THURSDAY, APRIL 10, 1902.

SENSE ORGANS IN THE VEGETABLE KINGDOM.

Sinnesorgane in Pflanzenreich zur Perception mechanischer Reize. Von Dr. G. Haberlandt, o.ö. Professor an der Universität Graz. Pp. viii + 163; 6 plates. (Leipzig: Engelmann, 1901.) Price 9*s.* net.

MR. HUXLEY has truly said[1] that "perhaps the most remarkable service to the philosophy of biology rendered by Mr. Darwin is the reconciliation of teleology and morphology, and the explanation of the facts of both, which his views offer." Prof. Haberlandt is a devoted adherent to the school of evolutionary teleology; one of his earliest publications (in 1877) was a study of the protective adaptations of seedlings, and the desire to understand the meaning of every detail of plant-structure is still the key to his activity. It has led him, following the footsteps of Schwendener, to specialise in what he names physiological anatomy, which might with equal propriety be termed teleological or adaptive anatomy. Haberlandt's book,[2] in which he elucidates the minuter structure of plants from this point of view, is a recognised classic and is found in every botanical library in the world. The present work will, we think, only add to his reputation as an investigator.

The title of his book, "Sense Organs in the Vegetable Kingdom," &c., would by itself suggest the school of thought to which Haberlandt belongs, and on his first page he asserts that the plants have specific forms of irritability which are completely analogous to the senses of animals. This school, which puts side by side the reflex movements of plants and animals, dates (in its modern development) from the writings of Pfeffer and Sachs in Germany, and from the publication of "The Power of Movement in Plants" in this country,[3] and is now generally accepted.

Haberlandt's book deals with the reflexes called forth by tactile stimulation, more especially with one branch of the subject, namely, the mechanism which localises and intensifies the touch. The means by which the disturbance, thus originated, is transmitted to the motor organs is for the moment of secondary importance with the author.

Haberlandt begins with the following definition:—

"Sense organs, or organs of perception, are those structural contrivances which contribute to the reception of an external stimulus, and show a more or less striking correspondence between structure and function."

According to this broad definition, the sense organ need not itself possess the quality of percipience. The essential characteristic is an arrangement for a sudden "deformation" of the ectoplasm in sense-cells. But certain plant-hairs and bristles are called sense organs, although they merely act like the vibrissæ of animals, that is to say like levers, the act of percipience occurring in the sensitive tissues in which they are imbedded. Haberlandt practically narrows his definition by applying the term *Stimulator* to the purely mechanical parts of sense organs, a terminology which seems to us of rather doubtful value, more especially as stimulators seem to graduate into sense organs in the narrower sense.

The simplest class of sense organs contains what the author calls *Fühlpapillen* or *Tactile-papillae*. These, as they occur in the stamens of Opuntia, &c., have been already described by Haberlandt in his "Physiologische Pflanzenanatomie"; the present book demonstrates the remarkable fact that tactile papillæ occur in many different organs and in widely distinct natural orders—a state of things with which we are familiar in many adaptive structures, and which never fails to interest us. The tactile papilla in Opuntia consists of a small conical projection from an epidermic cell, into which runs a promontory of protoplasm. The fact that the papilla projects above the general surface renders it liable to be touched by the visiting insects, and the thin walls of the apical half of the papilla allow deformation to result from contact. The papillæ in this instance are not, however, very sensitive to simple contact, for if the stamens are gently rubbed they curve but slightly, whereas if the filament is forcibly bent at the same time, as would be the case when an insect visited the flower, the reaction is greater. This is only one instance of the care with which Haberlandt has, throughout, distinguished the reaction due to contact that is produced by bending of the whole organ. In this case, and also in Portulaca, it seems that if the filament is merely stroked the needle slips over the papillæ without seriously affecting them, but pressure at right angles to the filament deforms the wall of the tactile papilla and also bends the filament.

In the filaments of Berberis, the tactile papilla is of still simpler structure, being formed by the convex projection of the whole outer wall of an epidermic cell. The distribution of the cells corresponds with that of the region sensitive to contact, and here in contrast to Opuntia a slight touch, which produces no bending of the filament, is sufficient to call forth the reaction. It is true that forcible bending of the filament also has an effect, but the movement produced is incomplete; it is interesting that the motor machinery should respond less to direct deformation of its own constituent cells than to a minute change of form in the cells specialised as sense organs.

The tactile cells in Berberis differ from the non-sensitive ones in being richer in protoplasm, in containing orange chromoplasts and starch grains. The exposed projecting wall of the sense cells is not thin as in Opuntia or Portulaca; the disturbance produced by contact is apparently due to a curious thinning away of the outer wall where it meets the radial walls. This hinge-like mechanism must allow a localised deformation of the ectoplasm to occur; the cell is, in fact, like a box with strong but loosely fitting hinged lid, the hinges being the region where deformation especially occurs. The same type—a bulging epidermic cell with a hinged connection to the radial walls—occurs in Abutilon in a different natural order. The irritable stamens of Helianthemum are worthy of notice, from the absence of all definite sense organs. Haberlandt assumes that the delicacy of the epidermis renders superfluous any special arrangements; and he compares the filaments to those tendrils in which histological adaptations are absent.

[1] "Life and Letters of Charles Darwin," ii. p. 201.

[2] "Physiologische Pflanzenanatomie." 1st Edit. 1884, 2nd Edit. 1896. (Leipzig: Engelmann.)

[3] The earliest popular statement of this point of view was published by the writer of this notice in NATURE, 1878, vol. xvii. pp. 390, 411, &c.

Simple tactile papillæ occur in stigma lobes of *Goldfussia anisophylla*; they are not highly sensitive, and a pressure on them sufficient to bend the lobe is required, but whether or no the deformation of the motile tissue acts as an accessory stimulus is not easily decided. In his section on irritable styles and stigmas, Haberlandt describes the curious movements of the style of Arctotis (Compositæ), which was discovered by D. Müller in 1853, but has, until recently, received too little attention. Like the filaments of Helianthemum, it has no special sense organs, and Haberlandt suspects that the reaction is called forth by the style being forcibly bent rather than irritated by touch.

In Darwin's "Fertilisation of Orchids" the mechanism by which Catasetum shoots out its pollen-masses was for the first time described. Haberlandt has now shown that in *C. Darwinianum* and *macrocarpum* the "antennæ" which receive the stimulus, and transmit an influence to the rostellum, are provided with sense organs. His drawings (especially Taf. iii. Fig. 7) fully confirm his remark that the tactile papillæ bear a striking resemblance to those on the filaments of Opuntia and Portulaca.

In an undetermined species of Catasetum a most remarkable divergence from the type occurs. Tactile papillæ are wanting, and the antenna is converted, by the development of mechanical tissues, into a vibrissa or lever; it is capable of bending near the base, and obviously functions like filaments in Dionæa,[1] where the movement of the stiff apical part deforms the percipient joint or hinge near the base.

Allied to the tactile papillæ are the *Fühl-tüpfeln* or tactile pits discovered by Pfeffer in certain tendrils, inasmuch as by their means the protoplasmic prolongations which fill the pits are brought close to the free surface, and in such a position that they are liable to deformation by contact. Haberlandt describes these structures in detail in a variety of genera, and gives drawings of several, including the cases where a relatively large crystal is included in the pit, an arrangement which must have the effect of a stone in a man's shoe in increasing the sensitiveness to contact.[2]

For the interesting account of the minute tactile pits in the tentacles of Drosera, the reader is referred to the original. The remaining sense organs described by Haberlandt may be placed together, although by the author they are subdivided into tactile hairs, tactile bristles, stimulators, &c. Their essential character has already been referred to in describing an unnamed species of Catasetum; it is the occurrence of a stiff terminal part the movement of which deforms either the base or the tissues from which it springs. A simple example occurs on the contractile stamens of *Centaurea montana*; here the sense organs consist each of a simple, strongly built hair, the movement of which acts on the thin-walled basal joint. Other organs of the same essential type have been described[3] in Aldrovanda, but here the sensitive joint is not at the base, but in the middle of the hair.

One of the most interesting points in the book is the discovery of similar organs in Mimosa and Biophytum. The sensitive lower surface of the pulvinus of *Mimosa pudica* bears a number of obliquely lying bristles, and Haberlandt finds that the familiar reaction follows a touch applied to one of these. To convince himself of the fact the observer must, it seems, select a plant not in the highest condition of irritability; with a slightly sluggish plant it is easy to convince oneself that the bristles are the most sensitive part of the surface. The bristles are of several types, of which the most interesting is described as the "cork-squeezer" pattern.

In the angle between the bristle and the surface of the pulvinus is a projecting mass of cells, which will necessarily be squeezed when pressure is applied to the end of the bristle. The same mechanical contrivance is found among the Oxalidæ on the leaves of Biophytum, the lever being in this case a stiff hair instead of a bristle. The author points out (p. 80) that the discovery of these organs throws light on the question of the biological meaning of the irritability of Mimosa. Their existence does not seem compatible with Sachs' view that the response to contact is useful as a protection against sudden violent hail- or rain-storms. On the other hand, it lends support to Pfeffer's theory that the movement of the leaf stalks serves to warn off small creeping insects, &c. In Java and Singapore, where *Mimosa pudica* is an introduced weed, Haberlandt has seen the leaves react to visitors of this type.

The book concludes with a short section on the comparison of the tactile organs of plants with those of animals, in which the interesting point is brought out that in insects the lever-like or hinged hairs bear a distinct resemblance to corresponding structures described by the author in plants.

FRANCIS DARWIN.

[1] Haberlandt, "Physiologische Pflanzenanatomie," Edit. ii., p. 481.
[2] See also Haberlandt, "Physiologische Pflanzenanatomie," Edit. ii., 1896, p. 478.
[3] Haberlandt, "Physiologische Pflanzenanatomie," Edit. ii., 1896, p. 480.

A NEW TREATISE ON THE CALCULUS.

An Elementary Treatise on the Calculus, with Illustrations from Geometry, Mechanics and Physics. By George A. Gibson, M.A., F.R.S.E., Professor of Mathematics in the Glasgow and West of Scotland Technical College. Pp. xix + 459. (London: Macmillan and Co., Ltd., 1901.) Price 7*s.* 6*d.*

AMONG several notable characteristics possessed by this work, the most prominent appears to be the severity of its logic. In one important respect it differs also from the usual English mathematical treatise—it seems to speak to the student, warning him against too probable error and giving him advice. This is a feature which should be encouraged. The aim of the writer of a text-book should be to educate his reader, frankly recognising the imperfections of human nature, and not merely to set forth a work of unassailable art full of unimpeachable truths.

While applied mathematics is the great field for the exercise of such a method of treatment—since erroneous views on the part of students are at once more probable and more numerous in this domain than in others—the calculus is probably, in the field of pure mathematics, the subject in which a student most needs the anticipation of errors and difficulties; and the really philosophical student will find in Prof. Gibson's treatise a work which

seems to leave no difficulty unnoticed, the Scottish love of pure logic being prominent throughout.

It is not a work for the mere smatterer who aims only at learning rules and practical processes, regardless of the logical foundations; and in its various applications and illustrations it lays under contribution the sciences of electricity, magnetism and heat. The student, however, who has no knowledge of these subjects is not hindered by the introduction of them; for they can be passed over for a more convenient season, and they are used only as examples which do not belong to the essence of the treatise.

The first hundred pages (five chapters) of the book are devoted to several subjects which are generally dealt with in other treatises—such as the elements of co-ordinate geometry, the most prominent properties of the conic sections, and the discussion of the limiting value of $\left(1 + \frac{1}{m}\right)^m$ when $m = \infty$. In these chapters, also, there is a good deal about the graphs of functions, algebraic, exponential and trigonometric. It is possible that Prof. Gibson need not have included the portion on conic sections, since students are certain to make a special study of this elsewhere.

The whole of chapter iv. is devoted to the exposition of rates and limits, and it is minutely logical and illuminating. We cannot imagine Prof. Gibson as accepting that truly wonderful measure or definition of a variable rate which we often find in works on dynamics when their authors treat of a variable velocity:

"the velocity, when variable, is measured by the distance that would be gone over in a unit of time if the velocity remained constant and equal to that which it is at the particular instant"!

It is in chapter vi. that the special subject of the treatise begins formally with the discussion of differentiation; and here Prof. Gibson adopts the good plan of associating in the mind of the student, from the outset, both the "derivative" and the function from which it comes; in other words, the student is learning his integral as well as his differential calculus, and he is exercised in the art of deducing the function which has a given one for its derivative. There is here a section specially devoted to the properties of hyperbolic functions. The names of these functions leave much to be desired, inasmuch as several of them suffer from the fatal defect of being unpronounceable. Thus, how are sinh x and tanh x to be pronounced? And does not cosh x suggest merriment? A very simple change would remove the first difficulty. If the prefix *hy* were put to each of the trigonometrical functions, all the names would be pronounceable and not too long. Thus *hysin x*, *hytan x*, &c., would at once be pronounceable and indicate the hyperbolic nature of the functions.

Prof. Gibson's paragraph (p. 157) on the conduction of heat, together with the accompanying page of exercises, is marked by his accustomed love of clearness, but it may not be appreciated by the student of pure calculus unless he happens to have studied previously comparatively advanced physics. It is, however, a good principle to keep the purely mathematical subject as much as possible in touch with physics. There is a dangerous tendency visible in some writers to overload the special subject in hand with applications and technicalities in several other subjects, with the result that much of the work is unappreciated by the student. In this respect, however, Prof. Gibson is more judicious than many other authors. The work abounds in warnings to the student against possible (and probable) errors, and the author never hesitates to give a useful collateral piece of information, which it is desirable that the student should have, whenever it can be simply and shortly conveyed—as, for instance, at p. 175, when the different ways in which a battery of a number of cells may be arranged are discussed. This would be regarded by the typical English author as quite outside the bargain which he considers himself to have made with his reader—to give him the truth, the whole truth, and nothing but the truth, with no extra useful information, advice, or warning.

There is also plenty of the graphic method of illustration in the book in dealing both with the processes of differentiation and with those of integration.

In dealing with partial differentiation (chapter xi.), the author has a few pages devoted to the elements of co-ordinate geometry of three dimensions, which will, probably, be found by the student who has advanced thus far to be unnecessary. The equations of thermodynamics and also Laplace's spherical harmonic equation supply appropriate applications of the subject of the chapter.

This is followed by a very good chapter on the theory of equations, in which the methods of approximate solution are well discussed, together with the reliance to be placed on successive approximations.

The successive reductions of the binomial integral $\int x^{m-1}(a + bx^n)^{\frac{p}{q}} dx$ are dealt with rather too shortly at p. 295. It is strange that such an old work as Hymers's "Integral Calculus" should have treated these integrals in such a helpful, complete, and systematic manner, and that Hymers' simple rules for reduction in any specified case should have been quite neglected or overlooked by subsequent writers.

The mechanical method of integration by Amsler's planimeter, together with the allied geometrical theorems on the displacements of a line, is given in chapter xiv. Near the end of the book there is a thorough discussion of series, their convergency, divergency, &c. The last chapter, xx., is devoted to a short discussion of linear differential equations; and it is to be hoped that this chapter will be considerably lengthened in the next edition with a good discussion of the symbolical method of integration—a subject on which we should expect Prof. Gibson's acute logic to be very illuminating.

Finally, the work seems to be exceptionally free from misprints. We notice the extraordinary letter "O" in the centre of fig. 65, p. 315, which looks like a branch of the curve, but is really the *origin* of coordinates. See a similar defect in fig. 83, p. 362; and in line 6 from the end of p. 379 the term $p^r n$ should be ${}_p r_n$.

GEORGE M. MINCHIN.

LECTURES ON ELECTRICITY AND LIGHT.

Leichtfassliche Vorlesungen über Elektrizität und Licht. By Prof. Dr. G. Jaumann. Pp. xii + 375. (Leipzig: Barth, 1902.) Price Mk. 6.

IN a book of 370 pages it is quite impossible that the subjects of magnetism, electricity and light could be treated in anything but a scrappy manner, so that we cannot expect from Prof. Jaumann anything more than a general view of the subjects treated. The book under review arose from a course of lectures at Prague for beginners at the University and teachers in the secondary schools, and is therefore of the nature of an outline to be used as a guide in study supplemented by other more technical reading. For this purpose, if there had been a good selection of references to standard treatises, the book would have been admirable; but, unfortunately, references are almost entirely absent. The author has undoubtedly made a most interesting volume and has treated the subject in a very original manner, dealing with the phenomena of magnetism, electricity and light from a physical point of view, using throughout the Faraday conception of tubes of force. The first eighty-four pages consist of an introduction dealing with stationary stream lines in the motion of a liquid to lead on to the conceptions of magnetic and electric lines of force. The analogies between liquid stream lines due to sources and sinks and vortices and lines of force due to charges and electric currents are well brought out, and considerable ingenuity is exercised in constructing cases of fluid motion to be analogous to the behaviour of lines of electric force when more than one dielectric is present in the field. It seems, however, curious to introduce, for the benefit of readers who cannot be supposed to understand lines of force, the lines of flow for a vortex filament in a steady stream as the first case of stream lines discussed. However, later on the author deals with the resultant of two sets of stream lines and shows how complicated cases can be built up out of simple cases. This might have been done at first and have led up to the more complicated and confusing cases which he presents to the reader at the very beginning. By means of a hot or cold region in the centre of a stream, he constructs stream lines which are analogous to the lines of force for a dielectric cylinder in a steady uniform electric field. The hot region is supposed to be produced by the sun shining on this part of the stream, the rest being in shadow. As a limiting case he has a region of vapour in the middle of the stream, and states in a footnote:—

"The conditions for a stationary state of flow with a region of vapour in the middle of the stream through which the water continuously flows are left undiscussed."

