address by Prof. W. A. Herdman on "The Geological Succession of Morphological Ideals." Referring to the many distinct groups of animal life found in the Lower Cambrian rocks, and which are usually taken to indicate that "we are already pretty far up in the history of evolution, and very far in time from the primitive fauna," he expresses the opinion "that the first differentiation of the great groups of invertebrates may have taken place very rapidly in pre-Cambrian times at the surface of the sea amongst soft-bodied pelagic animals." He then discusses the chief faunas of the Palæozoic rocks, pointing out the successive organic types which dominate as "representatives of the ideals which Nature seemed striving to attain in the successive geological periods."

THE observatory on Mount Etna, being situated at a height of 2950 metres, at the foot of the central crater and only 300 metres below the summit, it has been assumed that the ground on which it is built must be almost continually in a state of tremor. To show how unfounded the supposition is, Messrs. A. Riccò and L. Franco have made a comparative study of the tromometric records from the observatory there and from that at Catania, the instrument employed being the normal tromometer 1½ metres long, and the readings being taken six times a day for nearly eight years. In 46 per cent. of the observations on Etna, and in 62 per cent. of those at Catania, the tromometer was found to be in motion. The higher figure at Catania is partly due to the influence of external agents; for, when the sea is rough, the tromometer there is never still, while on the mountain it is unaffected. Also, taking only those observations made when the wind was strong, or very strong, the tromometer on Etna was in motion in 59 per cent. of all such cases, and that at Catania in 94 per cent. On the other hand, when there was little or no wind and the sea was nearly, or quite, smooth, the corresponding figures are 38 for Etna and 69 for Catania.

THE fifth part of "Zoological Results based on Material from New Britain, New Guinea, Loyalty Islands and Elsewhere, collected during the years 1895–1897," by Dr. Arthur Willey, has been published by the Cambridge University Press. The work will be brought to a conclusion by the publication of one other part in the course of the present year, and when it appears the six parts will be reviewed together.

THREE new volumes in Ostwald's series of "Klassiker der exakten Wissenschaften," published by Mr. Engelmann, Leipzig, have been received. No. 114 contains letters and other communications written by Volta in 1792–1795 upon the subject of animal electricity, and No. 118 contains Volta's accounts of investigations made by him in the period 1796–1800. No. 115 is devoted to de Saussure's research in hygrometry (1783). The three volumes are edited by Dr. A. J. von Oettingen, and are in German, like the other volumes in the series.

AN interesting synthesis of fumaric acid is given in the current number of the *Berichte* by O. Doebner. Under the action of pyridine, condensation between glyoxylic and malonic acids is readily effected. The condensation may be imagined to take place with the intermediate formation of maleic acid, but attempts to isolate this were unsuccessful.

IN his account last year of the properties of the remarkable hexafluoride of sulphur, M. Moissan mentioned that other bodies were formed at the same time containing sulphur and fluorine, and in the current number of the *Comptes rendus* he gives, in conjunction with M. Lebeau, a further contribution to this subject. The compound described is sulphuryl fluoride, SO_2F_2, and it is obtained by the regulated action of fluorine upon sulphur dioxide. The conditions of the reaction had to be carefully studied, as the reaction of these two gases is so violent that explosions frequently occur. The new gas is necessarily accompanied by others, owing to the operations being carried out in glass vessels, and the separation of these is effected by liquefying the whole at $-80°$ C. and fractionating *in vacuo*. Sulphuryl fluoride is a colourless, odourless gas, solidifying in boiling oxygen, melting at $-120°$ C., and boiling at $-52°$ C. Although in some respects it resembles its halogen homologues, in its stability and inertness in other reactions it recalls the properties of the hexafluoride. Thus it is without action upon water even in a sealed tube at 150° C. M. Moissan remarks that these experiments show that although fluorine is undoubtedly at the head of the halogen group, it is a little removed from the others, having special and characteristic properties which show affinities rather to oxygen than to chlorine.

THE additions to the Zoological Society's Gardens during the past week include a Patas Monkey (*Cercopithecus patas*), a Green Monkey (*Cercopithecus callitrichus*), an Anubis Baboon (*Cynocephalus anubis*), an African Civet Cat (*Viverra civetta*), a Denham's Bustard (*Eupodotis denhami*), a Royal Python (*Python regius*) from Falaba, Sierra Leone, presented by Mr. C. E. Birch; two White-collared Mangabeys (*Cercocebus collaris*), a Bay Duiker (*Cephalophus dorsalis*) from West Africa, presented by Mr. E. R. Cookson; a Herring Gull (*Larus argentatus*), European, presented by Mr. C. A. Hamond; a Jay (*Garrulus glandarius*), a Jackdaw (*Corvus monedula*), European, presented by Miss N. Eskell; a Merlin (*Falco oesalon*), European, presented by Mr. Gregory Haines; a Goshawk (*Astur palumbarius*), European, presented by Major-General A. A. Kinloch, C.B.; a Barn Owl (*Strix flammea*), European, presented by Mr. A. Masters; two Dwarf Chameleons (*Chamoeleon pumilus*) from South Africa, an Axis Deer (*Cervus axis*) from India, deposited; a Hoffmann's Sloth (*Cholopus hoffmanni*) from Panama, a Great Ant-eater (*Myrmecophaga jubata*) from South America, two Horned Tragopans (*Ceriornis satyra*) from the South-east Himalayas, four Californian Quails (*Callipepla californica*) from California, four Virginian Colins (*Ortyx virginianus*) from North America, purchased.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN MARCH.

March 2. 10h. 46m. to 12h. 3m. Moon occults κ Cancri, (mag. 5·0).
6. Outer minor axis of Saturn's ring = 15″·24.
7. 13h. 3m. Minimum of Algol (β Persei).
9. Mars in conjunction with α Leonis (Regulus), Mars 3° 49′ North.
10. 9h. 52m. Minimum of Algol (β Persei).
11. Saturn in conjunction with π Sagittarii (mag. 3·0). Saturn 1° South.
13. 6h. 41m. Minimum of Algol (β Persei).
14. 11h. Jupiter in conjunction with the moon. Jupiter 3° 25′ South.
14. 21. Saturn in conjunction with the moon. Saturn 3° 26′ South.
15. Venus. Illuminated portion of disc = 0·980.
15. Mars. Illuminated portion of disc = 0·979.
24. 7h. 37m. to 8h. 40m. Moon occults ω[1] Tauri (mag. 5·8).
25. 6h. 32m. to 7h. 42m. Moon occults *l* Tauri (mag. 5·5).
26. 9h. 15m. to 10h. 6m. Moon occults 68 Orionis. (mag. 5·6).
28. 6h. 16m. to 6h. 40m. Moon occults 1 Cancri (mag. 5·9).
29. 5h. 30m. to 6h. 33m. Moon occults A[2] Cancri (mag. 5·8).

VARIABILITY OF EROS.—The recent announcement by Dr. Oppolzer concerning the variation in the brightness of the minor planet Eros is confirmed by the accounts of two French observers, who communicate their results in the current issue of *Comptes rendus* (vol. cxxxii. pp. 396–398).

The first paper, by M. F. Rossard, describes a series of determinations made at the observatory of Toulouse with a Brunner equatorial of 0·23 metre aperture. Estimates with comparison stars were taken on the nights of February 14, 15, 16 at short intervals. Evidence of rapid variation was detected, the difference exceeding a magnitude, the extreme range being from 9·3 to 11·0. The times of the various phases observed were as follows:—

		h. m.					h. m.	
1901 Feb.	14	9 43	min.		1901 Feb.	16	7 34	max.
	14	10 48	max.			16	8 56	min.
	15	8 10	max.			16	10 3	max.
	15	9 32	min.			16	11 30	min.
	15	10 44	max.					

The comparison of these minima and maxima indicates that the variation in brightness shows a little less than ten periods in a day, *i.e.* the duration of the period is about 2h. 22m.; also that the period of increase from minimum to maximum is about 15 minutes shorter than the interval from maximum to the following minimum.

The second note is by M. Ch. André. He says the total variation takes place in about 6 hours, and in character is similar to the variable star U Pegasi, but with the stationary period a little longer, so that the planet Eros is to be regarded as a photometric variable, and may consist of a double system formed of two asteroids, whose diameters are slightly less than 3 : 2, and whose orbital plane passes through the earth. As the distance of Eros from the earth is about two-thirds that of the sun, the inclination of the line of sight on the plane of the orbit will change rapidly and continuously. The study of these variations will be important in giving a series of light curves, in which the only variation is that of the inclination of the line of sight on the plane of the orbit of the satellite.

NEW VARIABLE STAR, 1. 1901 (Cygni).—Mr. Stanley Williams announces the variability of the star situated in the position

$$\left.\begin{aligned} \text{RA.} &= 19^{h}\ 28^{m}\ 1^{s}\cdot 5 \\ \text{Decl.} &= +\ 28°\ 0'\cdot 5 \end{aligned}\right\}(1855).$$

The estimated photographic magnitude varied as follows:—

		Mag.
1900 Oct. 27	...	10·7
Nov. 18	...	9·9
Dec. 15	...	10·5

A chart of the region surrounding the star is given, and reference made to a previously published photograph of the region by Dr. Max Wolf (*Knowledge*, 1892, p. 130), on which the star is not shown. (*Astronomische Nachrichten*, Bd. 154, No. 3687).

RECENT WORK OF THE INDIAN MARINE SURVEY.[1]

THE importance of the work intrusted to the Indian Marine Survey, alike from the point of view of the hydrographer, of the geologist, and of the zoologist, is so well known to all men of science that it would be mere waste of time to attempt to emphasise it on the present occasion. All the Reports that have from time to time been published by this Survey bear witness to the zeal and energy with which the work is carried on—frequently under circumstances of great difficulty—and to the capacity and accomplishments of the officers to whom it is entrusted. But it will be no reflection on previous documents of the same nature if we call attention to the special interest attaching to the one now before us, on account of the varied nature of the subjects on which it touches, the philosophical manner in which these are treated, and the problems presented by many of them.

