THURSDAY, JUNE 1, 1899.

EVOLUTION WITHOUT SELECTION.

Die Farbenevolution bei den Pieriden. Von M. C. Piepers. "Tijdschrift der Nederlandsche Dierkundige Vereenignig ; 2. Deel v." Pp. 70–289. (Leiden, 1898.)

THE fact is becoming more and more widely recognised that the colours of animals, and especially of insects, afford excellent material for the investigation of dark places in the theory of evolution. As was long ago pointed out by Bates, and reiterated with increased emphasis by Wallace, the history of the modification of species is displayed to view on the wings of butterflies in a manner that is peculiarly legible and strikingly complete. There is, therefore, every justification for those students of evolution who, like Weismann, Eimer, Meldola, Poulton, Bateson, and several others, have devoted much attention to the colour patterns of lepidopterous insects, and have endeavoured with more or less success to use the facts made available by such detailed examination in the elucidation of the laws which govern the origin and development of species.

The pamphlet named at the head of this article is the work of an author whose credentials entitle him at least to an attentive hearing. He has resided for nearly thirty years in the Malay Archipelago—chiefly in the island of Java ; during the whole of which time, as he tells us, he has studied the entomology of that region, and has in particular continued to search for explanations of the various phenomena presented by the colours of its lepidopterous fauna. It might be expected, then, that he would be able to bring forward a mass of valuable material derived from such observations and experiments as can best be carried out amid the natural surroundings of tropical species, and would thus be in a position to afford real help towards the solution of questions like those of the value in the struggle for existence of mimetic or of warning colours, the importance of sexual selection and the protective significance of seasonal modifications. So far from this being the case, however, it must unfortunately be stated that he has done little or nothing to increase our knowledge in any of these or similar directions.

The cause of his failure is not far to seek. Being, as he informs his readers, in most respects a follower of Eimer, though disagreeing with his master on certain points of detail, he looks for an explanation of organic evolution in the direction of "laws of growth," uncontrolled by any process of selection, but working out the transformation of species under the influence of external conditions which act upon organisms of varying degrees of susceptibility. The essence of his contention is the non-recognition of selection in any form as a factor in evolution, and he is apparently so sure of his position on *à priori* grounds, that he has not thought it worth while to keep the selection hypothesis in view even as a provisional basis for observation and experiment. This, the πρῶτον ψεῦδος of his position, has had a most disastrous effect upon his work, both as an observer and as a reasoner. It cannot be said that he has any new arguments of weight to bring forward ; the main part of his treatise is taken up with a laborious attempt to show that the course of colour-evolution in the Pierids (or "white" butterflies) has followed, and is following, a definite succession of stages, which continually occur in the same order. Starting from an original red, the process of colour-change in the Pierids, according to Piepers, is always tending to reach a final stage of white, which may be attained either by means of a gradual paling through orange and yellow, or through an intermediate condition of black. This inevitable tendency, arising from an internal impulse towards change in a definite direction, taken in conjunction with external influences which act chiefly by way of accelerating or retarding the process of change, and in relation with individual differences of susceptibility to stimulus, he believes to have been sufficient for the production of the assemblage of diverse forms which constitute the Pierid sub-family as at present existing.

It is no doubt true that, speaking generally, there has been a fairly uniform tendency throughout this group of butterflies towards the replacement of an original dark by a white pigment. But this was not reserved for Piepers to discover, inasmuch as the view in question has been long ago advanced and supported by much more detailed evidence than that brought forward in the present treatise. Moreover, cases have been pointed out where, in consequence of mimetic adaptation or from other causes, the more usual process of change has been reversed or modified—a fact not noticed by Piepers, and not very favourable to his general view. But acquaintance with the work of his predecessors scarcely appears to be a strong point with the author, who frequently either ignores altogether, or dismisses in a curt sentence or two, results of other observers which certainly demand and deserve a careful comparison with his own. The part of his theory for which he really is entitled to claim originality, viz. that the primitive colour of Pierids was a uniform shade of red, seems to rest on extremely slender evidence. To any one who will take a comprehensive view of the whole sub-family, the conclusion from which Piepers does not shrink, viz. that the male of *Appias* (*Tachyris*) *zarinda* most nearly represents in coloration the earliest form of Pierid, will appear to savour of the *reductio ad absurdum.* Without going into the kind of detail which would here be out of place, we may safely assert that there is abundant evidence in favour of the contrary view ; and that in many cases, at all events, as in the genera *Mylothris* and *Dismorphia*, there is every reason to attribute the presence of much of the red or orange coloration rather to increased specialisation for a distinct purpose, viz. that of mimicry, than to reversion or survival. Hopkins's researches on Pierine pigments are not unknown to Piepers, but the latter, perhaps wisely, refrains from attempting to reconcile them with his own conclusions.

This brings us to what appears to us to be a serious offence on the part of the author against good taste and good manners in scientific controversy. Nothing but gratitude is due to him for the facts that he has recorded from his own experience ; most readers, indeed, will only wish that he had given us more of them. Nor can any one fairly complain of his absolute denial of the modifying influence of selection, even though he thereby puts himself in opposition to Darwin, Wallace, Fritz Müller, Weismann, and most of those whose labours have contributed to the establishment of the theory of evolution. But in speaking of views which he does not himself hold, he repeatedly allows himself to use language which is highly unbecoming in a scientific man. This is especially noticeable in his remarks on the subject of mimicry. We are of course prepared to find that he does not believe in it, but it might be thought that a view which commended itself to Bates, Wallace, F. Müller, and Trimen, to say nothing of Darwin himself, was at least deserving of respectful treatment. M. Piepers does not think so, and his language on the subject is so uncontrolled as to suggest doubts whether, in spite of his training as a jurist, he can be considered a fair and competent examiner of evidence. It is easy enough to throw about words like "Aberglaube" and "Humbuglehre" in reference to the views of other workers, and to suggest that opponents are "mentally abnormal"; but such expressions recall the methods of the advocate rather than of the judge, and they render their employer liable to severe retaliation, did any one care to administer it.

A conspicuous instance of this want of restraint occurs in the note on p. 279; where the author altogether overreaches himself in his denunciation of Schröder. It is not our business to correct his literary blunders, but we cannot help thinking that the original utterer of the famous line "homo sum; humani nil a me alienum puto" (misquoted, by the way) would be somewhat surprised to see himself referred to as "the old philosopher." This, however, may pass; more open to question is the wisdom of introducing the quotation at all. M. Piepers seems to think that the upholders of mimicry will be "angry" at his strictures. They are more likely to be amused, and perhaps a little saddened, for there is always an element of pathos in resistance to the inevitable.

Protective resemblance, in relation to selection, fares no better with the author than mimicry itself. Thayer's demonstration of the protective value of the pale underside of birds and mammals is convincing enough for most minds; Piepers simply dismisses it with the remark that he cannot admit it in the case of insects. One is tempted to ask him what he expected in the case of insects, but this dictum is a not unfair specimen of his critical method generally. It is difficult to answer a disputant who holds (p. 250) that the resemblance to forms of vegetation shown by the underside of *Euchloe cardamines* and even of *Kallima paralecta* is accidental. The somewhat unseemly comparison on the same page is perhaps meant for a joke. If so, it says very little for the author's humour; if not, it says even less for his logic.

The treatment of seasonal forms affords another instance of his curious reluctance to accept the plain and obvious explanation of certain facts, if that explanation involves a recognition of the principle of selection. Some of his remarks on the varying forms of Malayan butterflies have all the interest and importance which naturally belong to the personal observations of a good field naturalist, but it is strange to find him still advancing theories of the direct influence of local conditions which were long ago discarded by Wallace. The truth which underlies his statements is probably this—that polymorphism gives an opportunity to selection, under which influence it may become limited by locality and season. In his discussion of the permanent or variable whiteness of certain animals, he cannot of course shut his eyes to the fact that the same visual effect of whiteness is produced in different cases by different means. He remarks in a somewhat puzzled way that there is nevertheless evidently some connection between the whiteness caused by a white pigment (so-called) and that due to scattered reflection. Of course there is, or may be, such a connection; but the obvious key to the mystery, viz. selective adaptation, is not even noticed by him.

It is really pitiful to witness the straits to which those evolutionists are reduced who desert the firm and clear lines laid down by Darwin. Towards the end of his treatise M. Piepers makes a certain appeal for the indulgence due to an amateur. We are inclined to admit his claim, and to judge him leniently on that account. Courage and candour he does not lack, and it is deplorable that having tasted the "Pierian spring," he has not taken a deeper draught of its waters. A little more reading would have shown him that many of his discoveries had been already made, and that most of his difficulties had been answered by anticipation.

F. A. D.

PROFESSOR TAIT'S COLLECTED PAPERS.

Scientific Papers. By Peter Guthrie Tait, M.A., Sec.R.S.E., &c. Vol. i. Pp. xiv + 498. (Cambridge University Press, 1898.)

THE Cambridge Press has already laid mathematical and physical workers under deep obligations by its editions of Maxwell, Stokes, Thomson, and Cayley. It now proposes considerably to extend these obligations, and as an instalment of their fresh enterprises we have here the first volume of the collected papers of Prof. Tait. This reprint appeals to readers of widely different interests, and will be welcomed by all, not only on account of the highly specialised investigations of various kinds which it contains, but also as a monument to a writer to whom science owes a great deal.

It would be out of place, even if the reviewer were competent, to attempt any detailed examination of the papers here presented. They have been before the world for many years, and their value and originality have not been contested. A rapid sketch of the contents may, however, be given. A large proportion of the book is taken up with the quaternion investigations in which Prof. Tait first made his mark, and to which he has returned from time to time with undiminished enthusiasm. The precise scope and value of the quaternion method are questions on which opinions have greatly differed, and the number of mathematicians otherwise eminent who could be reckoned as fully concurring in Prof. Tait's views on these points is probably very limited. In this country there has been a certain natural diffidence, and perhaps a little want of courage, which have hindered the free expression of opinion; but on the continent the assertion has been made again and again that the subject has in some respects been unfortunate in its expositors, and that the elements of undoubted value in the theory have been unduly discredited by the somewhat excessive claims made on its behalf. It is possible to sympathise with this view, and yet to attach very high importance to the investigations now in evidence. They are concerned mainly with the processes of differentiation and integration as applied to quaternions, and especially with the properties of Hamilton's operator

$$i\frac{d}{dx}+j\frac{d}{dy}+k\frac{d}{dz},$$

a branch of the subject which (as is well known) has exercised a great fascination on many distinguished cultivators of mathematical physics, from Maxwell downwards. That Prof. Tait's papers remain the primary, and indeed almost the sole, authority on such matters, is ample warrant for the present republication. For the rest, a few items gathered from the titles, such as Fresnel's Wave-Surface, the Theory of Electrodynamics, the Theory of Strain, the Dynamics of Rotation, Green's Theorem, Isothermal Surfaces, and Minding's Theorem, will indicate the variety and importance of the subjects which Prof. Tait has sought to bring within the range of this ambitious calculus.

Passing from this group, we have to notice an elaborate investigation on "Knots," suggested originally by Thomson's theory of vortex-atoms. It deals with a branch of the Geometry of Position which few mathematicians (and those only of the ablest) have ventured to touch; and although the presentation disclaims any finality, there can be no doubt that Prof. Tait's investigations must be accounted a solid and valuable, as they are an interesting contribution to the subject.

It would be ungrateful to pass over a number of minor papers which are specially characteristic of Prof. Tait in respect of the symmetry and elegance of the mathematical treatment, or of the manner in which new light is thrown on well-worn topics. Of these the papers on Hamilton's Characteristic Function, and on the Hodograph, may be cited as specimens. In this latter we find the now well-known representation of a small oscillation in a resisting medium as the projection of motion in an equiangular spiral, as well as several other results or modes of proof which have long become common property. It is pleasant to be reminded of their real source.

A very attractive topic is treated alike with originality and elegance in the paper on "Mirage."

There remain the experimental papers. Of these it may be sufficient to here say that those on Thermo-Electricity have long ranked as classics; and that the paper on the pressure-errors of the *Challenger* thermometers is an interesting record of a laborious investigation undertaken to decide a very important practical question.

Some readers may perhaps be disappointed to find that one side of Prof. Tait's activity is not represented in these pages. He has in his time been engaged in many keen controversies, in which he has displayed the qualities of a "first-class fighting man." One cannot but feel, therefore, great admiration for the restraint he has shown in omitting all traces of such incidents from the present record of his work. There is, in fact, only one paper which one would willingly have spared, and that for quite other reasons. The lecture on "Force," with its insistence on what after all are verbal questions, is surely out of place in the present collection. The readers who are capable of following the *technique* of quaternions, or the intricacies of amphicheiral knots, do not need to be lectured on the looseness of newspaper language; whilst the grave discussion as to whether force or energy has the greater title to rank as a "thing" will hardly excite in them any other feeling than the amusement which (one suspects) may have been the real object of the whole discourse.

The printing and general appearance of the volume are beyond praise. One might, indeed, protest that the *format* is a little *too* luxurious. Many persons hold to the view that the octavo form adopted in the cases of Stokes and Thomson is far more handy and convenient for real work than the more imposing quarto. In the case of Cayley, the larger form was perhaps required by the nature of the subject-matter, with its long algebraical formulæ; but there is little in the present collection which could not with a little ingenuity have been accommodated in the smaller page. But such criticisms are, after all, somewhat ungracious. We conclude by thanking the University and Prof. Tait for this very acceptable volume, which we trust to see speedily followed by a second. And we venture to suggest to the University Press that an additional and welcome element of interest would be imparted to these reprints if they could be adorned with portraits of the authors, even when these are happily still amongst us. HORACE LAMB.

OUR BOOK SHELF.

Elementary Physiology. By Benjamin Moore, M.A. With 125 Illustrations. Pp. vi + 295. (London: Longmans, Green, and Co., 1899.)

THIS book contrasts favourably with most others of its class. A small treatise of three hundred pages on elementary physiology can scarcely avoid being superficial, and, from the students' point of view, inadequate; but to these inevitable shortcomings there are too often added, in books of the kind, the quite gratuitous defects of inaccuracy in statement and failure to keep up with the advance of knowledge. From faults of the latter description the work before us is practically free, and it may be commended with confidence to the junior student, who, as the author says, "is often plunged into a mass of detail, and gets so involved in this, that he loses sight of the main outstanding features of the subject." Most teachers of physiology have probably had experience among their pupils of the mental condition here referred to. Lucid and concise in statement, Mr. Moore's book manages to convey a large amount of accurate information in very small compass. It bears ample evidence of being no mere literary compilation, but the production of a genuine worker in physiology, whose mode of treatment is often striking and original. As might be expected from the author, the book is especially strong in such matters as digestion, absorption and metabolism.

The volume is in most respects so meritorious that it seems ungracious to call attention to its blemishes. These are, as a rule, not serious. It would be unfair to find fault with a book of this kind for being dogmatic; it is plainly not a fitting place for the discussion of controverted questions. The statement, however, on p. 14, with respect to the relations of cartilage and bone is distinctly misleading. But with few exceptions the points that call for criticism concern the form of the book rather than its matter. Thus, the author is occasionally guilty of an awkwardness or inelegance of language that might easily have been avoided, and we cannot say that we approve of such colloquialisms as "harking back again to our simple type," or "that bigger supply of blood to the cells which is required." In many places the sense is seriously interfered with by faulty punctuation, and we note a rather plentiful crop of misprints, especially towards the end of the book. Such are "centre nervous system," "tircuspid," "vertebræ," (for "vertebrata"), "cauda equinæ," "straining" (for "staining"), "Weber-Feehner law," "fenestra rotundis," (several times repeated), "scala tampani," "selerotic," "viteous humour." Nor do we care for the form "oculimotor." It is to be hoped that a future edition will be more carefully revised. The author has been fortunate in securing the use of the well-known and admirable figures from Quain's "Anatomy" and Schäfer's "Essentials of Histology." They add materially to the value of the work.

The Dawn of Reason. By James Weir, jun., M.D. Pp. xiii + 234. (New York: The Macmillan Company, London: Macmillan and Co., Ltd., 1899.)

THIS book on the mental processes of animals is the fruit of much original observation, and in many cases this observation has been supplemented by experiment; but, unfortunately, all the author's results are vitiated by his uncritical and biased attitude in favour of an extreme view of the mental life of animals, and there are few of his facts which the comparative psychologist would be justified in using without ample corroboration by other observers. Instinct is regarded as the great bane of psychology, and it almost seems as if the author believed it to be a special invention of those whom he calls "creationists." He poses as an ardent evolutionist, but is so blind to the most elementary principles of the evolution of mind that when a water-louse frightens some rhizopods, he can only conclude either that the latter have eyes and ears so small that lenses of the highest power cannot make them visible, or that these creatures are the possessors of senses utterly unknown to and incapable of being appreciated by man. He makes observations on spiders which show that they are differently affected by loud and soft vibrations of an organ—observations which do not even demonstrate the existence of hearing—and concludes that these animals have attained a very high degree of æsthetic musical discrimination. He has also seen a spider "intentionally beautifying" its web with flakes of logwood, and he has watched rhizopods employing their time in "simple amusement" resembling a game of tag. Nevertheless, among these extravagances, one meets with observations which would be of distinct value and interest if one had confidence in the observer.

The Arithmetic of Chemistry. By John Waddell, B.Sc. D.Sc. Pp. viii + 133. (New York: The Macmillan Company. London: Macmillan and Co., Ltd., 1899.)

THE volume does not differ essentially from other books on chemical arithmetic. Every teacher has his own method of presenting an arithmetical problem, which he often feels impelled to share with others. The author's methods seem thoroughly sound and logical, and no exception can be taken to them. There is a good deal to be said, too, for the plan of treating the calculations on a purely experimental basis independently of theories; but it is not always advisable to hold to it too rigidly. A good illustration is offered by the following example.

The author begins by showing that the combining weight of oxygen taken as 8 is thoroughly satisfactory, not only in its relation to hydrogen (1) in water, but to carbon (6) in its two oxides. It then becomes necessary to explain that this number for oxygen does not fulfil the expectations which it first raised, and that the formula for water HO(9) must be discarded in favour of H_2O(18). "It is found that while by electrolysis of water all of the hydrogen that is in the water is set free as a gas, and $\frac{1}{9}$ of the water decomposed is hydrogen; on the other hand, when sodium acts on water, only one-half as much hydrogen is set free, that is $\frac{1}{18}$ of the weight of water acted upon." It is questionable whether this explanation would carry conviction to the beginner. A plain dogmatic statement would surely serve the purpose better, until the student had advanced to a stage when he could grasp the whole question involved. The author has collected together an excellent set of examples from a variety of sources, which should be useful to teachers in elementary classes.

J. B. C.

The Flora of Cheshire. By the late Lord de Tabley (Hon. J. Byrne Leicester Warren), edited by Spencer Moore; with a Biographical Notice of the Author by Sir Mountstuart Grant Duff. Pp. cxiv + 399, with a portrait of the author and a map of the county. (London: Longmans, Green, and Co., 1899.)

THE manuscript of this "Flora," we are told, was completed a quarter of a century ago. Those who knew the sensitive, retiring disposition of the late Lord de Tabley will not be surprised that he laid it aside as not ready for press; nor will they be surprised at the excellence of what was done. There is little beyond an enumeration of the plants of the county, but made with extreme care and with conscientious acknowledgment of doubts and difficulties in dealing with critical plants.