This part of the book is the most interesting, but it is somewhat questionable whether the method would be really of use to a student.

The electrical and magnetic parts of the book are clearly and, on the whole, well done, in spite of the limited space at the author's disposal. The elementary parts of electrostatics are very clearly and concisely explained. There are some points which are somewhat carelessly treated—for example, it is too much to say that the process of solution of zinc in sulphuric acid is completely explained by an electrolytic decomposition due to small currents set up on the zinc producing zinc oxide and setting free hydrogen, the zinc oxide then dissolving in the acid. It is difficult to see how this is a complete explanation.

The last few pages are concerned with Röntgen, Becquerel and kathode rays. The author here is rather unfortunate, as he makes several wrong statements, *e.g.* kathode rays charge bodies on which they fall frequently with a negative, but more often with a positive charge. Also Röntgen rays are stated to be probably light rays of smaller wave-length than ultra-violet rays, and kathode rays are stated to be probably longitudinal electric waves. These statements seem extraordinary in view of the Stokes-Thomson theory of Röntgen rays and the universally accepted emission nature of kathode rays.

The illustrations are good, but sometimes superfluous—for example, on p. 270 is an illustration of a dynamo attached to a steam engine, with no description whatever in the text, and the illustrations of telescope and microscope have no accompanying description.

On the whole, the book is very interesting and would prove extremely useful to students who have already been introduced to the elementary facts of the subjects.

OUR BOOK SHELF.

The Principles of Mechanics. Part i. By Frederic Slate, Professor of Physics in the University of California. Pp. x+299. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1900.) Price 7*s.* 6*d.* net.

A Treatise on Elementary Dynamics. By H. A. Roberts, M.A. Pp. xi + 258. (London: Macmillan and Co., Ltd., 1900.) Price 4*s.* 6*d.*

AN interesting contrast can be made between these two little treatises on the methods of mathematical instruction in this country and America.

The English book is still full of elegant little calculus-dodging expedients, and no differential coefficient is allowed to appear, as it is intended for candidates for mathematical scholarships, who are still kept marking time so long over coordinate geometry as never to arrive at the calculus.

The American professor, on the other hand, addresses a class of college students of about the same age, but who have brought to their task a working knowledge of the calculus, as well as a good groundwork of experimental physics. This knowledge of experimental facts will enable the student to follow Prof. Slate's somewhat metaphysical presentation of the subject. Mr. Roberts has also incorporated the views of modern writers on the laws of motion, based mainly on Mach's "Science of Mechanics." This will make these treatises useful to students who are to become teachers in their turn; but Prof. Perry will say that they are unsuitable for the class of student he has in his mind, as the exercises and illustrations are throughout of the usual academic type, devoid of reality, or else based on microphysical conceptions.

Studien ü. d. Milchsaft v. Schleimsaft der Pflanzen. Von Prof. Dr. Hans Molisch. Pp. viii+109. (Jena: Gustav Fischer, 1901.)

PROF. MOLISCH gives a general account of the occurrence of laticiferous tissue and mucilage cells in plants, treating his subject specially from the point of view of the latex itself. He finds that the fluid is commonly acid or sometimes neutral in reaction, thus differing in this respect from protoplasm. He finds a curious form of vesiculated nucleus to be of common occurrence, and

describes the protein granules (first detected by H. Karsten), starch, oil, alkaloids and other contents in a number of examples. The protein granules are stated to arise (*e.g.* in *Cecropia*) inside special leucoplast-like structures, and elaioplasts are said to occur in the latex of croton. Of inorganic substances, calcium and magnesium are very often met with, but phosphorus, though present in the ash, is not apparently present except in organic compounds.

The mucilage cells and their contents are also discussed, and the author describes an apparently new substance, which he terms "luteofilin," as occurring extensively in monocotyledons and also in the Lobeliaceæ. A brief account of the aloin receptacles which are found in *Aloë soccotrina*, and some of the reactions and properties of their contents ends the volume.

Cast Iron: a Record of Original Research. By William J. Keep. Pp. xv + 225; with 117 illustrations. (New York: John Wiley and Sons. London: Chapman and Hall, Ltd., 1902.) Price 10*s.* 6*d.*

THIS volume possesses the distinction, which is yearly becoming less rare, of containing an account of original researches which are directly applicable to industrial work. Mr. Keep has devoted himself to the study of cast iron since 1885, and from time to time has expressed decided opinions regarding the best methods to be employed in foundries. In particular he has advocated the use of tests by which the amount of shrinkage during solidification is ascertained, his contention being that the quality of the metal to be tapped may thus be determined.

On p. v. a summary of the whole subject is given, so that a busy founder can in five minutes learn the practical results of Mr. Keep's teaching. In order to apply these results in practice, it is desirable also to read pp. 155 to 191, but the remainder of the book consists chiefly of the evidence on which the value of the recommendations rests, and is of interest only to those with a taste for science and a desire to understand what they are doing. The shrinkage test gives information mainly as to the percentage of silicon present, an addition of silicon being accompanied by a reduction in the shrinkage, and silicon, the author points out, acting through carbon, is the controlling element in cast iron.

Those founders who have not followed the course of scientific investigation on cast iron of late years would be well advised to study Mr. Keep's book, even if they do not agree with all that he says.

Test Papers in General Knowledge. By H. S. Cooke, M.A. Pp. vi + 97. (London: Macmillan and Co., Ltd., 1902). Price 1*s.* 6*d.*

THE author of this book has essayed a difficult task, and one cannot be surprised that he has achieved only a qualified success. The papers (eighty-five in number) are all short—too short, perhaps—but certainly do not lack variety. The work is intended for use in higher classes of primary schools, secondary schools and pupil teachers' "centres"; and the author's suggestion as to the use of the book is, "Each student should be provided with a copy, and a test (or more) should be given to the class one week, the answers of which should be returned the following week; this would give a fair opportunity of research in books of reference." There is much to be said in favour of such a plan. It may be doubted, however, if some of the knowledge which the students are thus set to obtain is of sufficient value to justify any expenditure of time on the attainment thereof. It is not easy to see, for example, what useful purpose is served by causing a youth to ascertain the length of time a letter would take to go from London to Moscow, or the cost of sending a parcel about two pounds weight to Winnipeg, or the price of a 100*l.* share in the Great Western Railway. Nor is much gained by knowing who wrote certain books unless something is also known of their nature, contents, and purpose. Are any of the pupils for whom the work is intended sufficiently grounded in scientific method to answer such questions as, "How did the teaching of Aristotle differ from that of Bacon?" or can any be expected to "compile (*sic*) a simple form of a Will?" It is only fair to the author to say that many questions are really admirable, *e.g.* "What results in history may be traceable to the discovery of the New World?" Scientific subjects, too, are, on the whole, well treated, and much useful knowledge must result from the efforts to answer thoroughly the questions asked. The general character of the papers, however, is hardly satisfactory from an educational point of view. Too much is made of mere knowledge and too little of the ability to use it. Hence one fears that they will ultimately prove tests of memory rather than of observation and resource, and that instead of "stimulating a many-sided *interest* in the facts of everyday life," the author will produce an irritating *curiosity* which grows on what it feeds. May we suggest a thorough revision? The book is worth it. Not only so, but in its present state there are many badly-worded questions and some few serious errors. We may attribute "in statu pupillar*ii*" and "Carmen Sylv*ia*" to careless proof reading; but the inaccuracies in the quotations in papers xi. and xxix. (to select two only) are quite unpardonable.

Class Book of Geology. By Sir Archibald Geikie. Fourth edition. Pp. xxi + 454. (London: Macmillan and Co., Ltd., 1902.) Price 5*s.*

SIR ARCHIBALD GEIKIE'S class-book of geology is likely to be one of those which will survive in the struggle for existence among the numerous handbooks of the subject which have been lately issued. There are many ways of accounting for the frequent appearance of new text-books. One of them, though perhaps not the principal one, is to be found in the varied requirements of pupils and teachers, and when an elementary work has run to a fourth edition, as in this case, we may fairly assume that it has met a want.

It is not easy to write a good text-book. This arises sometimes from the difficulty of observing a due sense of proportion all through, notwithstanding that the author is vastly more interested in some branches of the subject than in others, while sometimes it arises from the necessity of bringing before the student many subjects which are still matters of controversy, and the author has either to make positive statements in accordance with what he thinks the best supported theory or delicately to hint that doubts exist.

One reason why this class-book has been so successful is that Sir Archibald has covered all the most important parts of the subject without distracting the reader with controversy. In this he was, of course, much helped by the existence of his larger work, the "Text-Book," to which more advanced students can be referred.

The most important alterations in this edition are the introduction of descriptions and explanations of the phenomena of tectonic geology, for which his illustrations have been drawn chiefly from America, where these branches of the subject have been followed up with so much zeal and skill, and where recent travel has enabled Sir Archibald to examine the evidence and discuss the interpretation of the phenomena on the spot with his scientific friends on the other side of the Atlantic.

May he long enjoy the leisure he has so well earned, and still employ it in keeping his valuable educational and descriptive works up to date.

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.*]

Transport of Molluscs by Waterfowl.

YESTERDAY (March 19) I witnessed an interesting instance of the capacity of quite small waterfowl to carry aquatic molluscs of considerable size. A pheasant-tailed Jaçaná (*Hydrophasianus chirurgus*), which was at large, with partially clipped wings, on the tank in the Museum grounds, had attached to one of its feet a fresh-water mussel well over an inch long, which remained there for about an hour and a half to my knowledge.

The Jaçaná, although quite a small bird, only about the size of a turtle-dove, nevertheless flew quite as well with this burden as without, covering as much as sixty yards at a flight, with its legs naturally extended behind.

Of course the partial clipping of its wings hindered it from rising high and going off altogether; but had it not been thus handicapped I am sure it could have transported its burden for miles if forced to leave the tank.

I have had more than one specimen of this Jaçaná in which a toe, or part of one, was missing, an accident which might possibly be due to the pinch of a bivalve behaving as described above. A fish or turtle might more probably be guilty of such amputation, although the Jaçaná's slim green toes look very like weed-stems when it is swimming, and the resemblance might be protective so long as the bird floated quietly without paddling.

I find from my notes that six years ago I observed one of some Tree-ducks (*Dendrocycna javanica*) which I was then keeping on this tank, with what appeared to be a big water-snail remaining attached to its toe for some time.

Indian Museum, Calcutta, March 20. FRANK FINN.

Preservatives in Milk.

I HAVE been astonished to learn from your English Government Blue-book about the scandalous, unnecessary and unnatural practice prevailing in England of putting drugs into milk for purposes of its preservation—a wrong and unnecessary act of adulteration. It is amazing that it should be pursued and for one moment permitted. Your highly appreciated publication will, I am certain, feel the necessity of defending nature's produce. All milk drawn from healthy cows is yielded sterile. The remedy against the use of drugs and late-refrigeration, &c., is to purify and preserve the milk in its natural sterile condition by quickly—on drawing it—aërating, cooling and refrigerating it down to the non-decomposing and non-fermenting temperature of 50° Fahrenheit or lower at the farms and rural factories before being sent off from the country, and having it conveyed, so chilled, into ordinary cold stores—the same as doubtless most of your butchers have, and with less reason—at the town dairy premises. Meat is so preserved and so conveyed, I understand, in England, and it is not nearly so susceptible to decomposition. The totally unnecessary consequences that are revealed by your recent official inquiry are scandalous. Dairy men evidently—and must constantly—find the milk they have to sell, not only in an advanced, but also dangerous state of fermentation, which, in self-interest, they can only, however, temporarily suppress by the processes of drugging, late-refrigeration and other disorganising practices, through neglect in the country of purifying and cooling the milk at once when drawn warm from the cow. There are plenty of simple portable appliances to use for the purpose, so why should not English farmers have them, and rural ice depots near railway stations for refrigeration of milk, as well as Continental, and notably American, country milk producers? Your farmers and milk distributors certainly need reform in their system, for you cannot possibly compete in quality of milk, butter or cheese with other countries where immediate purification by the practice of quick aëration and refrigeration of milk is pursued down to a non-fermenting temperature as soon as possible after being drawn from the cow. I have heard of a new method of milk preservation based on the infusion of gases (oxygen and carbonic acid) into milk. Whatever may be the merits of this new process I am not prepared to say, but if drugs are to be prohibited, this infusion of gases should be swept away with the rest of the doctoring methods of milk. By all means let the prohibition be utterly complete, and thus allow the consumer to drink nature's production and not chemical compounds. In this country (Belgium) the use of any drugs has long been prohibited, and our milk is superior and never complained about, and were drugs permitted a general protest would result. L. J. SERIN.

Mont-sur-Marchienne, Charleroi, Belgium.

[Mr. Serin does not seem to be aware of the fact that the Departmental Committee on the use of Preservatives in Food condemned the use of preservatives in milk. (See NATURE, December 5, 1901, p. 102.)—EDITOR.]

Rearrangement of Euclid Bk. I., pt. i.

AS very widespread attention is being paid to the question of reform in geometrical teaching, and as a good many teachers are convinced that in this country the reform must be in the direction of a modification of Euclid's elements, I should be glad to elicit opinions as to the following rearrangement of the theorems in the first part of Book I. (to prop. 32, inclusive).

First, the theorems relating to angles made by two intersecting straight lines, viz., I. 13, 14, 15.

Then those relating to parallels, viz. 27, 28, 29, 30. Prop. 27 can be proved by superposition; for, if a transversal EF crossing two lines AB, CD makes the alternate angles equal, the portion BEFD can be exactly superposed on CFEA, so that, if AB, CD meet towards B, D, they must also meet towards C, A, which is impossible, ∴ AB, CD are parallel. I. 28 follows from I. 13; and 29, 30 from Playfair's axiom.

By taking these propositions early, we are enabled to rearrange the propositions respecting triangles in such a way that connected propositions are juxtaposed, which is of great assistance to the memory and to the growth of orderly ideas in the pupil's mind. The natural order would be to take those propositions which relate to a single triangle and then those which deal with the comparison of two triangles.

First, the fundamental theorem I. 32, with its corollaries, including I. 16, 17, and Euclid's axiom (which is the converse of 17).

Then 5, 6 with their extensions, viz. 18, 19, to which might be added the corollary that the perpendicular distance of a point from a straight line is the shortest.

Then 20, 21.

Then follow the *congruence* theorems 26, 4, 8, to which might well be added the conditions for the congruence of right-angled triangles in what would otherwise be the ambiguous case.

And lastly 24, 25, which are extensions of 4, 8 in much the same way as 18, 19 are extensions of 5, 6.

If to these are added the simple *locus* theorems regarding the locus of points equidistant from two given points, and the locus of points equidistant from two intersecting straight lines, the whole forms a well-rounded-off "First Part" of the deductive course.

The only innovation suggested here is the early introduction of the theorems relating to parallels. The effect of this is to render the course much more compact and orderly than is possible if the theory of parallels has to be approached through I. 16.

It is on the desirability (and the possibility, from the point of view of examinations) of this innovation that I earnestly desire opinions.

There is one other modification tacitly adopted in the above arrangement, and that is the cutting out of "constructions" from the deductive course. I believe this requires no defence. It is the first and greatest necessity, for any real improvement in geometrical teaching, that the course of constructions should be a parallel course to that of theorems, and not part of it.

Coopers Hill, April 2. ALFRED LODGE.

Protoplasmic Networks.

IN a presidential address delivered at Yale (*Contrib.*, Botanical Laboratory, Univ. Pennsylvania, ii., 1901, p. 183), Prof. Macfarlane announces his discovery of a "linin and chromatin" network continuous with the nuclear chromatin distributed through the protoplasm of plant cells. Certain other observations lead Prof. Marfarlane to suggest that these run from cell to cell, so that there is continuity, not only of cytoplasm, but also of the "hereditary substance."

It is now some three or four years since I discovered fibrils, hovering upon the limits of vision aided by the best oil-immersion lenses, which ran from nucleus to nucleus in the retina of vertebrates. The first hints were slowly followed up, and I have now established the fact that all the nuclei of the retina are connected together, by fibrils coming from the intra-nuclear networks, into a nuclear system; that is, into a reticulum of which the individual nuclei are the nodes.

As a student of the retina, my first interest in this nuclear system pervading the cytoplasmic framework turned upon the fact that it might supply us with the hitherto undiscovered link between the retinal nerve strands and the rods. This I have found to be the fact: the full details are described in a paper which I hope shortly to publish.