The first section of the Report is by Commander T. H. Heming, R.N., who has entire charge of the Survey; and geologists will read with great interest his account of the rapid silting-up of the Gulf of Martaban that is now in progress. It appears that an enormous quantity of sediment is being carried into the Gulf by the Salween River; a sample of water taken at spring tide during the dry season yielding no less than 1/300th of dry mud by weight. The deposit has mainly taken place outside the 10-fathom line, and so heavy is it that in spots where there were formerly from 40 to 50 fathoms, the depth is now reduced to from 15 to 20; the area affected being approximately 2000 square miles. "Putting the amount of water discharged by the river flowing into the Gulf at a low estimate," says the Report, "and supposing it capable of supporting on the average one-quarter of the proportion of sediment held in solution [? suspension] by the specimen examined, there would be more than enough solid matter carried into the Gulf in forty years to cause the silting-up which has actually taken place."

Another point of interest in this section is the longitude of the Andamans, which, as deduced by running a meridian distance to Sugar-loaf Island, was found to differ by 1′ 70″ from that given by the Great Trigonometrical Survey. In consequence of this discrepancy it is now proposed to run a meridian distance between Port Blair and Diamond Island both ways, in order to obtain the best possible results with the means at disposal.

Passing on to the section of the Report written by the Surgeon-Naturalist, Captain A. R. S. Anderson, we may call attention to the remark as to the rapid change in the coloration and appearance of the animals of Ford Bay, Great Cocos Island, when the coral bottom of the open channel is left for the sandy bottom of the bay. While quarantined off Colombo a lucky haul brought up no less than forty-one examples of the rare crustacean *Lupocyclus orientalis*, of which only three specimens were previously known to science. In another haul, which brought up a miscellaneous collection of dead corals, sharks' teeth, fish-bones and bones of turtles, the interesting fact was discovered that while some of these were in practically the same condition as at the time of their deposition, others had been highly impregnated with mineral matter. No embedding in sediment had, however, preceded the fossilisation (if the term is permissible in this connection), which had evidently taken place as the bones lay loose on the sea-bottom.

In a haul taken some distance east of the Maldives, Captain Anderson was fortunate enough to procure over 200 specimens of an echinoderm nearly related to the West Indian *Palaeopneustes hystrix*, but apparently specifically distinct. When placed in spirit these urchins turned it a magnificent rich purple, although their own colour was a dull madder-brown. Many other rare and interesting invertebrates were obtained at other dredging stations, but we must omit mention of any of these to refer to a totally different subject.

Between Colombo and Rangoon an excellent opportunity was afforded of carefully observing the flight of the common flying-fish (*Exocoetus evolans*). "When they first rise from the water," writes the narrator, "they do so with a very rapid fluttering of their wings lasting for two to three seconds; they then soar along till their speed is so reduced that they descend and touch the water, into which they either fall with a splash or dip the elongated tip of the caudal fin, and, I think, the ventral fins on which they seem to poise themselves, again rapidly vibrate their wings, and get up sufficient speed to renew their flight; this process I have seen them repeat as often as seven times in the course of one long flight. Very occasionally, however, I have observed these fish fluttering their wings without touching the water with their caudal and ventral fins."

After mentioning that in order to observe these motions calm weather and a binocular are necessary, Captain Anderson proceeds to say that he fails to understand how Moseley, as narrated in his "Naturalist on the *Challenger*," as well as several other observers, have denied the fluttering of the wings in flying-fish. Apparently he is unaware that it has been stated in the "Royal Natural History" by the editor, as the result of personal observation, that these fish do possess the power in question, as indeed had been attested in *Land and Water* by a much earlier observer. Captain Anderson's observations also corroborate the statement made by the writer last referred to, that flying-fish are capable of altering the direction of their flight: an attribute that was denied to them by Dr. Möbius in his well-known account.

In a later paragraph Captain Anderson draws attention to the circumstance that in flying-fish the lower surface of the body is flattened in order to enable them the more easily to rise from and hover over the water, and that in the allied genus, Hemirhamphus,[1] the members of which rush at full speed along the top of the water with only the hinder portion of the body immersed, a similar flattening is observable.

While lying in Burmese waters off Moulmein, the surveying vessel encountered a large quantity of drift-wood brought down by the Moulmein river. Some of this became entangled in the paddle-wheels, and on three mornings snakes were found on the floats. A female leopard, probably carried down by the strong tide, took refuge one morning on a cargo boat moored somewhat higher up, and eventually swam ashore, where she was shot. These instances are of much interest in connection with the dispersal of species.

Much of the latter portion of this section of the Report is occupied by an account of the author's experiences in the Andaman Islands, where he has much to say concerning both the natives and the fauna. In one passage he mentions that, while walking through the forest, a native announced the presence of a large mass of wild honey in the immediate neighbourhood, which he detected by its smell, although this was quite imperceptible to the European members of the party.

In conclusion, Captain Anderson refers to the remarkable circumstance that in the neighbourhood of the Andamans there occur masses of sandstone at a depth of between 39 and 226 fathoms which are quite bare of coral, although there is an abundant growth of the same in the immediate neighbourhood. It is inferred that the bare area, and probably also the larger portion of the bank, has never been within the zone of massive reef-building corals. "Had it ever been so, it is most improbable that there should be bare rock exposed at 39 fathoms. For that the bank is eminently suitable for the growth of coral, both the dredgings and the soundings, by bringing up live coral, showed; at no part of the bank was there any turbidity of the water sufficient to check coral-growth. . . . Were the theory correct that, given a bank rising within a comparatively short distance of the surface, deposit will accumulate on that bank and so form a basis for a coral island, there is no reason why, in the case of this bank, bare rock without any such deposit on it should be found."

Many other equally interesting and suggestive extracts might be culled from this valuable report did limitations of space permit. R. L.

[1] Administration Report of the Marine Survey of India for the Official Year 1898–99. Pp. 17. (Bombay: Government Central Press, 1900.)

[1] A mis-spelling of this and several other names is noticeable in the Report, but, as the writer of this notice is well aware, much allowance must be made for an author whose copy is set up by native Indian printers.

THE TEACHING OF PHYSIOLOGY.

IT is scarcely too much to say that the only real scientific knowledge is that obtained through personal experience. Lectures and text-books have their places in a scheme of instruction in science, but they only convey information at second-hand, whereas original experimental work creates and fosters the inquiring spirit characteristic of a progressive mind. What students need to be taught is that they must be not so much receptive as constructive; and the way to give force to this view is to insist upon their taking an active share in investigation at every stage of their careers. It is in the highest degree satisfactory to know that this principle is being acted upon in the courses of scientific instruction followed in many of our schools and colleges—more particularly in the Schools of Science and Higher Elementary Schools of the Board of Education. But a large class of students of a higher grade are introduced to scientific subjects on the old-fashioned plan, the reason in most cases being that they have no time to pursue a course of work constructed on rational lines. Metaphorically, they endeavour to enter the field of science by a short cut instead of following the route of patient and persistent observation, and in the end they find themselves without the certificate of admittance into the Delectable City. Medical students are the greatest sinners in this respect, but the fault lies not so much with them as with their masters and examiners. So many subjects have to be taken that it seems almost hopeless to look for greater opportunity for investigation or for the development of a spirit of research in students whose knowledge of practical chemistry is obtained by a few hours' test-tubing. In the teaching of physiology, also, there is a great gap between rational methods and existing practice, and Dr. W. T. Porter, associate professor of physiology in the Harvard Medical School, directs attention to it in an article which we reprint, slightly abridged, from the special educational number of the *Philadelphia Medical Journal*. Dr. Porter shows, in addition, how large classes of students may be carried along the well-known roads that lead to scientific power, and gives the results of one year's experience with a method of instruction different from that usually employed. His paper thus contains a statement of a course which has been proved to be practicable, and has been accepted by the Faculty of the Harvard Medical School. The methods described need not, however, be limited to medical education, as they are based upon principles which, *mutatis mutandis*, can be applied to instruction in any science. The paper is thus worthy of consideration by every one interested in the extension of natural knowledge.

To the physician the study of physiology is of use largely because it creates a habit of thought essential to the highest professional success. Physiology is a *rational* science. Its problems require the scientific method. They demand the precise statement of the question in hand, a severely critical examination of the results of experiments, and the arrangement of the accepted experiments in the order that shall lead logically, step by step, to a correct solution. Medicine is itself an experimental pursuit. Its higher walks are open only to those skilled in research. The scientific method cannot be acquired by the study of anatomy and pathology in the purely descriptive form in which they ordinarily are presented to the medical student; in this form they are stuff for visual and aural memory—not for the exercise of reason. Nor can the experimental state of mind be readily acquired by the study of clinical medicine. Reliance must be placed on a well-developed, highly rational science, cultivated to train rather than inform the mind, pursued, not for its stores of information, but for the highest product of human faculty—the system of inquiry that leads to light through darkness. Too often in our medical schools information is mistaken for knowledge. Only knowledge is power. The getting of mere information wastes the student's time. The vast accumulations of centuries of medical study confuse the undisciplined mind and crush the spirit. The burden of fact which any man can bear is relatively small, and each year grows relatively smaller. To find new truths and to look undismayed upon the old is the perfect fruit of education. This physiology can give, and on this power to train should rest the high position of physiology in schools of medicine.

The physiological lectures in medical schools are commonly given by one man and cover the entire field of physiology. This field is much too large to permit of even superficial personal acquaintance by one man. Necessarily, therefore, the instructor must take the chief part of his lecture from text-books. To this he adds citations of a few experiments or observations taken from the original sources. He has not and cannot have real knowledge as to the present state of special opinion on the majority of the chapters in his subject, because none but a specialist can cope with the constantly rising flood of meritorious research in any one chapter—to keep pace with the whole of a science which stretches ample arms over the larger part of human and comparative biology is impossible. Physiology could not be taught by the lectures now so largely given, even were lecturers gifted with superhuman knowledge. Physiology deals with phenomena, not with words. Many of these phenomena, for example the heart-sounds, cannot be described; others can be pictured dimly, but only to those who know related phenomena from having actually seen or otherwise sensed them; in no case can lectures properly instruct unless the fundamental facts or closely related facts have first been learned by actual observation in the laboratory. The student should come to the lecture already possessed by his own efforts of the phenomena to be discussed. Chapters, such as metabolism, in which the fundamental experiments are unusually difficult or protracted, should be preceded by less difficult though related chapters. If the obstacles to practical work in any field are insurmountable, the protocols of classical experiments in this field, together with a suitable connecting text, should be studied before the lecture. At present the lecturer too often merely offers a list of facts which mean little or nothing because they cannot be associated in the student's mind with phenomena already observed. The lecturer attempts to remind the student of that which the student never knew. The secondary schools have prepared the student to see nothing strange in this. Most men enter the physiological course persuaded that natural science can be acquired chiefly from books, and leave convinced that a deal of talk and a pennyworth of nature will give real knowledge of the action of living tissues.