Two classes of vegetation seem particularly to have attracted the author's notice, and both in a decidedly historical aspect. The one class is that of the alien plants, whose spread from ballast-heaps, &c., is traced; the other is the shore vegetation of a coast which has been much changed both by man and by tidal denudation. There probably exists no "Flora" of any county in Britain which approaches it in interest in either respect, unless it be that of Middlesex by Trimen and Thiselton-Dyer, published in 1869 at the time when Lord de Tabley was at work on what has just been printed.

To the matter which was put into his hands, the editor has wisely added enough to bring the work into line with our present knowledge of Cheshire botany. The biographical notice in its want of facts is a little disappointing; and the attempt to give each plant a binomial English name leads one to a curious and not altogether happy result. These, however, are small matters.

I. H. B.

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.*]

Fourier's Series.

THE statement of Fourier's theorem for the special case which has intermittently for some months past been a subject of discussion in NATURE, is as follows:—The function whose value is $\frac{1}{2}(\pi - x)$, when x lies between 0 and π, and $-\frac{1}{2}(\pi + x)$, when x lies between 0 and $-\pi$, can be expressed by the series

$$\sum_{k=}^{k=\infty} \frac{\sin kx}{k}$$ for values of x which lie between π and $-\pi$.

The proof of the theorem, whether in this special case or in more general cases, consists in summing the series; and the result obtained in this special case is that the sum of the series is

$$\begin{array}{ll} \frac{1}{2}(\pi - x), & \text{when } x \text{ lies between 0 and } \pi, \\ -\frac{1}{2}(\pi + x), & \text{when } x \text{ lies between 0 and } -\pi, \\ 0 & \text{, when } x = 0. \end{array}$$

Prof. Michelson has found a difficulty in this result in that, whereas the sum of any number of terms of the series is a continuous function of x, the sum of the series is a discontinuous function of x. If I have not misunderstood him, he contends that for extremely small positive values of x the sum of the series should be regarded as indeterminate and as having any value between 0 and $\frac{1}{2}\pi$, and I understand him to support this contention by the consideration that when n terms of the series are taken, so that x being extremely small nx is finite, such an indeterminateness is found.

Such a position involves a misconception of the meaning of the "sum of an infinite series." When $u_1+u_2+\ldots$ is the series, the terms being uniform functions of x, the sum of the series for any value of x is the limit of the sequence of numbers u_1, u_1+u_2, $u_1+u_2+u_3$, ... in each of which x has the given value; the limit of the sum of the series when $x=0$, is the result obtained by *first* summing the series for a finite value of x, and *afterwards* diminishing x without limit; the sum of the series when $x=0$ is the result obtained by *first* substituting 0 for x in the functions u_1, u_2, ... and *afterwards* forming the limit of the sequence u_1, u_1+u_2, ... In the example in question, the results thus obtained are $\frac{1}{2}\pi$ and 0 respectively. The results that can be obtained by summing the series to n terms, diminishing x indefinitely, increasing n indefinitely and keeping nx finite, generally do not coincide either with the sum for $x=0$ or with the limit of the sum for $x=0$, when these are different. Such results may, as I have pointed out in a previous letter, be useful for purposes of illustration, but they are quite beside the mark when it is a question either of the statement of Fourier's theorem or of the sum of Fourier's series.

M. Poincaré, in his letter printed in NATURE for May 18, does not assert that the sum of the series can be obtained by allowing x to approach zero and n to increase at the same time, in such a way that nx remains finite; but he states that Prof. Michelson is perfectly right in contending that the result of this process is indeterminate. So far as I am aware this contention has not been called in question in the course of the discussion.

Oxford, May 19. A. E. H. LOVE.

Bessel's Functions.

THE remarks of "C. G. K." (p. 74) concerning the defects of style which are frequently observed in the writings of scientific men, lead me to point out a grammatical error which is creeping into mathematical literature. I allude to the use of the incorrect phrase "Bessel Functions" in the place of "Bessel's Functions."

In certain cases the name of a person may be converted into an adjective by the addition of an appropriate termination, of which such words as *Elizabethan* and *Victorian* are examples; but to use the name itself (which is a noun) as an adjective, is a violation of one of the most elementary rules of grammar.

When the conversion of a proper noun into an adjective would be cumbrous or inelegant, the only correct mode of expression is to use the *genitive* case. If, therefore, we reject such an adjective as "Bessellian" on the ground of its inelegance, we must use the phrase "Bessel's Functions," that is functions of Bessel. The absurdity and incorrectness of the phrase "Bessel Functions" is at once seen by comparing it with such phrases as "*Green* Theorem," "*Chrystal* Algebra," "*Love* Elasticity."

The correct use of the genitive case is a subject upon which considerable misapprehension has existed. Thus we find in the Prayer Book the phrase "For Jesus Christ His sake," instead of "For Jesus Christ's sake." The error arose from the fact that the compilers of the Prayer Book were ignorant that the *'s* is not a conception of the pronoun *his*, but is the old Teutonic genitive which still exists in most German languages.

Fledborough Hall, Holyport, May 28. A. B. BASSET.

"The Art of Topography."

IN your issue of March 23 (No. 1534, vol. lix.) appears a review of "Recherches sur les Instruments, les Méthodes et le dessin Topographiques, par le Colonel A. Laussedat," signed by "T. H. H." The review brought to my attention several points of interest upon which I beg leave to comment.

Regarding planetable instruments, the reviewer says "that 'Russians and Americans' use very complicated instruments." Of the Russian instruments I have no knowledge, but this is certainly not true of the American.

The U.S. Geological Survey makes use of the planetable to a greater extent than any and all other organisations in America, fully two hundred of these instruments being constantly in use.

The instruments used are remarkable in simplicity and efficiency, are reasonably light, portable and accurate. The instruments are of a model designed by Mr. Willard D. Johnson, of the Survey, and are fully described on pages 79 to 89 of *Monograph* xxii. of the U.S. Geological Survey, entitled "Manual of Topographic Methods," by Mr. Henry Gannett.

This work also treats of the methods of accomplishing topographic mapping by the Geological Survey. Mr. Gannett explains the use made of the planetable, and shows that all work is controlled by points, located by triangulation or other means dependent upon numerical measurements and carefully computed. The triangulation is carried on with eight-inch theodolites reading, by micrometer microscopes, to two seconds.

The instructions to triangulators include the order that points must be selected and arranged so as to best control the area under survey, and that *three* points at least should be located on each atlas sheet of the map. Since these sheets differ in area in different parts of the country, ranging from 1/16 of a square degree to a square degree, the distance between triangulation stations necessarily varies considerably.

After the primary triangulation points are located in an area, dependence upon the planetable is absolute for the "secondary" triangulation within that area, the control, both horizontal and vertical, is carried on by use of this instrument. If the surveyor using a planetable for graphic work starts from accurately located points with check point available, he very soon discovers any "accumulation of error," in that it is impossible to make the several locations check one with another.

In regard to the use of "continuous contours" to express relief, the "Commission of 1826" seems to have drawn the remarkable conclusion that for scales less than 1 : 10,000 this system is insufficient.

The Geological Survey publishes topographic maps which vary in scale between 1 : 9600 and 1 : 250,000 (1 inch to 800 feet and 1 inch to 4 miles about, respectively), and on these maps the contour interval varies between 5 feet and 200 feet. The expression of relief is, I think, in these cases satisfactory, at least so far as giving accurate information is concerned; the artistic effect is very good also, especially when the topographic features are large and the slopes steep, cliffs appearing as broad heavy lines where differentiation of the individual contours is impossible.

About 1890, the use of mercurial barometers was abandoned by the Geological Survey, and trigonometric methods for obtaining heights were adopted. At the present time the primary heights are determined by spirit-levelling, from which elevations are carried in connection with the triangulation or by lines run with vertical angle readings and carefully measured distances. The use of the aneroid barometer is only allowed in inaccessible areas between the known elevations, and must be frequently checked. The experience of the writer in widely separated regions in the United States, in obtaining differences of elevation with the aneroid, leads him to the conclusion that, as a rule, the instrument fails to record differences as accurately when carried from a higher to a lower region as it does when the change of elevation is in the opposite direction. Also, that an aneroid which has been used in a region of elevation of given range must be given time to accommodate itself, if it be required to do good work in a region of greater or less elevation than that in which it has been used. The principle and construction of the aneroid is such that it never can be accepted as an instrument of precision except within well-defined limits, with frequent comparison with known elevations. The Survey has in use several hundred aneroid barometers, but no confidence may be had in any one of them unless frequently checked, as stated. It will be seen that the methods now in use in America agree more closely with those practised by the British Government, at least so far as the Colonial surveys are concerned, than with any other of the European surveys. R. H. C.

The Heating of the Anti-Kathode in X-Ray Work.

SINCE the beginning of X-ray work the heating of the anti-kathode has caused great difficulty, and with the introduction of the Wehnelt interrupter it is even more important that this should be prevented. In other words, we all along have had more energy from the coil than could be utilised in the Crookes' tube. Many workers like myself have tried to remedy this, and various plans have been adopted to keep the anti-kathode cool. It occurred to me that if we could get a piece of platinum, fused into the glass tube itself, to act as the anti-kathode, and placed opposite the kathode, this object might be attained. Such a tube, after many attempts, has at last been made; and although the first experiments have only been successful in making small tubes, others of a larger size are at present being attempted. The advantage of this method will easily be seen, because the heating of the piece of platinum can be prevented by placing the whole tube in a fluid cooling mixture or otherwise. These tubes are difficult to make at present, but I possess one which has retained its vacuum for some weeks.

179 Bath Street, Glasgow, May 28. J. MACINTYRE.

Variation of Species.

On p. 181 of Wallace's "Darwinism," ed. 1889, this passage occurs:—"Let us suppose that a given species consists of 100,000 individuals of each sex, with only the usual amount of fluctuating external variability. Let a physiological variation arise, so that 10 per cent. of the whole number—10,000 individuals of each sex—while remaining fertile *inter se* become quite sterile with the remaining 90,000. This peculiarity is not correlated with any external differences of form or colour, or with inherent peculiarities of likes or dislikes leading to any choice as to the pairing of the two sets of individuals. We have now to inquire, What would be the result?"

I have here attempted to investigate this question algebraically.

A. We shall suppose, as Dr. Wallace does, that the number of males in the species is the same as the number of females. Each of these numbers we shall denote by unity. For convenience, we shall speak of the number of either sex as the number of the species. Let then

$$x = \text{the number of the normal species,}$$

and

$$y = \text{the number of the variant variety,}$$

at any given stage of the change above described.

If in any given generation (x, y), the ratio, which the number of the variant individuals, born in a family of the normal species, bears to the total number of young born in that family, be denoted by k; and if (x', y') denote the generation which succeeds (x, y); then must

$$x' : y' :: x^2(1-k) : y^2 + kx^2;$$

with the relation

$$x' + y' = x + y = 1;$$

because the total species remains constant in number of individuals.

Now, if the variants succeed in establishing themselves as a new species, and the above two generations belong to the permanently settled state of the whole species, we must have $x' = x$, and $y' = y$.

Consequently, to determine x, y under this condition we have the equations

$$\frac{(1-k)x^2}{x} = \frac{y^2 + kx^2}{y}, \quad x + y = 1;$$

$$\therefore (1-k)x = 2x^2 - 2x + 1;$$

$$\therefore x = \tfrac{1}{4}(3 - k \pm \sqrt{k^2 - 6k + 1}).$$

To take Dr. Wallace's example, put $k = \cdot 1$. Then

$$x = \cdot 88508 \ldots, \quad y = \cdot 11492 \ldots;$$

or

$$x = \cdot 56492 \ldots, \quad y = \cdot 43508 \ldots.$$

Thus, taking Dr. Wallace's number 100,000, we find that, ultimately, the normal species will number 88,508 and the variant 11,492 These numbers differ but little from Dr. Wallace's, but they represent the final distribution of the original species into two species. Another possible distribution is given by the numbers 56,492 and 43,508. If by any chance the first permanent distribution be disturbed materially, then the total species might reach the second permanent state.

If, however, at any time the parent species were to cease to produce the variants, then the latter would quickly disappear. They could be saved from extinction only by the ceasing of intermarriage between the two species. For, if (x_n, y_n) denote the nth generation from the one (x, y) in which the variants ceased to be produced by the normal species, then

$$x_n : y_n :: x^{2^n} : y^{2^n}.$$

If $n = 4$, and $x = \cdot 9$, $y = \cdot 1$, as in Dr. Wallace's case, then

$$x_4 : y_4 :: (\cdot 81)^4 : \cdot 00000001;$$

so that the original species of 100,000 would have no variants left at all. The disappearance of the variants is due to the two facts, (1) that the total number of the two species together is constant, (2) that the number of unfruitful unions is very large in proportion to the number of unions possible to the smaller species. For example, if the variants be ·1 of the whole species, the probability will be that ·9 of their unions will be unfruitful; but that ·9 of the unions of the normal species will not be unfruitful.

B. We shall now consider the case when the unions between the two varieties are not sterile, and the hybrids are also fertile *inter se* and with the parent varieties.

Let the relative, effective, fertility of the hybrids and mongrels, *inter se* and with the parent varieties, be denoted by the factor k, which we shall assume to be always less than unity. Also, let the effective fertility of the normal species in the production of variants be denoted by the factor μ; and let z denote the number of the hybrid variety in the generation (x, y, z).

Then the equations which determine the stable and permanent condition, if there be one, are

$$\frac{(1-\mu)x^2}{x} = \frac{y^2 + \mu x^2}{y} = \frac{\{(x+y+z)^2 - x^2 - y^2\} \times k}{z},$$

$$x + y + z = 1. \quad \ldots\ldots\ldots \quad (1)$$

Put

$$\alpha = 1 - z, \quad k' = 1 - k, \quad \mu' = 1 - \mu;$$

then

$$\mu' x(1 - k'\alpha) = k, \quad \ldots\ldots\ldots \quad (2)$$

and

$$\mu' x\alpha = x^2 + (\alpha - x)^2. \quad \ldots\ldots\ldots \quad (3)$$

Put

$$\beta = (1 - k'\alpha)\mu'\alpha; \quad \ldots\ldots\ldots \quad (4)$$

then

$$\beta^2 - k(3-\mu)\beta + 2k^2 = 0. \quad \ldots\ldots \quad (5)$$

Whence

$$\alpha, \text{ or } 1 - z, = \frac{1}{2k'}\left\{1 \pm \sqrt{1 - \frac{4k'\beta}{\mu'}}\right\}, \quad \ldots \quad (6)$$

and

$$\beta = \frac{k}{2}\left\{3 - \mu \pm \sqrt{\mu^2 - 6\mu + 1}\right\} \quad \ldots\ldots \quad (7)$$

The roots of $\mu^2 - 6\mu + 1 = 0$ are ·17158 ... and 5·82842 ...

As we suppose μ less than 1, it follows that in no case must μ exceed the lower root, ·17158 . . . . (8)

From (7) it follows that β must $> k$.

From (6) it follows that $1 - \mu$ must $> 4k'\beta$, or $= 4k'\beta$;

$\therefore 1 - \mu$ must $> 4kk'$; $\therefore k$ must not $> \cdot 5$ . . . . . (9)

Also β must not $> \dfrac{\mu'}{4k}$, ... (10)

To take Dr. Wallace's example, put $\mu = \cdot 1$.

We find, then, that kk' must not $> \cdot 225$. If we put $kk' = \cdot 225$, and solve for k, we find that

$$k = \cdot 342 \ldots, \text{ or } \cdot 658 \ldots.$$

But kk' must not $> \cdot 225$; hence k must not lie between ·342 . . . and ·658 . . . ; ∴ by (9) k must not $> \cdot 342$ . . .

Take, for example, $k = \cdot 2$.

Then by (7), $\beta = \cdot 225969$ . . . or ·354031 . . . .

By (10) we must reject the second value of β.

Adopting the first value, we find from equations (2) and (1) the following two solutions,

$$x = \cdot 798 \ldots, \quad y = \cdot 104 \ldots, \quad z = \cdot 098 \ldots$$

and

$$x = \cdot 308 \ldots, \quad y = \cdot 040 \ldots, \quad z = \cdot 652 \ldots.$$

Here the effective fertility of the hybrids, *inter se* and with the parent varieties, must not exceed 34 per cent. of that of the parent varieties; and in no case must it exceed 50 per cent. of the latter. Also, in no case must the parent species supply more than, or even as much as, 18 per cent. of its total progeny to the variant species.

C. If no hybrid unions occur, and the two varieties supply individuals to each other in such a way that, taking the progeny of the generation (x, y), a fraction λ of the x progeny belongs to the y variety, while a fraction μ of the y progeny belongs to the x variety (where λ and μ are proper fractions), it is easy to prove that in the ultimate, established, state of the total species

$$x : y :: \mu : \lambda.$$

Therefore, if $\lambda = \mu$, the species will be, in its final state, equally divided between the two varieties. The equations for the established state are, since now there is no intermarriage,

$$\frac{x - \lambda x + \mu y}{x} = \frac{y - \mu y + \lambda x}{y}, \quad x + y = 1;$$

whence

$$\lambda x = \mu y;$$

i.e.

$$x : y :: \mu : \lambda.$$

This may also be proved by direct calculation.

Woodroffe, Bournemouth. J. W. SHARPE.

ON SOME RECENT ADVANCES IN SPECTRUM ANALYSIS RELATING TO INORGANIC AND ORGANIC EVOLUTION.[1]

In the last lecture I dealt with that new development of spectrum analysis which has enabled us to discuss, with greater fulness than was possible before, the various chemical conditionings in the different regions of our system as marked out for us by the Milky Way. I now have to refer to another development in a somewhat different direction. We have, as I think you will agree, by the discussion of the relation of the celestial bodies of all sorts to the Milky Way, demonstrated that the evolution of the cosmos in all probability took place from the gradual condensation of swarms of meteorites; and that such swarms are still more numerous there, and give rise to the new stars, bright-line stars and variable stars which are most numerous in its plane. When this work was begun our knowledge was so incomplete that a continuous chain of chemical facts was out of the question; but, thanks to the advances to which I have now to refer, we can deal with this cosmical evolution from a chemical standpoint, and what we have to do to-night is to consider the result of this inquiry.

I may begin by saying that now the gaps in our knowledge have been filled up, we find ourselves in the presence of a chemical evolution which is really majestic in its simplicity. Such a chemical evolution was suggested by me many years ago now, to explain the few stellar facts with which we were then familiar; but I do not propose to take up your time with any historical allusions; I must point out, however, that we to-night are in a very much better condition to consider this problem than we have ever been before, because at the present moment we have tens of thousands, I might almost say hundreds of thousands, of coordinated facts to go upon.

The first point I have to refer to is this: we have brought the sun and the stars together into line in all matters relating to the discussion of the effects of higher temperatures. The photographs taken during the recent solar eclipses show that when we deal with the hottest part of the sun that we can get at, which is hotter than that part of the sun which produces the well-known absorption spectrum marked by the so-called Fraunhofer lines, we are not in an unknown territory at all, but are brought face to face with similar phenomena to those in the atmospheres of stars which are hotter than our sun. The bright-line spectrum of the sun's chromosphere seen during an eclipse shows us the effects produced by heat in the hottest part of the sun that we can reach; these we can compare with the dark lines of a star which contains absorption lines very different from those represented by the Fraunhofer lines, and we find that they correspond almost line for line.

In this manner then we have an opportunity of correlating all the facts which have been obtained during the last, let us say, thirty years, in relation to the sun, with more recent facts than have been gathered with regard to the stars. In this work we were, by hypothesis, watching the effects of dissociation as the temperature rose higher and higher; but if we change our point of view, if we consider the phenomena no longer from the point of view of dissociation but from that of evolution, we find at once that the facts recently garnered carry us very far indeed along a new line of thought.