The importance of this discovery cannot, however, be confined to the retina. Not only have I succeeded in discovering similar inter-nuclear connecting fibrils in other tissues, *e.g.* in the brain, but the simple fact that in the retina they supply the paths for the nerve stimuli shows that they must lie somewhere nearer the basis of the morphology and physiology of protoplasm than we have hitherto succeeded in reaching.

In discussing the nature of this nuclear network and its bearing upon the "cell" doctrine, I have described a number of observations tending to show its relations, on the one hand, to the chromatin stored up in the nuclei, and, on the other, to the cytoplasm which forms the supporting framework of the retina. I have, further, endeavoured to show that it brings fresh light upon more than one difficult problem, for example, on the morphology of nerves and the nature of their peripheral terminations.

Several lines of argument made it almost certain to my mind that a similar nuclear network must also exist in plants, and I have little doubt but that Prof. Macfarlane's suggested continuity of the "hereditary substance" from "cell" to "cell" will ere long be demonstrable under the microscope.

I have suggested the term protomitomic as applicable to this nuclear system, that being as nearly as possible simply descriptive. The nuclear filaments, it is true, seem to supply some of the requirements of Strasburger's hypothetical kinoplastic fibrillar system. But the term kinoplasm, which I should have preferred using, has already passed into current use for structures which may have little or nothing to do with this nuclear connecting system, a preliminary announcement of which I have felt justified in making since my attention was called to Prof. Macfarlane's address.

HENRY M. BERNARD.

Clapham, S.W., March 25.

Beechen Hedges on Elevated Ground.

VISITORS to Buxton, who are observant of trees, have been exercised during the winter by noticing how the smaller beech trees, where isolated, and especially the beechen hedges, where unsheltered, have maintained their foliage through the winter, contrary to the habit of deciduous trees.

The spray enclosed was plucked, this morning, from a tree about 12 ft. high, one of a number similarly clothed, bounding the western side of the pavilion grounds where, exposed to the force of the storm winds, and standing at the elevation of the town, about a thousand feet above the sea; and, in the park close at hand, are long lengths of beech hedges exhibiting this appearance. In Ashwood Dale, half a mile away and well sheltered, the larger beeches are as leafless as the lime and the ash.

I see nothing in Kerner's "Natural History of Plants" to account for this departure—this tree being spoken of as constant in dropping its leaves—except the remark that the beech is most resourceful and to be regarded as a "weed" amongst trees, and calculated to oust others, where unhindered by human agency. Is this holding of the leaves, until pushed off by the growing points, to be regarded as a protective device in exceptional circumstances, and is this occurrence observable in young plants in similar elevated and exposed positions?

WM. GEE.

Barlboro' Cottage, Spring Gardens, Buxton, March 31.

Meristic Variation in Trochus Zizyphinus.

ON recently examining a number of specimens of *Trochus zizyphinus* collected at Plymouth in September 1900, it was noticed that one specimen exhibited a peculiar abnormality, viz. the presence of two supernumerary eyes on the right side (Fig. 1). On the left side of the animal both cephalic tentacle and ocular peduncle were perfectly normal. The right cephalic tentacle was also normal, and the ocular peduncle of this side, though bearing three eyes, presented only a slight furrow indicating a partial division between the original eye and the two which are secondary and supernumerary (Fig. 2). Several cases of supernumerary eyes in Gasteropods have already been recorded, and in some cases (for example, *Patella*, *Littorina*) duplication of the eye is accompanied by duplication of the cephalic tentacle.

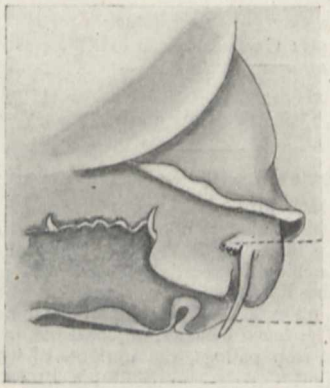


FIG. 1.—Head of abnormal specimen of *Trochus zizyphinus*, seen from the right side.

Double eyes have also been recorded in *Helix*, *Clausilia*, *Phidiana*, *Murex*, and *Sub-emarginula*[1]; in the latter, supernumerary eyes were found on both right and left sides, though in the majority of other cases they were present on one side only. It would thus appear that only double eyes have been so far recorded, and that the presence of three eyes on the right side of this abnormal specimen of Trochus is, apparently, unique. All three eyes are perfectly formed, each being provided with crystalline lens, retina, and optic nerve, thus all of them were, in all probability, functional during life.

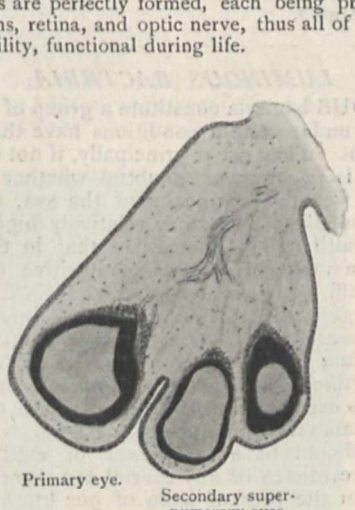


FIG. 2.—Longitudinal section of right ocular peduncle, showing the three eyes in section.

So far as can be made out from the examination of an unfortunately incomplete series of longitudinal sections through the right ocular peduncle, the innervation of the eyes is derived from a single optic nerve arising from the right cerebral ganglion. This nerve bifurcates, one branch going to the primary eye, the other branch again dividing into two, to supply the two secondary supernumerary eyes.

W. B. RANDLES.

Royal College of Science, London, March 25.

[1] For particulars and references, see Bateson's "Materials for the Study of Variation," pp. 279, 280.

Formula for the Perimeter of an Ellipse.

WILL one of your mathematical readers kindly state whether the following empirical formula gives a nearer approximation to the perimeter of an ellipse than that usually given in pocket-books of formulæ?

x and y stand for axes.

$$\text{Perimeter} = \pi\left(\frac{x^{\frac{\log 2}{\log \pi - \log 2}} + y^{\frac{\log 2}{\log \pi - \log 2}}}{2}\right)^{\frac{\log \pi - \log 2}{\log 2}}.$$

Molesworth's book gives the following:—

T = semi-major axis; C = semi-minor axis.

$$\text{Perimeter} = \tfrac{1}{2}\pi[\sqrt{2(T^2 + C^2)} + T + C] + 0{\cdot}2078(T - C).$$

State School, Beaudesert, H. TOMKYS.
Nr. Brisbane, Queensland, Australia, February 26.

Sounds Associated with Low Temperatures.

THERE is one place where the sounds mentioned by Mr. Cave (p. 512) can be (or used to be) heard to perfection. This is at the lower end of Beaumont Street, Oxford, where the road widens out in approaching Worcester College. The pavement and the fence adjoining it take a crescent form, and while walking on the former quite a loud metallic musical note may always be heard. The fence consists, or consisted, of boards, in front of which are iron palings, the uprights of which had a square section. SPENCER PICKERING.
Woolacombe.

Sun Pillars.

THIS evening a sun-pillar was again visible at Swindon, not so brilliant or long-lived as that which recently attracted such widespread attention, but nevertheless quite definite. I first observed it about 6.15 p.m., when the sun was a few degrees above the horizon. It was of a clear yellow colour, and extended from the dull-red sun vertically upwards. The sun set behind a bank of murky haze, and shortly after—about 6.45—the pillar had faded from view. H. B. KNOWLES.
Swindon, April 7.

LUMINOUS BACTERIA.

LUMINOUS bacteria constitute a group of organisms which under certain conditions have the power of emitting light. They occur principally, if not entirely, in sea-water. It is, however, doubtful whether they give rise to any general luminosity of the sea, such as is caused by noctiluca and other relatively high forms of marine life, although it is possible that in the tropics, where the amount of non-living nutritive material is present in sufficient quantities, that bacteria do occasionally cause a general luminosity; but the opportunities of verifying this are rare. One organism in particular, the *Photobacterium Indicum*, from its forming a surface pellicle in artificial fluid cultures, which is very luminous, may at times cause luminosity of sea-water at the surface. It is remarkable that an unicellular organism such as a bacterium should have the power of emitting light. There is no evidence of any special structure in the cell itself, and in the present state of our knowledge it is difficult to regard it as other than a result of functional activity, exactly as heat is evolved by other forms of life, as an accompaniment of the metabolism of the cell. What is, however, the exact difference between the evolution of heat by some organisms and that of light by others it is at present impossible to say. Oxygen is absorbed in both instances and carbon dioxide evolved, but there is evidently some other factor of which at present we know nothing. The fact that light and heat are manifestations of the same form of energy may apparently simplify the matter; but further consideration shows that there is a different problem to be solved in each.

We are not acquainted with any artificial method of light production, in which chemical action takes place, where light is evolved except through the medium of heat, yet in nature, by a simple cell, light is produced which is apparently unaccompanied by any invisible radiations whatever.

These organisms are sometimes referred to as "phosphorescent," but the term is hardly a suitable one, as the phenomenon is likely to be regarded as analogous to the emission of light by inert chemicals and minerals, or to the continued glow of vacuum tubes after an electrical

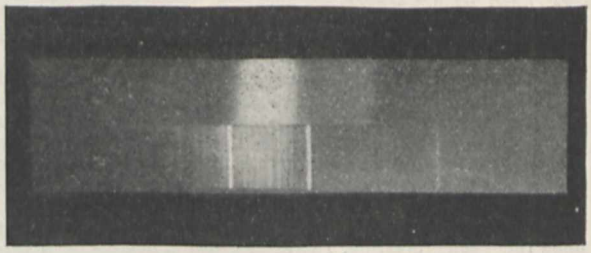


FIG. 1.—(*a*) Spectrum of luminous bacteria. (*b*) Spectrum of hydrogen for comparison.

current of high potential has been passed through them. In all marine light-producing animals, the light is not emitted continuously, but is given out at intervals in response to some stimulus or irritation. It is possible that bacteria act in the same way, but it is difficult to determine this point, as the individual organism is not sufficiently luminous to enable the observer to study it under the microscope by its own light. In fluid cultures they apparently respond to any agitation or excitation so

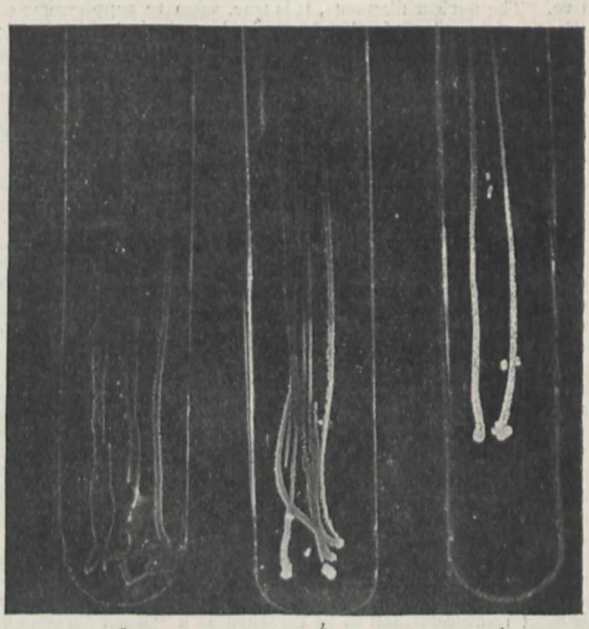


FIG. 2.—Cultures of different ages. (*a*) seven weeks; (*b*) three weeks; (*c*) young culture.

long as the supply of oxygen is maintained, but they can be kept in a luminous condition on fluid media if oxygen is continuously supplied in other ways, although they may remain at rest. This can be done, for instance, by allowing the wool plug, used to close the orifice of the glass vessel containing a fluid culture, to become saturated with the culture, when the plug will continue to glow for days, although the culture in the vessel may only become luminous when agitated. This points to

the agitation only resulting in the introduction of fresh oxygen and not as being a direct exciting cause.

The number of species isolated up to the present is about twenty-five, but it is more than probable that some of these are identical, or at any rate closely related.

In artificial cultivations, these organisms grow best on a medium containing a considerable percentage of a soluble chloride in addition to the nutritive material. They will grow on an ordinary peptone-beef-broth gelatine medium, but they do not all emit light, and none of them emit the maximum amount they are capable of producing. The best results are to be obtained by adding to the culture medium 2·6 per cent. of sodic chloride, ·075 per cent. of magnesia chloride, and ·3 per cent. of potassic chloride.

Either of the chlorides which occur in sea-water, if added to a nutritive medium in suitable proportions, will cause some luminosity, but the results are not so good as on the medium mentioned.

In the case of fluid nutrient media, some means must be taken to replenish the oxygen, as the amount held in solution is speedily exhausted. Either free oxygen can

FIG. 3.—Plate culture of luminous bacteria.

be allowed to bubble through the medium, in which case very brilliant cultures can be obtained, or frequent agitation can be resorted to.

The temperature at which these organisms grow is variable. Those found in northern latitudes can grow and remain luminous at 0° C., the optimum temperature being about 15°, at which reproduction is very rapid and luminosity at its maximum. Some organisms found in the tropics grow, however, at a much higher temperature, but none of them have an optimum as high as blood-heat, 37° C. Spectroscopically, the light emitted by these organisms is confined to a small portion of the visible spectrum, never extending into the ultra-violet or infra-red. Visually it only includes the green and blue, and photographically it extends very slightly further towards the violet.

Fig. 1 shows a photograph of the spectrum of this organism (*a*), with the spectrum of hydrogen beneath for reference (*b*). It will be seen that the former is continuous, and the brightest portion lies between the lines F and G. There is some extension towards the D line, but it is not well marked, and it is only with very long exposure that this becomes evident. This result has been confirmed by using a spectroscope with a quartz system, but owing to its low dispersion, the photograph here shown was regarded as more suitable for purposes of illustration.

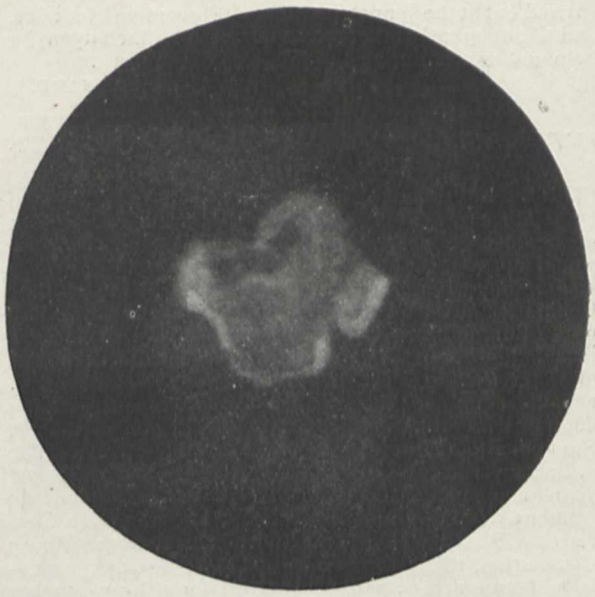


FIG. 4.—Single colony of luminous bacteria, magnified about forty-five diameters.

Figs. 2, 3, 4 and 5 are all cultures of luminous organisms, photographed entirely by their own light.

Fig. 2 is a photograph of three growths on gelatine to show the power of emitting light for long periods. The first one (*a*) is the oldest growth, some seven weeks old, in which, as always happens, the light has diminished at the centre of the streak, but is still bright at the edges, where reproduction of the organisms is still taking place. The next (*b*) is a three weeks' growth, while (*c*) is a young culture, showing that the streak is equally bright through-

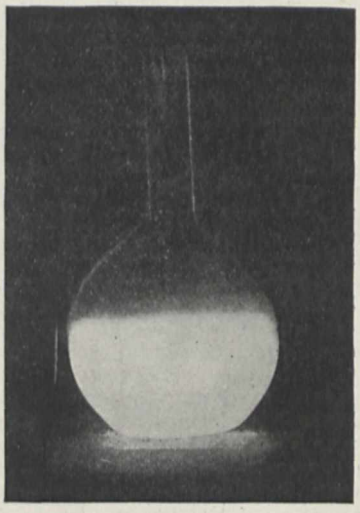


FIG. 5.—Fluid culture of luminous bacteria.

out. Fig. 3 is a plate cultivation one week old to show the individual colonies. Fig. 4 is a single colony magnified about forty-five diameters, showing that even in young bright growths the emission of light is greatest at the edges,

where reproduction is proceeding most actively. Fig. 5 is a large flask containing a fluid culture through which air was passed continuously while the photograph was taken.

My investigations on these organisms have been carried out at the Jenner Institute of Preventive Medicine, and I am greatly indebted to Dr. Allan Macfadyen for help and advice during the progress of the work.

J. E. BARNARD.

INTERNATIONAL COMMITTEE OF WEIGHTS AND MEASURES.