A natural science cannot be well taught except by those who have themselves made experimental investigations in the special field which they would teach. No one in these days can work profitably in many fields, and only necessity should make one man attempt to teach them all. A man trained, for example, in the physiology of digestion is likely to have but a relatively feeble grasp on the physiology of the circulation, and nervous system, or the special senses. It follows that most of the instruction in the one-man system does not adequately represent the present state of knowledge. It is behind the times in all except the special field cultivated by the instructor himself. So far as possible, the didactic instruction in each field should be given by the member of the physiological staff actively at work therein, but this wise principle of the division of labour is not usually regarded.

Passing now to the demonstrations, we find that in the larger schools they are made before an audience of at least two hundred. Thus the greater number cannot see the demonstration clearly. If the class be divided into small sections, the brief glimpse allowed each man does not suffice for a full grasp of the details. Very commonly the demonstrations requiring much time are given in a course separate from the lectures. In short, most of the demonstrations as now given are an aid to the memory rather than a means of training in science. The position awarded them by the usual lecturer and by almost every student is one of the evidences of the fundamental pedagogical error which renders most medical teaching of anatomy and physiology so largely futile, namely, the deplorable notion that demonstrations are merely illustrative, and the book and the lecture the main force. Never was the pedagogical cart more squarely before the horse. Contact with nature is the essential of all training in biology.

The laboratory work in large schools is usually done in relatively small sections, and is not coordinated with the regular lecture course. The student feels that the experiments are purely secondary. The experiments are imperfectly arranged into groups. They merely illustrate the text-book. In no case do they present a full picture of any field. The time allowed is so short that criticism of results and insistence upon the proper standard of excellence is not attempted.

The instruction is the same to every student without regard to what his life is to be. Much time is given to matters which have a very remote connection with the future of most students, and which are not better material for training the mind than matter bearing directly on the student's future work.

It is important to inquire how this extraordinary system was developed. The reply is that the present method is a survival of mediæval methods; the student of tradition finds a rich field in the history of medical teaching. The teaching of physiology has broken away from anatomy; men now living have taught both subjects in the same course of lectures. Descriptive anatomy became the most conspicuous discipline in medicine at a time when the best mental training could be had only from books, from lectures, from abstractions. It was the flowering time of metaphysics, of authority, of the deductive method. The true principle of approaching nature discovered by the

Greeks survived only in a few men of genius, a spark that in our own time has been fanned into flame. Joined to the powerful example of the most liberal education of that period was the difficulty of obtaining material for dissection. Stark necessity united with specious theory to fasten upon this most concrete of sciences the methods of the schoolmen, and to this day the bulk of the instruction in anatomy remains didactic, and consists of books, diagrams, and more or less misleading models. Dissections are made to illustrate the book. The printed description is learned by rote, and the dissection practised too often simply as a manual exercise. The anatomy of the medical college is largely a memory drill—such as belongs pedagogically in the secondary schools. These seventeenth-century notions have been passed from anatomy to physiology. That which began as a makeshift has become a dogma.

Practical work in physiology has also been kept back by the erroneous ideas that the cost of apparatus and other materials is prohibitory, that medical students cannot master the details of exact experimentation, that delicate apparatus cannot be trusted in their hands, and that instruction to the extent required cannot be given to large classes because the course will become too complicated to be carried out.

Perhaps the chief obstacle which has kept physiology in an ancient and now almost abandoned path, is the public belief that because anatomy and physiology were once taught chiefly from books, they should still be so taught; that the functions of living organs can be learned from books with the occasional exhibition of dead organs; that the natural sciences should continue to be studied in secondary schools without laboratory work; in brief, that nature can be studied apart from nature. The public has a just contempt for men who profess to have learned disease without practical observation of the sick—experience is conceded to be necessary here—but the public is ready to applaud, and even to compel by law the study of the same organs in their normal state by reading or hearing a description at second hand of what some third person saw. The real drags upon progress are the failure of the secondary schools to teach science by scientific methods, and the fatal conservatism that binds teachers of medicine to a past that we should do well to forget. These venerable delusions no longer impede experts in pedagogy, but unfortunately medical teachers for the most part are more zealous than learned in pedagogy. They fail to see that medical training should be "for power," and only secondarily for information.

If it be replied to these strictures that a system which produces so many able physicians cannot be much in need of improvement, I answer that the men of talent veil the defects of the mass. They owe much to themselves; genius will thrive on the intellectual diet that stunts the merely industrious man. The average student does not build upon a sound foundation. He knows little anatomy, less physiology, and still less chemistry, and even his training in practical medicine has to be supplemented where possible by postgraduate work in a hospital. On the whole, it may be said that his industry has been largely misdirected.

The picture I have drawn of the instruction in physiology in the average medical school will be accepted by teachers of that science. The sense that the usual methods of instruction neither develop nor much inform the mind is general. Careful inquiry should therefore be made to determine how far the defects can be remedied with the means at our disposal. The problem is: How far can the correct theory be realised in practice? To what extent can all students of physiology be taught in the manner in which men are trained to be professional physiologists? Evidently physiologists are likely to study their own subject in the most profitable and labour-saving way.

The expansion of physiology has broken it into specialities. Even professional physiologists can no longer have personal acquaintance with the whole subject, or even a relatively large part of it. To a considerable degree the physiologist himself must acquire his information from reading the work of others. It would therefore be idle to expect the student to get a personal experimental knowledge of the whole subject. His limited time must be used chiefly for training, and not chiefly for the acquisition of facts, as at present, and this training must follow the lines laid down by physiologists for their own development.

Deal so far as possible with the phenomena themselves, and not with the descriptions of them. Where the fundamental experiments cannot all be performed, fill the gap with the original protocols from the classical sources. Associate facts which the student can observe for himself with those which he cannot observe. Use as the basis of professional instruction, where practicable, the facts and methods to be used by the student in earning his living. Teach the elements by practical work. Let the student state his observations and results in a laboratory note-book, which, together with the graphic records of his experiments, shall form one of the requirements for the degree. Control his progress and remove his difficulties by a daily written examination and a daily conference, in which the instructor shall discuss the observations made by the student and supplement them from his own reading. Stimulate the student by personal intercourse in the laboratory, by glimpses of the researches in progress, and by constant reference to the original sources. Diminish the distance between professor and pupil; both are students, and both should be fed on the same intellectual diet. There is but one way to get and keep an education. Demand of every student a written discussion of some very limited thesis, giving the results of the original investigators, together with any observations the student has made for himself. Give the more capable students opportunity for original experimental work. Towards the end of the instruction, when the student is ripe for such work, offer a liberal number of courses of didactic lectures with demonstrations. Let each course consist of from one to four lectures not more than forty-five minutes in length, presenting all that is known of the chosen subject. These lectures should show the student the historical development of scientific problems, the nature of scientific evidence, and the canons of criticism that help to sift the wheat from the chaff of controversy. From the beginning to the end of the instruction hold fast to concentration, sequence and election. Such are the lines along which sound theory would direct the teaching of physiology in medical schools.

Concentration, sequence and election are the safeguards of economical labour.

Whether the student's time is to be given wholly or only in part to the subject taught is the first problem to be solved in planning the actual instruction. Men in training for professional physiology commonly concentrate their energies for a sufficient period on this one subject; and this is regarded as the most economical way of mastering any science, for the ground gained by one day's work is still fresh in the mind when the next day's work begins, and continuity of thought is not disturbed. The plea that the instruction in one subject should be broken by the study of other subjects in order that the instruction in each may have "time to sink in" need not be entertained; experience shows that much of it sinks in so far that it cannot be recovered without the loss of valuable energy. A more serious objection is that the method of continuous application is highly fruitful in men of exceptional powers, who are keen in spite of protracted effort, but is wasteful for the average brain, which is fatigued and unreceptive after some hours of unremitting labour. The truth of this must be allowed; but the objection does not apply to wide-ranging sciences such as anatomy and physiology, which are not narrow, hedged-in areas, but which consist rather of broad and diversified domains composed of many contiguous fields, the varied nature of which is a perpetual refreshment.

A correct sequence of study is also highly important. Very often in medical schools the lectures in physiology are given before the student has any acquaintance with the anatomy of the structures considered, and still more are heard before the student has any true anatomical knowledge—that based on actual contact with tissues and not upon a glimpse of a distant prosection or a hasty glance at a diagram. Similar instances are not uncommon in later parts of the curriculum. The natural sequence demands that the study of structure should precede the study of function, and the study of the normal precede that of the abnormal. Thus the natural order of medical study is descriptive anatomy, physiology, pathology and medicine. There is a considerable advantage in treating organs individually, studying their structure, physiology, pathology, diseases and treatment in continuity, but practical difficulties in arranging such a course make this inadvisable.

Election is correct in theory and unavoidable in practice. Generations have passed since it was possible to teach every clever student all things. Yet in many schools the effort is still made. The herd of students is driven hastily past the monuments of genius and learning in the hope that they who run may read. Students are exhorted to be great, while littleness is thrust upon them. The obstetrician and the ophthalmologist still receive the same instruction. It is obvious, however, that this indiscriminate gorge will be soon an unpleasant memory. The wonderful growth of medicine is breaking bonds already centuries old. All minds in one mould is ceasing to be the ruling axiom in medical teaching, not because it is a terrible delusion which by retarding discovery has cost the lives of countless thousands, but because it is no longer practical. Success demands some acquaintance with all subjects and an intimate knowledge of one. Day by day the walls rise higher between one speciality and another. The parting of the ways begins at the threshold. In anatomy, physiology and pathology the student should spend his time on those portions which are directly associated with his future work as practitioner or investigator.

This early election will be strenuously resisted by partisans of the tradition. They will contend that the present instruction embracing the entire field is known to give a very inadequate acquaintance with the subjects taught; therefore, instruction covering only a part of the ground will give still less. The argument is beside the mark. The present method of instruction would be inadequate in any event. The medical degree is granted for superficial information in twenty-five or thirty subjects. The sign of the scholar and man of science, namely, thorough knowledge of some one field, is wanting. Yet this training of the man of science is more and more necessary for success. Moreover, a thorough training in at least one subject increases the power of acquiring the fundamental data of related subjects while it protects the mind against superficiality. A further necessity for election is seen in the fact that the great medical schools are university departments. They are attended by an increasing number of men who will never practise medicine but will become investigators in some branch of biological science.