Let me give you an idea of what I mean. Let us deal, for instance, with well-known chemical compounds, say chloride of sodium, that is common salt, and oxide of iron, that is iron-rust. We have no difficulty in recognising the fact that chlorine and sodium in one case and oxygen and iron in the other must have existed before their compounds, common salt and iron rust, could be formed or associated. Water is split into hydrogen and oxygen at a high temperature, so that there is a temperature above which the two gases would remain in contact but uncombined; when the temperature falls water is produced. Dissociation, therefore, in all its stages must reveal to us the forms the coming together of which has produced the thing dissociated or broken up by heat. If this be so, the final products of dissociation or breaking up by heat must be the earliest chemical forms. Hence we must regard the chemical substances which visibly exist alone in the hottest stars as representing the earliest evolutionary forms. That, I think, is pretty obvious.

If we were only dealing with ordinary chemical forms it might be objected that it was only a question of *seeing*; that all chemical substances were really *present* in the reversing layer, that is the part of the atmosphere of the stars which we can study, but some only made their appearance; but I shall show later that the orderly progression includes lines of substances which we cannot see at all and others which we can only see at the highest possible temperatures in our laboratories.

Two or three times over I have used the words "evolution" and "evolutionary forms." What do these words really mean?

Perhaps I can give an idea of this by referring to another line of work altogether in which the word is frequently used and thoroughly understood. It is important that I should do this for another reason, which you will gather later. That line of work has to do, not with inanimate forms, like the chemical elements and the stars, but with living things, with so-called organisms. Some of my audience to-night doubtless remember Huxley's lectures here in 1860 On the Relations of Man to the Lower Animals, and most of you know that what we now recognise as one of the greatest triumphs of the century just ending was the determination of the truth of a so-called "organic evolution" in which we have, I suppose, the most profound revolution in modern thought which the world has seen.

That evolution tells us that each kind of plant and animal was not specially created, but that successive changes of form were brought about by natural causes, and that the march of these forms was from the more simple to the more complex. Organic evolution, in fact, may be defined as the production of new organic forms from others more or less unlike themselves; so that all the present plants and animals are the descendants, through a long series of modifications or transformations, or both, of a limited number of an ancient simpler type. We must not suppose that this change has gone on as if things were simply mounting a ladder; the truth seems to be that we have to deal with a sort of tree with a common root and two main trunks representing animal and vegetable life; each of these is divided into a few main branches, these into a multitude of branchlets, and these into smaller groups of twigs.

This new view represents to us the evolution of the sum of living beings; shows that all kinds of animals and plants have come into existence by the growth and modification of primordial germs. Now I want just to say that this is no new idea, it is the demonstration which is new to us in our present century and generation; we have really to go back to the seventeenth century, if indeed we must not go as far back as Aristotle, for the first germs of it; but with regard to the history, however, I have no time to deal with it. There are two or three points, however, to be considered in regard to this evolution. The individual organic forms need not continuously advance; all that is required is that there shall be a general advance—an advance like that of our modern civilisation—while some individual tribes or nations, as we know, stand still, or become even degenerate. With

[1] A Lecture to Working Men, delivered at the Museum of Practical Geology on Monday, April 24, by Sir Norman Lockyer, K.C.B.

this reservation; the first forms were the simplest. It may be that as yet we know really very little of the dawn of geological history; that the fossiliferous rocks are nowhere near the real base. This conclusion has been derived by Prof. Poulton[1] from the complexity of the forms met with in them; still we find that we have not to deal with such a vast promiscuous association of plants and animals of lowest and highest organisation as we know to-day; we deal relatively only with the simplest. The story both with regard to plants and animals is alike in this respect.

Let me deal with the plants first. The first were aquatic—that is to say, they lived in and on the waters. So far as we know, the first plant life was akin to that of the algæ which include our modern seaweed, moss-like plants followed them, and then ferns, and it is only very much later that the forms we know as seed plants with gaily coloured flowers living on the land made their appearance. The general trend of change amongst the plants has been in the direction of a land vegetation as opposed to one merely in or on the surface of the waters, and some present seaweeds exhibit the initial simplicity of plant-structure which characterised the beginning of vegetable life, while the seed plants I have mentioned are of comparatively late development; but we still have our seaweed; so that with all the change in some directions some forms like the earlier survive.

After this explanation, relating to work in an apparently different direction, you will have no difficulty in understanding the meaning I attach to the word "evolution" in relation to stars and the chemical elements which visibly exist in them, so far as the history of plant change is concerned; but we are not limited to plant life. The same conceptions apply to animal life, and it is important for my subject that I should refer to that also. What do we find there? We are brought face to face with the same progression from simple to complex forms. This is best studied by a reference to the geological record

Stratigraphical geology is neither more nor less than the anatomy of the earth,[2] and the history of the succession of the formations is the history of a succession of such anatomies; or corresponds with development as distinct from generation. In stratigraphical geology, as can be gathered from any book on geology, we find the names of certain beds which contain certain different forms of animal and vegetable life. We begin with the Laurentian and Algonkian and then pass to the Cambrian, then to the Ordovician, the Silurian and Devonian, and so on through a long list of beds and geological strata until we come eventually to the Recent, that is to say, the condition of things which is going on nowadays on the surface of the earth. And if we prefer to map those many different beds into more generic groupings, we begin with the Primary or Palæozoic, we pass on to the Secondary or Mesozoic, and then we finally reach the Tertiary or Cainozoic. The deposition of these beds and of the animal life which has been going on continuously on the surface while those beds have been deposited gives us the various changes and developments which have taken place with regard to animal forms. It is worth while to go a little into details and to indicate the changes in these forms which have taken place, in the most general way. Beginning with the Lower Cambrian, we find that the animal forms were represented by Invertebrata such as Sponges, Corals, Echinoderms, Brachiopods, Mollusca, Crustacea and many early Trilobites; not to mention true Fucoids and other lowly plant-remains. When we come to the Silurian, we find a large accession of the above forms, especially of Corals, Crinoids, and Giant Crustaceans (such as *Pterygotus*) and armoured animals (Ostracodermi) without a lower jaw, or paired fins; the beginnings of Vertebrate life, not yet fully evolved, and one lowly organised group of armoured fishes named *Cyathaspis* (without bone cells in their shelly-shield). Here, too, we meet with the first Air-breathers; the wing of a Cockroach, and several entire and undoubted Scorpions! Thus in addition we get vertebrates as opposed to invertebrates, and the first traces of the fishes. In the advance to the Devonian the fishes (associated with giant Crustacea) predominate; it has been called the age of fishes. In the next series, the Carboniferous, we find the first certain traces of amphibians, of which the early existence is like that of a fish: a state of things illustrated by the frog, which the majority of us in our early days have, I am sure, studied as a tadpole in its early stages; and some of these amphibians still retain fish-like characters. It is not until we arrive at the Permian that the true reptiles are met with, but in the next great series, the Triassic, we meet with a remarkable evolutionary group of Reptiles, the Theriodontia, or beast-toothed animals, because (unique among reptiles) they possess a dentition like a dog or a lion, with incisors, canines and cheek-teeth; the precursors doubtless of the succeeding Mammalian type. We pass easily thus from the reptiles to mammals which are related to them; for instance, the ornithorhynchus and the echidna are both Australian mammals which bring forth their young within the egg as do the reptiles. Well, after that we begin to deal with birds. The early birds were strikingly reptilian in some of their characters; and the pterodactyle, which many of you may have seen remains of in different museums, was really a winged reptile and not a bird. From that we gather that mammals and birds are variants of reptiles. When we progress from the Jurassic to the Recent, we find man making his appearance as a direct descendant of all those early forms. There is not much new in this. This, as I have said, is what Huxley largely demonstrated in this theatre thirty-nine years ago in a previous course of these Lectures to Working Men.

When we come to study the life-history of the various forms brought before us by the geological strata, we find it to vary considerably, a fact indicated by the presence or absence of the different genera in the various strata. We find that the trilobites, for instance, only appear in the very early geological formations; there is no trace of them in the recent, but if we take the annelids we find that they are continuous from the earliest to the latest formations; we still have our worms. Again we find that certain other organic forms made their appearance very low down in the time scale, forms which were not represented at all in the earlier Cambrian and Silurian, and that some of these are continuous to the present day. Let us take the story of the fishes. A great many fishes made their appearance at the Devonian stage, there were few in the Silurian; some of these stopped there, whereas others have been continued from the Devonian times to our own. Take, for instance, the Australian mudfish *Ceratodus*; to judge from the teeth this fish might well have lived on unchanged from late Palæozoic times until the present day! We see there is a tremendous variation of possible life-range, so to speak, with regard to these different forms, and the plant record, although necessarily more imperfect than the animal on account of the nature of the organism, tells the same story in its fragmentary evidence. In that way, then, the geologist has been able to bring before us the continuity of life in various forms from the most ancient geological strata to the most recent. The record may be incomplete, but is complete enough for my purpose. But that is not the only evidence of evolution to which I can refer.

The teachings of embryology confirm the argument based upon the study of geology, and suggest that the life-history of the earth is reproduced in the life-history of individuals. The processes of organic growth or em-

[1] Presidential Address, Section D, British Association Meeting at Liverpool, 1896.
[2] Huxley, *Q. J. G. S.*, xxv. p. xliii.

bryonic development present a remarkable uniformity throughout the whole of the zoological series; and although knowledge is still limited, some authorities hold that there is the closest possible connection between the development of the individual and the development of the whole series of animal life. There are others, however, who do not regard the argument derived from embryology as a very convincing one. However this may be, if we study the embryos of the tortoise, fowl, dog and man, we find that there is a wonderful similarity between them at a certain stage. At a further stage of development the similarity is still borne out. This does not mean that a vertebrate animal during its development first of all becomes a tortoise, and then the various animals which are represented by these embryos; it simply means that they are all related inasmuch as there is continuity.

After these references to plants and animals it should be clear what organic evolution really is, and therefore what evolution is generally. I wish next to bring before you some considerations having relation to the stratigraphical record.

The question for us now is—Is there any equivalent to this in the inorganic world? or, to put it in another way, in those facts which have been revealed to us by the presence of the various chemical forms in the stellar strata represented by stars of varying temperatures? That is the question.

When I referred in my last course of Lectures here to cosmical evolution, I said that there we dealt with a continuity of effects accompanied by considerable changes of temperature; from the gradual coming together of meteoritic swarms until eventually we had a mass of matter cold and dark in space. The various stars which represent the different changes have been got out and have, in fact, been arranged along a so-called temperature curve. As we ascend one branch of this curve the stars get gradually hotter and hotter till ultimately at the top we find the hottest stars that we know of. Then on the descending branch are represented the cooling bodies, and finally they come down in temperature until we reach that of a dark world like the companion of Sirius, of our own moon, and the planet in which we dwell.

We can now deal with all these bodies in relation to their chemistry. We find that in the hottest stars we get a very small number of chemical elements; as we come down from the hottest star to the cooler ones the number of spectral lines increases, and with the number of lines of course the number of chemical elements. I will only refer to the known substances, it looks as if at present we have still many unknowns to battle with. In the hottest stars of all, we deal with a form of hydrogen which we do not know anything about here (but which we suppose to be due to the presence of a very high temperature), hydrogen as we know it, the cleveite gases, and magnesium and calcium in forms which are difficult to get here; we think we get them by using the highest temperatures available in our laboratories. In the stars of the next lower temperature we find the existence of these things continued in addition to the introduction of oxygen, nitrogen and carbon. In the next cooler stars we get silicium added; in the next we get the forms of iron, titanium, copper and manganese which we can produce at the very highest temperatures in our laboratories; and it is only when we come to stars much cooler that we find the ordinary indications of iron, calcium and manganese and other metals. All these, therefore, seem to be forms produced by the running down of temperature. As certain new forms are introduced at each stage, so certain old forms disappear. In order to connect this work with the stratigraphical work, to which I have referred, I have recently tried to define these various star-stages by means of their chemical forms which they reveal to us; so that we may treat these stellar strata, so to speak, as the equivalent of the geological strata to which I have already called your attention.

From the hottest to the coldest stars I have found ten groups so distinct from each other chemically that they require to be dealt with separately as completely as do the Cambrian and the Silurian formations. Imitating the geologist, I have given the following names to these groups or genera beginning with the hottest, that is the oldest dealing with the running down of temperature:—Argonian, Alnitamian, Achernian, Algolian, Markabian [a "break in strata"], Sirian, Procyonian, Arcturian (solar), Piscian.

I have gone further, and defined the chemical nature of these stellar genera as the biologist defines the nature of any of his organic genera; we can say, for instance, that the Achernian stars contain chiefly hydrogen, nitrogen, oxygen and carbon, and to a certain less extent they contain proto-magnesium, proto-calcium, silicium and sodium,[1] and possibly chlorine and lithium; so that at last, by means of this recent development of spectrum analysis, we have been able really to do for the various stars what the biologist a good many years ago did for the geological strata.

Now, considering this inorganic evolution from the chemical point of view, there are several matters which merit consideration. We shall not get much help by thinking along several obvious lines, for the reason that in the stars we are dealing with transcendental temperatures; for instance, we must not make too much of the difference between gases and solids, because, at high temperatures all the chemical elements known to us as solids are just as gaseous as the gases themselves; that is to say, they exist as gases; at a high temperature, everything, of course, will put on the nature of gas. Those substances with the lowest melting points, such as lithium and sodium, will, of course, under our present conditions put on the gaseous condition very much more readily than other substances like iron and platinum, but those are considerations which need not be taken into account in relation to very high stellar temperatures; of course, there would be no solids at a temperature of 10,000° C.

Then with regard to metals and non-metals. Here again we really are not greatly helped by this distinction. The general conception of a metal is that it is a solid, and that therefore a thing that is not a solid is not a metal; but the chemical evidence for the metallic nature of hydrogen has been enlarged upon by several very distinguished chemists. With regard to non-metals, there are certainly very many. Carbon is supposed to be a non-metal, and it is remarkable that, so far as the stellar evidence which I have brought before you has gone, carbon seems to be the only certain representative of that group. I want to point out specially that the table of the chemical definitions of the various stellar genera which I show you, which contains nothing but hard facts, is perhaps, like the geological record, more important on account of what it indicates as to the presence of the chemical elements in the stars than it is for what it omits.

There are a great many reasons why some of the substances which may exist in these stars should not make their appearance. I wish to enlarge upon the fact that, seeing the very small range of our photographs of stellar spectra, and seeing that it does not at all follow that the particular crucial lines of the various chemical substances will reveal themselves in that particular part of the spectrum which we can photograph, that the negative evidence is of very much less importance than the positive evidence. I think it is very likely, for instance, that we must add lithium to

[1] Campbell, "Astronomy and Astro-physics," 1894, xiii. p. 395.

the substances which we find in the table, we must certainly add sodium, and also aluminium, and chlorine possibly, but about sulphur at present I have no certain knowledge; you will see the reason for these references later on. At all events, we can with the greatest confidence point out the remarkable absence of substances of high atomic weights, and the extraordinary thing that the metals magnesium and calcium undoubtedly began their existence in the hottest stars long before, apparently, there is any obvious trace of many of the other metals which a chemist would certainly have been looking out for.

In relation to this new work, the first point to make is that the chemical forms we see in the hottest stars are amongst the simplest. What is the justification for this statement? Well, there are two reasons. The chemist will acknowledge that if there be such a thing as chemical evolution, an element of low atomic weight is simpler, that is, less massive, than an element of high atomic weight. If we rely upon spectrum analysis we can say, when dealing with the question of "series," about which I hope to say something in my next lecture, that the elements which have the smallest number of "series" are in all probability simpler than those which have a large number, and this is still truer when we find that all the lines in the spectrum of a substance can be included in those rhythmical series, as happens in the case of the cleveite gases. So that the first stage of inorganic evolution, if there has been such an evolution, is certainly a stage of simplest forms as in organic evolution.

The next point is that the astronomical record, studied from the evolution point of view, is in other ways on all-fours with the geological record. We get the same changes of forms, I may say that we get the sudden breaks in forms, disappearances of old accompanied by appearances of new forms, and with this we get, whether we consider the atomic weight point of view or the series point of view, a growth of complexity.

The geological story is exactly reproduced. Now, here it is obvious that a very important point comes in. In inorganic evolution we are dealing with a great running down of temperature; how tremendous, no man can say. We know the temperature of our earth, but we do not know, and we can not define, the temperatures of the hottest stars. So that how great the temperature of the earth may once have been, supposing it to be represented by the present temperature of the hottest star, no man knows anything with certainty.

With regard to organic evolution, however, which has to do with the plant world and the animal world, there can have been no such running down of temperature at all. The temperature must have been practically constant. Please bear that in mind, because I shall have to refer to it later on.

It is proper that I should say that just as the work of Darwin in the nineteenth century was foreshadowed by seventeenth century suggestions, so the stellar demonstration which I have brought before you to-night has been preceded by hypotheses distinctly in the same direction. The first stage of chemistry, as you know, was alchemy. Alchemy concerned itself with transmutations, but it was found very early that the real function of the later science of chemistry was to study *simplifications*, and, of course, to do this to the utmost we want precisely those enormous differences in temperature which it appears the stars alone place at our disposal.

With regard to the general question of inorganic evolution, the first idea was thrown out in the year 1815 by Prout, who, in consequence of the low atomic weight of hydrogen, suggested that that gas was really the primary element, and that all the others, defined by their different atomic weights, were really aggregations of hydrogen, the complexity of the aggregation being determined by the atomic weight; that is to say, the element with an atomic weight of twenty contained twenty hydrogen units; with an atomic weight of forty it contained forty, and so on. The reply to that was that very minute work showed that the chemical elements, when they were properly purified and examined with the greatest care, did not give exactly whole numbers representing their atomic weights. They were so and so plus a decimal, which might be very near the zero point, or half-way between, and that was supposed to be a crushing answer to Prout's view. The next view, which included the same idea—that is to say, a physical connection between these different things as opposed to the view that they were manufactured articles, special creations, each without any relation whatever to the other, was suggested by Döbereiner in 1817, and the idea was expanded by Pettenkofer in 1850. Both pointed out that there were groups of three elements, such as lithium, sodium, and potassium, numerically connected; that is, their atomic weights being 7, 23, and 39, the central atomic weight was exactly the mean of the other two, $7 + 39 = 46$, divided by 2, we get 23. Another way, however, of showing that is that $7 + 16 = 23$, and $23 + 16 = 39$; the latter method suggests a possible addition of something with an atomic weight of 16.

In 1862 de Chancourtois came to the conclusion that the relations between the properties of the various chemical elements were really simple geometrical relations. That, you see, is a much broader view. It is not till 1864 that we come to the so-called "periodic law," which was first suggested by Newlands, and elaborated by Mendeléeff in 1869. According to this law, the chemical and physical properties of the elements are periodic functions of their atomic weights. Lothar Meyer afterwards went into this matter, and obtained some very interesting results from the point of view of atomic volumes. He showed that if we plot the atomic volumes of the different elements, arranged according to their atomic weights from left to right, there is a certain periodicity in the apices of the curve indicating the highest atomic volumes.