THE International Committee of Weights and Measures at Paris has just issued an account of its business and proceedings for the past year.[1] It would appear from the report of the director of the International Bureau (at Sèvres, near Paris), made to the Committee at their session in October last, that the work of the Bureau has, under the directions of the Committee, included :—Research as to the mass of a cubic decimetre of water (giving for the specific mass of water at 4° C. a value equal to 0·9999707) ; the study of dividing engines ; investigations as to the dilatation of metals, the precise measurement of temperature, &c. The ordinary verification work of the Bureau during the past year has included :—The re-verification of metric standards (metres and kilogrammes) for the High Contracting States who have given adhesion to the Metric Convention, 1875 ; the verification of standards (particularly thermometers, and decimetres) for a large number of scientific and official authorities ; and the installation of new bases for geodetic measurements. We are glad to see that the Committee has now been able to extend and repair its laboratories at the Pavillon de Breteuil and to perfect its arrangements for undertaking electrical measurements.

We congratulate the new secretary of the Committee, Prof. P. Blazerna (Rome) ; who has succeeded the late secretary the lamented Dr. A. Hirsch ; on the present issue of the *Proceedings* of the Committee. Four useful appendices are attached to the volume, including :—Annexe i., on the danger of introducing normal secondary standards in the definition of metric units ; a *résumé* (annexe ii.) of legislation in different countries, derived from reports presented to both Houses of Parliament by the British Foreign Office in 1900 and 1901 ; and particularly annexe iv., which recapitulates the decisions of the Troisième Conférence Générale held at Paris last October, as to the definition of the metric units, metre, kilogramme and litre, and the true measurements of standards of those units. The Committee also was much engaged in the discussion of these definitions, which are now published in the *Compte rendus* des Séances de la Conférence (Paris, 1901).

The members of the Committee included MM. Arndsten, D'Arrillaga, Benoit, Blazerna, De Bodola, Chaney, Cornu, Egoroff, Gautier, Hasselberg, Hepites, Von Lang, De Macedo ; and M. Mendeléeff, formerly an active member of the Committee, has now been named one of the honorary members of the Committee.

Last year the annual budget of the Committee was, as in previous years, fixed at 75,000 francs ; but at the meeting at Paris in October 1901 of the General Conference it was proposed that the budget should be increased to 100,000 francs annually. This proposition did not, however, receive the support of the delegate from Great Britain, but we are now glad to see that the Treasury has given its sanction for the increase in the proportionate contribution payable by this country to the Committee, based on the annual budget of 100,000 francs.

[1] "Comité International des Poids et Mesures." Procès Verbaux. Pp. 281. (Paris : Gauthier Villars, 1902.) 1 vol.

SIR JOHN DONNELLY, K.C.B.

SIR JOHN DONNELLY, whose death occurred on Saturday last after a painful illness of more than six weeks, will probably be best remembered for his unceasing and devoted service in developing and administering Governmental schemes for the promotion of scientific education in this country. Soon after the end of the Crimean War, through which he served with distinction as a Lieutenant of Royal Engineers, being twice mentioned in despatches and recommended for the Victoria Cross—an honour, however, rather unjustly withheld from him—he was appointed to the charge of a detachment of Royal Engineers quartered at the South Kensington Museum. At that time this institution was but newly born, under the fostering care of the Department of Science and Art, the principal permanent chief being Sir Henry Cole, who formed the highest opinion of Donnelly's marked abilities as a clear-sighted, shrewd and wholly trustworthy young officer. About 1858-1859, Captain Donnelly succeeded the late Lord (then Dr.) Playfair as inspector for science, and a general scheme of grants applicable to the whole country was formulated and set in operation. The subjects of science towards which instruction in aid was obtainable were at first few. Among the examiners was Huxley, with whom Donnelly came to be closely associated. This close association ripened into an intimate and affectionate friendship. It is probable that to few, if any, other men did Donnelly turn with equal confidence for counsel and advice more frequently than he did to Huxley.

From a beginning of thirty-eight local science classes and schools with 1330 students in 1860 were developed the existing 2000 classes and schools attended by at least 160,000 students. Grants for practical work in laboratories at such schools were made by the Government in 1870. As early as 1867 Donnelly had a large share in putting forward a scheme for aiding local efforts to establish local scholarships and exhibitions to assist the higher instruction of students in science.

Besides the management and care of these wide-reaching operations, he assisted in reorganising the old Royal College of Chemistry in Oxford Street and the School of Mines in Jermyn Street which became in 1890 the Royal College of Science, of which the first dean was the late Prof. Huxley. In 1868 Donnelly was appointed on a commission to consider what steps should be taken to constitute a separate Department of Science and Art for Ireland, and, acting also as secretary of the commission, he drafted its report. The commission could not see its way to reporting in favour of establishing a separate Department, and up to Donnelly's retirement in July 1899 various State-aided institutions in Ireland were subject generally to his control as Secretary of the Science and Art Department, to which office he was appointed in 1884, having held the office of Director for Science from 1873.

To develop the Museum of Science as a worthy companion to the Museum of Art at South Kensington, Donnelly pressed upon the notice of his chiefs the desirability of holding a very important and successful loan exhibition of scientific instruments and apparatus, which was opened in 1874 by Her Majesty Queen Victoria in person. This led to the formation of a museum of scientific apparatus for teaching and research. For many years after the retirement of Sir Henry Cole in 1873, Donnelly was untiring in his exertions to secure Parliamentary grants for the completion and erection of properly devised permanent buildings to house the Museums of Art and Science, the component sections of which were dispersed throughout in temporary and straggling makeshift galleries and sheds. The obvious scandal that a Government could permit the existence of such a

condition gathered strength. Opponents and friends of the Department of Science and Art approached the scandal from different points of view; and in 1896 a Select Committee of the House of Commons was appointed. No witness before a Select Committee has, it is believed, ever been subjected to such a prolonged course of petty ignorant spite and vexatiousness as Sir John Donnelly was. For months he had to undergo an almost daily crossfire of idle questions. However, the main upshot of the Committee's reports was a vote by Parliament of the handsome sum of 800,000*l.* to complete the permanent science and art buildings at South Kensington, thus securing the very object to obtain which Donnelly had laboured so hard. So far as concerned the relatively unimportant malicious statements and inaccuracies which were aimed at Sir John Donnelly in passages of the Committee's reports, the Lord President and Vice-President of the Council on Education issued a minute animadverting upon them and emphasising the fact that their lordships alone were responsible for the administration of the museums; their directions had been loyally carried out by the staff and they retained the fullest confidence in Sir John Donnelly and his colleagues. There can be little doubt now that the irritation to which the Select Committee's persistent attacks put Sir John told upon his health.

Sensitive and reserved, he had an almost over-exacting sense of rectitude. He did not court society—in the conventional sense—but preferred the exclusiveness of his own circle of friends, which included many men prominent in science and art. During his yearly holidays, chiefly spent in the quiet retirement of his house amongst the pine-woods at Felday, Surrey, he frequently sketched, and season after season one or two of his painstaking etchings and water-colour paintings were to be seen at either the Royal Academy or the New Gallery.

NOTES.

IT is too early to estimate fully the effect of the magnificent endowments provided for by the will of Mr. Cecil Rhodes, but we are all able to admire the noble conception which aims at promoting a good understanding between England, Germany and the United States. It would be difficult to suggest a better means of accomplishing this than that outlined by Mr. Rhodes. Students from our colonies, the United States and Germany are to be encouraged to spend three years in the University of Oxford, where they will become familiar with our national characteristics. Nothing but good can come from the friendships which will thus be founded; and there will be a strong influence tending to bring the three nations into close relationship with one another, which will enable political and commercial questions to be discussed without the distrust usually connected with them. Rarely have endowments been made with so lofty an object; and with such an example we look hopefully to the future for other ties to bind nations together. For the present, a brief statement of the provisions of the will as regards education will be sufficient to show the scheme by which this unity of race is to be furthered. Sixty scholarships of 300*l.* a year each are to be founded for colonial students. The scholarships will be tenable at any Oxford college for three consecutive years, and twenty are to be awarded every year, this number being distributed among the various portions of the British Empire. Two scholarships of the same value are allocated to each of the fifty States and Territories of the United States of America. Moreover, in recognition of the encouragement now given in German schools to the study of English, fifteen scholarships of the value of 250*l.* a year, tenable at Oxford by German students for three years, are to be established. The will thus provides for scholarships amounting to nearly 52,000*l.* per annum, which means a capital sum of from one and a half to two millions. Some of the scholarships would have been made tenable at Edinburgh if the University there had been on a residential system; for Mr. Rhodes mentioned in his will that fifty or more students from South Africa were studying there, many of them attracted by the excellent medical school, but the want of a residential system made him refrain from establishing any scholarships in connection with the University. Oxford, like Cambridge, has such a system, and the will suggests that "it should try to extend its scope so as if possible to make its medical school at least as good as that at the University of Edinburgh." The world will now look to Oxford to increase the value of its medical school, and we shall wait with interest to see what developments are made. Mr. Rhodes's old college at Oxford, Oriel College, receives 100,000*l.*, of which 40,000*l.* is for the erection of new buildings, as a fund to cover the loss to College revenue involved in the removal of houses to make room for them; 40,000*l.* to endow an increase of income of resident fellows working "for the honour and dignity of the College"; 10,000*l.* to increase the comforts of the High Table, and the remaining 10,000*l.* is to be a fund for providing for the maintenance and repair of the College buildings. A sum yielding 2000*l.* a year is set apart for the cultivation of Mr. Rhodes's property at Inyanga, and he directs in particular that irrigation should be the first object kept in view. Other objects to be borne in mind are experimental farming, forestry, market and other gardening, fruit farming, and the teaching of any of those things, and the establishment and maintenance of an agricultural college. Mr. Rhodes's gifts are both bounteous in amount and grand in intention; and they reveal a greatness of character not often found.

MR. GEORGE WILSON, whose death was announced in our last issue, was one of those who early appreciated the immense importance of applying science to manufacturing industries. The results in his case were seen in the excellence of his products and in the importance of the incidental substances which were brought to light in the course of the manufacture. In his days the importance of scientific method and its superiority to rule of thumb were not so much insisted on as they are now. Mr. Wilson was not only a chemist, but an enthusiastic horticulturist, adopting gardening at first as a recreation, and of late years making it the occupation of his life. Although he published nothing but ephemeral notes on his favourite pursuit, he constantly insisted on the necessity of applying scientific principles to practical horticulture. In a very interesting little book entitled "The Old Days of Price's Patent Candle Company," in which the history of the manufactures which resulted in such vast improvements in candle making is detailed, he says: "Laboratory training teaches careful observation and close watching, both useful in gardening, which gives a wide field for experiment. If I read the future aright ten years hence good fruit will be much more general than it is now, and for one beautiful nardy plant now common in our gardens we shall have ten." This forecast was written in 1876, and it has certainly been fulfilled, if not quite in the way that Mr. Wilson had in his mind.

FOUR zoological lectures will be delivered in the meeting-room of the Zoological Society after the general meetings on April 17, May 22, June 19 and July 17. The subjects and lecturers are:—"Flying Reptiles," by Prof. H. G. Seeley, F.R.S.; "Horses and Zebras," by Prof. J. Cossar Ewart, F.R.S.; "The Okapi," by Prof. E. Ray Lankester, F.R.S.; and "Elephants," by Mr. F. E. Beddard, F.R.S.

ARRANGEMENTS have now been made for the Nature-Study Exhibition to be held at the Gardens of the Royal Botanic Society, Regent's Park, on July 23 and following days. It will be open to colleges and schools of every grade, and the exhibits will include all that bears upon nature study. Various technical instruction committees and other educational authorities have already arranged to defray the cost of the conveyance of exhibits from their respective areas, and preliminary exhibitions for the purpose of selecting the best material to send are being organised in several districts. Full particulars may be obtained on application in writing to the hon. secretary, Nature-Study Exhibition, Royal Botanic Gardens, Regent's Park, London, N.W.

THE annual general meeting of the Iron and Steel Institute will be held on May 7 and 8. At the opening meeting the Bessemer gold medal for 1902 will be presented to his Excellency F. A. Krupp, of Essen. Among the subjects to be brought before the meeting are :—The nomenclature of metallography ; the microstructure of hardened steel ; gas from wood for use in the manufacture of steel ; the physical and chemical properties of carbon in the hearth of the blast-furnace ; the sulphur contents of slags and other metallurgical products ; and Brinell's researches on the influence of chemical composition on the soundness of steel ingots.

SIR SAMUEL WILKS, Bart., F.R.S., has been elected president of the Hampstead Scientific Society in succession to the late Sir Richard Temple.

THE *Times* announces the death, at Munich, of the well-known bacteriologist Prof. Hans Büchner, in the fifty-second year of his age. Prof. Büchner, who was president of the Hygienic Institute at Munich, rendered important services to science in developing the modern theory of infectious diseases. From the same source we learn of the death, at the age of eighty-seven, of M. Emile-Jean Renou, founder, in 1873, of the Saint Maur Meteorological Observatory. In 1840 he was commissioned by the Government to explore Algeria, Morocco and Tripoli, and he drew up the first geological map of Algeria.

THE *Chemical News* announces that the Fifth International Congress of Applied Chemistry will be held at Berlin during the Whitsuntide holidays in 1903, under the presidency of Dr. Clemens Winkler. The House of the Imperial Parliament (Reichstag) has been placed at the disposal of the Congress, and Geheimrath Prof. Otto N. Witt has been nominated president of the organising committee, Dr. Bottinger, member of the German Parliament, acting as treasurer. A fund of about 3000*l.* has already been collected by voluntary subscriptions from societies and private individuals towards the expenses of the Congress.

WE learn from *Science* that at the February meeting of the council of the American Institute of Electrical Engineers a resolution, brought forward by the committee on standardisation, in favour of the metric system was unanimously adopted. The committee's report and resolution were as follows :—(1) The metric system of weights and measures offers very great advantages by its simplicity, consistency and convenience in every-day use, as well as in all engineering calculations and computations. (2) These advantages have already been demonstrated by the universal adoption and entirely successful use of the metric system in all civilised countries except Great Britain and the United States. (3) All the electrical units in universal use, such as the volt, ampere, ohm, watt, &c., are metric units. (4) The industrial use of these electrical units would be much facilitated by the general adoption of the metric system. (5) This committee unanimously recommends the introduction of the metric system into general use in the United States at as early a date as possible without undue hardship to the industrial interests involved. (6) The committee favours such legislation by Congress as shall secure the adoption of the metric system by each department of the National Government as speedily as may be consistent with the public welfare.

IN a note contributed to the *Atti dei Lincei*, xi. 4, Signor C. Somigliana shows that Lord Kelvin's method of images can be applied to the solution of the equations of elasticity, under certain conditions, for solids with plane boundaries.

THE Vienna *Sitzungsberichte* contains a note by Dr. Josef von Geitler on some experiments conducted for the purpose of proving the action of kathode rays on a magnetic needle. It now appears that a source of error has been discovered in the heating of the brass tubes employed, where the rays fall on them, and the consequent production of thermoelectric currents. Unfortunately, the direction of these currents is such as to deviate the magnet in the *same* direction as it would be deviated by the rays themselves. It appears only possible by means of quantitative measurements to ascertain whether any portion of the observed effect exists over and above what is directly attributable to the source of error in question.

THE "red rain" which fell in many parts of Italy and extended as far as Vienna and other central European stations on the evening of March 10, 1901, has been subsequently studied by Prof. N. Passerini, and an account of the phenomena is now given by him in the *Bolletino mensuale* of the Italian Meteorological Society. The phenomenon appears to have travelled slowly from south to north, occurring at Palermo in the night of March 9-10 and at Florence in the night of March 10-11. Prof. Passerini found that the precipitation of the earthy substance was accompanied with very little rain, and a rough analysis showed it to contain about 44 per cent. of fine sand, 32 per cent. of argillaceous matter, 12 per cent. of calcareous matter and about 10 per cent. of organic and volatile substances destroyed by calcination. The red colour was probably due to ferric hydrate. In the samples found in Pisa and elsewhere, fragments of Diatomaceæ, as well as spores, are said to have been observed. It is suggested that the material deposited in this and other so-called "rains of blood" that have occurred at different times in Italy may probably have been transported by a cyclonic disturbance, and may have had its origin in the equatorial regions of Africa or America.

THE "Results of Rain, River and Evaporation Observations" made in New South Wales during 1899 have been published by Mr. H. C. Russell, Government Astronomer, and contain, as usual, valuable observations for each month and tables showing the records for various stations since 1840. The number of observing stations has risen to 1724, the observers being mostly volunteers. The year 1899 is the fifth dry year in succession, the shortage of rain for the whole colony being 21 per cent., but in a large area west of the Darling the rainfall was from 16 to 67 per cent. below the average. Six good years, 1889 to 1894, had an average of 28·61 inches of rain, and five bad ones, 1895 to 1899 inclusive, had an average of 20·49 inches. Mr. Russell remarks that only the richness of the soil and the climate save the stock under such droughts, for even a shower will often give a good growth of grass and be in time to save the stock. The crops in 1899 were to a large extent saved, except in the western districts, by the rains which fell between June and October.

THE Meteorological Service of Manila, which, under the superintendence of the Observatory at that place, has for many years published valuable annual summaries, has been reorganised on the lines of the United States Weather Bureau. From the beginning of the year 1901, the new Philippine Weather Bureau has issued monthly bulletins, containing data deduced

from hourly observations, with a chronicle of the weather in English and Spanish. The bulletin also includes accounts of unusual occurrences and notes on the crops obtained from stations established throughout the Archipelago. Among the occurrences is an account of the earthquake of December 15 last. This was the strongest shock experienced since 1880, and was felt over an area almost as large as Spain. It lasted for a minute and a half, but, owing especially to the slowness of the motions, the damage caused was not great.