Following the idea of concentration, sequence and election, I have proposed that the student's undivided attention be given to one principal subject at a time. The principal subjects in medicine are anatomy, physiology, pathology and clinical medicine including surgery. The four years' course in medicine is divided into eight terms or semesters, which usually comprise sixteen weeks of instruction. The first of the eight terms may be given to the primary course in anatomy, including histology; the second to the primary course in physiology, including physiological chemistry; the third to the primary course in pathology, including bacteriology; the fourth to pharmacology, clinical chemistry and physical diagnosis; and the four remaining terms to clinical medicine and surgery. The primary courses just mentioned provide the instruction in anatomy, physiology and pathology which every student is advised to take. Advanced instruction in these subjects may be offered in subsequent elective courses.

To meet the needs of the several classes of students found in universities the department of physiology must provide: (1) The primary course already mentioned, suitable for every student of biological science, including medicine; (2) An advanced course, intermediate between the primary course and research; this advanced course will be taken by candidates for the degree of Doctor of Philosophy who have selected physiology either as their principal subject or as one of the two or three subordinate subjects required of such candidates; (3) Opportunities for physiological research.

The primary course in physiology is held from 9 a.m. to 1 p.m. daily during the second term of four months in the first year of the medical curriculum. The afternoons of these four months are devoted to physiological chemistry. The primary instruction in physiology is divided into three parts. Part i., of five weeks' duration, provides thorough experimental work in some limited field. In this, the student should acquire the point of view, the general physiological method, training in technique, and a complete knowledge of one or more tissues to serve as an introduction to the physiology of the remaining tissues. There can be little doubt that the physiology of muscle and nerve should be chosen for this purpose. It is the most fully developed chapter in physiology, and is well adapted to train the mind in habits of exact experimentation and close reasoning. Moreover, the physiology of muscle and nerve is in large measure the physiology of all living tissues, so that a man learned in this one field is in effect already acquainted with the general principles of physiology. Part ii., of about seven weeks' duration, comprises carefully arranged fundamental experiments, giving in turn the elements of each field in physiology except that of nerve and muscle, which has just been studied. In part iii., covering the remainder of the term of sixteen weeks, the instruction is divided into special courses on the physiology of the eye, ear, larynx, digestion, the spinal cord, the innervation of the heart, &c. Each course is long enough to include all the practicable experiments that should find a place in a systematic, thorough study of the subject. The number of such experiments, and hence the length of the special courses, is naturally different in the various instances; thus the experimental physiology of the eye occupies more time than the physiology of the larynx. The student may elect the subjects that most interest him, but must choose a sufficient number to occupy him during the entire four weeks of instruction. In planning these courses the aid of distinguished specialists is sought.

Each student is required to present one written discussion of some small and sufficently isolated thesis, giving the work of the original investigators. The way of dealing with the sources at first hand is thus learned. Many of these essays are read and discussed before the class. The discussions begin with the sixth week of the course and are held daily during nine weeks. None is held during the last two weeks. The literature of each subject is divided into two portions and each is assigned to one man. The fifty-four subjects, therefore, are presented in one hundred and eight essays. The men chosen for this purpose are the best in the class; their choice is determined at first by the results of their examinations in anatomy, and, so soon as practicable, by the results of their work in physiology. In addition to the two men who read theses, one or more of the investigations on each subject are studied by four men, who are thus specially qualified for the discussion. The four are selected in turn from the whole class. To illustrate, let us take as an example "The Transmission of the Cardiac Excitation Wave." One student defends the theory that the cardiac excitation wave is transmitted through muscular tissue; a second defends transmission through nerve tissue. Each presents a carefully written account of the evidence pro and con. The four men, each of whom has read at least one of the investigations on this subject, lead the discussion, which is held by the entire class and the departmental staff. The subjects chosen for discussion are, as a rule, such as cannot be fully studied in the laboratory. Thus the discussions complement the remaining instruction. The subjects to be discussed are bulletined before the appointed day so that the class may come to the discussion somewhat prepared.

In the last two weeks of the course, students who have performed their experimental work especially well may elect instruction in physiological research. The subject chosen must necessarily be very narrow, and, where possible, should be one the literature of which has been already examined in the preparation of the student's thesis. Experience has shown that after fourteen weeks of strenuous labour in experimental physiology, the student of average ability learns to work rapidly and carefully, so that much can be accomplished in two weeks of experimentation in one small subject. Even a very brief experience of investigation is of the greatest value and interest. Examples of subjects suitable for training in investigation are: "The Compensatory Pause;" "The Tetanus Curve;" "The Action of Calcium and Sodium Ions on Rhythmic Contractility."

Beginning with the second week of the course, a daily written examination, twenty minutes in length, is held. One or, at most, two questions are asked. They concern the student's own experiments. The purpose of the examination is to cultivate precision in statement. The emphasis which the question gives imparts a correct perspective. Further, the examination reveals men whose indolence or incapacity marks them for special care. The following questions are some of those asked in such examinations: "Give experimental evidence to show where stimulation begins on the closure of the galvanic current. Explain the difference between the stimulating electrodes and the physiological anode and kathode in the stimulation of human nerves. Give the experimental basis for an explanation of the auriculo-ventricular interval."

The didactic instruction consists of a ten-minute talk in the laboratory, commenting on the examination of the previous day and explaining any special difficulties in the experiments, and of a daily lecture. In every instance this lecture is intended to discuss experiments. Wherever possible the experiments are to be performed by the students themselves before coming to the lecture. Experiments which the students cannot do for themselves are studied by them from the original protocols, furnished with a suitable explanatory text. Thus the fundamental elementary information is gained from the original sources before the lectures. The students are questioned concerning these fundamental experiments. The questions are arranged in the sequence required for a systematic presentation of the subject. Wherever necessary, the lecturer adds from his own stores to the information already possessed by the student. The class is encouraged to question the lecturer concerning matters not quite clear. At the close of the exercise the lecturer sums up briefly. The end in view is the development of the mind rather than the imparting of information. For example, the fact that the pressure of the saliva in the ducts of the submaxillary gland during secretion is higher than that of the blood in the carotid artery is not presented as a fact to be memorised, but is discussed with reference to its bearing on secretion by filtration; the student has learned the fact itself from the original source before coming to the lecture. Some of the lectures on special subjects, such as the eye, are given by distinguished specialists in practical medicine. Each instructor gives as an elective one or more lectures describing, with demonstrations, his own investigations; the investigator discussing his own experiments is a powerful intellectual stimulus; too little account has been taken of this educational force.

The student should be provided with what may be called a laboratory text-book. This text-book consists of a series of experiments and observations, taken from the original sources, and arranged in the sequence suited to develop the subject. Very often the historical sequence serves this purpose best. The description of the experiment follows the original so far as practicable. The experiments are provided with a suitable commentary text. The student is made to feel at every step that physiology is an experimental science, that the only material proper for discussion consists of observations and experiments free from error, and that safety demands constant reference to the original source. The laboratory text-book is supplemented by the student's laboratory note-book, in which the student preserves the graphic records of his experiments and the notes of his observations.

Little need be said concerning the instruction intermediate between the primary course and research. In the intermediate course the experiments chosen for the individual student vary with his goal, and are arranged in the order that seems best adapted to train the mind for research in the direction desired.

The methods of primary and advanced instruction here presented are obviously the methods of the investigator. They can be carried out effectively only by those whose chief purpose is the advancement of human welfare by discovery. In many schools, instructors are still selected mainly because they can talk agreeably of the work of others; in some, the instructor must have made one experimental study in the subject which he teaches; in a very few of the large schools, the higher positions are occasionally bestowed on men to whom research is more than a memory, but these positions almost invariably are burdened with a mass of petty administrative detail. The university devotes these men to researches which the university prevents them from making. Thereby its best minds are set to its lowest work. A change is necessary here. No man who has not made at least one experimental investigation should be appointed assistant in a department of physiology, no man who has not shown marked capacity for original work should be made instructor, and the professor's chair should be filled only by those in whom the ardour of discovery is not likely to be cooled by the advancing years. At least half the day should be set aside for research, and the hours thus reserved for the highest studies should be guarded against every encroachment. The best elementary instruction can be given only in the atmosphere of research. Discovery fires the imagination of youth, consoles the aged, and lifts the mind from mediocrity to greatness.

W. T. PORTER.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The following is the text of the speech (composed by Mr. A. C. Clark of Queen's College) delivered by Prof. Love in presenting Principal Lodge for the degree of D.Sc. *honoris causa* on February 12:—

Adest Oliverus Josephus Lodge, Naturæ rerum indagator acerrimus. Qui, ut vitam eius brevissime percurram, iam quinquaginta abhinc annos natus in Collegio Universitatis Londinensis primo institutus, in Universitate Londinensi gradum Doctoris Scientiæ adeptus est: mox in Collegio Universitatis de Liverpool Professor Physicæ creatus summa laude viginti annos floruit: anno denique proximo Universitatis novæ de Birmingham primus Præses factus est. Magna iamdudum fama inclaruit hic vir, quod in rebus physicis experimentorum longum ordinem peritissime commentus est et felicissime confecit: quo in genere sæpe numero ei contigit ut re acu tacta difficillimam aliquam quæstionem, in qua hæserant doctissimi Physicæ auctores, felicissime explicaret. Primo quidem quæ et qualis sit vis illa Naturæ moderatrix, quam ἐνέργειαν vocant, quibus mutationibus utatur, quærebat, neque laborum laude debita diu caruit a Regali Societate iam tredecim abhinc annos Sodalis electus. Iam tum vestigia Fitzgeraldiana secutus radiorum electricorum naturæ studere inceperat. Docuerat enim Maxwell, huius rei peritissimus, vim electricam oscillationibus quibusdam per inane spatium transferri posse, quo duce usi apud Germanos Hertzius, apud nostros Lodge, harum oscillationum signa et indicia certa deprehendere conabantur. Hertzium quidem ad metam primum pervenisse non nego, ad quam tamen Lodge eandem viam ingressus certo cursu ferebatur: illud vero affirmaverim veritate ab Hertzio patefacta hunc meliorem viam quærentibus monstravisse et novæ doctrinæ prædicatorem insignissimum exstitisse. Neque civium utilitatibus non inserviebant eius labores, cum in nuntiis arte telegraphica sine filo metallico mittendis, tum in fulminibus avertendis et in postes aeneos, tectorum nostrorum tutamina, sine fraude derivandis. His denique diebus magnam rem felicissime aggressus est cum quæreret de terræ cursu per medium illud ætherium, quo lux et vis omnis electrica et magnetica pervehitur, et doceret hoc medium, quod vocant, penitus stagnare et materiæ crassioris motibus omnino carere. Multum denique profecit in natura radiorum illorum explicanda quos Lenardus, Röntgen, Zeeman, viri acutissimi, primi detexerunt. Insignem eius operam in his variis generibus agnovit Universitas Sancti Andreaa, quæ gradu Legum Doctoris, et Regalis Societas quæ numismate aureo Rumfordiano eum iure ornavit.