So far there was no reference to the action of temperature in relation to this, but in 1873 I suggested that we must have a fall of temperature in stars, and that the greater complexity in the spectra of certain stars was probably due to this fall of temperature. This idea was ultimately utilised by Sir William Crookes in an interesting variation of the periodic law, in which he assumes that temperature plays a part in bringing about the changes in the characters of the elements. Brodie, in 1880, came to the conclusion that the elements were certainly not elementary, because in what he called a "chemical calculus" he had to assume that certain substances, supposed to be elements, were really not so; and he then threw out the very pregnant idea that possibly in some of the hotter stars some of these elements which he predicted might be found. Nine years afterwards, Rydberg, one of the most industrious investigators of the question of "series" to which I have referred, stated that most of the phenomena of series could be explained by supposing that hydrogen was really the initial element, and that the other substances were really compounds of hydrogen; so that you observe he came back to Prout's first view in 1815.

All these ideas imply a continuous action, and suggest that there was some original stuff which was continuously formed into something more complex as time went on. That is to say, that the existence of our chemical elements as we know them does not depend upon their having been separately manufactured, but that they are the result of the working of a general law, as in the case of plants and animals.

You see at once that the stellar facts which have already been brought before you are entirely in harmony with the highest chemical thought, and indeed establish the correctness of its major contention. We may be said to pass from chemical speculation to a solid chain of facts, which doubtless will be strengthened and lengthened as time goes on. In all these changes we seem to be in the presence of a series of what chemists call polymerisations, that is, roughly, a series of doublings. The greater complexities may also have been brought about by the union of different substances. In either case, as temperature is reduced, we get a possibility of combinations which was not present before; so that more and more complex forms are produced.

That brings us to a possibility of considering the processes of inorganic evolution in relation to those of organic evolution. I have already referred to the fundamental difference in the conditions. We had a running down of temperature which no one could define in the case of the stars; in the case of the organic evolution going on under our present conditions, we cannot be very much removed from the temperature conditions of the Cambrian formations. That is a point which I have made before, and it is important to insist upon it; clearly there cannot have been any very great change of temperature during the whole cycle of organic life. Previous to it we have found complexity brought about by doublings and combinations, the result being, as I have already mentioned, more complex forms. Of course, at the dawn of organic life on the surface of the earth there may have been residua of the earlier chemical forms; that is to say, not all the elements which we found in the hottest stars had combined to form the substances of which the earth was composed. However this may be, the work of organic evolution, unlike that of inorganic evolution, must have been done under widely different temperature conditions, but the result has been the same; it has since provided us with another succession of forms getting more complex as time has gone on, and there is still a residuum of early forms. We are led then to the conclusion that life in its various forms on this planet, now acknowledged to be the work of evolution, was an appendix, as it were, to the work of inorganic evolution carried on in a perfectly different way. Although the way was different, still nature is so parsimonious in her methods—she never does a thing in two ways that can be as well done in one—that I have no doubt that when these matters come to be considered, as they are bound to be considered with the progress of our knowledge, we shall find a great number of parallels; but I am not looking for these parallels now. What I wish to drive at is a chemical point of view which I think of some importance in relation to what has gone before; it is a point which I wish to make depending upon the existence of those elements which make their appearance in the hottest stars. In inorganic forms, in those represented to us in the hottest stars and the stars of gradually lower temperature, we have forms produced by a junction of like or unlike forms. Very good; but the more of these junctions the more the early forms must have disappeared, unless we may take it that they may have been made occasionally to reappear by the destruction of the later forms: that is a point to bear in mind. If the simpler forms must go on doubling to provide the more advanced forms, then if all the simpler forms are so used up there will be none left, and the only chance of getting the simpler forms again is to destroy something which had been previously made; and we can quite understand, of course, that there were many conditions of this distruction possible at the time when the crust of the earth was being formed. But however that may be, the gaseous elements with the non-gaseous elements first formed, would be the chief chemical substances on the surface and over it. Now the substances over the crust, of course, would be the gases, oxygen, hydrogen, nitrogen, and from the stars we can suggest carbon combined with them; that is to say, hydrocarbons, carbonic acid, and so on. On the surface, whether the surface be one of land or water, we should expect, in addition to the low melting point metals lithium and sodium, those two metals which we know existed in the hottest stars long before the others, magnesium and calcium. I have told you that lithium probably and sodium certainly exist in some of the relatively hot stars; the evidence also suggests sulphur, and this is rendered more probable because of the simplicity of its spectrum-series. Now these are very remarkable associations, and seem far away from ordinary chemical considerations, but they are the most important substances in sea water.

Constituents of Sea Water.

Chloride of sodium	77·75
,, magnesium	10·87
Sulphate of ,, ...	4·73
,, lime	3·60
,, potash	2·46
Bromide of magnesium	0·21
Carbonate of lime	0·34

The most easily thinkable evolution under these circumstances would be that of organisms built up of these chemical forms, chiefly because they would represent the more mobile or the more plastic materials. You would not expect evolution to have begun in iron, you would have expected it to have begun in something which was the most mobile and the most plastic. The available matter then for this evolution would be those gases plus those metals and those non-metals to which I have referred. Now, mark this. Suppose you have this evolution; if the forms so composed were to be multiplied indefinitely, the available material would be used up and organic evolution would be brought just as certainly to a dead-lock as the inorganic evolution was brought to a dead-lock when there was no possibility of any considerable reduction of temperature. We should expect a tendency to growth among the organic molecules, I dare not call it an inherited tendency, but I feel almost inclined to do so, having the growth of crystals in mind. Now, suppose that after you have got these new organic forms, the results instead of being stable were emphatically unstable, and still better, suppose you could induce a dissolution or the destruction of parts or wholes, progress would always continue to be possible, and indeed it might be accelerated.[1]

The new organic molecules would ultimately not have the first user of the chemical forms left available by the inorganic evolution, but they would have the user of the gases and other substances produced by the dissolution of their predecessors. They would be shoddy chemical forms, it is true, but shoddy forms would be better than none. Under these circumstances and in this way, the organic kingdom would be allowed to go on; in other words, the dissolution of parts or wholes of the new organisms would not merely be an advantage to the race, but might even be an essential condition for its continuance.

It therefore looks very much as if we can really go

[1] My friend and colleague, Prof. Howes, has called my attention in this connection to Prof. Weismann's views ("Weismann on Heredity," vol. i. p. 112), who seems to have arrived at somewhat similar conclusions, though by a vastly different road. He says, in his "Essay on Life and Death," "In my opinion life became limited in its duration not because it was contrary to its very nature to be unlimited, but because an unlimited persistence of the individual would be a luxury without a purpose."

The general view I have put forward, however, suggests that perhaps it was not so much a question of *luxury* for the living as one of *necessity* in order that others might live; it was a case of *mors janua vitae*.

The whole question turns upon the presence or absence, in all regions, of an excess of the early chemical forms ready to be used up *in all necessary proportions*. Hence it may turn out that the difficulty was much greater for land- than for sea-forms, that is, that dissolution of parts or wholes of land-forms proceeded with the greater rapidity. It is a question of the possibility of continuous assimilation (see Dantec, "La Sexualité," p. 11), and the word "parts" which I have used refers to the somatic cells, and not to the "immortal" part of living organisms.

back as far as these very early stages of life on our planet to apply those lines of Tennyson :—

> " So careful of the type she seems,
> So careless of the single life."

We have arrived, then, at a condition in which the same material may be worked up over and over again; in this way ultimately higher forms might be produced. Now, if to this dissolution, as a means of giving us new material, we add reproduction, then we can go a stage very much further. If we take bi-partition, which was the first method of multiplication, as we know both in the vegetable and animal world, we have a multiplication of forms by halving instead of the inorganic multiplication of forms by doubling, then we can have a very much increased rate of advance.

These then, roughly, are the conclusions as to an organic evolution which are suggested by the stellar evidence as to inorganic evolution, and the collocation of the simplest forms noted in the hottest stars.

Let us turn finally to the facts. Biologists, as I have said before, are very much more happy than astronomers and chemists, because they can see their units. A chemist professes to believe in nothing which he does not get in a bottle, although I have never yet seen the chemist who was ever happy enough to bottle an atom or a molecule as such ; but the superstition still remains with them, and they profess to believe in nothing that they cannot see. Now, the organic cell is the unit of the biologist, which is itself a congeries of subordinate entities, as a molecule is made up of its elementary atoms, manifesting the properties common to living matter in all its forms.

The characteristic general feature of the vegetable activity of the plant forms is their feeding upon gases and liquids, including sea-water. The progress of research greatly strengthens the view that there was a common life plasm, out of which both the vegetable and the animal kingdoms have developed. Be that as it may, you see the vegetable grows upon these chemical forms to which I have referred, and the animal feeds either upon the plant or upon other animals which have in their turn fed upon plants ; so that there we get the real chemical structure of the protoplasm, of the real life unit, in our organic evolution.

The last question, then, that I have to touch upon is this. Is there any chemical relation between the chemical composition of the organic cell and the reversing layers of the hottest stars—the reversing layer being that part of a star's anatomy by which we define the different genera ?

When we come to consider the chemical composition of this cell we find it consists of one or more forms of a complex compound of carbon, hydrogen, oxygen, nitrogen, with water, called protein ; and protoplasm, of which you have all heard, the common basis of vegetable and animal life, is thus composed. This substance is liable to waste and disintegration by oxidation, and there may be a concomitant reintegration of it by the assimilation of new matter.

The marvellous molecular complexity of the so-called simple cell may be gathered from the following formulæ for hæmoglobin :

Man ...	C 600	H 960	N 154	Fe 1	S 3	O 179
Horse ...	C 712	H 1130	N 214	Fe 1	S 2	O 245.[1]

Various different percentage compositions have been given of this protoplasm, but I really need not refer you to them. It is more important to consider the other chemical substances which go to form it, for there are others beside which it is of interest to study from our stellar point of view. I quote from Mr. Sheridan Lea.[2]

1 " Verworn," p. 104.
2 " The Chemical Bases of the Animal dy," p. 5.

" Proteids ordinarily leave on ignition a variable quantity of ash. In the case of egg-albumin the principal constituents of the ash are CHLORIDES of SODIUM and potassium, the latter exceeding the former in amount. The remainder consists of SODIUM and potassium, in combination with phosphoric, sulphuric and CARBONIC acids, and very small quantities of CALCIUM, MAGNESIUM and iron, in union with the same acids. There may be also a trace of SILICA."

My point is that the more one inquires into the chemistry of these things the more we come back to our stellar point of view and to the fact that, taking the simplicity of chemical form as determined by the appearance of these different chemical substances in the hottest stars as opposed to the cooler ones, and in relation to the " series " of spectra which they produce, we come to the conclusion that the first organic life was an interaction somehow or other between the undoubted earliest chemical forms. Not only have we hydrogen, oxygen and nitrogen among the gases common to the organic cell and the hottest stars, but those substances in addition which I have indicated by capitals.

Surely we have here, I think, thanks to some of the recent advances made by spectrum analysis, a quite new bond between man and the stars.

We shall consider in the next lecture the simplicity of chemical forms as evidenced, not by atomic weight, but by the study of spectrum-series, to which I have already made two or three references.

THE BERLIN TUBERCULOSIS CONGRESS (1899).

THE Congress, which has just brought its proceedings to a close, was not, as has been frequently stated in the medical and lay press, an International Congress ; it was a German Congress to which foreign delegates and communications were invited. The mass of communications were made in German, this being the official language of the Congress ; a few, some half-dozen, in English and French. The necessity, or at any rate advisability, of discoursing in German, may account for the very meagre manner in which English medicine was represented either privately or officially. It seemed somewhat anomalous that the staff of only one London consumption hospital (the North London) was represented at the Congress. Further, the English doctors practising at foreign health resorts, who probably have unrivalled opportunities for observing the different phases of consumption, and the influence of treatment upon them amongst better class patients, were for the most part conspicuous by their absence. This nonchalance is to be regretted, especially as the hygienic treatment of phthisis, a relatively, at any rate in its systematic form, new development, occupied some 50 per cent. of the whole time of the Congress.

The enormous amount of material at the disposal of the Committee was classified in two ways. All papers were in the first instance denominated as lectures ("Referate"), or discussion communications. For the former twenty minutes was allowed, for the latter ten. The subject-matter was divided into five Sections. I. Extent and Spread of Tuberculosis. II. Aetiology. III. Prophylaxis. IV. Treatment. V. Sanatorium Treatment.

Section I.—Dr. Bollingen (Munich) read a paper upon tuberculosis amongst domestic animals, and its relationship to tubercular disease in man. Amongst many important points, the lecturer emphasised the importance of milk as a source of tubercular infection to men, directly and indirectly. Indirectly in the sense that tuberculosis is very common amongst pigs, who get infected in considerable numbers from being fed with the milk of tuberculous cows. Dr. Krieger (Strassburg) discussed the re lationship of external surroundings to the spread of tubercular disease. The author pointed out the unsatisfactory nature of statistics upon this subject, owing to the complexity of apparently simple factors. Constant attendance upon phthisical patients in badly ventilated rooms, and certain occupations giving rise to irritation of respiratory tract from dust, metallic or otherwise, were however, according to the lecturer, potent factors in the spread of tuberculosis. Papers followed upon tubercular disease among various employés, notably knife and sword makers, bookbinders, compositors, and cigar makers.

Section II.—Aetiology.—This Section was opened by Prof. Flügge (Breslau), who read a well-appreciated paper upon the relation of the tubercle bacillus to tuberculosis. Recent work has not in this connection modified to any extent the dicta originally enunciated by Koch. The tubercle bacillus is the immediate cause of tuberculosis, and arises in practically all cases from a tuberculous animal. Its parasitic nature is obligatory, *i.e.* except in the case of artificial cultures the bacillus cannot develop outside the animal organism. By means of artificial cultures it is possible to modify the tubercle bacillus in certain ways, notably with regard to its morphological character, and its virulence. Prof. C. Fränkel (Halle) discoursed eloquently upon the nature and *modus operandi* of tubercular infection. He pointed out that outside the animal body tubercle bacilli die in from six to seven months, the important factors in killing them being light, and the fact that they lose their water by evaporation, and with it their life. As a result of this it is, as a rule, only the immediate neighbourhood of the patient, from 1 to 1½ metre, that is infective. Infection usually takes place through the infected person inhaling fresh and moist tubercle bacilli which ("infected drops") have been ejected usually during a coughing fit, also by the inhalation of dust contaminated with dried sputum. He further pointed out that man was relatively unsusceptible to tubercular infection, and that, as a rule, it was only by repeated and continued inhalation, &c., of tubercle bacilli that infection occurred.

A subject of great interest to physicians was considered at some length by Prof. Pfeiffer (Berlin), viz. "mixed infection." Consumption, as we know it, is rarely due simply to the tubercle bacillus, but to the superadded action of other infective organisms. As many as twenty-four different varieties of bacilli have been obtained from the sputum of a phthisical patient. An important practical point brought out by the lecturer was that cases of mixed infection ought to be recognised in consumptive hospitals, and isolated, as they may be a source of danger to phthisical patients; that is, these latter may get a mixed infection superadded to their other troubles. Prof. Löffler read a short paper upon heredity, immunity and disposition in their relation to tuberculosis. Hereditary tuberculosis in the sense, for instance, of congenital syphilis, is unknown. In this disease hereditary influences probably play a relatively small part as such. Tuberculosis occurs in members of the same family, mostly because by living together the members infect each other. Prof. Löffler quoted one family as an instance of this. The father and mother, two daughters and seven sons, all died of phthisis. The family consisted of fifty-eight other members, not one of whom was tuberculous. The infection was entirely confined to the members of the family living together. The lecturer emphasised the fact that no natural immunity to tuberculosis exists. Dr. von Zander gave some aetiological statistics of tuberculosis. Out of 312 cases investigated, 116 were communicated from man to man; amongst these infection between sisters occurred the most often.

Section III.—Prophylaxis.—Dr. Roth (Potsdam) discussed certain rules for the prevention of tubercular infection. These mostly consisted of measures directed to the disposal of the sputum, and the use of a cloth in front of the mouth during coughing fits, to limit the area of "infective drop" dispersion. Prof. v. Leube (Wurzburg) considered the prophylactive methods against tuberculosis in hospitals. If measures such as those mentioned above are thoroughly carried out, tubercular patients need not be isolated from the general hospital inmates. Care should be taken by attendants and nurses especially in dusting rooms, when it would be advisable for them to have their mouth and nose protected by a mask.

All members of the Congress listened most attentively to a short paper, by Prof. Virchow, upon the prevention of tuberculosis in so far as concerns food. Prof. Virchow considered four articles of diet: (1) beef, (2) pork, (3) poultry, (4) milk. Of these he regarded milk as far the most important. He advised a more careful and systematic exclusion (under central control) of tubercular meat and cattle, and the rejection of milk from all cows which reacted to the tuberculin list. Even these measures the author described as palliative, the only curative measure being the killing of all animals that reacted to the tubercular list. In this connection, Dr. Schumburg (Hannover) gave the result of his researches as to whether ordinary butcher's meat contained tubercle bacilli. The result of twenty-four inoculations (intra-peritoneal) of guinea-pigs with the juice of twelve different meat samples, was that two animals died of purulent peritonitis, two greatly diminished in weight, the remaining twenty remained well. Dr. Baer (Berlin) discussed the much-vexed question of alcohol and tuberculosis. He concludes, upon apparently very insufficient grounds, that alcohol in the consumptive sanatoria should only be used as medicine under the most urgent circumstances. Dr. Ritter read a paper upon the protection of children from tuberculosis. An interesting communication upon the diminution in the total death-rate from consumption due to modern methods of treatment was made by Dr. Julius Lehmann (Copenhagen). Dr. Kuno Obermüller discussed some interesting investigations upon the presence of the tubercle bacillus in ordinary market milk and butter. He centrifugalised the milk, and injected less than ·5 cc. of the sediment into the peritoneal cavity of guinea-pigs. The milk was taken from a dairy which supplies Berlin with 80,000 litres daily. The result was that 30 per cent. of the injected animals died in from eleven to thirteen weeks of tuberculosis. The milk used was the best and most costly infant milk. According to the author, Berlin butter is also largely infected with virulent tubercle bacilli, which are quite distinct from the so-called butter bacillus. Dr. Hambleton, President of the Polytechnic Physical Development Society, was the author of a communication on the prevention of pulmonary tuberculosis. One of the most potent factors to this end is, according to the author, chest development, and he took this opportunity of bringing before the notice of the Congress the work of the Society in this direction. This method had, according to the author, been most successful in preventing and even arresting tuberculosis among the employés of trades having an injurious effect upon the respiratory organs.

F. W. TUNNICLIFFE.

THE JUBILEE OF SIR GEORGE GABRIEL STOKES.

THE celebrations in connection with the jubilee of Sir George Gabriel Stokes, who has occupied the Lucasian Chair of Mathematics at Cambridge University since 1849, begin this afternoon (Thursday) with the delivery by Prof. Cornu, of the École Polytechnique, Paris, of the Rede Lecture. Prof. Cornu has chosen as his subject, "The Wave Theory of Light and its Influence on Moder Physics."

This evening a banquet will be given by Pembroke College, at which many of the distinguished guests and older colleagues of Sir George will be entertained in the hall of the College, which he entered as a freshman in 1837. During the evening the University will entertain about one thousand visitors and residents at a conversazione in the Fitzwilliam Museum, an interesting feature of which will be the presentation by Lord Kelvin of two busts, executed by Mr. Hamo Thorneycroft, of Sir George Stokes—one to the University, and the other to Pembroke College.