THE *Annuaire Météorologique* for the present year, published by the Belgian Royal Observatory, under the direction of M. A. Lancaster, has been received. The annual is full of interest, and contains many useful facts and much accurate information on meteorological matters in general. Thus, after a short summary of the more important astronomical ephemerides, we find a meteorological calendar and the second portion of the history of meteorology in Belgium, covering the period from the foundation of the Brussels Academy of Science to the first publications of the Royal Observatory. M. Lancaster brings together all the facts relating to the temperature, rainfall and wind pressure at Brussels from the year 1833 to 1900, and prints, not only the monthly means or totals, as the case may be, but the mean value for each season and for the whole year. M. Vanderlinden writes a most interesting essay on the meteorological conditions of the upper atmosphere, and describes the various means that have been and are now adopted for exploring great heights meteorologically. A number of miscellaneous tables and data follow this article, and the annual concludes with an account of the movements of the atmosphere from cloud observations made at Brussels, a *résumé* of the meteorological observations made at Uccle, near Brussels, during the year 1901, and, lastly, a description of the climate of Belgium for the year 1900.

AN illustrated account of Mr. Wilbur Wright's aëronautical experiments with gliding machines is given in the *Scientific American* for February 22. These experiments differ from those of Messrs. Lilienthal, Pilcher and Chanute in two important features, (1) the horizontal position of the operator when gliding, which is calculated to save about half a horse-power by the diminution of air-resistance, and (2) the use of a front rudder instead of one at the back of the machine. In describing one of these experiments, made with a machine of 308 square feet in a wind blowing thirteen miles an hour, the *Scientific American* states:—The machine sailed off and made an undulating flight of a little more than 300 feet. To the onlookers this flight seemed very successful, but to the operator it was known that the full power of the rudder had been required to keep the machine from either running into the ground or rising so high as to lose all headway. The experiments also showed that one of the greatest dangers in machines with horizontal tails had been overcome by the use of a front rudder, and the operators escaped from positions which had proved very dangerous to preceding experimenters. In subsequent experiments the machine with its new curvature never failed to respond promptly to even small movements of the rudder. Many glides were made whenever the conditions were favourable.

THE Report of the Felsted School Scientific Society for 1900–1 contains an interesting account, by Mr. A. A. G. Dobson, of an expedition down the Bermejo River, organised by the Messrs. Leach, the well-known sugar- and coffee-planters of the Tucuman district of Argentina.

THE most important paper in the portion of the *Proceedings* of the Philadelphia Academy for 1901, which we have just received, is one by Miss C. B. Thompson on a new nemertean worm (*Zyguepolia littoralis*) recently discovered in Massachusetts. The account, which is illustrated by five plates, occupies eighty pages.

WE have received the second (April) number of a new monthly illustrated journal, *The Country*, published by J. M. Dent and Co. and edited by Mr. H. Roberts. In addition to ordinary subjects connected with the country, inclusive of sporting, farming and gardening, this number has three articles on natural history. One of these deals with wild life in Britain, as exemplified by the black-headed gull, the second treats of the songs of birds, from the point of view of systematic classification of the species, while the third describes bird-haunts. All three are well and pleasantly written, and the first and third are attractively illustrated.

MESSRS. BLACKWOOD have sent us a copy of the first number of a new journal, the *Field Naturalist's Quarterly*, edited by Dr. G. Leighton. The part, which is illustrated with a couple of excellent full-page photographic reproductions, opens with an account of certain uncommon British sea-fishes, by Mr. F. G. Aflalo, and contains thirteen other articles, four of which deal with animals and nature in winter. That the editor does not intend to confine his purview to British subjects is indicated by an anonymous article on the fauna of New Zealand; while the wide range proposed to be embraced is made evident by one on telegony in dogs, by Prof. Ewart. The appearance of this new journal may be taken as an earnest of the reviving interest in field natural history.

WE have received parts i. and ii. of vol. lxxi. of the *Zeitschrift für wissenschaft. Zoologie*. The former is entirely devoted to an elaborate memoir on the development of the kidneys in the amniote vertebrates, by Herr K. E. Schreiner, of the Anatomical Institute of the University of Prague. Important conclusions are drawn as to the relationship of the permanent to the primitive kidneys. Among the contents of the second part is a paper on the development of the Anatidæ, as represented by the domesticated duck, by Prof. P. Mitrophanow; while another, by Herr E. Botezat, deals with the nerves in the epithelium of the tongue of mammals. In a third communication, Herr F. Urban describes a new genus and species (*Rhabdodermella nuttingi*) of calcareous sponge from Monterey Bay, California.

THE issue of an annual report by the president of the Philadelphia Academy of Sciences, which has been in abeyance since 1881, has been resumed for the past year. In this Report Mr. S. G. Dixon gives a satisfactory account of the position and prospects of the Academy, the financial resources of which were largely increased in 1900. As in most institutions of a kindred nature, the attendance at the weekly meetings has, however, sensibly decreased owing to the increasing specialisation of natural history. An enormous increase has taken place of late years in the zoological collections of the Academy, the molluscan department having since 1887, when it was regarded as the leading collection in the world, received no less than 30,000 "lots."

IN the *Quarterly Journal of Microscopical Science* for March, Mr. E. S. Goodrich publishes the first part of a paper on the structure and homology of the renal organs of Amphioxus, or, as it should properly be called, Branchiostoma. The announcement of the author's important discovery as to the identity of these organs in their segmental arrangement, function and histological structure with the nephridea (renal organs) of polychætous worms like Phyllodoce has been already made in a preliminary paper, and the evidence is now submitted to the scientific world in fuller detail, accompanied by excellent illustrations. Bearing in mind that in both cases the renal organs are furnished with so-called "solenocytes," there seems, as the

author remarks, a strong probability that they are homologous. With characteristic caution, he prefers, however, to await an nvestigation into their developmental history before definitely stating that this is the case. Even the provisional identification of true nephridea in the vertebrate phylum is a most important advance in our knowledge. If this be confirmed by future investigation, it is not a necessary sequence that vertebrates are derived from the polychætous worms, all that is demonstrated being that the remote common ancestor of these now widely divergent branches was of a much more specialised type than has been commonly supposed.

THE authorities at the Royal Botanic Gardens have just published, as an appendix to the *Kew Bulletin*, a list of new garden plants which have been recorded during the past year. Only a few are actually in cultivation at Kew, but of these some will be available for distribution in the regular course of exchange. In the case of the remainder, reference is given, where possible, to the individual in whose garden or collection the plant was first brought to notice. One of the objects in publishing this list is to endeavour to ensure a uniform and correct naming of new plants.

MR. J. H. MAIDEN, in an extract from the *Agricultural Gazette* of New South Wales, directs attention to the practice adopted by the Australian aborigines of obtaining water from the roots of various plants in arid districts. The trees tapped for this purpose were species of Eucalyptus known as Mallee, and Hakea or Needlebush. Also some Casuarinas were known by the natives to store up water in their stems. The usual method of treating the roots was to cut them up into pieces about nine inches long; these might receive a preliminary chew, or without being subjected to that stimulus would be set on end in order to pour out their stock of water.

THE coal resources of India formed the subject of a paper lately read by Prof. W. R. Dunstan before the Society of Arts (*Journal*, March 21). He points out that India possesses a practically inexhaustible supply of coal, mainly of permo-Triassic age, and occupying an area estimated at about 35,000 square miles. The industry of coal-mining is at present in its infancy. During the year 1900 a little more than six million tons were produced, mainly from Bengal. The principal coalfields in that province are estimated to contain 136 million tons of coal. Excellent steam and coking coal occur in Bengal and also in Assam.

A SKETCH of the geology of the north-east coast of Labrador has been contributed by Mr. Reginald A. Daly (*Bull.* Mus. Comp. Zoology, Harvard Coll., vol. xxxviii., 1902). The foundation rocks of this coast consist mainly of a crystalline complex of schists and gneisses with intruded masses and dykes of granite, diorite and gabbro, with also slates and sandstones perhaps of Cambrian age. The general strike of the rocks, whether of cleavage or stratification, coincides with the trend of the coast; and in discussing this subject the author throws out the suggestion that the great Bank of Newfoundland may be a submerged mountain-plateau at the intersection of the Labrador and Appalachian structural axes. Attention was, however, mainly given to the glacial phenomena, to the general direction of ice-movements, the "lunoid furrows" described by Packard, and the post-Glacial movements as proved by raised beaches. The ice-movement at all elevations, both in the valleys and on the hill-tops, was found to have been outward from the central part of the peninsula. The "lunoid furrows" are crescent-shaped depressions five to fourteen inches broad by three to nine inches long, and about an inch deep vertically in the rock. Mr. Daly considers that they originate from the tension or shearing stress set up in the bed-rock by boulders dragged along beneath the ice, and that the actual hollows are due to the action of frost in post-Glacial times prizing up the fragments of disturbed rock. The limit of glaciation was about 2100 feet above the sea, so that the higher massifs formed nunataks overlooking the Pleistocene ice-sheet.

THE *Journal* of the Franklin Institute contains a long and elaborate paper on the Alasko-Canadian frontier, by Mr. Thomas Willing Balch. The historical evidence is carefully analysed, and there are reproductions of a number of old maps. The author concludes that the evidence shows overwhelmingly that the United States are entitled to an unbroken strip of land on the continent from Mount St. Elias down to the Portland Channel, and believes that they should never consent to refer the matter to arbitration.

WE have received from the author a copy of a pamphlet entitled "A Sketch of the Subject of Map Projections," by Major C. F. Close, R.E. A list of selected projections is given and a short explanation of the formulæ used in constructing each, also a list of examples and books of reference. The paper, which might well be expanded into the much-needed English text-book on the subject, will be extremely useful to anyone dealing with map projections. We note that the references contain no mention of the works of Tissot, Hammer or Zöppritz.

SEVERAL popular and instructive articles on scientific topics appear in this month's magazines. The frontispiece in *Pearson's Magazine* is a reproduction of a photograph of the head of a cobra, taken when the snake's head was only a yard away from the camera. Mr. S. S. Buckman describes and illustrates some characters and actions of babies similar to those exhibited by monkeys and suggesting a common origin. Dr. C. Brown gives a number of striking pictures of fossils of various kinds, and indicates the lessons taught by them. Stages in the opening of leaves of several plants are dealt with by Mr. G. Clarke Nuttall, and are pleasingly illustrated. A number of curves drawn with a compound pendulum accompany a description by Mr. A. Williams. In the *Royal Magazine*, Mr. W. M. Webb writes an account of a caterpillar farm at Scarborough, where moths and butterflies are reared as a business. The *Sunday Magazine* has several photo-micrographs of parts of caterpillars; and a number of "minute marvels of nature" are illustrated in *Good Words*, from photo-micrographs by Mr. J. J. Ward.

THE American Society for Plant Morphology and Physiology held their annual meeting at Columbia University under the presidency of Dr. Erwin F. Smith, of the Department of Agriculture. The president, besides delivering his address on plant pathology, presented a paper dealing with the destruction of cell walls by bacteria. Leaves of the turnip were inoculated with the bacterium *Pseudomonas campestris*. The disease appeared on the leaves and passed down to the root. Sections of the root showed the bacterial masses in the vessels and adjacent parenchyma. The bacteria grow in between the cells, dissolve first the middle lamella and then the rest of the cell walls, and finally occupy large cavities which have been formed by the destruction of large portions of tissue. Dr. C. O. Townsend described another bacterial disease occurring generally on the bulbs, sometimes on the roots or leaves of the Calla lily. At the same meeting, Dr. Harshberger suggested several lines of research which might be undertaken in the West Indies, and proposed that, owing to the suspicious nature of the Tahitians, a steamer should be fitted up as a research laboratory. Prof. Ganong discussed the teaching of plant physiology to large elementary classes. Dr. Margaret E. Ferguson gave an account of investigations into the condition of germination of Basidiomycetous spores, and Prof. Conway Macmillan described his observations on Pterygophora.

THE new volume of the "Statesman's Year Book," edited by Dr. J. Scott Keltie, with the assistance of Mr. J. P. A. Renwick, has been published by Messrs. Macmillan and Co., Ltd. This annual is now in its thirty-ninth year of publication, and every year brings political and other changes which necessitate the revision of much of the information contained in its pages. So far as it is possible for a volume to reflect the condition of the States of the world, the "Statesman's Year Book" performs that function most creditably. Nothing of importance in political geography is overlooked; and the shifting scenes, figures and activities are faithfully recorded. The volume for 1902 contains much revised material relating to the accession of King Edward VII., the census of Great Britain and of India, the development of our educational system, and colonial changes. The maps and diagrams show the results of recent censuses at home and abroad, existing and projected railways in East Central Africa, the new Indian province, and the projected Central America canals. The contents now occupy 1332 pages, and the volume should not be permitted to exceed this number very largely, or it will lose its handy character. How the editor will prevent the ultimate expansion of matter beyond the present limits of space is a problem to which he will need to give careful consideration.

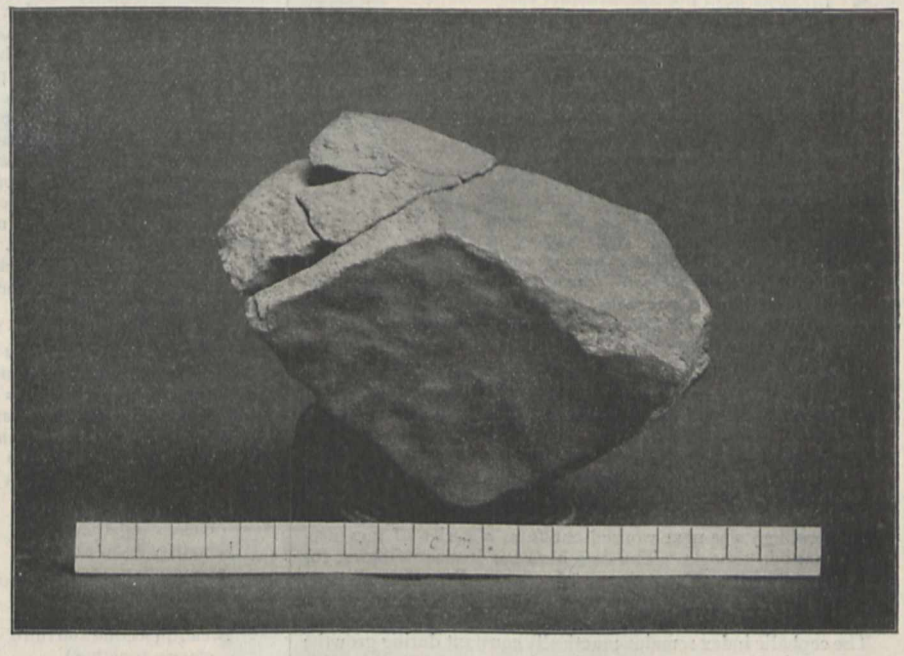
THREE new volumes of Ostwald's series of "Klassiker der exakten Wissenschaften" have been received from Mr. W. Englemann, of Leipzig. (London: Williams and Norgate.) The volume No. 119 (price 2*s.* 6*d.* net) contains two papers on hygrometry, by H. B. de Saussure (1783), edited by Dr. A. J. von Oettingen. The papers deal with the theory of evaporation and the application of the theory to some meteorological phenomena. No. 120 (price 3*s.* net) contains a German translation, with notes by Dr. M. Möbius, of two papers by Malpighi (1675 and 1679) on the anatomy of plants. Fifty figures illustrate the text, and the editorial notes will be of service to German students. Two papers on plant hybrids, by Gregor Mendel (1865 and 1869), edited by Dr. E. Tschermak, form No. 121 of the series. The price of this volume is 1*s.* net.

A NEW edition (the tenth) of Mr. W. T. Lynn's booklet on "Remarkable Comets" has been published by Messrs. Sampson Low, Marston and Co. The only comet expected to return this year is Swift's comet, having a period of 5½ years. This is due towards the end of the year.

THE additions to the Zoological Society's Gardens during the past week include two Black Apes (*Cynopithecus niger*) from the Celebes, presented by Miss A. T. M. Elliot; a Malayan Bear (*Ursus malayanus*) from Malacca, presented by the Marquis of Downshire; a Suricate (*Suricata tetradactyla*) from South Africa, presented by Mrs. Philips; a Golden-naped Amazon (*Chrysotis auripalliata*) from Central America, a Yellow-billed Amazon (*Chrysotis panamensis*) from Panama, seven Elegant Terrapins (*Chrysemys scripta elegans*) from North America, two Wrinkled Terrapins (*Chrysemys scripta rugosa*) from the West Indies, deposited; six Ruffs (*Machetes pugnax*), four Snow Buntings (*Plectrophenax nivalis*) European, eight Undulated Grass Parrakeets (*Melopsittacus undulatus*) from Australia, purchased; an Eland (*Orias canna*) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE FELIX METEORITE.—In a recent number of the *Proceedings* of the United States National Museum, Mr. G. P. Merrill gives an account of the fall of a meteoric stone at 11.30 a.m. on May 15, 1900, near Felix, Alabama. A luminous meteor was seen and three loud reports as of explosion were heard. The main mass weighed about 7 lbs. and was found buried six inches deep in soft ground. In aspect of fractured surface the material is like that of the stones of Warrenton and Lancé, but the chondritic character is more pronounced than in the latter and the colour is darker than in the former, owing to the presence of graphitic carbon in appreciable quantity. The essential minerals are, olivine (73 per cent.), augite and enstatite (18 per cent.), with troilite (5 per cent.), nickel-iron (3 per cent.) and graphitic carbon (0.4 per cent.): the micro structure is tuff-like.