Neque id silendum arbitror quod huic viro intima Naturæ penetralia reserare nequaquam satis erat, sed et in tironibus instituendis et in rebus gubernandis pari industria et felicitate eminuit: quo in genere haud parvam partem laudis suæ debet Universitas de Liverpool, de qua optime meritus est. Huius viri ingenio multiplici latior profecto campus iam datur, cum Universitatis novæ de Birmingham Præfectus sit.

The Junior Scientific Club held their 221st meeting on Friday, February 15. Mr. W. B. Croft, M.D., of Pembroke, read a paper on "The management of light waves," which was followed by a paper by Mr. A. C. Inman, of Wadham, entitled "René Descartes, and his physiology."

Mr. R. E. Baynes, Lee's Reader in Physics, has been appointed a delegate of the University Museum, in place of Sir John Conroy, F.R.S., deceased.

The Provost of Oriel (D. B. Munro) and the President of Trinity (H. F. Pelham) have been appointed representatives at the ninth Jubilee of the University of Glasgow.

CAMBRIDGE.—Mr. W. D. Niven, F.R.S., has been appointed an elector to the Cavendish professorship of experimental physics.

THE *American Naturalist* for January gives a list of gifts and bequests made to various educational institutes in the United States for eleven months of the year 1900, ending November 30; they amount to over sixteen million dollars. The largest amount is a gift, not to exceed three million dollars, from Mr. Andrew Carnegie, for the enlargement of the Carnegie Institute, Pittsburg, Pennsylvania. The number of gifts or bequests recorded is about eighty.

THE report of the Technical Education Committee of the Derbyshire County Council shows that continued progress is being made in the provision of adequate laboratory and workshop accommodation in important centres of the county. In the department of agriculture, the headquarters of the agricultural teaching have been transferred from Nottingham to the farm centre at Kingston, where additional buildings have been constructed to enable practical science work to be carried on.

THE Senate of the Royal University of Ireland has passed the following resolution:—"That in the opinion of the Senate the relations of the University with its own colleges and students are unsatisfactory, and it is most desirable that a Royal Commission should be issued to inquire into the working of this University as an examining and teaching body in relation to the educational needs of the country at large, and to report as to the means by which University education in Ireland might receive a greater extension and be more efficiently conducted than it is at present."

AN influential committee, headed by the Duke of Devonshire, the Duke of Argyll, the Earl of Derby and Earl Spencer, have issued an appeal with the object of raising 150,000*l.* in celebration of the jubilee of Owens College, Manchester. Fifty thousand pounds are needed to discharge debts that have been contracted and 100,000*l.* for additional endowment. Among the objects the promoters have in view are the extinction of the debt of 22,000*l.* on the buildings of the medical school; special endowments for existing chairs, including chemistry, education, anatomy and philosophy; the establishment of an institution for bacteriological investigation and for the study of hygiene, and of research Fellowships; and the creation of a pension fund for members of the teaching staff.

SCIENTIFIC SERIALS.

American Journal of Mathematics, vol. xxiii. No. 1, January.—The new volume opens with a memoir by S. Kantor, entitled "Die Typen der linearen Complexe rationaler curven im R_r."—E. J. Wilczynski writes on transformation of systems of linear differential equations. It has been shown by Staeckel (*Crelle*, band 111) that the most general transformation, which converts a general homogeneous linear differential equation of order $m > 1$ into another of the same form and order, is

$$T : x = f(\xi),\ y = \phi(\xi)\eta,$$

where $f(\xi)$ and $\phi(\xi)$ are arbitrary functions of ξ. If $m = 1$ the most general transformation is

$$x = f(\xi),\ y = \phi(\xi)\eta^{\lambda}\ (\lambda \text{ a constant}).$$

The present paper considers a *system* of linear differential equations, and finds the most general transformation which converts such a system into a system of the same order. The transformation thus formed contains T as a special case. Staeckel's method is adopted in essence. The author is working at a theory of invariants of such systems, based on this general transformation.—Distribution of the ternary linear homogeneous substitutions in a Galois field into complete sets of conjugate substitutions, by L. E. Dickson, and the following paper, "Distribution of the quaternary linear homogeneous substitutions in a Galois field into complete sets of conjugate substitutions," by T. M. Putnam, are in continuation of a memoir by the former writer in vol. xxii. (pp. 121–137).—On the determination and solution of the metacyclic quintic equations with rational coefficients, by J. C. Glashan, is a tardy fulfilment of a promise made in vol. vi. p. 114.—E. O. Lovett contributes a construction of the geometry of Euclidean n-dimensional space by the theory of continuous groups.—A table of class numbers for cubic fields, by Legh W. Reid, is calculated with a view to furnishing for the general algebraic number fields an amount of number material sufficiently great to be of use in the further study of these fields, and in particular in that of the cubic fields. It gives for each of 161 cubic number fields the class number, h, the discriminant Δ, a basis, and the factorisation of certain rational primes into their prime ideal factors. The method is founded upon a theorem of Minkowski's. In every ideal class there is an ideal, $\mathfrak{j}$, whose norm, $n(\mathfrak{j})$, satisfies the condition

$$n(\mathfrak{j}) < \left(\frac{4}{\pi}\right)^r \frac{m!}{m^m} \left| \sqrt{\Delta} \right|,$$

where m is the degree and Δ the discriminant of the field, and r the number of pairs of imaginary fields found among the m conjugate fields, $k^{(1)}, k^{(2)}, \ldots k^{(m)}$. The writer refers to Hilbert, "Bericht über die Theorie der Algebraischen Zahlkörper"; Minkowski, "Geometrie der Zahlen," and Woronoj, "The algebraic integers, which are functions of a root of an equation of the third degree" (translation of Russian title). The tables take up ten pages.—On certain properties of the plane cubic curve in relation to the circular points at infinity, by R. A. Roberts, contains an investigation of some methods of generating a plane cubic curve.—With this opening number is presented an excellent portrait of Dr. George Salmon, and a supplement gives a still more excellent one of Prof. Mittag Leffler.—Prof. Frank Morley is the editor in chief.

Bulletin of the American Mathematical Society, January.—Prof. Lovett gives an account of the proceedings at the International Congress of Philosophy, which was held at Paris on August 1–5, 1900, and furnishes *résumés* of the papers read and the discussions occasioned by them, so far as they bore, more or less directly, upon mathematical questions. The sketch is founded upon the account printed in the September (1900) number of the *Revue de Métaphysique et de Morale*. It occupies pp. 157–183.—A demonstration of the impossibility of a triply asymptotic system of surfaces, by Dr. Eisenhart, was read before the Society on December 28, 1900. It is a notelet founded upon Bianchi's Lezioni.—Prof. E. W. Brown writes short notices of Berry's "Short History of Astronomy" and of H. Suter's "Die Mathematiker und Astronomen der Araber und ihre Werke." This latter, though only a catalogue of over five hundred names of mathematicians and astronomers, and so at first sight not giving promise of much interest, is really, as Prof. Brown shows, a work of considerable interest. He illustrates this statement by a few extracts.—There are a fair amount of notes and new publications.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, February 22.—Prof. S. P. Thompson, president, in the chair.—A paper on how air subjected to X-rays loses its discharging property, and how it discharges electricity, by Prof. Emilio Villari (Hon. Fellow), was read by the chairman. Air made active by X-rays in passing through a long tube coiled in many turns loses much more of its discharging power than it does in passing through the same tube if straight. During this process the tube charges itself to a certain potential. If active air is allowed to stream on masses of wire gauze or wound up ribbons, enclosed in tubes, the metals, independent of their nature, take a positive or negative charge according to whether the active air rubs against them with force or lightly. Experiments have been performed to prove this. For instance, tubes of copper or lead, if short and straight, take negative charges, but if long and coiled they take positive charges. These phenomena cannot be attributed to chemical actions, but seem to be produced by a special rubbing of the active air upon metallic surfaces, as the result of which they assume one of the charges, and the other charge ought to manifest itself in the air. This is not the case, the charge of the air being often of the same kind as that of the metals. It has previously been shown by the author that active air by streaming against an electrified body is reduced either to ordinary air or to air charged with the electricity which disappears. Hence it may be supposed that the active air in rubbing upon the metallic surfaces develops the two electricities, one of which manifests itself upon these surfaces, and the other goes to reduce the active air to ordinary air, and therefore does not become manifest. The electroscope used in the experiments consisted of a fixed brass plate and a gold leaf whose position was determined by means of a telescope with an eye-piece scale.—The chairman said he had observed the fact that metals were charged sometimes positively and sometimes negatively by active air. Mr. Watson asked if any experiments had been performed on the viscosity of gases rendered active by X-rays.—A paper on the propagation of cusped waves and their relation to the primary and secondary focal lines, by Prof. R. W. Wood, was read by Mr. Watson. This paper is a discussion of the reflexion of a plane wave by a hemispherical mirror, the reflected wave being likened to a volcanic cone. The cusp of the wave, or the rim of the crater, traces the caustic and is continuously passing through a focus. This accounts for the increased illumination along the caustic. The wave fronts were drawn by constructing the orthogonal surface, which in section is an epicycloid. The evolute of this curve is the caustic, and the reflected wave fronts form a family of parallel curves which are the involutes of the caustic. The wave front between two focal lines is expanding along one meridian and contracting along a meridian at right angles to it; in other words, the wave is convex along one meridian and concave along the other. The outer slope of the volcanic cone representing the reflected wave corresponds to the portion of the wave front between the focal lines. A useful piece of apparatus can be made by silvering the outside of a hemispherical glass vessel. The concave mirror thus formed should be mounted on a stand, and a small electric lamp arranged so that it can move along the axis of the mirror. A spherical wave starting at the focus of a hemispherical mirror is reflected as a saucer-shaped wave, the curved sides of the saucer coming to a focus in a ring surrounding the nearly flat circular bottom. If the lamp is placed at the focus the luminous ring and the uniformly illuminated area within it can be shown on a ground glass screen. If the lamp be moved to a point midway between the focus and the mirror, a ring of intense brilliance, with very little light within it, is formed.—A paper on cyanine prisms, by Prof. R. W. Wood, was read by Mr. Watson. Prof. Wood has already described a method of making prisms of solid cyanine by pressing the fused dye between plates of glass. Until recently, angles of about half a degree were the largest that could be used with advantage on account of the small quantity of green light transmitted. A new supply of the dye has been found to transmit a large quantity of green light with an angle of over one degree. By viewing the filament of an incandescent electric lamp through one of these prisms the anomalous spectrum is seen, the colours being arranged in the order green, blue, violet, red, orange. Prof. Wood has crossed one of these prisms with a photographic copy of a diffraction grating having 2000 lines to the inch. On viewing a naked arc lamp the diffraction spectra are deviated by the prism, the red ends being turned up and the blue-green ends turned down.—The chairman said he had been trying to obtain some cyanine, but had not succeeded. Rosaniline has an anomalous dispersion, but cannot be fused. The acetate of rosaniline might, however, be used. The Society then adjourned until March 8.