On Friday at 11 a.m., in the Senate House, the addresses of congratulation will be presented to the Vice-Chancellor, and handed by him to Sir George Stokes. Some sixty-five different institutions from all parts of the world will be represented. At 7 o'clock the delegates and their hosts will be entertained at luncheon by the Vice-Chancellor at Downing College, and at 2.45 a second congregation will be held in the Senate House, at which the Chancellor, the Duke of Devonshire, will preside. At this congregation, the honorary degree of Sc.D. will be conferred on Profs. A. Cornu and J. G. Darboux of Paris, on Prof. A. A. Michelson of Chicago, on Prof. M. G. Mittag-Leffler of Stockholm, on Prof. G. H. Quincke of Heidelberg, and on Prof. W. Voigt of Göttingen. A gold medal struck in honour of the occasion will be presented to Sir George Stokes by the Chancellor, and replicas will be sent to all the Universities and learned societies who are represented at the Jubilee.

Later in the afternoon a garden party will be held in the grounds of Pembroke College, and in the evening the University will entertain the delegates and guests at a dinner given in the hall of Trinity College. The Chancellor will take the chair, and amongst other distinguished guests who have accepted invitations may be mentioned the Lord Lieutenant of Cambridgeshire, the Bishop of Ely, the President of the Royal Society, the Vice-Chancellors of the Universities of Oxford, Aberdeen, and London, the Earl of Rosse, Lord Kelvin, Lord Rayleigh, Lord Blythswood, the Provost of Trinity College, Dublin, Monsignor Molloy, and many others.

There will be a special meeting of the Cambridge Philosophical Society, at which some of the foreign members will, it is expected, read papers. This will probably take place on Monday, June 5. Many of the guests will leave Cambridge for London to take part in the anniversary celebrations of the Royal Institution.

NOTES.

A MEETING for discussion will be held at the Royal Society on Thursday next, June 8. The subject to be discussed—preventive inoculation—will be introduced by M. Haffkine.

ARRANGEMENTS for the sixty-ninth annual meeting of the British Association at Dover, in September next, are making satisfactory progress. The local committees are actively at work, and in response to the appeal of the hospitality committees over 1500*l.* has already been subscribed. As previously announced, the president of the meeting will be Prof. Michael Foster, and the presidents of the various sections are to be:—Mathematical and physical science, Prof. J. H. Poynting; chemistry, Mr. Horace T. Brown; geology, Sir Archibald Geikie; zoology, Mr. Adam Sedgwick; geography, Sir John Murray, K.C.B.; economical science, Mr. Henry Higgs; mechanical science, Sir William H. White; anthropology, Mr. C. H. Read; physiology, Mr. J. N. Langley; botany, Sir George King, K.C.I.E. The first general meeting will be held at the Connaught Hall on Wednesday, September 13, at 8 p.m. precisely, when Prof. Michael Foster will deliver an address; on Thursday evening, September 14, at 8.30 p.m., there will be a soirée in the School of Art; on Friday evening, September 15, at 8.30 p.m., a discourse will be delivered by Prof. Charles Richet, on "La vibration nerveuse"; on Monday evening, September 18, at 8.30 p.m., a discourse will be delivered by Prof. Fleming, F.R.S., on "The Centenary of the Electric Current"; on Tuesday evening, September 19, at 8.30 p.m., there will be a soirée in the School of Art; on Wednesday, September 20, the concluding general meeting will be held at 2.30 p.m. Excursions to places of interest in the neighbourhood of Dover and to the continent will be made on Thursday, September 21. Members of the Association Française pour l'Avancement des Sciences will visit Dover on Saturday, September 16. Members of the British Association are invited to visit Boulogne on Thursday, September 21.

THE following naturalists have been elected foreign members of the Linnean Society:—M. Adrien Franchet of Paris, Prof. Emil Christian Hansen of Copenhagen, Dr. Seiitsiro Ikeno of the Imperial University, Tokyo; Prof. Eduard von Martens of Berlin, and Prof. Georg Ossian Sars of Christiania.

THE gold medal of the Linnean Society, which was presented at the anniversary meeting on May 24, has this year been awarded to Mr. John Gilbert Baker, of Kew, in recognition of his important contributions to botanical science. Amongst these may be mentioned his *Synopsis Filicum*, his monographs of the daffodils and roses, handbooks on the *Amaryllideae*, *Irideae*, *Bromeliceae*, and the fern allies; three volumes on the *Compositae* in Martins's "Flora Brasiliensis," and several papers on Malagasy botany, the Flora of Mauritius and the Seychelles, the Bulbous Flora of the Cape, and the *Leguminosae* of British India, "Flora of the English Lake Country," and numerous papers communicated to the *Journal* of the Linnean Society, the *Journal of Botany*, and other periodicals.

AT the annual meeting of the Victoria Institute, to be held on June 19, an address will be delivered by Sir Richard Temple.

THE anniversary meeting of the Royal Geographical Society will be held on Monday next, June 5. The Society's annual conversazione will be held in the Natural History Museum on Wednesday, June 7.

THERE will be no Friday evening discourse at the Royal Institution to-morrow (June 2), as Mr. H. G. Wells, who was to lecture on "The Discovery of the Future," is in too weak a state of health to do so.

AT the recent annual meeting of the American Academy of Art and Sciences, Mr. Alexander Agassiz was elected president of the Academy. The Rumford medal was awarded to Mr. Charles F. Brush, of Cleveland, for "the practical development of electrical arc lighting."

A REUTER telegram dated Helsingfors, May 26, says:—"The collected pieces of the aërolite which fell at Bjurholm some time ago have been sent here, and placed in the geological museum. The largest piece is said to weigh 206 Russian pounds, while all the parts together weigh 850 lbs."

DR. L. A. BAUER has resigned his position as assistant professor of mathematics and mathematical physics at the University of Cincinnati, in order to accept the position of chief of the newly-formed division of terrestrial magnetism of the United States Coast and Geodetic Survey. To this division has been assigned the magnetic survey of the United States and the countries under its jurisdiction, and the establishment of magnetic observatories. Dr. Bauer has also been appointed lecturer in terrestrial magnetism at the Johns Hopkins University. The journal, *Terrestrial Magnetism and Atmospheric Electricity*, beginning with the June number, will be issued hereafter from the Johns Hopkins University Press, Dr. Bauer continuing as editor-in-chief.

ON the evening of May 13 a meeting of the New York Electrical Society was held at Madison Square Garden, where an Electrical Exhibition is now going on, to celebrate the centennial of the discovery of the electric battery by Alessandro Volta. Mr. Edison sent a letter expressing his admiration of Volta's investigations and researches, and associating himself with the fraternal messages which were sent to the Italian electrical society and to the Electrical Exhibition at Como, the birthplace of both Volta and the voltaic cell. The New York *Electrical Review* states the following message was cabled to the Italian Premier :—"The electricians of America, celebrating the Volta Centennial in New York, extend heartiest congratulations to the fellow-workers in Italy, and, in doing so, desire to express the hope that the work of such pioneers as Galvani, Volta, Pacinetti and Ferraris may be renewed and repeated by other members of the Italian race in the century which is now dawning. America owes a deep debt of gratitude to Italy for electrical discoveries, which have done so much to abridge distance and add to the welfare of mankind. Please communicate these sentiments to King Humbert in the name of the New York Electrical Society.—Gano S. Dunn, President."

THE Berlin correspondent of the *Times* states that the committee which is organising the German Antarctic expedition has decided that the expedition is to be composed of one ship only. The vessel, which is to be built entirely of wood, is to be laid down this autumn. The expedition is to be ready to start in the autumn of 1901, and is to be away two years altogether. After touching at the Cape, the expedition is to make for the Antarctic continent south of the Kerguelen Islands, and there establish a scientific station at some point suitable for wintering. A pack of Siberian dogs is to be taken, and dashes will be made on sledges towards the South Pole and the south magnetic pole. Meteorological observations will also be made from a captive balloon. After the breaking up of their winter quarters, the expedition will attempt to make as complete a survey as possible of the coast line of the Antarctic continent. As already announced in these columns, the leader of the expedition is to be Dr. von Drygalski, who conducted the German exploration of Greenland in the years 1891–93. The committee expresses great satisfaction that the English Antarctic expedition has at last been definitely decided on, and points out that the value of the two sets of meteorological observations will be greatly enhanced by their being carried on simultaneously.

AN Industrial Exhibition organised by the Artist Club was opened at the Crystal Palace on Tuesday by the Duke and Duchess of Connaught. The exhibition has been furnished by about one hundred leading British manufacturers, and the element of competition has been eliminated by only including one set of exhibits of any particular industry. Engineering appliances of various kinds are prominent. Railway and steamship interests are also well represented. Refrigerating processes employed in the Colonial meat trade are shown in operation. There is also an interesting display of printing machinery at work, and of type-setting by Linotype machines. Electricity figures in the exhibition, and a number of novel devices of various kinds are to be seen. As an example of quick work in photography, it is worth mention that the opening ceremony was photographed and projected upon the screen by the Biograph and Mutoscope Company before the Royal party left the Crystal Palace three hours later.

AT the annual general meeting of the Institution of Electrical Engineers, held on Thursday last, the announcement was made that the premiums for papers read during the session 1898–99 had been awarded by the Council as follows :—The "Institution Premium," value 25*l.*, to Mr. P. V. McMahon, for his paper on "Electric Locomotives in Practice, and Tractive Resistance in Tunnels, and Notes on Locomotive Design"; the "Paris Electrical Exhibition Premium," value raised to 20*l.*, to Mr. W. Duddell and Mr. E. W. Marchant, for their paper, "Experiments on Alternate Current Arcs by aid of Oscillographs"; two "Fahie Premiums," none having been awarded in 1898, of 10*l.* each, one to Prof. O. Lodge, F.R.S., and one to Mr. G. Marconi, for their papers entitled respectively "Improvements in Magnetic Space Telegraphy" and "Wireless Telegraphy"; two extra premiums of 10*l.* each, one to Mrs. Ayrton for her paper on "The Hissing of the Electric Arc," the other to Mr. J. Elton Young, for his paper on "Capacity Measurements of Long Submarine Cables"; the Senior "Students' Premium," value 10*l.*, to Mr. W. G. Royal-Dawson, student, for his paper on "Alternating Currents of very High Frequency"; the second "Students' Premium," increased in value to 10*l.*, to Messrs. M. R. Gardner and W. P. Howgrave Graham, for their paper on "The Synchronising of Alternators"; the third "Students' Premium," value 5*l.*, to Mr. Leonard Wilson, student, for his paper on "The Effect of Governors on the Parallel Running of Alternators"; extra "Students' Premium," value 4*l.*, to Mr. L. R. Morshead, for his paper on "Enclosed Arc Lamps," and an extra "Students' Premium," value 3*l.*, to Mr. H. M. Dowsett, student, for his paper on "Electricity Meters"; the Salomons Scholarship for 1899–1900, value 50*l.*, was awarded to Mr. H. J. Thomson, a student of the Central Technical College.

THE hydrographical surveys made in H.M. surveying vessels during the year 1898, and referred to in the recent report by the Hydrographer of the Admiralty, led to a number of important results. Resurveys of parts of the Thames and Medway show that remarkable changes have taken place. An examination of the Shingles patch in the Duke of Edinburgh Channel has shown that this patch now has 15 feet of water on it, and its steady growth since 1882 has reduced the width of the Duke of Edinburgh Channel, at present the principal passage into the Thames for heavy vessels, from 1½ miles to about ½ a mile. The total obliteration of the passage, which seems by no means impossible, would entail a long circuit at the time of low water to large vessels to or from the Thames and Medway, but the operations of nature in this estuary are far too great to be controlled by works. A resurvey was made of the Middle Swin. This passage way, the main route for the enormous trade between London and the north, has of late years much contracted and shoaled, and gives considerable anxiety to the Trinity House, as, if necessary to alter the route, many changes in lights and buoys would be necessary to make another passage safe. There is now very little more than 19 feet on the bar at low water.

A SERIES of observations with a deep-sea current meter carried out in the large Strait of Bab-el-Mandeb by the officers of H.M. surveying vessel *Stork*, are referred to by the Hydrographer in his report. The observations, which are valuable as bearing on the system of circulation in the oceans, have been published in a report on the under-currents of the Straits of Bab-el-Mandeb; but the broad result may be briefly stated. There was a permanent current on the surface setting *into* the Red Sea of about 1½ knots an hour. There was at 105 fathoms depth a permanent current of about the same velocity setting *outwards*. The tidal stream was about 1¼ knots at its maximum, and flowed for about twelve hours each way, as might be expected from the fact that in this locality there is practically only one tide in the day. This tidal stream prevails to the bottom with variations of strength. Somewhere about 75 fathoms below the surface is the dividing line between the two permanent currents, but there were not sufficient observations to determine the exact depth with any precision.

IN the current number of the *Psychological Review*, Prof. Wesley Mills points out that in investigating the psychology of animals, care must be taken to observe them under conditions as nearly approaching their normal surroundings as possible. He maintains that to place a cat in a box, as has been done, and then to expect it to act naturally, is about as reasonable as to enclose a living man in a coffin, lower him, against his will, into the earth, and attempt to deduce normal psychology from his conduct. Besides, the highest animals should be compared with the lowest human beings before maintaining that there is an essential difference between the respective mental lives of animals and the human race.

A SERIES of instructive experiments on young chicks have been made by Dr. Edward Thorndike. About sixty chicks of all ages were studied, and some remarkable instances of instinctive muscular coordination and emotional reaction were observed. A four days' chick will jump down a distance eight times his own height without hurting himself. Thrown into a pond, he will make straight for the shore, while an adult hen would float about aimlessly. For the first four or five days there is no fear of strange objects or sounds, such as the sight of a man or a hawk's cry. Instinct does not always lead to the same reaction. A loud sound may make one chick run, another crouch, another give the danger call, and another do nothing whatever.

AT Montgomery, Alabama, the daily forecasts of the U.S. Weather Bureau are shown on all street letter-boxes. The postman who collects the letters also fixes the forecast cards in position, so that the morning predictions of weather become known throughout the city by about 1 p.m. of the date of issue.

THE *Mitteilungen aus den deutschen Schutzgebieten* contains a valuable contribution to our knowledge of the Harmattan winds in the form of three short papers by competent observers in Togoland, and a discussion of the material by Dr. von Danckelmann. The investigation leads to the conclusion that the Harmattan, strictly so called, is a strengthening of the general north to south movement of the atmosphere prevalent in the western Sudan between October and April, caused by special modifications in the distribution of pressure which are not yet fully explained. The excessive dryness of the air, and its dustiness, are due to the origin of the current in the regions north of the bend of the Niger; and it is shown that the wind may penetrate into coast districts normally exposed to the influence of the moist sea breeze. The characteristic low morning temperatures are probably due to excessive radiation, but the point requires further elucidation.

WE have received the seventh annual report of the Sonnblick Society, for the year 1898, containing the meteorological observations on the summit of the Sonnblick mountain, lat. 47° 3′ N., long. 12° 57′ E., altitude 10,191 feet, and also at two intermediate stations, respectively nearly 4000 and 3000 feet above the sea. The observations have been carried on with great care and regularity, and the observatory on the summit is now under the entire management of the Austrian Meteorological Society. The difficulty of carrying on the work of this important station may be gauged from the following results for the year. The mean annual temperature was 22°·3, the absolute maximum 46°·4, and the minimum minus 13°·7. Fog occurred on 250 days, and rain (or snow) on 200 days. The report also contains useful detailed information respecting the mineral products of the neighbourhood, and particulars relating to the high observatories in the Alps.

THE Central Physical Observatory of St. Petersburg has recently published its *Annals* for the year 1897, consisting of two large quarto volumes. The first part contains the meteorological and magnetic observations made at the stations of the First Order, and the extraordinary observations at stations of the Second and Third Orders; for several stations, observations are published for every hour. The second part contains the meteorological observations of the Second Order stations, arranged according to the international scheme, and gives the observations made three times a day, and results for eighty-two stations, and a *résumé* of the monthly and annual means for 661 stations. Each set of observations is preceded by a detailed introduction, giving particulars of the methods employed and of the instruments used. In accordance with the decision of the Meteorological Conference at Paris in 1896, a useful list is added of all the periodical publications appearing in Russia which contain meteorological observations. The Director of the Meteorological Service is General M. Rykatcheff, Member of the Imperial Academy of Sciences of St. Petersburg.

DR. KEILHACK contributes a short paper on the hydrography of north-western Germany to the *Verhandlungen* of the Berlin Geographical Society. The relation of the later glacial deposits to the existing valleys and lakes is discussed, and a map shows the supposed successive positions of the inland ice, and the courses of the longitudinal valleys associated with each phase of its movement.

WE have received No. 3 of the "Current Papers" published by Mr. H. C. Russell in the *Proceedings* of the Royal Society of New South Wales, along with which is a chart showing the tracks of floats between September 1896 and September 1898. The additional information confirms the result stated in the second paper, that the rate of drift increases with latitude south of 30° S. One float gave an average rate of 12·4 miles per day in latitude 47°·16 S.

CHARLES WACHSMUTH (of Burlington, Iowa), who died in 1896, had for forty years zealously studied the fossil Crinoidea of the older rocks of North America, being assisted during the latter half of the period by Mr. Frank Springer. The labours of the two on "The North American *Crinoidea camerata*" have been published in an important monograph containing 838 pp. and 83 plates; and this work has now been subjected to an elaborate criticism by Mr. F. A. Bather, of the British Museum (Natural History), who has reprinted his series of articles, which were published in the *Geological Magazine* (1898–99). These critical essays form an important contribution to the study of the Crinoidea, and they are appropriately accompanied by a portrait and brief biography of Wachsmuth.

MR. ARNOLD HAGUE, in his presidential address to the Geological Society of Washington (February 1899), took as his subject the "Early Tertiary Volcanoes of the Absaroka Range." This range extends along the east side of the Yellowstone Park, in the State of Wyoming, and several of the higher peaks and the long western spurs slope gradually towards the Park, and lie within its borders. The Absarokas present a high plateau, ranging from 10,000 to over 12,000 feet above sea-level, and composed of agglomerates, tuffs, and lava flows, based upon Archæan and Palæozoic rocks, and including masses of intrusive igneous rock. The volcanic materials constitute the bulk of the mountains, and they were ejected from numerous vents and fissures at several successive epochs, mainly in the following order: early acid breccia, early basic breccia, early basalt sheets, late acid breccia, late basic breccia, and late basalt sheets. Evidence of the long duration of the period of volcanic activity is furnished by the remains of plants found at different horizons; over 150 species having been identified, many of them new to science. In one instance, a grand old tree, *Sequoia magnifica*, was found firmly imbedded in the early basic breccia.

IN NATURE for March 9 we gave a short account of the late Prof. Cope's researches on the Vertebrate remains from the Port Kennedy bone deposit in Pennsylvania. We have since received the detailed account of the excavations carried on in 1894-96 by Mr. Henry C. Mercer (*Journ. Acad. Nat. Sc.*, Philadelphia, vol. xi. part 2, April 1899). The results lead to the conclusion that the original configuration of the fissure in which the remains were obtained was that of a deep, well-like chasm opening vertically downward from the sloping surface of a hill, and that the animals stampeded by a flood had rushed to their destruction into the abyss. We have previously mentioned the principal fossil remains obtained. Of these, no less than 377 individuals and 66 species were recognised, of which latter 40 are extinct. No traces of man were discovered, and the general evidence favours the view that the fauna is of earlier date than that which witnessed the presence of man on the American continent.