The Felix Meteorite. The scale below the meteorite is divided into centimetres.

ON THE RELATION BETWEEN INTELLIGENCE AND THE SIZE AND SHAPE OF THE HEAD.

THERE is a popular belief that men of great ability have larger heads than the average population; this belief, however, is not based on trustworthy statistics handled in a satisfactory manner.

In a paper read before the Royal Society, January 23, Prof. Pearson gives the results of statistical investigations undertaken with a view to determine whether any head measurements, and if so, which, are correlated with intellectual capacity.

He points out that although the professional classes are more intellectual and have a larger mean head capacity than the hand-working classes, this does not lend any support to the current notion; for the former are better developed physically, and the difference is probably only due to difference of nurture. It is necessary to take a homogeneous class in order to investigate the matter.

The Cambridge Anthropometric Committee furnished a series of measurements made on Cambridge undergraduates, and information was obtained from the University Registry of the degree (honours or poll, class-place, subject, &c.) taken by each of the individuals whose measurements were given.

The undergraduates furnish a homogeneous class of the same general habits.

They were divided into two groups—honours and poll men—and fourfold tables were made for :—

(1) Cephalic index and degree ; (2) length of head and degree ; (3) breadth of head and degree.

The table for (1) will illustrate the method in which all the tables were made.

Cephalic Index.

		Under 80.	Over 80.	Total.
Ability	Honours ...	307·5	216·5	524
	Pass	276·5	210·5	487
	Total	584	427	1011

The tables were worked by the method given in Prof. Pearson's memoir "On the Correlation of Characters not Quantitatively Measurable" (*Phil. Trans.*, vol. cxcv. A., pp. 1-47).

The divisions taken for length were under 7″·65 and over 7″·65, and for breadth over 6″·05 and under 6″·05. The correlation between ability and dolichocephaly was found to be ·0305 ± ·0349 ; between ability and long heads ·0861 ± ·0332 ; between ability and broad heads ·0450 ± ·0322.

If the numbers here given were of sensible magnitude, they would lead to the conclusion that ability is directly correlated with increased length and with increased breadth of the head and also with dolichocephaly. But on a comparison of the numbers with their probable errors it is seen that the correlation has no significance in the cases of cephalic index and of breadth ; in the case of length, the correlation is between two and three times the probable error, but it is in itself too small to be of any real importance.

The Cambridge results may consequently be taken to show that there is no marked correlation between ability, as judged by entry for an honours examination, and the size or the shape of the head.

The problem was next worked out from a series of measurements made in schools. The data here are less satisfactory, for the measurements were made in schools of all grades all over the country, and consequently give a mixture of classes and of ages.

The cephalic index remains practically constant during growth ; children of all ages may therefore be put together in this measurement ; the length and the breadth of the head change with age, and the measurements in these cases must be reduced to the same age.

This was done by forming tables of correlation between length of head and age, and between breadth of head and age.

1856 boys were taken of ages running from four to nineteen years ; the mean length was found for each year of age and a curve obtained of the average length of head of boys from four to nineteen years of age.

This curve showed apparently a period of rest in growth during the twelfth year. (A similar but less-marked rest in the twelfth year is also shown by T. W. Porter's curves for growth of head of St. Louis boys.)

The twelfth year was consequently chosen as the standard age to which all the measurements were reduced. The growth of the average boy for every year of age was then found. These values were added to the lengths for boys under twelve and subtracted from the lengths for boys over twelve. This gives what would be the length of head at twelve under the assumption that each boy grows like the average boy ; this is, of course, not actually the case, but for a broad classification will hardly lead to serious error.

The same method was applied to the measurements on the breadth of head.

The children were arranged by their schoolmasters into the following classes :—

Quick-Intelligent, Intelligent, Slow-Intelligent, Slow, Slow-Dull, Very Dull.

In forming the correlation tables for ability and head-measurements, Quick-Intelligent and Intelligent were placed in one class and all the rest into a second class, called respectively Intelligent and Slow.

The divisions for cephalic index were taken as under 78·5, over 78·5 ; for length of head (reduced to twelfth year) below 184·5 mm., above 184·5 mm. ; and for breadth of head (reduced to twelfth year) below 145 mm., above 145 mm. The results found were :—

Correlation between ability and dolichocephaly = ·0052 ± ·0240
Correlation between ability and long heads = ·0437 ± ·0242
Correlation between ability and broad heads = ·0843 ± ·0240

The results are in complete agreement with the Cambridge results.

The Cambridge and the school results taken together give practically a (mean) correlation of ·065 between size of head and ability. This value was taken and the class of people considered who have an ability so great as only to occur in 2 per cent. of the population—a fairly high standard. This was worked out by the tables of the probability integral, and it was found that 44 per cent. of the population have heads as large or larger than the mean head of the exceptional 2 per cent. of the population. Conversely, 44 per cent. of the population are as able or abler than the 2 per cent. of the population with exceptionally big heads.

But as 50 per cent. of the population are abler or larger-headed than the mean of the population, the above result shows the smallness of the basis upon which the argument from ability to largeness of head, or *vice versâ*, depends.

The Cambridge statistics were then investigated in the following manner. The honours men were divided into the three classes taken in examination. Two tables were made ; in the first table, first- and second-class men were put in one division and third-class men in another, and a fourfold table was made with cephalic index. The correlation between ability and dolichocephaly came out = ·0641 ± ·0487. In the second table, the first-class men were taken alone for one division, and the second- and third-class men formed the second division ; the correlation was found to be = − ·0254 ± ·0490. The numbers in both cases are non-significant ; there is no evidence to show that ability as tested by examination is related to shape of head.

Corresponding tables were made for length of head and for breadth of head. The results were :—

Length (first and second classes together) ... correlation = ·0865 ± ·0471
Length (second and third classes together) ... correlation = ·1263 ± ·0439
Breadth (first and second classes together) ... correlation = ·0056 ± ·0475
Breadth (second and third classes together) ... correlation = ·1689 ± ·0478

These results seem to show an increasing correlation between ability and size of head when the first-class men are separated from the rest, but it seems possible to attribute the divergence of the results to other causes. Length and breadth of head increase with age, and here, on the whole, the honours men are older than the poll men and the first-class men than the second, for a considerable number of resident dons were included in the measurements of the honours classes.

Of course the scale of intellectual ability must always be a vague one. A man is reputed to be "able" by his contemporaries, but future ages may rate him as of small importance. All we can do is to take a more or less popular appreciation. The examiner's test is not a perfectly satisfactory one, but it is idle to suppose that *on the average* it does not distinguish between the able and the dull. The same may be said of the teacher's estimate ; it is far from absolutely correct, but it is reasonable *on the average* and better than the examiner's. Lastly, we have the youth's own opinion of his capacity, as judged by the reading for a poll or honours degree. Tried by all these three tests, there is in the general population very insignificant correlation between ability and either the size or shape of the head. Very brilliant men may have a slightly larger head than the average, but the increase is so small that no weight can be laid on it in our judgment of ability.

THE EXPLORATION OF THE ATMOSPHERE AT SEA BY MEANS OF KITES.

FOR some years past, kites have been persistently and successfully employed by Mr. A. L. Rotch at his observatory at Blue Hill, U.S.A., for obtaining a knowledge of the movements, temperature and humidity of the upper air, and heights of three miles have been reached; their use was also systematically begun about the same time on the continent of Europe, especially at M. Teisserenc de Bort's observatory at Trappes, near Paris, where altitudes exceeding those at Blue Hill have been attained. We have also frequently referred to similar experiments both with kites and balloons made at the request of the International Aëronautical Committee. Valuable results have been obtained and published, so far as the land is concerned, and experiments will, we believe, be undertaken in this country under the superintendence of the Royal Meteorological Society. But in order to raise the kites to any considerable height, a wind of certain velocity is necessary. Mr. Rotch's flights were made when the wind velocity on the ground was between twelve and thirty-five miles per hour, and he points out that certain types of weather, such as anti-cyclonic conditions, with very light winds, or stormy conditions, can rarely be studied by that means.

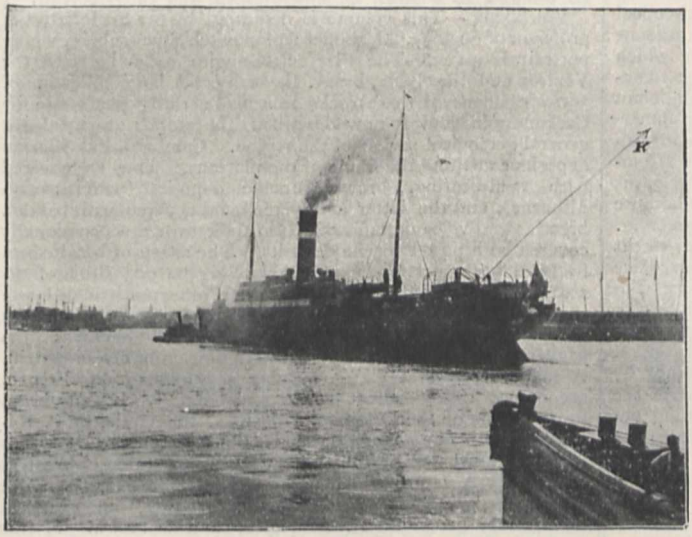


FIG. 1.—S.S. *Commonwealth* leaving Boston (kites were flown from K).

The prediction of weather for a day or so in advance has been brought to considerable perfection by the combined efforts of various meteorological services and the publication and study of synoptic weather charts; but further progress is necessary, and we believe that it is to the investigation of the upper air, especially if, as has been suggested, observations could be carried out in equatorial and trade-wind regions, where the changeable conditions of our latitudes do not exist, that further advance in weather knowledge may be confidently expected.

The plan proposed in a paper recently communicated to the Royal Meteorological Society by Mr. Rotch, and published in its *Quarterly Journal* for January last, with reference to the extension of kite observations to the sea, will doubtless lead to important results, and such observations will show whether the conditions prevailing over the ocean differ materially from those existing over the land. We give illustrations of Mr. Rotch's endeavour to obtain data with kites sent up from the s.s. *Commonwealth* while crossing the Atlantic, through the courtesy of Captain J. McAuley. Fig. 1 shows the vessel leaving Boston on August 28, 1901, and the position from which the kites were flown, while Fig. 2 shows the installation of the kite-reel on the after-deck of the vessel.

The kites can be used on ships to better advantage than on land. For example, even when the air is calm, by steaming through it at a speed of ten or twelve knots the kites can be raised to the height they would reach in the most favourable natural wind, and attain the altitude of the upper air-currents. During the passage of the *Commonwealth*, anticyclonic conditions mostly prevailed, and the wind blew only four to twelve miles an hour; but as the vessel steamed about fifteen knots, it was possible to use the kites on five days out of eight occupied in crossing the Atlantic. In one of the flights it was found that the air was 5°·6 warmer at a height of 130 metres than it was at the sea-level, and remained so during the afternoon (August 31). Another advantage gained by flying kites from a steamship is that wherever the observations in the upper air may be made there is always the observing station on the ship at sea-level, and not far distant, horizontally, with which to compare them.

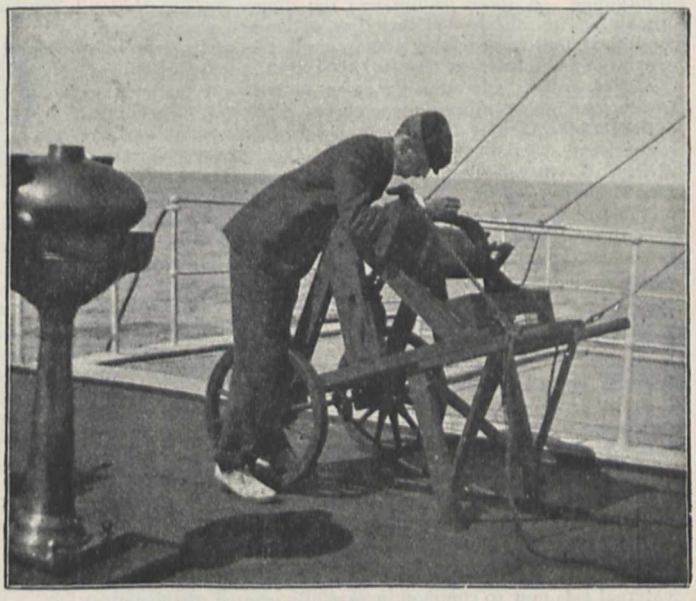


FIG. 2.—Kite-reel on after-deck of s.s. *Commonwealth*.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE Technical Instruction Committee of the City of Liverpool is the recognised local authority through which the Board of Education deals with all the science and art classes in the city with only two exceptions. The Committee carries on its work through many agencies in an organised plan, and every year several important developments are recorded. From the Report for the year 1901 we learn that the committee again renewed the grant of 200*l.* in aid of the scientific work carried on by the Lancashire Sea Fisheries Joint Committee. A permanent sea fisheries laboratory in the zoological department of University College, under the direction of Prof. Herdman, is partly supported by this grant; and trained assistants are constantly at work in this laboratory, investigating fisheries' questions that may arise in connection with the local industries. One of the rooms of the zoological museum at University College is devoted to a permanent fisheries collection, illustrating the local fishing industries, but no part of the grant made by the Technical Instruction Committee is expended on this museum. In connection with courses of lectures to gardeners on plant diseases, given by Prof. Harvey Gibson, a course of special lectures, followed by practical work in the botanical laboratory, has been arranged in the new Hartley Botanical Laboratory at University College. This attempt to show practical working gardeners the scientific methods of

observation and investigation into such problems as those of plant disease is likely to be of the greatest value.

THE Report of the Technical Education Committee of the Derbyshire County Council states that the Technical School at Glossop, erected by Lord Howard of Glossop, has during the past year been furnished and equipped by the Glossop Town Council, aided by a grant of 600*l.* (in addition to the loan of chemical and physical apparatus) from the County Council. There are now nine schools of science in the administrative county, of which seven are co-educational schools for boys and girls. It is sometimes complained that the "school of science" curriculum is not sufficiently commercial, but early specialisation in purely commercial subjects, such as bookkeeping, commercial geography and business letter writing, should certainly not be encouraged. The Committee quotes in this connection Mr. Sydney Webb's remarks that "English business is not being driven to the wall because of a dearth of qualified clerks and trained office boys. . . . What we have to do is to train our business men, be they clerks or partners, not merely or even chiefly to discharge their office routine, but to let their intellects play round their business, to put into their work, not only brains, but brains of the highest or inventive kind. This is where they seem at present to fall behind the German and the American. Now we may take it for granted that we cannot get business men of wider minds by narrowing their education, nor produce that heightening of the imagination which makes discoveries by carefully shutting out all knowledge of the world that is not business. The most efficient business man, in this highest sense of the word efficient, will, we may be sure, not be an uncultivated man nor a man of narrow range."

SCIENTIFIC SERIALS.

Bulletin of the American Mathematical Society, February.—Prof. F. N. Cole is the chronicler of the proceedings at the eighth annual meeting, in New York City, of the Society on December 27, 28, 1901. Though now two days are devoted to the conference, owing to the large number of papers sent in (twenty-seven), this time is hardly adequate, and it is becoming a serious question whether it will not be necessary to adopt a practice of selection, permitting the presentation, even then in condensed form, of more important papers only. The meeting was largely attended, the number of members present amounting to fifty-nine. A social feature was the dinner on the Friday evening. The officers and members of council were elected. Sir Robert Ball was present, and amongst the abstracts of the papers communicated is that of his recent researches in the theory of screws. Miss Scott's paper on a recent method for treating the intersections of plane curves investigates the nature of the set of equations discussed in Dr. F. S. Macaulay's paper in the London Mathematical Society's *Proceedings*, vol. xxxi., giving different and simpler proofs of the theorems obtained by Dr. Macaulay.—Prof. Holgate gives an account of the proceedings at the January meeting of the Chicago section, held at Evanston, Illinois, January 2, 3, 1902. Here also the attendance was unusually large. Nineteen papers were presented, and abstracts of them are here given. "The Vector Analysis" of Dr. E. B. Wilson is reviewed by Prof. A. Ziwet. Prof. Gibbs's "Elements of Vector Analysis" (1881–4) attracted wide attention, though it was only a pamphlet (83 pp.) printed for the use of his students. This Mr. O. Heaviside adopted, with slight modifications, and expounded fully in his "Electromagnetic Theory" (1893). Dr. Wilson's work is founded upon Prof. Gibbs's course of lectures delivered in 1899–1900, and gives the first generally accessible authentic record of Prof. Gibbs's system. The additions to the theory of the (1881–4) pamphlet are not extensive, though Dr. Wilson's book runs into 436 pp. This bulkiness is due to the lavishly open print and partly to the author's effort to make the subject easily intelligible by supplying numerous illustrations and applications. A good index is a desideratum, and the printing details lack the advantage of external aids now so common in carefully printed mathematical text-books.—Mr. J. L. Coolidge gives an interesting notice of Dr. Max Simon's "Euclid und die sechs planimetrischen Bücher" and of Prof. M. J. M. Hill's "The Contents of the Fifth and Sixth Books of Euclid."—The notes and new publications give the usual interesting information.