Chemical Society, February 7.—Prof. Thorpe, president, in the chair.—The action of hydrogen bromide on carbohydrates, by H. J. H. Fenton and M. Gostling. The authors, having previously shown that bromomethylfurfuraldehyde results from the action of hydrogen bromide on lævulose, sorbose, inulin or cane sugar, now show that all forms of cellulose give large yields of the same bromomethylfurfuraldehyde under similar conditions; since the formation of this substance is characteristic of ketohexoses or of substances which give rise to them by hydrolysis, it seems conclusively proved that cellulose contains a nucleus similar to that of lævulose.—The ketonic constitution of cellulose, by C. F. Cross and E. J. Bevan. The authors contribute a statement of the evidence, other than that contained in the previous paper, in favour of the supposition that lævulose or some other ketose is the raw material used in the plant for the elaboration of cellulose.—Note on a method for comparing the affinity values of acids, by H. J. H. Fenton and H. O. Jones. The authors have shown that oxalacetic phenylhydrazone is decomposed on heating with water, giving carbon dioxide and pyruvic hydrazone, whilst on heating with acids, pyrazolone carboxylic acid and water are produced in accordance with the following equations:—

$$\begin{array}{l} CH_2.CO_2H \\ | \\ C:N_2HPh \\ | \\ CO_2H \end{array} = \begin{array}{l} CH_3 \\ | \\ C:N_2HPh + CO_2. \\ | \\ CO_2H. \end{array}$$

$$\begin{array}{l} CH_2.CO.OH \\ | \\ C:N.NHPh \\ | \\ CO_2H \end{array} = \begin{array}{l} CH_2.CO \\ | \quad\;\; | \\ C:N.NPh + H_2O. \\ | \\ CO_2H \end{array}$$

It is shown that, on heating with acids, the volumes of carbon dioxide evolved are in the inverse order of the affinity values of the acids used, other conditions remaining the same.—Organic derivatives of phosphoryl chloride and the space configuration of the valencies of phosphorus, by R. M. Caven. The author has prepared substituted phosphoryl chlorides of the form $OP\begin{cases} R_1 \\ R_2 \\ R_3 \end{cases}$, in which the groups R_1, R_2 and R_3 are ethoxyl and the anilido- and paratoluido-residues respectively; the same substance is obtained irrespective of the order in which the substituting groups are put into the molecule, and the author therefore concludes that these three groups are similarly situated with respect to the rest of the molecule.—α-Hydroxycamphorcarboxylic acid, by A. Lapworth and E. M. Chapman. A method for the preparation of camphorquinone in quantity is given, and it is shown that this substance reacts with hydrogen cyanide to form a mixture of stereoisomeric α-hydroxycyanocamphors, $C_8H_{14}\begin{cases} C(OH).CN \\ | \\ CO \end{cases}$; this substance behaves as an α-hydroxynitrile, and may be hydrolysed to α-hydroxycamphorcarboxylic acid, $C_8H_{14}\begin{cases} C(OH).CO_2H \\ | \\ CO \end{cases}$.—The bacterial decomposition of formic acid, by W. C. C. Pakes and W. H. Jollyman. The authors show that certain bacteria decompose formic acid as sodium formate into equal volumes of carbon dioxide and hydrogen.—Preparation of substituted amides from the corresponding sodamide, by A. W. Titherley.—Note on two molecular compounds of acetamide, by A. W. Titherley.—Diacetamide: a new method of preparation, by A. W. Titherley. Diacetamide may be directly prepared by the action of acetyl chloride on acetamide.—Organic derivatives of silicon, by F. S. Kipping and L. L. Lloyd. Silicon tetrachloride, when treated with one molecular proportion of an alchohol, exchanges one chlorine atom for an alkyloxy-group yielding a substance of the composition $SiCl_3.OR$. The latter, by similar treatment with two other alcohols, can be converted ultimately into a substance of the constitution $SiCl(OR_1)(OR_2).OR_3$.—Isomeric hydrindamine camphor-π-sulphonates. Racemisation of α-bromocamphor, by F. S. Kipping. From the examination of the *dl*-hydrindamine *d*-camphor-π-sulphonate, it is concluded that slight racemisation occurs during the sulphonation of *d*α-bromocamphor.—Tetramethylene carbinol, by W. H. Perkin, jun. Tetramethylenecarboxylic chloride is reduced by sodium and moist ether to tetramethylene carbinol, a colourless oil boiling at 143–144°.

Zoological Society, February 5.—Mr. Howard Saunders, vice-president, in the chair.—Mr. Sclater called attention to the fine specimen of Prjevalsky's Horse (*Equus prjevalskii*) now mounted and exhibited in the gallery of the Muséum d'Histoire Naturelle of Paris, and made some remarks on its structure and peculiarities.—Mr. Oldfield Thomas gave an account of the mammals which Mr. R. I. Pocock and he had collected during a trip to the Balearic Islands in the spring of 1899. Twenty-four species were enumerated and remarked upon, amongst which was a new form of hedgehog, described as *Erinaceus algirus vagans*.—Dr. W. G. Ridewood read a paper on the horny excrescence on the snout of the southern right whale (*Balaena australis*), known to whalers as the "bonnet," in which he showed that the minute structure is the same in essential features as that of the *stratum corneum* of the normal skin of the whale. The cuticular fibres were set at right angles to the surface, and were not sharply differentiated or readily separable. Comparisons were drawn by the author between the structure of this horny excrescence and that of the nasal horn of the rhinoceros, the hoof of the horse, the horn of the ox and the baleen of the whale.—Mr. G. A. Boulenger, F.R.S., enumerated the species of batrachians and reptiles represented in a collection made by Dr. Donaldson Smith in Somaliland in 1899. Of the reptiles two were new to science and were described under the names *Hemidactylus laevis* and *H. barodanus*.—Mr. Sclater made some additional remarks on the two pieces of zebra-skin, exhibited at a previous meeting, which had been sent to him by Sir H. H. Johnston, K.C.B., from the Semleki Forest on the borders of the Uganda Protectorate, and expressed his opinion that they belonged to a hitherto unknown species, for which he proposed the provisional name of *Equus johnstoni*.—Mr. J. L. Bonhote read a paper on a second collection of Siamese mammals made by Mr. Th. H. Lyle, consul at Nau, Siam. The collection, although small, was of considerable interest, the twenty specimens composing it being referable to eleven species, one of which, *Sciurus macclellandi kongensis*, was described as new. Mr. Bonhote also communicated a paper containing an enumeration of the 139 species of birds of which specimens had been collected during the "Skeat Expedition" to the Malay Peninsula in 1899–1900.—Mr. F. E. Beddard, F.R.S., described a new species of freshwater annelid, under the name of *Bothrioneuron iris*, from specimens obtained in the Malay Peninsula during the "Skeat Expedition" in 1899–1900.

Entomological Society, February 6.—The Rev. Canon Fowler, president, in the chair.—The president exhibited a specimen of *Colias edusa* var. *helice*, with the margins of the wings entirely dark, as in the male; also a variety of *Cartero-cephalus palaemon*, with the hind wings dark save for one conspicuous orange spot.—Dr. T. A. Chapman exhibited a large series of Endrosæ, collected during the last few years by himself, Mr. A. H. Jones, and especially by Mr. Tutt, showing the relative approximation of the several species. Except *irrorella* from England, Finmark, and the Tyrol, and a few *aurita* from the Tyrol, all were from the Western Alps of Switzerland, Italy and France. Examples from each locality, he said, when sufficiently numerous usually have a special facies. Some, as all those from Arolla, radiate; those from Bourg St. Maurice are without radiate forms, and so on. Some are more yellow; others deeper orange; some more mixed. Elevation tends to produce radiation, but no other general conclusion as to the effect of height, latitude or longitude seems fully justified by the specimens.—Mr. G. C. Barrett exhibited for Mr. G. O. Day, of Knutsford, a black variety of *Aplecta nebulosa*, Tr., with white cilia, and an asymmetrical ♀ var. of *Fidonia atomaria*, Linn.—Mr. M. Jacoby exhibited an unknown specimen of the family Halticidæ.—Mrs. Nicholl exhibited a collection of Rhopalocera from the Lebanon district of Syria, and Mr. H. J. Elwes, on her behalf, read a paper explaining and illustrating the several species included. Among other species Mr. Elwes drew especial attention to *Thecla myrtale*, which, since it was described by Klug in 1832, has remained one of the least known members of the palæarctic fauna. No specimens, it appears, had been taken in the interval until Mrs. Nicholl found it on the high mountains not uncommonly in May and June.—The following papers were communicated:—A revision of the genus Astathes, Newm., and allied genera of Longicorn Coleoptera, by C. J. Gahan, M.A., and a preliminary catalogue of the Lepidoptera-Heterocera of Trinidad, by W. J. Kaye.