A RECORD of the work accomplished in the chemical laboratory of the Austrian Geological Survey during the year 1898 is summarised in the Director's Annual Report (*Verhandlungen der k. k. geol. Reichsanstalt*, No. 1, 1899). In addition to the petrographical examination of many rock-specimens, the official work comprised the analysis of no less than 203 samples, such as coals, rocks, ores, and waters. Additional researches, carried out for scientific purposes, are also recorded. Many samples of the materials employed in the construction of the new Danube embankments were examined and reported upon by Dr. v. John, who also concluded the analyses of various Bohemian mineral waters. The results of this last work are published in the September number of the *Jahrbuch*, 1898. Of special economic value are Herr Aug. Rosiwal's experiments for ascertaining methods which shall furnish definite standards whereby all the factors of stability determining the technical utility of building stones may be accurately measured. Some interesting results attained in this connection have already appeared in the *Verhandlungen*, Nos. 5 and 6, 1898.

WE have recently received from the publishers parts 38-40 of Prof. Enrico Morselli's "Antropologia Generale," now in course of publication at Turin. As these fasciculi deal with the intricate problem of man's evolution from the lower animals, they are of more than ordinary interest. The author has done wisely in reproducing a large number of the phylogenetic trees published by modern zoologists, thus giving his readers an opportunity of seeing in what respects they agree or differ from one another. Manifestly, however, his sympathies are with Haeckel's tree of mammals, in which, as is well known, the marsupials form an early offshoot from the main stem. As regards the anthropoids themselves, the author adopts Schlosser's tree, in which a primitive gibbon (*Prothylobates*) is taken as a starting point, from which the gibbons rise as one branch, while *Dryopithecus* forms the main stem. This latter is continued directly upwards to give rise to the orang and chimpanzee, while on one side branches the gorilla, and on the other *Pithecanthropus* and *Homo*. The weak point of this is the wide separation of the chimpanzee and the gorilla. Apart from this, the gibbon-like character in the skull of *Pithecanthropus* (which can scarcely be regarded as generically distinct from *Homa*, unless mental characteristics be taken into account) affords considerable support to the general plan of the phylogeny.

TWO reprints from the *Botanical Gazette* have reached us, by Prof. C. J. Chamberlain and Prof. J. M. Coulter, both referring to the phenomena of fertilisation and embryology in the Coniferæ.

THAT patient observer, Mr. Thomas Meehan, continues, in the *Proceedings* of the Academy of Natural Sciences of Philadelphia, his contributions to the life-history of plants, mostly relating to the phenomena of fertilisation.

THE most recently published part of Engler's *Botanische Jahrbücher*, vol. xxvi. Heft 5, is chiefly occupied with the conclusion of Kränzlin's Orchidaceæ of Guatemala and adjacent countries, and a further instalment of the editor's monograph of the Araceæ. There are also revisions of the genera *Philodendron*, *Dieffenbachia*, and *Tropaeolum*.

FOR the past ten years experiments have been carried on, on an extended scale, to test the suitability of the soil and climate of Indiana for the production of beet-sugar. The results of these experiments are now published in *Bulletin* No. 68 of the Purdue University Experiment Station (Lafayette, Ind.). They show that, wherever the needful precautions have been observed, beets of satisfactory character have been produced in every section of the State, and that it is probable that Indiana can produce enough beets of satisfactory quality to furnish the raw material for a large number of factories.

THE third part of Drs. D. S. Jordan and B. W. Evermann's "The Fishes of North and Middle America," being a descriptive catalogue of the species of fish-like vertebrates found in the waters of North America, north of the Isthmus of Panama, has been issued by the Smithsonian Institution as *Bulletin* No. 47 of the U.S. National Museum.

IT is a little surprising that Wiedemann and Ebert's "Physikalisches Practikum," the fourth edition of which has just been published by Friedrich Vieweg and Son, Brunswick, has not been translated into English. The volume contains a well-arranged and complete course of laboratory work suitable for students who are already familiar with elementary physical operations. Physical-chemical experiments receive particular attention.

MR. C. BAKER has issued a new catalogue of microscopes and accessory apparatus. Many instruments for histological and bacteriological work are included in the catalogue, and outfits suitable for various technical purposes. It is evident from the catalogue that, apart from the medical practitioner, naturalist and amateur, the microscope is being more and more used in trade and professional work.

THIRTEEN important memoirs are published in the *Atti* of the Naples Academy of Physical and Mathematical Sciences (1899, ser. ii. vol. ix). Among the subjects dealt with are: remains of great Pleistocene lakes and rivers in southern Italy, with special reference to the geological conditions which produced such plains as the great Vallone di Diano (full descriptions, with maps, are given of the Agri, Mercure, and Noce); chemical analyses of the waters of the hot springs of Iscia; contribution to the biology of ferns; flora of the basin of the Liri; and fossil fishes of the Eocene chalk of Gassino, Piedmont. The remainder of the memoirs deal with mathematical and geometrical subjects.

WITHOUT disparaging the Smithsonian Institution in the slightest degree, it may be said that the most valuable part of the Annual Report is the appendix, which comprises a selection of interesting memoirs upon scientific subjects. The report for 1897, just distributed, contains no less than thirty-eight memoirs of this kind, dealing with the position and progress of various branches of science. The memoirs are "not for the specialist, but interesting and popular expositions of what the specialist knows to be sound and opportune." A number of the memoirs are reprints of addresses and articles which have appeared in NATURE, some are original articles, and others are translations or reprints from contributions to various scientific publications. Almost every phase of scientific activity seems to be included among the papers, and many subjects are illustrated by fine half-tone pictures. The Smithsonian Institution does good service to science by the publication of these sound and instructive surveys of the state of natural knowledge.

THE additions to the Zoological Society's Gardens during the past week include a Smooth-headed Capuchin (*Cebus monachus*) from South-east Brazil, presented by Mr. Herbert Gibson; a Palm Squirrel (*Sciurus palmarum*) from India, presented by Miss Aggie O'Connor; a Kinkajou (*Cercoleptes caudivolvulus*, ♀) from South America, presented by Mr. J. J. Quelch; a Mexican Guan (*Ortalis vetula*) from Cartagena, Colombia, presented by Captain W. H. Milner; a Martinique Gallinule (*Ionornis martinicus*), captured at sea, presented by Mr. H. O. Milner; a Leith's Tortoise (*Testudo leithi*) from Egypt, presented by Mr. S. S. Flower; a Black-tailed Wallaby (*Macropus ualabatus*, ♀) from New South Wales, three Rabbit-eared Bandicoots (*Peragale lagotis*, 3 ♂), two Spotted Bower Birds (*Chlamydodera maculata*) from Australia, two Westermann's Cassowaries (*Casuarius westermanni*) from New Guinea, a White-throated Monitor (*Varanus albigularis*) from South Africa, two Starred Tortoises (*Testudo elegans*) from India, four Elephantine Tortoises (*Testudo elephantina*) from the Aldabra Islands, deposited.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN JUNE:—

June 1. 14h. 53m. to 15h. 40m. Occultation of the star 19 Piscium (mag. 5·2) by the moon.
7. 16h. 43m. to 17h. 53m. Partial eclipse of the sun visible at Greenwich. The greatest phase occurs at 17h. 17m., at which time 0·188 (nearly one-fifth) of the sun's disc will be obscured. At places N.W. of Greenwich the eclipse will be of somewhat greater magnitude.
11. 2h. Saturn in opposition to the sun.
15. Illuminated portion of the disc of Venus 0·904, of Mars 0·913.
20. 11h. 30m. Minimum of the variable star Algol (β Persei).
22. 7h. Saturn in conjunction with the moon.
23. 8h. 19m. Minimum of the variable star Algol (β Persei).
23. 10h. 34m. to 11h. 41m. Occultation of B.A.C. 6343 (mag. 5·8) by the moon.
24. 13h. 17m. to 14h. 12m. Occultation of *f* Sagittarii (mag. 5·1) by the moon.
25. 10h. 45m. to 11h. 48m. Occultation of B.A.C. 7145 (mag. 6·0) by the moon.
27. 12h. 59m. to 14h. 2m. Occultation of κ Aquarii (mag. 5·5) by the moon.
28. 11h. 22m. to 12h. 10m. Occultation of κ Piscium (mag. 5) by the moon.

COMET 1899 *a* (SWIFT).—

Ephemeris for 12h. Berlin Mean Time.

1899.	R.A. h. m. s.	Decl. ° ′	Br.
June 1	17 58 35	+ 56 13·1	
2	17 36 8	55 13·8	1·34
3	17 15 28	54 1·7	
4	16 56 46	52 39·2	1·18
5	16 39 54	51 9·5	
6	16 24 46	49 34·6	1·03
7	16 11 13	47 57·1	
8	15 59 12	+ 46 18·1	0·88

The comet is now passing with a greatly accelerated motion in a south-westerly direction. During the week it will traverse the constellations Draco and Herculis; on the 1st it passes close to ξ Draconis, while on the 8th it will be a little more than 1° north-west of φ Herculis. In *Ast. Nach.*, No. 3567, Prof. A. A. Nijland, of Utrecht, says that, viewed with a finder of 74 mm. aperture on May 5, the comet appeared about 5·5 mag., having a tail about 1°·5 in length.

TEMPEL'S COMET (1873 II.).—

Ephemeris for 12h. Paris Mean Time.

1899.	R.A. h. m. s.	Decl. ° ′ ″	Br.
June 1	19 34 17·4	− 3 52 50	1·121
3	37 19·0	3 58 10	
5	40 18·6	4 5 17	1·271
7	43 16·1	4 14 21	
9	46 11·7	4 25 27	1·439
11	49 5·4	4 38 45	
13	51 57·2	4 54 22	1·625
15	19 54 47·2	− 5 12 25	

As the comet approaches perihelion (June 18) it is rapidly becoming brighter, and should now be visible with small instruments. It reached its highest northerly declination on May 26, and is now travelling to the south-east through Aquila into the head of Capricornus.

NEW VARIABLE OF ALGOL TYPE.—M. Ceraski, of the Moscow Observatory, writes in *Astr. Nach.* (Bd. 149, No. 3567), announcing the discovery of a new variable of the Algol type in the constellation Cygnus. The star was detected by the varying intensity of its image on photographs taken during May and July 1898. Its position is

B.D. + 45°·3062. 1855. R.A. = 20h. 2m. 24·5s.
Decl. = + 45° 52·9.

Its magnitude is usually about 8·6, but on May 8 this year it was observed to be at minimum about 13·4h., Moscow mean time, its light then being nearly two magnitudes fainter than the normal.

VARIABLE RADIAL VELOCITY OF ζ GEMINORUM.—Prof. W. W. Campbell has called attention to this star in a paper communicated to the *Astrophysical Journal* (vol. ix. p. 86, 1899), where he gives the results of measures on three photographs. In *Astr. Nach.* (Bd. 149, No. 3565), M. A. Belopolsky gives the results of an extensive series of measures he has been able to obtain with the 30-inch refractor and two-prism spectrograph of the Pulkowa Observatory. The individual observations are given, and also a summation in the form of a table showing the radial velocities at stated intervals from minimum. This latter is as follows:—

Interval from minimum d. h.	Velocity	Interval from minimum d. h.	Velocity
0 2	+ 4·76 g.M.	5 1	− 2·70 g.M.
0 12	+ 2·86	6 19	+ 1·96
1 12	+ 0·71	8 1	+ 3·00
2 1	+ 0·68	8 5	+ 3·02
3 1	+ 0·04	9 6	+ 5·06
3 12	+ 0·50	9 15	+ 4·41
4 1	− 0·40	10 2	+ 4·11
4 13	+ 0·34		

Prof. Campbell's maximum and minimum values were 20 kil. and 6 kil. respectively.

THE RESULTS OF THE "VALDIVIA" EXPEDITION.

DR. SUPAN gives the following summary (based on the official report in the *Reichs-Anzeiger* of March 25) of the chief results of the German expedition in the *Valdivia* to Antarctic waters, in the April number of *Petermann's Mitteilungen*.

(1) Rediscovery and determination of position of Bouvet Island, first discovered by Bouvet in 1739, and sighted since then only by Lindsay (1808) and Norris (1825). The island, which lies in lat. 54° 26′ S., long. 3° 24′ E., and is 9½ kilo-

metres from E. to W. and 8 kilometres from N. to S., is a volcanic mountain, the edge of the crater rising to a height of 935 metres on the northern side. It is entirely covered with ice, which comes down to sea-level, and presents a steep wall to the sea: it would seem from this that in this region a tongue of polar cold projects northwards, a conclusion supported by the serial temperature observations. No trace of vegetation could be recognised with the telescope, and animal life appeared to be exceedingly scanty. No definite information was obtained as to the existence of Thompson Island.

(2) Enderby Land was not visited, as the course was again turned northward at lat. 64° S., but the samples of the sea-bottom yielded evidence that the land is not volcanic. Along the edge of the pack-ice the bottom was covered with diatom ooze, mixed with a larger proportion of clay the nearer Enderby Land was approached. In lat. 63° 17′ S., long. 57° 51′ E., material from ground-moraines, carried to sea by icebergs, was obtained; this consisted of gneiss, granite, schists, and one large piece of red sandstone.

(3) *Climate.*—The zone of fresh westerly winds and low barometer extends south of Africa only to lat. 55° S., and of Kerguelen only to 56½° S.; south of this a belt of calms and light variable winds extends to 60° S., and beyond 60° S. the prevailing winds are easterly. In other parts of the Southern Ocean, the westerly winds extend further south, to 60° and 64° S. latitude. Hence it may be supposed that the position of the Antarctic anticyclone is towards the western part of the Indian Ocean, and not directly over the pole.

In November 1898 the limit of drift ice was found in long. 7° E., to be in lat. 56¾° S. On the voyage from the most southerly point in the neighbourhood of Enderby Land, no icebergs were met with north of 61° 22′ S.

(4) *Oceanography.*—Amongst the most important achievements of the *Valdivia* expedition is the making of a large number of new soundings, with the discovery of an extensive deep-water area. It has hitherto been assumed that the sea-bottom rose rapidly towards the south from the Eastern Atlantic and the western part of the Indian Ocean, but it now seems likely that deep water extends from both these basins into Antarctic latitudes. Kerguelen, and the Crozet and Prince Edward Islands were regarded as projections on the margin of a supposed Antarctic plateau, and this idea had obtained so strong a hold that both V. v. Haardt (1895) and Fricker (1898) simply ignored the soundings of the *Challenger* in their maps, although these had shown depths of over 3000 metres in the Indian Ocean between long. 80° and 95° E. and lat. 60° and 66° S. In the regions sounded by the *Valdivia*, between 7° and 53° E. long., the depth has been found to exceed 5000 metres.

South of the fifty-sixth parallel, the bottom temperature was everywhere below 0° C., but nowhere below −0°·5 C. The serial temperatures in 63° S. lat., 54° E. long., in the month of December, gave the following distribution: (*a*) a surface layer, 120 metres thick, with temperatures between 0° C. and −1°·7 C.; (*b*) an intermediate layer, about 2200 metres thick, with temperatures above 0° C., and rising to 1°·7 C.; (*c*) a bottom layer of equal or greater thickness with temperatures below 0° C., but never colder than −0°·5. Temperature fell from the surface down to 80 metres, then rose to 1200 metres, and then again fell slowly to the bottom. The same arrangement was found further to the west, but the temperatures were somewhat lower, and again to the east, in the track of the *Challenger*; but in the latter case the cold surface layer is thicker, and the warm layer usually reaches to the bottom (3000 to 3300 metres), the cold under-layer being only met with in a sounding of over 3600 metres. The lowest temperature observed by the *Challenger* was −1°·7, the highest only 1°·4. The sea in the region of Enderby Land would thus seem to be favoured by relatively high temperatures, and it remains to bring this into direct relation to the warm Kerguelen stream: this must be done by more observations to the south of Kerguelen.

(5) *Marine Biogeography.*—The quantity of plankton increases down to about 2000 metres, diminishing rapidly at greater depths, although no level is destitute of animal life. The quantity of vegetable plankton, on the other hand, reaches its lowest within 300 or 400 metres of the surface. The characteristic of the Antarctic plankton is the abundance of diatoms, and the occurrence of special forms: the appearance of the Antarctic type begins as far north as 40° S., but in 50° S. the presence of forms belonging to warmer seas is still noticeable.

THE WEARING AWAY OF SAND BEACHES.

THE rate of erosion of cliffs and land bordering on the sea, caused by the action of the waves, has been the subject of frequent investigation, and numerous records exist as to the rate at which the land is being encroached on by the sea. On low flat coasts the means of ascertaining the result of the contest between the sea and the land is more difficult to ascertain. The ordinary means of measurement is by a comparison of old charts, which are seldom trustworthy for this purpose. These charts being for navigable purposes, the depth of the water and the position of objects on shore forming sea marks were the subjects for which accuracy alone was required. The same remarks apply to old plans of estates and manors which were intended to delineate the property of the owners, the sea shore below high water not being a matter requiring trustworthy accuracy.

The results obtained by the Department of the Waterstaat in Holland, from periodical measurements of the coast adjacent to the North Sea, are therefore of great interest as showing the effect of the sea on flat beaches in low countries.

Between the years 1843–46, the Department caused to be placed all along the Dutch coast, extending from the Helder to the Hook of Holland, a distance of 75 miles, at the foot of the sand hills, oak posts at intervals of one kilometre (·62 mile) to form a permanent base line; and from these, at regular intervals, measurements have been periodically taken to the foot of the dunes on the land side, and to the low water line on the sea side.

The results are recorded in the *Proceedings* of the Dutch Institution of Civil Engineers.[1]

They are also set out in considerable detail, and tables given for the different periods, in the report of a Commission appointed to investigate the shell fishery of the coast, issued in 1896.[2]

The coast between the two parts named forms the arc of a very large circle, the depth of the embayment in the centre being 5½ miles. The main direction for the southern part faces about N.W., and of the northern part W.N.W. The winds which have most effect on the coast are those from the S.W., changing round to N.W.

The set of the flood tide is from south to north, the range decreasing from 5 feet at the Hook of Holland to 4¼ feet at the Texel. The coast line is bordered seaward by a sand beach extending from 300 to 350 feet to low water, lying at a slope of about 1 in 70; and on the land side by sand dunes, which vary from 1 to 3 miles in width and from 40 to 50 feet in height. These decrease in size towards the Texel.

With the exception of the detrital matter brought down in suspension by the river Maas, there is no source for a supply of material to feed the beach. The cliffs which border the French coast, from which the shingle and sand on the beach there is derived, terminate at Sangatte. The drift of the shingle and sand derived from the erosion of these cliffs extends only for a limited distance, and dies out a little beyond Calais and Dunkirk.

As regards the Belgian coast, the beach along which consists entirely of sand, from comparisons made by the Government engineers a few years ago of the various charts and plans dating from the beginning of the present century, and from a comparison of surveys of the coast made in 1833 and 1870, the conclusion was arrived at that no material alteration in the beach of the Belgian coast has taken place, so far as any means of comparison existed; and this was confirmed by measurements, taken in 1833 and 1870, of the height of the beach at the groynes at Ostend, Heyst and Wendyke, which showed that there had been no material alteration in the form of the beach.

The Dutch coast, between the periods to which the present investigations extend, has been subjected to two disturbing elements, in addition to one abnormally heavy gale in December 1894. The opening out of the new water way to Rotterdam through the Hook of Holland, and the construction of the harbour at Ymuiden for the entrance to the Amsterdam Canal, with the long piers extending across the beach, led to a considerable transposition of material at those parts of the shore; but the effect was local, and extended only over a short distance.