Memoirs (Trudy) of the Kazan Society of Naturalists, vol. xxxiii., 5 and 6.—Researches into the soils and flora of the Penza and Gorodische districts, by J. Sprigin.—On the Erinaceæ of Russia, by K. Satunin (with one plate). The following five species, found in European Russia, Caucasia and Transcaspian territory, are described:—*Erinaceus europaeus*, *E. auritus*, *E. albulus*, *E. macracanthus* and *E. hypomelas*.

Vol. xxxiv.—This volume is dedicated by the Society to the professor of geology, Alexander Antonovitch Stuckenberg, whose portrait is given.—The Plagioclase-augite rocks between the Yenisei and the Lena, by A. Laversky. A large collection of 350 specimens of these rocks was made thirty years ago by Czekanowski and is now described, the author giving also a general geological review of the region. Cambrian and Silurian deposits constitute the frame of the plateaus. They are covered with coal-bearing, brown Jurassic deposits (perhaps also Miocene), and the latter are pierced and covered with basalts, breccias and volcanic tuffs, which in their turn are occasionally covered with post-Pliocene deposits. The sheets of basalt seem to have been ejected immediately after the deposition of the coal-bearing sandstones, and cover an immense space—larger than anywhere else on the globe—and are similar to the basalt sheets of Novaya Zemlya, Franz Josef Land, Greenland, Jan Mayen, Iceland and the north-western portion of Great Britain. A map and several plates, as also a summary in French, accompany this excellent and very elaborate work.—Materials for the fauna of the Devonian deposits of the Urals, by P. Kazansky, with one plate (summed up in German).—Materials for the knowledge of the soils and the vegetation of Western Siberia, by A. Gordyaghin, part i. Under this modest name the author gives, as an introductory chapter, an excellent description, geographical, geological and botanical, of the region in the basin of the Irtysh (from 49° to 61° N. lat.), where we see the gradual transition from the black-earth steppes to the forest region. Some very interesting discussions about desiccation and the periodical changes in the precipitation in Western Siberia are incorporated in this chapter.—On the Turbellariæ of the Solovetsk Islands, by I. P. Zabusoff. Descriptions of the thirty-nine species, some of which are new, which were found in this part of the White Sea, and anatomical descriptions of four especially interesting forms (long summary in German, and three large plates).—The fauna of the Carboniferous limestone on Shartymka River, on the eastern slope of the Urals, by M. Ianishevsky (seven plates and one map). No less than 328 different species, some of which are new, are described, and the conclusion is that these limestones (described already by Verneuil and Murchison) seem to belong to the Lower Carboniferous age.—First addition to the "Fauna of the Permian Deposits of Eastern European Russia," by A. Netchayeff, with three plates. Eighteen species, of which nine are new, are described in Russian and in German.

Bulletin de l'Académie des Sciences de St. Pétersbourg, 5e série, tome xi., 1–5.—Observations of minor planets, made at Pulkova with the 15-inch refractor in 1898 and 1899, by W. Séraphimoff. The positions of thirty-five minor planets are given.—Observations of terrestrial magnetism at Obdorsk and Samarovo (North Siberia), by H. Abels.—On the products of oxidation of the new alkaloid cotarnine, by G. Wulff.—On the determination of the form of the solar disc, by W. Ceraski.—Actinometric measurements at Ekaterinburg, by P. Müller.—Determination of the velocity and direction of motion of clouds, by V. Kouznetsov (according to Pomortseff's method), with a plate.—Researches into the coefficient of refraction of ethyl ether in the vicinity of the critical point, by Prince B. Galitzin and J. Wilip (in German). The chief results of this elaborate work are: the critical temperature is 193°·61 C.; critical pressure, 36·28 atm.; critical volume, 3·84 c.c. The formula of Lorentz represents very well the relations between the refraction-coefficient and the volume, and covers a wide range of temperatures (10° to 100°), both for the liquid and the gaseous states. The Lorentz constant is C = 0·3025. "It must also be admitted that in certain circumstances the liquid state may persist above the critical point—a phenomenon which is quite analogous to the retardation of evaporation."—Contributions for explaining various information from oriental sources about Eastern Europe, by F. Westberg. A learned and very interesting series of researches about the information found in these sources about different nations—the Rûs, the Madjars, the Vyes, and so on.—On the classification of the Chrysomonades, by L. Iwanoff (in German). Certain peculiarities of structure

of the genus Mallomonas permit the author to establish a classification of this difficult division.—A new archaic inscription of the Roman forum, by A. Enmann.

Bulletin du Jardin Botanique de St. Pétersbourg, tome ii. fasc. i.—On the causes of the absence of wood on the *yailas* (high mountain plateaus) of Crimea, by G. J. Tanfiljew. The cause is probably in the late thawing of snow—often in May only—and the consequent saturation of the soil with water.—Lichenological notes, by A. A. Elenkin.—Communications.

Memoirs of the Novorossian (Odessa) Society of Naturalists, vol. xxiii., 2.—Remarks on the Crimean stag, by A. Brauner (two plates). Unlike Ward, Nikolsky and Lydekker, the author considers this stag as *C. elaphus*, L., which is near, not to the typical individuals from the forests, rich in food, of middle Europe, but to the island type (also mountain and southern type), and especially to the Corsican representative of this species (summary in German).—On the nitrification of water, by E. Gredig.—Note on the Sarmatian deposits of Transcaucasia, by V. Lashkarev, on the basis of Prof. Ernest Favre's collection at Geneva.—Fauna of the caves of Crimea, by J. Lebedinski, with one plate. First attempt to explore these caves.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, November 28, 1901.—"Micro-crystalline Structure of Platinum." By Thomas Andrews, F.R.S.

The crystalline structure of platinum does not appear to have been studied, although it forms an interesting subject for investigation. A small ingot of pure platinum was obtained for the experiments. A section was cut therefrom and machined to 5/16th inch square and 1/10th inch in thickness. The section

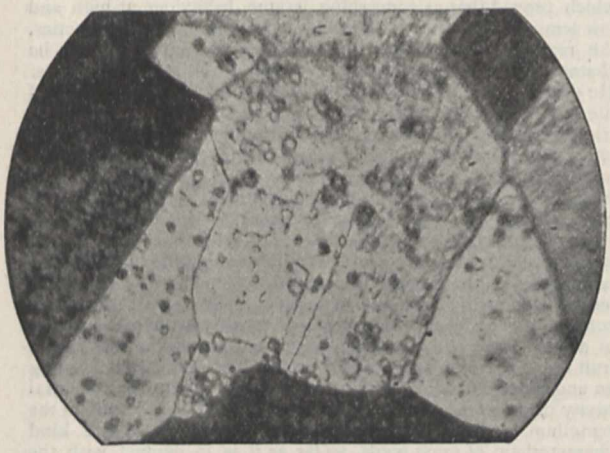


FIG. 1.—Micro-crystalline structure of platinum as seen in section at 360 diameters.

was then carefully polished and etched in aqua regia. The etching was very difficult and required the greatest care in manipulation to satisfactorily develop the crystalline structure. The result of the etching was the development of a beautiful crystalline structure which manifested, not only the large or primary crystal grains, but also the secondary or very minute crystalline development which is illustrated on a plate accompanying the paper, as seen in section at magnifications respectively of 50, 120, 360 and 360 diams. The last two of these figures are here reproduced. The larger or primary crystal grains were observed to consist of irregular polygons of varying size, the etched indications of the facet junctions being often clearly and sharply defined. The minute or secondary crystals (whose intercrystalline junctions were also clearly seen) were in the mass observed to be in varied positions of orientation, but the orientation was generally identical, or on the same plane, within the area of each larger crystal grain. The general orientation of the smaller crystals varied, however, in each separate larger crystal, and the consequent varied reflection of the light has given the face of the microsections, as a whole, the appearance of lighter or darker areas in the photomicrographs. In some portions of the mass there were observed minute triangular crystals; these appear, however, to be only developments resulting from the cutting of certain crystals in section. The general microcrystalline structure of platinum was observed to be allotriomorphic in character

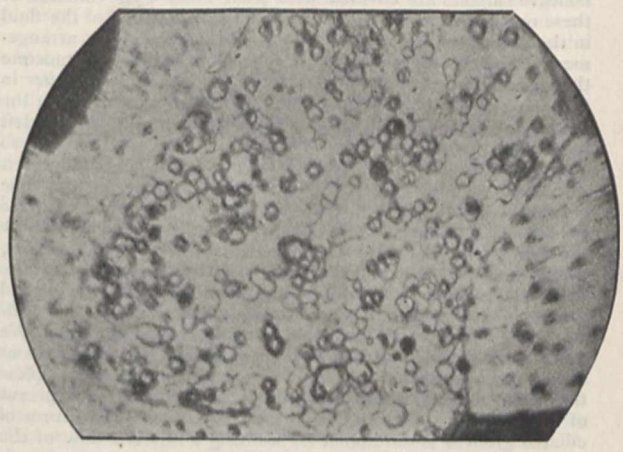


FIG. 2.—Micro-crystalline structure of platinum as seen in section at 360 diameters.

and derived from a system of interfering cubes and octahedra, the cubic and hexagonal form being frequently noticeable. The size of the large crystal grains varied from about 0·002 inch to 0·04 inch in size, and the smaller crystals ranged from about 0·0002 inch to about 0·007 inch. There were indications that the smaller or secondary crystals were each built up of even more minute crystalline ramifications. The crystalline structure of platinum appears to generally resemble that of gold and silver. The descriptive words "primary" and "secondary" crystals are only used in relation to size, and they are not intended to convey the idea of distinctive times of formation during solidification.

February 13.—"Preliminary Note on a Method of Calculating Solubilities and the Equilibrium Constants of Chemical Reactions, and on a Formula for the Latent Heats of Vaporisation." By Alexander Findlay, M.A., B.Sc., Ph.D. Communicated by Prof. Ramsay, F.R.S.

If R and R′ represent the ratios of the absolute temperatures at which two substances have the same solubility, the author shows that $R = R' + c(t' - t)$, where c is a constant having a small positive or negative value and t' and t are the temperatures at which one of the substances has the two values of the solubility in question. The formula is precisely similar to that which Ramsay and Young showed to hold in the case of vapour pressures (*Phil. Mag.*, 1886, xxi. 33). Given the solubility curve of one substance it is therefore possible to calculate the solubility of a second substance provided the solubility of the latter at two temperatures is known. The author shows that this method can be applied to the calculation of "equilibrium constants" of chemical reactions.

It is further shown that if L_1 is the known latent heat of vaporisation at the absolute temperature T_1 of one substance, and L_2 the latent heat of the second substance at the temperature T_2 at which the vapour pressure of the second substance is equal to that of the first at the temperature T_1, then $L_1/L_2 = T_1^{x_1}/T_2^{x_2}$. A less exact, but simpler formula is $L_1 = L_2 T_2^{x}$. These formulæ appear not to be applicable when the pressure exceeds 10,000–20,000 mm.

February 20.—"On a Pair of Ciliated Grooves in the Brain of the Ammocœte, apparently serving to promote the Circulation of the Fluid in the Brain-cavity." By Arthur Dendy, D.Sc., F.L.S., Professor of Biology in the Canterbury College, University of New Zealand. Communicated by Prof. G. B. Howes, F.R.S.

The author demonstrates the existence in the brain of the Ammocœte of a pair of remarkable ciliated grooves. The structures in question were discovered by the author in the

Ammocœte of *Geotria australis*, the New Zealand lamprey, and subsequently he found similar organs in sections of an Ammocœte of *Petromyzon* in the zoological laboratory of Owens College. The grooves in question run along the roof of the brain-cavity from about the hinder margin of the posterior commissure to the *recessus subpinealis*. They are lined by a sharply defined epithelium of very long columnar cells, and their concave surfaces are covered with short cilia. The function of these organs is apparently to promote the circulation of the fluid in the brain-cavity, and this view is supported by the arrangement of the choroid plexuses. In the New Zealand Ammocœte the choroid plexus of the mid-brain dips down into the *iter* in the shape of a highly vascular longitudinal septum dividing the upper part of the brain-cavity in this region into right and left halves, and it is significant that the ciliated grooves are so arranged as probably to direct a stream of brain-fluid along each side of the septum. It has been already suggested that the choroid plexuses of the vertebrate brain are concerned with the gaseous interchanges which take place in the cavities of the ventricles. In the young Ammocœte the first choroid plexus, which may be supposed to be especially concerned in the respiration of the fore-brain, is not yet developed; the second and third choroid plexuses, belonging respectively to the mid- and hind-brain, are, on the other hand, already extensive. We need not, therefore, be surprised to find that the fore-brain at this stage is dependent to a large extent for its means of respiration, and perhaps also for its nutrition, upon the choroid plexus of the mid-brain, and that a special apparatus in the form of ciliated grooves is developed for securing a forward flow of the necessary fluid in the brain-cavity.

March 20.—"On the Development of the Layers of the Retina in the Chick after the Formation of the Optic Cup." By John Cameron, M.B., Ch.B. (Edin.) Communicated by Prof. Macintosh, F.R.S.

The inner wall of the retinal cup in a fourth-day chick has exactly the same structure as the wall of the embryonic cerebral vesicle or spinal cord at the same date. All the structures which His has described in the wall of the embryonic spinal cord can be also recognised here, and may, therefore, receive similar names—thus, there is a network (the myelospongium) which is formed by spongioblasts, and between the fibres of the myelospongium are found germinal cells which divide to form neuroblasts. From the latter are formed the cells of the outer and inner nuclear layers and the ganglion cells of the retina. On the eighth day the internal molecular layer appears, and on the ninth day the external molecular layer. The first appearance of these layers is due to a rearrangement of the myelospongium, and they map out the three cellular layers. Three kinds of cells are found in the internal nuclear layer at the twelfth day—amacrine, bipolar and basal cells. The cells of the external nuclear layer become rod and cone cells, and from them rods and cones begin to develop on the twelfth day of incubation. The hexagonal pigment cells develop from the outer wall of the retinal cup, and their processes also appear on the twelfth day.

Linnean Society, March 6.—Mr. Herbert Druce in the chair, succeeded by Mr. A. D. Michael.—Mr. J. E. Harting exhibited and made remarks upon some unpublished coloured drawings by Messrs. J. G. Millais and A. Thorburn of British freshwater Anatidæ illustrating intermediate phases of plumage, through and irrespective of moulting, not hitherto figured.—A paper by Prof. A. Gruvel, of Bordeaux, was read, dealing with some cirrhipedes preserved in the British Museum of Natural History. The chief feature of the paper was the introduction of several new families into the group Lepadidæ as accepted by Darwin, and modified by Gerstäcker by the separation from it of the Alcippidæ for a single species.—The zoological secretary gave an abstract of a memoir by Prof. Elliott Smith, of Cairo, "On the morphology of the brain in the mammalia, with especial reference to that of the lemurs, recent and extinct." The author has examined either the brain or cast of the brain-cavity of every lemuroid genus living and extinct, and his work is the result of an investigation of the collections of the Royal College of Surgeons Museum, the British Museum, the Zoological Society, aided by gifts of material by Captain Stanley Flower, Mr. Hose, and other persons named. A critical *résumé* of the literature of the subject is followed by a detailed consideration of the sulci, the calcarine and sylvian fissures receiving special attention. The author shows that the simplest lemuroid type of brain is that of the Galaginæ, the most specialised that of the Indrisinæ and Lorisinæ. He shows that in Cheiromys the individual variation of the sulci is so great that the supra-sylvian and lateral fissures alone remain unchanged, and he finds proof in this genus of ontogenetic retrogression, which substantiates the conclusions of Forsyth-Major originally deduced from the study of the living Galaginæ, the Tertiary genus Microchœrus, and more recently from that of the Madagascar genera Globilemur and Megaladapis. For Tarsius he shows, while the brain, in respect to its occipital overlap and the presence of a posterior cornu, as also to the assumption of the microsmatic condition, is the most pithecoid of that of all lemurs; conversely, in the characters of its corpus callosum, hippocampus and cerebellum, it is shown to conform to the lowest Eutherian type. Regarding Tarsius as a lemur, the author concludes that the lemuroid brain is intelligible only on the supposition that it has advanced along the main primate stem and later undergone retrogression. A caudo-occipital curtailment of the hemisphere is regarded as the dominant change which the lemuroid brain has undergone, with accompanying structural simplification; and evidence is adduced to prove that while the lemuroids were ancestrally macrosmatic, the macrosmatic condition at present found to exist in them has been secondarily acquired from a pithecoid microsmatic state, of the order of that retained in the tarsier. Beyond this, the memoir deals exhaustively with the comparative morphology of the pallium of the chief mammalian orders, with especial reference to confusion of ideas concerning fissures to which the term "sylvian" has been applied.