Linnean Society, February 7.—Prof. S. H. Vines, F.R.S., president, in the chair.—Mr. H. W. Monckton exhibited some lantern-slides showing a large ammonite in the Kimmeridge clay at Swanage, and several views taken at the Pentland oyster-bed at Tilly Whim, and the Purbeck oyster-bed in Durleston Bay.—The president, whilst demonstrating the property possessed by certain vegetable liquids, such as coconut milk and the juice of the pineapple and the potato, to cause the oxidation of guaiacum tincture in the presence of hydrogen peroxide, a blue colour being produced, drew attention to the recent researches of Raciborski on the subject. Raciborski has made the interesting discovery that certain tissues of the plant-body, more particularly the sieve-tubes and the laticiferous tissue, contain some substance, to which he gives the name *leptomin*, which likewise causes guaiacum to turn blue in the presence of hydrogen peroxide, and has gone on to infer that this leptomin may be regarded as discharging in the plant a function analogous to that of hæmoglobin in the animal body. The president urged, against this assumption, that although both leptomin and hæmoglobin give the guaiacum reaction, yet this fact does not prove that leptomin can combine with oxygen, and can act as an oxygen-carrier in the organism, in the manner which is so characteristic of hæmoglobin; and that, therefore, the suggested analogy between the two substances is at least premature.—Mr. H. M. Bernard read a paper, of which an abstract had been previously circulated, on the necessity for a provisional nomenclature for those forms of life which cannot be at once arranged in a natural system. A discussion followed in which Prof. Ray Lankester, Sir W. T. Thiselton-Dyer, Mr. Bateson, Mr. Elwes, and Prof. Jeffery Bell took part. It was proposed by Prof. Lankester, and seconded by Mr. H. J. Elwes, that the discussion be adjourned to another meeting, and that resolutions be framed for submission to that meeting when called.

Anthropological Institute, February 12.—Prof. Haddon, F.R.S., in the chair.—Mr. A. L. Lewis, treasurer of the Institute, showed slides illustrative of the recent damage to Stonehenge.—A paper was read on Malay metal-work, by Mr. Walter Rosenhain. The paper dealt with some specimens of Malay metal-work submitted to the author for microscopic and other examination by Mr. W. W. Skeat.—Some Malay processes actually witnessed by Mr. Skeat were described, and the bearings of the microscopic examination on the explanations of these processes were discussed. The first question dealt with was the production of the "damask" pattern on a Malay kris. Microphotographs were given showing that the "damask iron" really consists of layers of loosely welded wrought iron, the only other metal used being tool steel. The body of the blade is made of steel and a layer of laminated "damask iron" is welded upon either side of the central layer of steel; a thin layer of steel is welded on outside the "damask iron." The author believes that the striated "damask" effect is due to the opening of the loose welds in the damask iron during the forging of the blade, steel being driven between the laminæ. The outside layer of steel is entirely ground away, and when the compound surface so produced is "etched" by the pickling process employed, the more readily corroded steel is attacked, leaving the edges of the layers of iron as a series of narrow projected ridges.—The final section of the paper dealt with the Malay method of producing chains by casting, and was illustrated by some successful experiments.

Mathematical Society, February 14.—Dr. Hobson, F.R.S., president, in the chair.—Dr. Larmor, F.R.S., gave an abstract of a paper by Mr. T. Stuart, entitled "The Distribution of Velocity and the Equations of the Stream Lines, due to the Motion of an Ellipsoid in Fluid Frictionless and Viscous."—Lieut.-Colonel Cunningham communicated a paper on factorisable twin binomials. Mr. C. E. Bickmore spoke on the subject.—Mr. Tucker gave an account of the brocardal properties of some associated triangles.—The following papers were communicated by the president: Concerning the Abelian and related linear groups, by Dr. L. E. Dickson.—A geometrical theory of differential equations of the first and second order, by Mr. R. W. Hudson.—A note on stability, with a hydrodynamical application, by Mr. Bromwich.—Remarks on notation in Lie's theory of groups, and on Schur's determination of a continuous group of given structure, with remarks on Mr. Campbell's paper (read at the January meeting), by Mr. H. F. Baker, F.R.S.; and a note on curves similar and parallel to one another, by Mr. D. B. Mair.

CAMBRIDGE.

Philosophical Society, February 4.—Prof. Macalister, president, in the chair.—Geometrical notes, by the Master of St. John's College. These notes give simple proofs of Halley's construction for the normal or normals from a given point to a parabola, and Frégier's theorem that a chord of a conic which subtends a right angle at a fixed point of the curve passes through a fixed point on the normal thereat.—On the interference bands produced by a thin wedge, by Mr. H. C. Pocklington. The interference bands produced when monochromatic light from a small but finite source falls obliquely on a thin wedge of slightly reflecting material are investigated. It is shown that if the incident light is a parallel beam, the bands do not lie in the wedge, but in the air in a plane passing through the edge of the wedge and perpendicular to the reflected light, and that the distance between consecutive bands is $\lambda/2a$.—On some rare and interesting fungi, collected during the past year, by Prof. Marshall Ward.—On geotropism, by Mr. F. Darwin. The experiments described were directed to the question whether or not the tip of the root is the region where the gravitation stimulus is perceived. The germinating seeds were so placed that the tip of the root was fixed in the horizontal position, while the base of the root together with the seed could move. Since the supposed sensitive region remains horizontal, it was expected that the motor region of the root would continue to curve in response to the continued stimulation of the tip. This was found to be the case. But the great technical difficulties of the method and certain difficulties of interpretation render the evidence less striking than might have been hoped.—Notes on artificial cultures of Xylaria, by Miss E. Dale (communicated by Prof. Marshall Ward). Two species were cultivated from ascospores and grew equally well on pieces of the sterilised wood of beech, oak and silver fir, on which they produced several types of conidiophores.—The mycelium penetrates into all the tissues of the wood which forms its substratum, passing from cell to cell through the pits. Its action on the wood fibres is peculiar. Straight hyphæ pass down the lumen and give off branches which penetrate the pits and grow spirally, each lying in a channel which it has made in the cell-wall, apparently by excreting some wood-destroying enzyme.—The habits and development of some West African fishes, by Mr. J. S. Budgett. The paper gave an account of a part of the material obtained during a recent visit to the Island of McCarthy on the Gambia river, in order to investigate the development of *Polypterus*. The young larva of *Polypterus lapradii*, Steind., was described which had not yet developed the bony scales on the body. The nests and larvæ of *Protopterus annectens*, Ow., were described and the development shown to be remarkably similar to that of *Lepidosiren*. The floating nests and the development of *Gymnarchus niloticus*, Cuv., were described and also the very large nests and the larvæ of *Heterotis niloticus*, Cuv. The larvæ of both these forms possess externally produced gill-filaments, while the development of *Gymnarchus* is in some respects shark-like. Two other forms, *Sarcodaces odoë*, Bl., and *Hyperopisus bebe*, Lacep., were shown to possess in the larval condition well-developed cement organs on the front of the head.—On a new form of microtome, by Mr. H. M. Leake (communicated by Mr. A. E. Shipley.)—The ignoration of coordinates, by Mr. T. J. I'A. Bromwich.—A theorem on curves belonging to a linear complex, by Mr. J. H. Grace.

DUBLIN.

Royal Dublin Society, December 19, 1900.—Prof. W. N. Hartley, F.R.S., in the chair.—Prof. E. A. Letts and Mr. R. F. Blake read a paper (communicated by Dr. W. E. Adeney) on a simple and accurate method of estimating the dissolved oxygen in fresh water, sea water and sewage effluents.—Mr. E. St. John Lyburn read a paper (communicated by Prof. W. N. Hartley) on prospecting for gold in the county of Wicklow, with an examination of Irish rocks for gold and silver. The author deals with the history of the discovery of gold in Ireland, and more especially with the results of a six months' prospecting tour in the county of Wicklow. One hundred and ten samples were taken and subjected to assay, the highest assay giving 4 dwts. pure gold per ton (2240 lbs.); this sample was obtained from a quartz vein, about eight inches wide, on the Croghan Kinshelagh mountain, and in the immediate vicinity of the Government workings of 1798. The author expressed the view that the locality he explored was worthy of further attention.

January 16, 1901.—Dr. W. E. Adeney in the chair.—Prof. Hugh Ryan read a paper on the preparation of amidoketones; and Prof. E. A. Letts and Mr. R. F. Blake communicated a paper on some problems connected with atmospheric carbonic acid, and on a new and accurate method of determining its amount, suitable for scientific expeditions.

PARIS.