As a general result, the measurements show that during the last half-century, on the Dutch coast, the sea has been

[1] "Tidschrift Van het Koningklijk, Instituut Van Ingenieurs" (1883).
[2] "Uitkomst Van het Onderzoek of de Schelpvisscherij Langs de Noordzeekust Nadeelig Kan Zijn Voor Het Weerstandsvermogen Van Het Strand en het Behoud Der Duinen als Zeewering" (1896).

encroaching on the coast. The low water line has crept landward, and the beach has become more steep. There has also been a wasting away of the foot of the sand dunes.

For the first part of the period over which the observations extend (1843-56), there appears to have been a retreat of the low water line from the shore, and consequent increase in width of the beach, in the northern portion of the coast for the first forty-four miles, and this continued up to 1866 to a less extent. After this, the low water line began to advance landwards until 1877, when the northern beach began again to grow wider, but the decrease continued along the southern half. On an average there has been a loss of beach along the whole coast between 1846 and 1894, the total average loss for the forty-six years being 155 feet for North Holland and 108 feet for South Holland. The greatest change has taken place between the Helder and Petten, a distance of 12 miles, the low water line having advanced landward an average of 160 feet. Near Callangstoog, where the effect of the great gale of 1894 was most felt, the low water line is from 200 to 270 feet more inland than in 1846, and the foot of the dunes has been driven back more than 300 feet.

Near Zandvoort there has been a gain of 100 to 130 feet. Near Scheveningen the low water line has approached nearer the shore, for a length of about four miles for about 200 feet, and the foot of the dunes has been scoured away to an average of 100 feet, and in one place as much as 400 feet. The dunes have also wasted, although in a less degree. From the Helder to Egmont, a distance of 25 miles, there has been an average loss of about 150 feet. From there to Ymuiden the foot of the dunes has remained about stationary; and from Ymuiden to the Hook of Holland, excluding the part at Scheveningen, there has been an average gain of about 65 feet.

Ymuiden Harbour is situated nearly in the centre of the embayment, and the piers project about a mile out from the shore. The works were commenced in 1865, and finished in 1876. Since the commencement of the piers, sand has accumulated both on the north and south sides of the harbour, and in 1894 the accumulation had extended along the north pier seaward for a distance of about 1500 feet, and along the beach for $1\frac{1}{2}$ miles, this being the measure of the two sides of the triangle forming the pocket where the material had collected.

On the south side of the harbour the seaward measurement of the accumulation was at the same period 360 feet, and along the beach about $1\frac{1}{4}$ miles.

The material thus accumulated appears to be due to a transposition of material, as previous to the piers the beach was increasing at this part of the coast, and has since considerably diminished.

The accumulation at the piers, forming the entrance to the Maas, which extend seaward about a mile, has not been so great. On the north side the sand has extended seaward, since the construction of the piers in 1863-72,820 feet, the width of the extension along the beach being 2 miles. On the south side the accumulation extends outwards 700 feet. Here also there is a corresponding diminution of the beach for some distance to the north of the piers.

In December 1894 there occurred a very heavy gale, accompanied by the highest tide on the Dutch coast recorded during the present century, and an immense amount of damage was done to the fishing fleet. Out of 200 boats moored at the foot of the sand hills near Scheveningen, not one escaped without injury, and many were entirely destroyed. The damage done to the sand dunes, on which this part of the country depends for its protection from the sea, was very extensive, and throughout nearly the whole length the foot was washed away, leaving the mounds with steep sides. The stone pitching on the Helder Sea Dyke was damaged over a surface of about 5000 square yards. In North Holland, the tide broke through the sand hills in several places, and near Callanstoog the hills were breached for a distance of 2 miles, the tide inundating the low land behind.

W. H. WHEELER.

RESULTS OF THE SCIENTIFIC EXPEDITION TO SOKOTRA.

DURING the past winter a biological and geographical investigation of the Island of Sokotra (lying in about 12° north latitude and 54° east longitude), some 600 miles south-east of Aden, was undertaken, on behalf of the British Museum, by Mr. W. R. Ogilvie-Grant, and, on behalf of the Liverpool Corporation, by the Director of Museums (Dr. H. O. Forbes). Mr. W. Cutmore, of the Liverpool Museum, accompanied the party as taxidermist. From the *Bulletin* of the Liverpool Museums we learn that the expedition landed at Aden on November 18, 1898. Political difficulties between the Government of India and the Sultan of Sokotra unfortunately caused some delay in starting, but through the kindness of the Political Resident, Brigadier-General Creagh, V.C., these days were employed in visiting Sheik Othman and Lahej in South Arabia, where collections of considerable interest were made. On December 1, the difficulties referred to having been surmounted, the party was enabled to leave for Sokotra on board the Royal Indian Marine steamer *Elphinstone*, which had most generously been placed at its disposal by the Indian Government. Permission was also kindly given to detain the vessel for some days at Abd-el-Kuri, a previously unexplored island lying between Sokotra and Cape Guardafui, the eastern horn of Africa. There four days were spent in making as complete a collection of the fauna, flora and geology of the island as the time permitted. On December 7, the expedition was landed on Sokotra, near Hadibu, the capital, and it remained on the island till February 22, 1899. On the return voyage, a second visit was paid to Abd-el-Kuri for a couple of days, to enable more complete collections from that out-of-the-way spot to be made.

A complete account of Sokotra, with a map, a list of the collections, and full descriptions of the new species obtained by the expedition, illustrated by plates and blocks, will be published as a special volume, which is now in active preparation. Meanwhile, short diagnoses of some of the more conspicuous zoological novelties are given in the May number of the *Bulletin* of the Liverpool Museums.

Dr. Forbes reports to the Museums Sub-Committee that the share which Liverpool receives of the collections is as follows:—Of mammals, there are examples of one or two species of rat, of one species of civet cat, of one species of bat, and of the wild ass. Of birds, there are some 300 specimens, 250 in skin and 50 in spirit, out of which seven species have been diagnosed as new to science; a large series of reptiles has been acquired, which contains one genus and eight species new to herpetology. Numerous scorpions, millipedes and spiders, their exact number not yet ascertained, have been obtained, among which there turn out to be at least one new genus and seven new species; the land-shells number several thousands, of which Mr. Edgar Smith, of the British Museum, has already described eight species as new to his department of zoology. No doubt others will prove to be previously unknown. Of insects—almost the whole of which were collected by Mr. Ogilvie-Grant—there are several thousands, the majority of which have not yet been examined.

The plants, of which living specimens or ripe seeds—over 200 in number—have been brought home, are not only of the highest scientific interest, but, being at this moment unique out of Sokotra, are of great commercial value. Their cultivation is being undertaken by Prof. Bayley Balfour in the Royal Botanical Gardens, in Edinburgh. The plants, when in a condition to exhibit, will attract the keenest interest of all horticulturists by the beauty of many of them and by the bizarre form of others.

The report states that the true Sokoterians are only poorly civilised Mohamedans, living in caves or rude cyclopean huts, and possess but few utensils, implements, or ornaments, and no weapons. The ethnographical collection is consequently very small. Specimens of their pottery, of their primitive quern-like mills, of their basket work, and of their weaving apparatus were, however, obtained, and also two large blocks of stone, inscribed with an ancient script, which may perhaps throw some light on the indigenes of the island in a past age, and of whose cyclopean remains photographs were obtained.

Dr. Forbes concludes his report by pointing out that among scientific circles, especially among geographers and biologists, there has everywhere been expressed the warmest appreciation of the liberality and public-spirited action of the Liverpool Museums Committee and the City Council in taking part in the exploration of Sokotra; and also a hearty recognition of the great credit which unquestionably belongs to them of having been the first non-metropolitan Committee to recognise that it was the part of a great Corporation possessing an important scientific institution like the Liverpool Museums, not only to furnish their galleries with examples of what is already known, but also to further the advancement and increase of knowledge by actively sharing in the investigation of unknown regions.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The 202nd meeting of the Junior Scientific Club was held on May 26. After private business, Mr. J. M. Wadmore (Trinity) read a paper on caoutchouc; Mr. M. Burr (New College) exhibited some live walking-stick insects; and Mr. H. E. Stapleton (St. John's) read a paper on Dulong and Petit's law.

AN exhibition of practical work executed by candidates at the recent technological and manual training examinations of the City and Guilds of London Institute will be opened by the Duke of Devonshire, at the Imperial Institute, on Friday, June 9.

THE Edinburgh correspondent of the *Lancet* states that the court of the University of Edinburgh had recently before them a report from the committee appointed to draw up a statement and appeal for funds for University purposes, in which it was stated that the funds required for the equipment of the Public Health Laboratory and for the preparation of a library catalogue had been provided, the former by the generosity of Mr. John Usher of Norton, and the latter from the munificent bequests of the late Sir William Fraser. For the library, however, funds are still urgently required. The most pressing wants are: (1) a fire-proof room for the storage of rare books of the fifteenth and early sixteenth centuries and the MSS., which number about 7000; (2) a fund, amounting at the lowest figure to 25,000*l.*, for the purchase of scientific and literary journals and of larger works of reference; and (3) extensive structural changes and new book-cases, costing at least 5000*l.*, or a new and suitable building for the library. Another direction in which it will soon be necessary to spend money is the establishment of the Physical Laboratory. The construction and equipment of this laboratory will be a large undertaking, but it is one which will have soon to be faced if the scientific reputation of the University is to be maintained.

SCIENTIFIC SERIALS.

American Journal of Science, May.—Some experiments with endothermic gases, by W. G. Mixter. The endothermic gases operated upon were acetylene, cyanogen, and nitrous and nitric oxides. A beautiful experiment described is one in which acetylene is decomposed at a dull red heat. The gas issues from a narrow tube into a wider tube, heated by a Bunsen burner. When the glass begins to glow there is a slight puff, and the stream of gas issuing from the narrow tube glows, or rather the carbon particles glow in it with the heat of dissociation of the acetylene.—A hypothesis to explain the partial non-explosive combination of explosive gases and gaseous mixtures, by W. G. Mixter. Detonating gas, a mixture of carbonic oxide and oxygen, one of cyanogen and oxygen, and other explosive mixtures of gases, do not explode below certain pressures when sparked. Explosions do not occur because of the infrequency of impacts of molecules having a velocity or internal energy adequate for chemical union. Some of the molecules combine, but the heat of their union is not sufficient to restore the energy lost by radiation, and the change is therefore not self-propagating.—Occurrence of palæotrochis in volcanic rocks in Mexico, by H. S. Williams. Origin of palæotrochis, by J. S. Diller. These two papers effectually dispose of the hypothesis of the organic origin of the siliceous formations described by Emmons as due to some primordial coral. Prof. Williams describes some specimens coming from an old eroded volcanic cone made up of altered porphyry and volcanic tuffs, situated north-east of Guanajuato in the Santa Rosa mountains. A microscopical study of thin sections reveals the fact that the nodules are spherulites, a common feature of acid igneous rocks.—Association of argillaceous rocks with quartz veins in the region of Diamantina, Brazil, by O. A. Derby. Red clay is always associated with the quartz veins of the diamond region of Minas Geraes, Brazil. The author describes a remarkable layer of that kind, one to two metres thick, which has received from the miners the name of *Guia* (Guide), because, as they state, diamonds were to be looked for below the outcrop of this layer, and not above it.—Volatilisation of the iron chlorides in analysis, and the separation of the oxides of iron and aluminium, by F. A. Gooch and F. S. Havens. The fact that ferric oxide is completely volatile in HCl gas applied at once at a temperature of 500°, and at 200° if the acid carries a little chlorine, opens the way to many analytical separations of iron, notably to the separation of intermixed iron and aluminium oxides.—Preliminary note as to the cause of root pressure, by R. G. Leavitt. The author applies the latest researches on osmotic pressure to the known facts of plant physiology.

Bulletin of the American Mathematical Society, May.—Prof. Holgate gives an account of the April meeting, of the Chicago Section, at Evanston, April 1. There were two sessions in the day, and twelve papers were communicated.—Prof. Bôcher gives an elementary proof that Bessel's functions of the Zeroth order have an infinite number of real roots. This was read at the Society's February meeting (*cf.* Gray and Mathews' "Treatise on Bessel Functions," p. 44.) A generalisation of Appell's factorial functions (read at the December 1898 meeting), by Dr. Wilczynski, is a slight modification of Appell's proof. The writer proposes to discuss these functions more fully later on. A paper, read at the February meeting, by Prof. J. Pierpont, entitled "On the Arithmetization of Mathematics," is an attempt to show why arithmetical methods form the only sure foundation in analysis at present known. General reasons are indicated in a paper by Klein ("über Arithmetisirung der Mathematik," *Göttinger Nachrichten*, 1895). The paper enters into considerable detail. There is much metaphysics as well as mathematics. —Prof. E. W. Brown contributes an appreciatory review of Prof. Darwin's work on the tides and kindred phenomena of the solar system, and also notices "Leçons sur la théorie des Marées," by Maurice Lévy.—The Notes give an account of a projected change in the "Annals of Mathematics," which is to be inaugurated in vol. xiii., and a full list of the subjects of lectures at a dozen German universities, besides some notes of personal matters.

Wiedemann's Annalen der Physik und Chemie, No. 4.—Pitches of very high notes, by F. Melde. The author reviews the various methods by which very high pitches have been determined. These include subjective methods like those by direct hearing and by difference tones, and objective ones like the various vibrographs and the author's own method of resonance. The author admits that the method of difference tones is untrustworthy, and points out certain advantages of the sensitive flame which might be utilised.—Viscosity of gases, by P. Breitenbach. Of the two methods for determining the viscosity of gases, that of transpiration through a capillary tube, and that of the oscillation of a solid, the latter indicates a greater increase of viscosity in the temperature. But in any case the increase is not quite proportional to the temperature.—Effect of electric oscillations upon moist contacts, by E. Aschkinass. Two pointed copper wires which just touch each other act as an ordinary coherer in air or alcohol, but when immersed in water, or when the points are only connected by a drop of water, the action is reversed, since electric waves have the effect of temporarily increasing instead of reducing the resistance. In another form of the experiment, a few drops of water are added to the copper filings of an ordinary coherer. This reversed action is as yet entirely unexplained.—Emission and absorption of platinum black and lamp black with increasing thickness, by F. Kurlbaum. The emission of blackened surfaces is compared with that of an "absolutely black body" in the shape of an orifice of a brass vessel blackened inside and kept at a constant temperature by circulating steam. A bolometer is exposed to radiation from this orifice and to films of black substances kept at the same temperature. It appears that platinum black has a higher absorptivity and emissity at greater thicknesses, whereas that of lamp black is greater in very thin layers. Neither of these substances absorbs heat rays of great wave-lengths. For most purposes, platinum black is to be preferred, if only on account of the facility in controlling its electrolytic deposition. —Radius of molecular action, by W. Mueller-Erzbach. Films of bees-wax or sealing-wax were protected by thin layers of gum against the dissolving action of carbon bisulphide vapour. The thickness of the layer of gum required for effectively protecting sealing-wax was 0·35 mm., whereas bees-wax was sufficiently protected by a layer only 0·14 mm. thick.

THE April issue (vol. lxv. part 4) of the *Zeitschrift für Wissenschaftliche Zoologie* contains five articles, of which, perhaps, the one by Messrs. Eimer and Fickert, on the evolutionary history of the Foraminifera, is the most generally interesting.

More than one hundred pages of the journal are devoted to this subject; and the elaborate genealogical tree given on p. 464 supplies in concise form the general results of the authors' investigations. The other articles include one on the Infusoria found in the stomachs of domestic Ruminants, by A. Günther; one on the urinogenital system of certain Chelonians, by F. von Müller; a third, by J. Meisenheimer, on the morphology of the kidneys of the Pulmonate Mollusca; and a fourth, by G. Forssell, on the Lorenzinian ampullæ in the Spiny Dogfish. After describing in detail the histology of these head-organs, the author considers that further experiments must be made before their precise function can be fully determined.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, May 26.—Mr. T. H. Blakesley, Vice-President, in the chair.—A paper, by Prof. S. Young and Mr. Rose-Innes, on the thermal properties of normal pentane (Part 2), was read by Mr. Rose-Innes. In the first paper on this subject, read before the Physical Society last December, it was shown that the relations existing between the volume temperature and pressure of normal pentane could be closely represented by the equation

$$p = \frac{RT}{v}\left\{1 + \frac{e}{v + k - gv^{-2}}\right\} - \frac{l}{v(v + k)}.$$

This formula was first used in connection with isopentane, and it has been shown that the values of R and l/e are the same for the two isomers. The authors find that if l and e be taken separately equal to each other, and if the constants k and g be calculated from experiments on normal pentane, errors of 2 per cent. occur between the calculated and experimental results. This point has been investigated both algebraically and graphically, and the supposition that these constants are separately equal has been thought incorrect. Taking the values of R, l/e, and g as being the same in the two pentanes, the constants l and k have been determined, and by this means the relations between volume temperature and pressure have been represented by the formula to within 1 per cent. The authors conclude that the difference in pressure of two isomeric substances at a given volume and temperature is of the same order as the deviation from Boyle's law, and involves the second power of the density. Mr. Rose-Innes said the formula proposed was not an absolute solution of the problem, although it was the best of a large number which had been tried. It has been applied with success to Andrews' experiments on carbonic acid, and to experiments which have been made upon ether and hexane. In the latter case, the range in volume was too small to afford a rigorous test of the value of the formula. The range in volume in isopentane was from 4000 to 3·4; in normal pentane, from 300 to 3·4; and in ether, from 350 to 3·4. The temperature varied in different experiments from 40° C. to 280° C. Objections have been raised to the formula on account of the number of constants it contains and its complexity. Mr. Rose-Innes pointed out that it was necessary to have a complex formula, as they were not dealing with a simple problem, but with the results of experiments which went so far below the critical temperature that the volume occupied was only 3·4 times as great as the space which would have been occupied by the molecules at their closest packing. The reader of the paper compared the proposed formula with formulæ of Clausius, Sutherland, and Tait containing four, four, and six constants respectively, and finally with the original equation of Van der Waals applied to experimental results by Amagat. It was shown that the agreement was much closer and the range greater. Prof. Callendar expressed his interest in the wide applicability of the authors' formula, and asked if any theoretical significance could be assigned to the various constants which appeared. Mr. Rose-Innes said the R of their formula was the R of the perfect gas equation, and that the l and e corresponded respectively to the β and α of the ordinary Van der Waals expression. So far as he knew, the k and g were meaningless.—A paper on the distribution of magnetic induction in a long iron bar, by Mr. C. G. Lamb, was postponed until the next meeting.

Chemical Society, May 18.—Prof. Thorpe, President, in the chair.—The following papers were read:—Corydaline (Part vi.), by J. J. Dobbie and A. Lauder. Corydaldine, $C_9H_7NO(OMe)_2$, an oxidation product of corydaline, is shown to be closely related to oxyhydrastinine; the so-called corydalinic acid is an acid ammonium hemipinate.—Oxidation of furfural by hydrogen peroxide, by C. F. Cross, E. J. Bevan and T. Heiberg. Furfural is oxidised by hydrogen peroxide in presence of iron salts to a hydroxyfurfural and the corresponding hydroxypyromucic acid; the hydroxyfurfural reacts with phloroglucinol and resorcinol in a similar way to the lignocelluloses. It is shown thus that a furfuralphenol is a constituent of the lignocelluloses.—Note on the reactions between sulphuric acid and the elements, by R. H. Adie.—On the action of ethylene dibromide and of trimethylene dibromide on the sodium derivative of ethylic cyanacetate, by H. C. H. Carpenter and W. H. Perkin, jun. Improved methods for preparing tri- and tetra-methylene derivatives are given. Ethylic trimethylenecyanocarboxylate (1,1), is prepared by the action of ethylene bromide on ethylic sodiocyanoacetate, and ethylic tetramethylenecyanocarboxylate (1,1), is obtained by the action of trimethylene bromide on ethylic sodiocyanoacetate; the salts are hydrolysed by cold alcoholic potash with formation of the corresponding acids.—The maximum vapour pressure of camphor, by R. W. Allen. Experimental values for the maximum pressures of camphor vapour at 0–80° are given.