Academy of Sciences, February 18.—M. Fouqué in the chair.—On a new form of the equations of mechanics, by M. H. Poincaré.—On the secondary radio-activity of metals, by M. Henri Becquerel. Metals receiving the direct rays from a radio-active substance appear to give off a secondary radiation. The penetrating power of this secondary radiation is more feeble than that of the primary rays, and is analogous to the same property of the secondary Röntgen rays discovered by M. Sagnac. The effect of this is that a metallic plate, placed upon a photographic plate, instead of acting as a screen to arrest the radiation from the source, gives, on the contrary, a stronger impression.—On a new gaseous compound, sulphuryl fluoride, SO_2F_2, by MM. Moissan and P. Lebeau (see p. 426).—On the alkyl cyanomalonic esters and the alkylcyanacetic acids derived from them, by MM. A. Haller and G. Blanc. It is shown that cyanomalonic ester contains the group CH, and that the substitution of alkyl radicles takes place on this atom of hydrogen, since in all the derivatives obtained from it the radicles are united to the carbon atom of the group CH.—Note on a congenital lacrymopharyngo-facial fistula, open below the left nostril, by M. Lannelongue. A description of a congenital fistula representing, in the form of an anomaly, a transition state in development. The case has an important bearing upon the theory of the development of the human embryo, and would appear to be in direct contradiction to the views of Albrecht on the development of the nose and upper lip. The operation described effected a complete cure.—On the discovery of a sea urchin of the Cretacean age in the eastern Sahara, by M. de Lapparent. The fossil described, which was found accidentally by Colonel Monteil at Zau Saghair, near Bilma, has been recognised by M. Victor Gautier as belonging to the same genus as an echinoderm discovered in the upper layers of the Cretacean in Baluchistan. It is thus proved that towards the end of the Cretacean epoch, about the time when in Europe the sea underwent such a marked retrogression, not only did it persist in the Lybian Desert, but it advanced to the neighbourhood of Tchad, manifesting by its fauna affinities with the Indian region.—On the propagation of waves in viscous fluids, by M. P. Duhem.—Observations on the variability of the planet 433 Eros, made at the Observatory of Toulouse with the 23-cm. Brunner equatorial, by M. F. Rossard.—On the luminous variability of Eros, by M. Ch. Andre (see p. 426). From the photometric observations, it is concluded that the planet is formed of a double system of two asteroids, of which the diameters are very nearly in the ratio of three to two, and whose orbital plane passes through the earth.—On the deformation of the paraboloid, by M. C. Guichard.—On the problem of the isoperimeters, by M. A. Hurwitz.—On functions of two variables analogous to modular functions, by M. R. Alexais.—On a new micrometer eye-piece, by M. L. Malassez.—On the specific absorption of the X-rays by metallic salts, by MM. Alexandre Hebert and Georges Reynaud. Results are given for experiments on the relative specific absorption of a series of metallic nitrates, from which it is shown that, in general, the absorption of the X-rays by the nitrates becomes greater with the increase in the atomic weight of the combined metal. The curve for the specific absorption plotted against the atomic weights as abscissæ is practically an equilateral hyperbola.—On hydrocinchonine, by MM. E. Jungfleisch and E. Leger. The substance previously obtained by the authors by the action of dilute sulphuric acid upon cinchonine and described by them as cinchonifine, is now shown to be identical with the hydrocinchonine of Caventou and Willm.—On diphenylcarbodiazine, by M. P. Cazeneuve.—On a new alcohol derived from limonene, by M. P. Cazeneuve. The new alcohol, named limoneol, is prepared by the action of peroxide of nitrogen upon limonene. It is a secondary alcohol, like pinenol, and gives a ketone on oxidation with chromic acid mixture.—The transformation of dimethylacrylic acid into dimethylpyruvic acid, by MM. Bouveault and A. Wahl. If the aminodimethylacrylate of ethyl, the preparation of which is described in a previous paper, is heated with aqueous hydrochloric acid, ethyl dimethylpyruvate is produced, the oxime and semicarbazone of which were prepared for the purpose of identification.—Action of the monohalogen acids of the fatty series upon pyridine and quinoline, by MM. L. J. Simon and L. Dubreuil.—On the pyrogallolsulphonic acids, by M. Marcel Delage.—The reserve hydrocarbon in the tubercles of *Arrhenathererum bulbosum*, by M. V. Harlay. The tubercles on extraction with dilute alcohol yield 4·8 per cent. of a carbohydrate, which on hydrolysis with dilute sulphuric acid gives pure lævulose. The original substance differs from inulin in solubility and rotatory power.—Nervous transmission of an instantaneous electric stimulus, by M. Aug. Charpentier. From the researches described it follows that an electrical stimulus may give rise to a double transmission on the part of the nerve, one part being transmitted nearly instantaneously, like an ordinary conductor, with a velocity too great to be measured in the usual way, the other part of the stimulus is transmitted, always electrically, with the very moderate velocity of about 20 to 30 metres per second.—The physiological action of wine, by M. L. Roos. From experiments on guinea-pigs the author concludes that the daily use of wine with the food, even in relatively large proportions, exerts no unfavourable effect.—The luminescence obtained with certain organic compounds, by M. Raphael Dubois. In presence of alcoholic potash a considerable number of organic substances become luminescent. The reaction may be of some service in the qualitative analysis of certain essential oils.—The nucleated red blood corpuscle behaves like a vegetable cell, from the point of view of osmosis, towards urea in solution, by M. R. Quinton.—On the absorption of monocalcium phosphate by arable earth and humus, by M. J. Dumont.—Observations relating to the propagation in apple orchards of *Nectria ditissima*, by M. Descours-Desacres. Nicotine, tannin and tannic acid have proved to be the most efficacious remedies against this disease.—On the petrographical province of the north-east of Madagascar, by M. A. Lacroix.—On a mass of metallic iron which was said to have fallen from the sky in the Soudan on June 15, 1900, by M. Stanislas Meunier.—Concerning the mineral layers of oolitic iron of Lorraine and their mode of formation, by M. Georges Rolland.

ST. LOUIS.

Academy of Science, January 21.—Rev. M. S. Brennan read a short sketch of the progress of astronomy in the United States, in which the material equipment and the discoveries made during the past century were passed in review.—A paper by Prof. T. G. Poats, entitled "Isogonic Projection," was presented in abstract.—Prof. F. E. Nipher showed, by means of the lantern, a series of negatives printed by contact from a lantern slide or positive picture by the light of a 300-candle incandescent lamp. The unit of exposure adopted was one lamp-metre-second. The exposures varied from 0·0054 to 4800. All were developed in the dark-room with hydrochinon, those above 0·1 exposure having in the bath one drop of saturated hypo to the ounce of bath. The plate having an exposure of 0·1 seemed to be normally exposed. An exposure 210 gave a negative showing some fogging, but a print from it by ordinary methods gave a very satisfactory result. With longer exposures, the plate began to reverse, locally. With an exposure of 3600, which was an exposure of one hour at a distance of one metre from a 300-candle lamp, half of the plate still showed as a negative. The shadow on the gown of a figure in the landscape showed white as a negative, and the part of the gown in sunshine showed white as a positive. The penumbra between light and shadow was darker. All the details were sharp, but lights and shadows were somewhat incongruous. With an exposure of 4800 the details had not yet all reversed, but the greater part of the plate had become a positive. The greatest exposure giving a negative which would yield an acceptable print was 210, which was 39,000 times the least exposure which would give a good negative. All exposures of 210 and over gave complete positives when the plates were developed 1·41 meter from a 16-candle lamp, or in stronger light. As good a picture as has been obtained had an exposure of 4800, and was developed within half a meter of a 300-candle lamp. A fair picture had even been obtained from a two-hour exposure to direct sunlight with a Cramer "Crown" plate. It was stated that hypo in the developing bath did not affect the zero condition, or change the character as to positive and negative. When no hypo is used, the plate fogs so quickly that the picture is invisible before it has time to fully develop. After fixing, the thin shadowy picture showing on the fogged plate has the same local positive and negative characters that are shown on the clearly defined picture of the same exposure when developed in the hypo-hydrochinon bath. The greatest exposures giving good results that have been measured with reasonable accuracy were about 900,000 times as great as the least exposure giving a good negative in the dark-room. This factor can certainly be trebled. A plate having any intermediate exposure can be developed either as a good positive in the light or as a good negative in the dark-room.

DIARY OF SOCIETIES.

THURSDAY, FEBRUARY 28.

ROYAL SOCIETY, at 4.30.—On the Structure and Affinities of Fossil Plants from the Palæozoic Rocks. IV. The Seed-like Fructification of *Lepidocarpon*, a Genus of Lycopodiaceous Cones from the Carboniferous Formation: Dr. D. H. Scott, F.R.S.—A Preliminary Account of the Development of the Free-swimming Nauplius of *Leptodon hyalina*, Lillj.: Dr. E. Warren.—On the Result of Chilling Copper-Tin Alloys: C. T. Heycock, F.R.S., and F. H. Neville, F.R.S.—On the Theory of Consistence of Logical Class-frequencies, and its Geometrical Representation: G. Udny Yule.

SOCIETY OF ARTS, at 4.30.—Railways and Famine: Horace Bell.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Conclusion of discussion on Mr. Madgen's paper.—Followed, if possible, by Cables: M. O'Gorman.

FRIDAY, MARCH 1.

ROYAL INSTITUTION, at 9.—Enamels: H. H. Cunynghame.

GEOLOGISTS' ASSOCIATION, at 8.—The Post-Pliocene Non-Marine Mollusca of the South of England: A. S. Kennard and B. B. Woodward.—The Pleistocene Fauna of West Wittering, Sussex: J. P. Johnson.

SATURDAY, MARCH 2.

ROYAL INSTITUTION, at 3.—Sound and Vibrations: Lord Rayleigh, F.R.S.

MONDAY, MARCH 4.

SOCIETY OF ARTS, at 8.—The Bearings of Geometry on the Chemistry of Fermentation: W. J. Pope.

VICTORIA INSTITUTE, at 4.30.—A Visit to the Hittite Cities, Eyuk and Boghas: Rev. G. E. White.

TUESDAY, MARCH 5.

ROYAL INSTITUTION, at 3.—The Cell as the Unit of Life: Dr. Allan Macfadyen.

ZOOLOGICAL SOCIETY, at 8.30.—On some Extinct Reptiles from Patagonia, of the Genera *Mioannia*, *Dimlysia*, and *Genyodectes*: Dr. A. Smith Woodward.—Note on the Innervation of the Supra-orbital Canal in *Chimaera monstrosa*: R. H. Burne.—Contributions to the Knowledge of the Structure and Systematic Arrangement of Earthworms: F. E. Beddard, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Discussion of paper on the Rotatory Process of Cement Manufacture: W. H. Stanger and Bertram Blount.—Ballot for Members.

WEDNESDAY, MARCH 6.

SOCIETY OF ARTS, at 8.—Modern Artillery: Lieut. Arthur Trevor Dawson.

GEOLOGICAL SOCIETY, at 8.—Recent Geological Changes in Central and Northern Asia: G. F. Wright.—The Hollow Spherulites of the Yellowstone and Great Britain: J. Parkinson.

SOCIETY OF PUBLIC ANALYSTS, at 8.—The Determination of Dissolved Oxygen in Water in Presence of Nitrites and Organic Matter: Dr. S. Rideal.—Some Analyses of Oatmeal: Dr. Bernard Dyer.—The Detection and Estimation of Preservatives in Milk: M. Wynter Blyth.

THURSDAY, MARCH 7.

ROYAL SOCIETY, at 4.30.

LINNEAN SOCIETY, at 8.—A Contribution to the Fresh-water Algæ of Ceylon: Messrs. W. West and G. S. West.—On Mediterranean Malacostraca: A. A. Walker.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Insulation on Cables: M. O'Gorman.

CHEMICAL SOCIETY, at 8.—(1) Nomenclature of the Acid Esters of Unsymmetrical Dibasic Acids; (2) Additive Compounds of α- and β-Naphthylamine with Trinitrobenzene Derivatives; (3) Acetylation of Arylamines: J. J. Sudborough.—Formation of Amides from Aldehydes: R. H. Pickard and W. Carter.

RÖNTGEN SOCIETY, at 8.—Exhibition of Skiagrams and Apparatus.

FRIDAY, MARCH 8.

ROYAL INSTITUTION, at 9.—Vitrified Quartz: W. A. Shenstone, F.R.S.

ROYAL ASTRONOMICAL SOCIETY, at 5.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Sewage Treatment: C. Johnston.

SATURDAY, MARCH 9.

ROYAL INSTITUTION, at 3.—Sound and Vibrations: Lord Rayleigh, F.R.S.

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