Linnean Society, May 4.—Mr. A. D. Michael, Vice-President, in the chair.—Mr. I. H. Burkill exhibited specimens of a daisy (*Bellis perennis*), found at Kew, in which the ray of the outer florets was so nearly absent that these consisted of scarcely more than ovary, naked style, and stigma.—Mr. F. G. Parsons read a paper on the position of *Anomalurus* as indicated by its myology. The paper contained an account of the muscles of *Anomalurus*, and a comparison of them with those of the different suborders of rodents. From previous examination of the muscles of rodents, the author arrived at the conclusion that *Anomalurus* should be placed among the Sciuromorpha, but that it had certain Myomorphine tendencies. He contrasted its muscles with those of *Pedetes caffer*, but found little reason to regard these two animals as nearly related.—Mr. George Murray, F.R.S., on behalf of Miss Ethel S. Barton, communicated a paper on *Notheia anomala*, an obscure species of parasitic Alga, and described its mode of growth and reproduction, some remarks being made by Mr. W. Carruthers, F.R.S.—A paper by Mr. George West on variation in Desmids was read. The Desmidieæ was shown to be morphologically specialised and to exhibit a marked pattern and symmetry of form, major and minor symmetries being recognisable in many species. Variations in form and symmetry were specially dealt with, and a summary given of all that is known concerning the variation in the cell-contents and in the conjugation of these plants. Observations were also made on the variability of the pyrenoids and moving corpuscles in the genus *Closterium*.

Geological Society, May 10.—W. Whitaker, F.R.S., President, in the chair.—The geology of the Davos district, by A. Vaughan Jennings. Alpine geology has attracted many workers since the date of Prof. Theobald's classic memoir on the district of which Davos forms part, and new principles of interpretation have been established. The author has more especially studied (*a*) the age of certain rocks formerly classed as "Bündner Schiefer," but distinct from the grey shales variously regarded as of Jurassic or Tertiary age; (*b*) the origin and date of the serpentine near the Davoser See; and (*c*) the tectonic structure of the district. The author discusses at length the physical structure of the district. The general trend of the Davos Valley is rather oblique to that of the greater rock-masses, which, however, is somewhat irregular. He shows that these (which have a general dip towards the south and east) form three great acute and rudely parallel over-folds, the westernmost being the most complicated; of this fold, the serpentine forms a part. It is more recent than the crystalline schists and the Casanna Schiefer, and is associated with the red and green schistose rocks already mentioned, in a way which he considers indicative of intrusion; but it nowhere cuts the Haupt-Dolomit. Accordingly he considers it to be later than the Verrucano, and not earlier than the middle part of the Trias. Certain crystalline breccias occur in the neighbourhood of the serpentines; these the author considers to be due to earth-movement, and he goes on to give reasons for regarding them as the equivalent of the Casanna Schiefer of other localities. There is, in his opinion, no evidence of the presence of post-Jurassic strata such as Prof. Steinmann believes to exist.—Contributions to the geological study of County Waterford. Part 1, § i. The Lower Palæozoic bedded rocks of the coast, by F. R. Cowper Reed. This paper opens with an account of the previous publications on the geology of the district, and then goes on to describe the sections exposed along the coast at the following localities: Raheen and Newtown Head, Tramore Bay, Garrarus and Kilfarrasy, Annestown and Dunabrattin, Knockmahon, Ballydouane Bay, and Killelton Cove to Ballyvoyle. These sections expose shales and limestones with abundance of igneous rocks partly interbedded, but mainly intrusive; and the author is able to make out the following succession of rocks, tabulated in descending order: (4) Raheen Series. Mudstones, slates, felsites and tuffs, and fossiliferous shales. (3) Carrigaghalia Series. Graptolitic shales, thin flags, cherts, tuffs, and felsites. (2) Tramore Limestone Series. Divided into three stages. (1) Tramore Slates. Calcareous and argillaceous slates.

Zoological Society, May 16.—Dr. W. T. Blanford, F.R.S., Vice-President, in the chair.—The Secretary read extracts from letters received from Mr. J. S. Budgett, containing an account of the progress of his expedition to the Gambia, and announcing his proposed return in July next.—Mr. G. A. Boulenger, F.R.S., exhibited a specimen of the Bornean lizard (*Lanthanotus borneensis*), belonging to the Sarawak Museum, and remarked that it was the second example of this reptile that had reached Europe. An examination of the specimen had confirmed Mr. Boulenger's suspicion that its affinities were with the *Helodermatidae*, and that it was not, as its original describer (Steindachner) had supposed, entitled to family rank by itself.—Mr. G. E. H. Barrett-Hamilton exhibited the skins of two hares (*Lepus variabilis*), and made some remarks on the winter whitening of Mammals in connection therewith.—Mr. G. A. Boulenger, F.R.S., read an account of the fishes obtained by the Congo Free State Expedition, under Lieutenant Lemaire, in Lake Tanganyika, in 1898. Ten new species were described, of which three were made the types of new genera.—Mr. E. M. Corner read a note on the variations of the patella in the divers, grebes, and cormorants, by which the functions of the bones in these birds were explained.—A communication was read from Mr. Stanley S. Flower, containing notes on a second collection of reptiles made in the Malay Peninsula and Siam, from November 1896 to September 1898, and a list of the species recorded from those countries. The species enumerated in the paper were 221, of which one was the type of a new species, described under the name of *Typhlops floweri* by Mr. G. A. Boulenger.—A communication was read from Marquis Ivrea on the wild goats of the Ægean Islands. A series of heads and some photographs of the goats of the islands of Antimilo and Joura were exhibited, with the object of showing that the effect of a cross between *Capra aegagrus* and *C. hircus* (such as had been proved to have occurred on the former island) was not to produce an animal corresponding to *C. dorcas* (Reichenow), and that consequently the goat of Joura had not, as was generally assumed, been so produced, but was, as a matter of fact, a local variety of the wild goat, for which the name *C. aegagrus*, var. *jourensis*, was suggested. Mr. W. Cunnington read a paper on a new Brachyuran Crustacean from Lake Tanganyika, obtained by Mr. J. E. S. Moore, for which he proposed the name *Limnothelphusa maculata*. The crab, unlike its nearest allies, was wholly aquatic, and would seem to be the most primitive member of the Thelphusine group.—A paper was read by Mr. W. T. Calman on some Macrurous Crustaceans obtained by Mr. J. E. S. Moore in Lake Tanganyika. A new genus (*Limnocaridina tanganyikae*) and a new species of *Palaemon* (*P. moorei*) were described, it being pointed out that neither of them furnished any particular facts bearing on the general question of the origin of the Tanganyikan fauna.

Cambridge.

Philosophical Society, May 15.—Mr. J. Larmor, President, in the chair.—Mr. J. J. Lister exhibited specimens of *Branchipus* and *Estheria* raised from dry mud, obtained from the upper pool of Gihon near Jerusalem. The mud had been placed in water, after remaining dry for three years, and three days later the water was found to be peopled with the nauplius larvæ of these genera. Representatives of species of *Daphnia, Ostracoda* and *Copepoda* had subsequently appeared, probably identical with those described by Baird from the same locality (*Annals and Magazine of Natural History*, series iii. vols. iv. and viii.). It was pointed out that in *Branchipus* food travels forward towards the mouth along the groove which separates the thoracic appendages of the opposite sides; and the suggestion was offered that a similar course of the food may explain the masticatory character of the basal inner lobes of the anterior thoracic appendages of *Apus*.—Notes on the Binney collection of carboniferous plants; (2) a new type of Palæozoic plant, by A. C. Seward. The author gave a brief description of a fragment of stem from the Coal-Measures of Lancashire, which exhibits anatomical features differing from those of any known genus. The primary structure agrees in certain respects with that of *Heterangium*; but there are definite peculiarities which render advisable the institution of a new generic name. Among the more important characteristics may be mentioned the large isodiametric metaxylem tracheids, the position of the protoxylem elements and the structure and course of the leaf-traces.—On the modification and attitude of *Idolum diabolicum*, a Mantis of the kind called "floral simulators," by Mr. D. Sharp. Mantises are voracious insects with the front legs of remarkable form, suited to the capture of living insects which form the sustenance of the Mantis. Certain of these Mantises assume attitudes and make movements that cause them to resemble flowers, and they are moreover possessed of some modifications of structure and colour that are believed to strengthen the illusion caused by their attitudes. The facts as regarded *Idolum diabolicum* were stated, and from a comparison with other Mantises the conclusion was deduced that the modifications of structure are really slight, and that the attitude is the important point. In reference to the origin of the peculiarities, he concluded that, granted that the instinct of the creature caused it to assume the attitudes, the slight structural modifications might follow from simple physical causes.—On the product $J_m(x)J_n(x)$, by Mr. W. McF. Orr.

Paris.

Academy of Sciences, May 23.—M. Van Tieghem in the chair.—On the deformation of general surfaces of the second degree, by M. Gaston Darboux.—On some new compounds of camphor with aldehydes, by M. A. Haller. In continuation of previous work on the subject, the author has studied the action of piperonal and of meta- and para-methoxybenzaldehydes on the sodium derivative of camphor, and has prepared a number of new compounds. Metamethoxybenzylidenecamphor crystallises in long needles melting at 51°–52° and is reduced by sodium amalgam to metamethoxybenzylcamphor. Paramethoxybenzylidenecamphor forms large crystals melting at 125°, and is converted by reduction into paramethoxybenzylcamphor, which crystallises in prisms melting at 71°. Piperonylidenecamphor crystallises in needles melting at 159°·5, and yields, on reduction, piperonylcamphor, which forms small white plates melting at 70°. Piperonyl piperonylate, which is formed along with piperonylidenecamphor, crystallises in needles melting at 97°.—On isothermic surfaces and the deformation of the paraboloid, by M. A. Thybaut.—On the deformation of certain surfaces related to surfaces of the second degree, by M. Tzitzeica.—On the development of a uniform branch of analytic functions, by M. Paul Painlevé.—On the calculation of divergent series by Taylor's theorem, by M. Emile Borel.—On the calculation of the maximum available force at the draw-bar of a motor, by M. A. Petot.—On the decomposition of silicates by hydrogen sulphide, by M. P. Didier. The majority of silicates, when heated in a porcelain tube at about 1400° C., are decomposed and partially converted into sulphides. In some cases, the latter are easily separated, owing to the occurrence of volatilisation or of crystallisation, or by their solubility in dilute acids; in others, the sulphides obtained are only attacked by reagents which decompose the original silicate. The reaction is always incomplete, since the silicate becomes covered with a protective layer of sulphide, and in the greater number of experiments the somewhat remarkable formation of a small quantity of sulphuric acid was noted. A portion of the silica appears to be reduced to silicon, and this is also found to occur in the action of hydrogen sulphide on silica alone.—On di-isoamylacetic acid, by M. H. Fournier. Ethylic di-isoamylmalonate, obtained by the malonic ether synthesis from isoamylic bromide, is a colourless liquid boiling at 278°–280°, and the corresponding acid crystallises in white plates melting at 147°–148°. The latter, when heated to 175°, is converted into di-isoamylacetic acid, which crystallises in white needles melting at 46°–47°, and is insoluble in water but very soluble in organic solvents. The corresponding amide crystallises in white, silky needles melting at 115°.—Fluorine in mineral waters, by M. Charles Lepierre. It is maintained, in opposition to M. Parmentier, that minute traces of fluorides have been detected in many natural waters, and that considerable quantities —equivalent to 10 or 12 milligrammes of fluorine per litre—are present in the mineral water of Gerez (North Portugal), which is much esteemed for its efficacy in diseases of the liver.—On the genesis of the iron ores of Lorraine, by M. P. Villain. Arguments are brought forward in support of the theory that the oolitic ore of Lorraine is a littoral deposit, the mineralisation of which has been effected by the action of hot springs in the bed of an ancient sea.—On a parasitic fungus in cancerous affections, by M. J. Chevalier. The author has succeeded in isolating what appears to be a specific fungus from cancerous tumours, from the blood of patients, and from the air of hospitals. A temperature of from 28° to 35° is most favourable to its growth, but it is highly resistant, the spores not being destroyed by ten minutes' heating at 100°. The parasite exists in the form of conidia, a mycelium, or spherules, according to the stage of development and the medium employed. Its specific character is confirmed by the results of inoculation experiments, but further study will be required before the causal connection between the parasite and cancerous affections is definitely established.

DIARY OF SOCIETIES.

THURSDAY, JUNE 1.

ROYAL SOCIETY, at 4.—Election of Fellows. —At 4.30.—The Parent-Rock of the Diamond in South Africa: Prof. T. G. Bonney, F.R.S.—Experimental Contributions to the Theory of Heredity. A. Telegony.—I. Introductory: Prof. J. C. Ewart, F.R.S.
ROYAL INSTITUTION, at 3.—Water Weeds: Prof. L. C. Miall, F.R.S.
LINNEAN SOCIETY, at 8.—On the High Level Plants of the Andes as illustrated by the Collections of Sir W. Martin Conway, Mr. Edward Whymper, and others: W. Botting Hemsley, F.R.S.—On some Australasian Collembola: Sir John Lubbock, Bart., F.R.S.
SOCIETY OF ARTS, at 4.30.—The Port of Calcutta: Sir Charles Cecil Stevens, K.C.S.I.
CHEMICAL SOCIETY, at 8.—The Hydrosulphides, Sulphides, and Polysulphides of Potassium and Sodium: W. Popplewell Bloxam.—On the Relative Efficiency of various Forms of Still-head for Fractional Distillation: Dr. Sydney Young, F.R.S.—The Salts of Dimethylpyrone, and the Tetravalence of Oxygen: Dr. J. N. Collie, F.R.S., and Thomas Tickle.

FRIDAY, JUNE 2.

GEOLOGISTS' ASSOCIATION, at 8.—The Pleistocene Deposits of the Ilford and Wanstead District: Martin A. C. Hinton.—The Pleistocene Mollusca of Ilford: A. S. Kennard and B. B. Woodward.—The Raised Beach and Rubble Drift at Aldrington, between Hove and Portslade-by-Sea, Sussex, with Notes on the Microzoa: Frederick Chapman.

SATURDAY, JUNE 3.

GEOLOGISTS' ASSOCIATION.—Excursion to Reigate. Directors: Miss M. C. Crosfield and Rev. Ashington Bullen.

MONDAY, JUNE 5.

ROYAL GEOGRAPHICAL SOCIETY, at 3.—Anniversary Meeting.
SOCIETY OF CHEMICAL INDUSTRY, at 8.—A New Method for the Analysis of Commercial Phenols: Dr. S. B. Schryver.—A Demonstration of Printing by Electricity without the aid of Rollers or Ink: Dr. S. Rideal.—Notes on Cacao Butter: Dr. J. Lewkowitsch.—The Use of Iron as the Active Element in Primary Batteries and for Electrolysing: Colonel J. Waterhouse.

TUESDAY, JUNE 6.

ZOOLOGICAL SOCIETY, at 8.30.—An Account of a Collection of Fishes made by Mr. R. B. N. Walker on the Gold Coast: Dr. A. Günther, F.R.S.—On a Specimen of *Cervus belgrandi*, Lart. (*C. verticornis*, Dawk.) from the Forest-Bed of East Anglia: Dr. S. F. Harmer, F.R.S.—On a Few Points in the Structure of Laborde's Shark (*Euprotomicrus labordii*, Müll. and Henle): Dr. R. O. Cunningham.

WEDNESDAY, JUNE 7.

GEOLOGICAL SOCIETY, at 8.—On the Geology of Northern Anglesey: C. A. Matley.—On an Intrusion of Granite into Diabase at Sorel Point (Northern Jersey): J. Parkinson.
ENTOMOLOGICAL SOCIETY, at 8.

THURSDAY, JUNE 8.

ROYAL SOCIETY, at 4.30.—Meeting for Discussion.—*Subject*: On Preventive Inoculation: introduced by M. Haffkine.
MATHEMATICAL SOCIETY, at 8.—On Solitary Waves, Equivoluminal and Irrotational, in an Elastic Solid: Lord Kelvin, G.C.V.O.—On Several Classes of Simple Groups: Dr. G. A. Miller.—The Transmission of Stress across a Plane of Discontinuity in an Isotropic Elastic Solid and the Potential Solutions for a Plane Boundary: Prof. J. H. Michell.—On Theta Differential Equations and Expansions: Rev. M. M. U. Wilkinson.—Finite Current Sheets: J. H. Jeans.—On a Congruence Theorem having reference to an Extensive Class of Coefficients; and on a Set of Coefficients analogous to the Eulerian Numbers: Dr. Glaisher, F.R.S.

FRIDAY, JUNE 9.

ROYAL ASTRONOMICAL SOCIETY at 8.
MALACOLOGICAL SOCIETY, at 8.

BOOKS, PAMPHLET, and SERIALS RECEIVED.

BOOKS.—Handbuch der Anatomie und Vergleichenden Anatomie des Centralnervensystems der Säugetiere: Drs. E. Flatau and L. Jacobsohn, I. (Berlin, Karger).—Annales de l'Observatoire National: d'Athènes, Tome 1 (Athènes).—The Use of Lead Compounds in Pottery: W. Burton (Simpkin).—Catalogue of the Library of the Royal Botanic Gardens, Kew (London).—The Psychology of Reasoning: Dr. A. Binet (K. Paul).—An Introduction to the Study of Materia Medica: Prof. H. G. Greenish (Churchill).—La Crime, Causes et Remèdes: C. Lombroso (Paris, Schleicher).—The Coccidæ of Ceylon: E. E. Green, 2 Parts (Dulau).—The Geography of Mammals: W. L. Sclater and Dr. P. L. Sclater (K. Paul).—Animals in Motion: E. Muybridge (Chapman).—Antiquities from the City of Benin, &c., in the British Museum: C. H. Read and O. M. Dalton (London).

PAMPHLET.—Geology of the Country around Carlisle: T. V. Holmes (London).

SERIALS.—Quarterly Journal of Microscopical Science, May (Churchill). Papers read before the Engineering Society of the School of Practical Science. Toronto, No. 12, 1898–99 (Toronto).—Agricultural Gazette of New South Wales, April (Sydney).—American Geologist, May (Ginn).—Records of the Australian Museum, Vol. 3, No. 5 (Sydney).—Proceedings of the Royal Physical Society, Session 1897–98 (Edinburgh).—Himmel und Erde, May (Berlin).—Memoirs of the Geological Survey of India, Vol 28, Part 1 (Calcutta).—Journal of Applied Microscopy, April (Rochester, N.Y.).—North American Fauna, No. 14 (Washington).—Science Gossip, June (Strand).—English Illustrated Magazine, June (Strand).—Chambers's Journal, June (Chambers).—Bulletin of the American Mathematical Society, May (New York).—Good Words, June (Isbister).—Sunday Magazine, June (Isbister).

CONTENTS. PAGE