March 20.—Prof. S. H. Vines, F.R.S., president, in the chair.—Prof. J. C. Bose read a paper on electric response in ordinary plants under mechanical stimulus. He first explained his apparatus and methods, and then performed, with the aid of his assistant, a series of experiments showing electric response for certain portions of the plant organism, which proved that as concerning fatigue, behaviour at high and low temperatures, the effects produced by poisons and anæsthetics, the responses are identical with those hitherto held to be characteristic of muscle and nerve and of the sensitive plants. He drew the final conclusion that the underlying phenomena of life are the same in both animals and plants, and that the electrical responses which he had demonstrated are but the common physiological expression of these.—Dr. O. Stapf read a paper on the fruit of *Melocanna bambusoides*, Trin., an endospermless viviparous genus of Gramineæ. Fruits of this very singular grass collected last year were forwarded through Mr. Wild, Conservator of Forests, Bengal. They are of the shape and size of small apples or inverted pears, usually terminating with a short or long beak, the longest measuring as much as 5 inches in length. They consist of a hard, thick, fleshy pericarp, which contains a great deal of starch stored in a parenchymatic tissue, of a testa developed as nutrient layer and present in the mature fruit in an "obliterated" condition, and an embryo possessing an enormous ellipsoid scutellum which fills up the large central cavity of the pericarp, or is partly empty. The epidermis of the scutellum is developed as haustorial epithelium of the kind characteristic of grass-seeds, so far as it is in contact with the pericarp or, rather, the nutrient layer. It is traversed by numerous vascular strands which start from a plate of tangled strands in the axis of the embryo, and send out innumerable branchlets near the surface of the scutellum. The fundamental tissue in which the strands are embedded is delicately walled parenchyma, full of starch. There is no endosperm. Germination starts while the fruits are still on the tree, and the young shoots may attain a length of as much as 6 inches, whilst a bundle of roots is formed simultaneously. During germination, the scutellum acts on the pericarp as it acts in typical grasses on the endosperm, depleting not only the store of starch and other nutrient matter deposited in the cells of the parenchyma, but finally inducing also the partial solution of the cell-walls. This structure of the fruit of Melocanna is almost unique in grasses, and was not known before. It is probably repeated, although with some modifications, in the genera Melocalamus and Ochlandra, which the author intends to make the subject of another paper.—Messrs. A. O. Walker and Andrew Scott read a paper on Crustacea Malacostraca from the island of Abd-el-Kuri, in the Red Sea, collected by Messrs. H. O. Forbes and W. Ogilvie Grant during their expedition to Socotra in 1899. The specimens described were picked out of the residue from a collection of Algæ procured in April of that year, in rock pools

and tidal inlets on the above-named island. Of 13 species thus obtained, seven were described as new to science and three were regarded as belonging probably to new genera. One of these genera (Kuria), it appeared, could not be referred to any of the recognised families of Amphipoda.

Zoological Society, March 18.—Dr W. T. Blanford, F.R.S., vice-president, in the chair.—Dr. H. Gadow, F.R.S., read a paper on the evolution of horns and antlers. He stated that three main types could be distinguished in the evolution of the ornamental weapons on the heads of ruminants, and that all these types were referable to an ancient condition in which the beginning weapon, be it one of offence or defence, appeared as a mere exostosis with a thickened skin-pad. This stage resembled that of Dinoceras of the Eocene. Secondly, there was found exostosis of the frontal bone producing a pedicle, surmounted by a cartilaginous mass of apical growth, which by subsequent basal ossification became an antler. Skin originally unaltered and hairy; this, and the chondrostoma or cartilaginous later osseous growth, was shed periodically and constituted the cervine type. A side issue of type ii. was that of pro-giraffe-like animals. Cartilaginous growth preponderant, with multiple and broadened bases. Ossification delayed, but still proceeding from the base, *e.g.* the Samotherium of the topmost Miocene. A further development of this type (ii. *a*) was shown by the giraffe, in which the outgrowth proliferated freely and now formed free growths, ossifying independently, of the cranial bones, but ultimately fusing with them. Type iii. was a continuation of the main line from ii., represented by the prong-buck; predominant epidermal growth produced a horn-shoe, which was periodically shed, but had abolished the shedding of the bony core which represented the antler. Type iv., the highest stage, was represented by the hollow-horned ruminants, in which the horn-shoe was now a permanent feature; but it was important to note that these animals still shed the first, or earliest, generation of the horny sheath. Horns and antlers were developed alike with a cartilaginous matrix, with subsequent ossification. These four types were an illustration of onward phyletic evolution, and these stages were still faithfully repeated in the development of the recent species; this was a clear instance where ontogeny was a shortened recapitulation of phylogeny.—Mr. R. Trimen, F.R.S., communicated a paper by Lieut.-Colonel J. M. Fawcett, entitled "Notes on the Transformations of some South-African Lepidoptera." This memoir was in continuation of one by the same author, already published in the Society's *Transactions*. It illustrated the earlier stages of thirty-two species, of which six belonged to the Rhopalocera and twenty-six to the Heterocera.—Mr. R. I. Pocock gave an account of a new stridulating organ discovered in the scorpions belonging to the African genus Parabuthus. This organ consisted of a granular sharpened or finely ridged area upon the dorsal side of the seventh abdominal somite and of the first and second segments of the tail. The sound was produced by scraping the point of the sting over these granular areas.—A communication from Dr. R. Broom, on the organ of Jacobson in the elephant-shrew, was read, in which the author showed that the organ of Jacobson, which in Erinaceus was of the Eutherian type, was in Macroscelides marsupial in all its details, and was most nearly comparable to that of Perameles. Pointing out that in the allied genera Petrodromus and Rhynchocyon marsupial characters had been discovered by Parker in the skull, the author concluded that Macroscelides was "a very near relation of the marsupials, and had probably little affinity with the more typical insectivores." Dr. Broom noted that Macroscelides had a discoidal deciduous placenta, and that its young were born in a well-developed condition.—A communication from Mr. Frederick Chapman contained an annotated list of the collections of Foraminifera and Ostracoda made by Dr. C. W. Andrews on Cocos Keeling Atoll in 1898.—Mr. G. A. Boulenger, F.R.S., described three new species of fishes from the French Congo under the names *Allabenchelys longicauda* (gen. et sp. nov.), *Labeo lukulae* (sp. nov.) and *Chilochromis duponti* (gen. et sp. nov.).

Entomological Society, March 19.—Dr. F. DuCane Godman, F.R.S., vice-president, in the chair.—Mr. W. J. Kaye exhibited a number of insects from British Guiana, many of them taken by himself, illustrative of Müllerian mimicry. Dr. DuCane Godman remarked that in these regions many different forms of the same butterfly would often occur within a radius of fifty miles, showing a wide range of variation.—Prof. E. B. Poulton, F.R.S., exhibited cocoons of *Malacosoma neustria* collected by Mr. Hamm in 1900, spun upon black-currant and apple-trees in his garden at Oxford. All of them had been attacked by birds through the leaf, this being the thinnest part of the cocoon, and the pupa thus more easily abstracted. With regard to the resting habit of *Hybernia leucophearia*, he said that Mr. Hamm had observed that this moth usually rested in a horizontal position. Dr. Longstaffe said that all the specimens he had observed on green stems affected a similar position, and that he had only found one on a birch-tree. Mr. M. Jacoby said that he never found the species on oak at all, but on palings, also in the same position, which facts Prof. Poulton said tended to show that the protective instinct of the species was retained in such localities.—Mr. G. T. Porritt exhibited two bred black *Larentia multistrigaria* from Huddersfield, and said that the dark form was rapidly increasing in Yorkshire. Of those already emerged and reared from the same brood, three were normal and two dark.—Dr. Frederick A. Dixey read a paper, illustrated by lantern slides, entitled, "Notes on some cases of Seasonal Dimorphism in Butterflies, with an account of Experiments made by Mr. Guy A. K. Marshall." He said that he had long since formed the opinion that *Catopsilia crocale*, Cram., was specifically identical with *C. pomona*, Fabr., and had suspected that the differences between them might prove to be seasonal in character. The belief in their specific identity was held by Piepers and by de Nicéville, neither of whom, however, thought that the dimorphism thus shown had any relation to the seasons. Colonel Yerbury said that a temporary rainfall in a dry season in dry places had a marvellous effect in producing intermediate and wet-season forms. Mr. F. Merrifield pointed out the difference between experiments upon tropical and European species. In the tropics there are not any very great distinctions of seasons and temperature, whereas in temperate climates the seasons are clearly marked off from one another. Prof. E. B. Poulton expressed his opinion that by breeding species through, Mr. Marshall had proved that one form gives rise directly to the other, the pairing of the two forms being a biological test of very considerable value. Colonel Swinhoe, Dr. Jordan and Dr. F. DuCane Godman also joined in the discussion.—Prof. Poulton, F.R.S., read a paper on mimicry illustrated by the Sanger-Shepherd three-colour process, supplementary to his paper read at the meeting of the Society on March 5.

Mineralogical Society, March 25.—Dr. Hugo Müller, F.R.S., president, in the chair.—Mr. G. T. Prior contributed a paper on the petrology of British East Africa, the result of examinations of the collection of rock specimens made by Prof. J. W. Gregory during his expedition to Mt. Kenya and Lake Baring in 1892–3, and of collections from the Uganda Protectorate made recently by Sir Harry Johnston. Descriptions were given of the three main groups of rocks, viz., the basement Archæan gneisses and schists, the Palæozoic shales and sandstones and the Tertiary volcanic rocks. The gneisses and schists are associated with dykes both of acid pegmatites and of basic diabasis and epidiorites, and also with granulitic rocks analogous to the Charnockite series of India and Ceylon. Of the Palæozoic Karagwe series a collection of ferruginous shales and siliceous schists from Unyoro was described. These rocks present striking similarities with those of Hatch's Hospital Hill series of the Transvaal and with rocks from the Ingwenyaberg, Swaziland, and a correlation between the Karagwe series and the Cape System of the Transvaal was suggested. The volcanic rocks consist mainly of soda-rich phonolitic rocks which have resulted doubtless from a nepheline-syenite magma. The lavas from the volcanoes of the Great Rift Valley and of Mt. Kenya and the region between are characterised, like those of the Canary Islands and the Azores, by the prevalence of anorthoclase, by the large amount of soda-amphiboles (cossyrite, catophorite, arfvedsonite) as well as of soda-pyroxenes and by the absence of sphene and noseau. They form a remarkable example of a rock-series showing a gradation in composition from basic phonolites, containing nepheline both in large phenocrysts and in the groundmass, through phonolitic trachytes containing no recognisable nepheline, to phonolitic quartz-trachytes, and finally to acid riebeckite-rhyolites containing much quartz. The later eruptive rocks from Mt. Elgon and the western side of the Great Rift Valley present some points of distinction with the earlier erupted rocks. They are generally of a more basic character like those of Kilimanjaro as compared with those of Mt. Kenya. Another point of distinction is the presence in them of titanic acid in large amount, in the form of

perofskite in the more basic nephelinites, and as sphene in the phonolites which are of the more ordinary type without soda-amphiboles. Most of the specimens from Mt. Elgon and the neighbourhood consist of nephelinites, but in some of them the nepheline, both as phenocrysts and in the groundmass, is partially or wholly replaced by melilite. Examples of melanite-nepheline rocks allied to borolanite, and of monchiquite dyke-rocks from Mt. Elgon, were also described. A specimen of nephelinite from the neighbourhood of Ruwenzori containing much perofskite suggested the contemporaneity of the eruptive rocks of Mt. Elgon and of the volcanic region at the foot of Mt. Ruwenzori.

Royal Meteorological Society, March 19.—Mr. W. H. Dines, president, in the chair.—Mr. W. N. Shaw, F.R.S., read a paper on la lune mange les nuages, which was really a note on the thermal relations of floating clouds. He also exhibited an arrangement of apparatus whereby the conditions applicable in the case of a floating cloud can be experimentally realised.—Mr. F. J. Brodie read a paper on the prevalence of gales on the coasts of the British Islands during the thirty years 1871–1900. The total number of gales of all kinds dealt with during this period was 1455, the yearly average being 48·5, of which 10·6 were severe. The worst year was 1883, while the quietest was 1889. The stormiest month was January, 1890. At all seasons of the year excepting the summer, the prevalence of gales from south-west is greater than from any other quarter. The minimum of such gales is reached in the spring, when rather less than 20 per cent. are from south-west, more than half the storms being, however, from points between south-west and north-west. The prevalence of gales from polar directions is then at its maximum, more than 21 per cent. blowing from points between north and east. In the spring of 1883, out of a total of eleven gales no. fewer than seven were from these quarters, the proportion being about three times the average. The highest velocities recorded were those at Fleetwood during the westerly gales on December 22, 1894, and on January 12, 1899. On the former occasion, for nine hours, from 7 a.m. to 3 p.m., the mean velocity was sixty-four miles per hour, and at 9 a.m. it reached a maximum of seventy-eight miles. It appears that on the average 43 per cent. of the storm systems which visit our coasts advance from some point of the compass lying between south and south-west, and travel towards some point lying between north and north-east. 39 per cent. have an easterly motion, while less than 1 per cent. move westwards. A mean of 264 cases shows that the deep cyclonic systems which visit our islands travel on an average at the rate of 24·1 miles per hour; in some cases, however, the rate was not more than eight or ten miles, while in others it amounted to forty, fifty and even sixty miles per hour. The author concluded his paper by exhibiting a series of weather maps showing the progress of some of the most notable gales during the period covered by the discussion.

CAMBRIDGE.

Philosophical Society, March 3.—Prof. Macalister, president, in the chair.—On a method of increasing the sensitiveness of Michelson's interferometer, by Mr. H. C. Pocklington. It is shown that the sensitiveness of Michelson's interferometer can be greatly increased if we can cause the interfering beams to be circularly polarised in opposite senses. This can be done approximately in the ordinary form of the instrument (with, however, an unsilvered inclined mirror) by placing an eighth-wave plate of mica in front of each of the perpendicular mirrors so that a principal axis of each plate is parallel to the line of intersection of the mirrors, and suitably choosing the plane of polarisation of the incident light. A theoretically better method, in which the inclined mirror and the compensating plate are placed rather less than a quarter-wave apart, is discussed, but it is concluded that only experiment can decide which will be the better method in practice.—The influence of currents in metals on reflected and transmitted light, by Mr. P. V. Bevan.—(*a*) On the conductivity of the vapours of the alkali metals; (*b*) on induced radio-activity, by Prof. J. J. Thomson. The investigation was undertaken with the intention of seeing whether the "induced radio-activity" shown by a metal rod after long-continued negative electrification in the open air would occur if the rod were placed in a closed vessel instead of outside in the open air. The closed vessel was a zinc gasometer 102 cm. high and 75 cm. in diameter; the vessel was insulated and used as one of the electrodes, the other electrode was a metal tube placed at the axis of the cylindrical gasometer. A potential difference of 800 volts between the cylinder and this rod was produced and the current between these electrodes was measured. This current was "saturated" and was therefore a measure of the total ionisation in the gas in the vessel; if the rod became radio-active, the ionisation and therefore the current would increase. The current was measured in the morning, and the rod in the vessel kept connected with the negative terminal of a Wimshurst machine for six or seven hours, when it was disconnected from the machine and the current again measured; if the gas in the vessel were not exposed to Röntgen rays whilst the rod was negatively electrified, the author was not able to detect any increase in the current through the gas as the result of the long negative electrification: if, however, the gas were exposed to Röntgen rays during the negative electrification of the rod, then a well-marked increase in the current took place—the increase being some 16 or 17 per cent.; this increase was due to some alteration in the rod and not to a change in the gas in the vessel, for if a rod similar to the one which had been electrified, but which had not itself been electrified, were substituted, the current sank to its former value. No increase took place in the current if the rod were positively electrified. A number of experiments were made on the currents through the vessel when the vessel was not exposed to rays and when the rod was not electrified. Rods of different sizes and different metals were tried—these all gave approximately the same current; if the rod were carefully wrapped round with dry filter paper, the current showed a decided increase, while if the filter paper were damp, the current was many times its value for the bare rod; the current in this case is greatest when the negative ions move up to the paper-covered rod—a large effect is also produced when the paper is wetted with brine or alcohol, but a solution of H_2O_2 produces by far the largest effect yet found.—On the Hall effect in gases at low pressures (second paper), by Mr. H. A. Wilson. The experiments described in this paper are a continuation of those described in the paper entitled "On the Hall Effect in Gases at Low Pressures" (*Proc.* Camb. Phil. Soc., vol. xi. pt. iv.), read to this Society last October. Measurements have been made of the Hall effect and electric intensity in the uniform positive columns in oxygen and hydrogen, and also of the variation of the Hall effect along the discharge in air at various pressures. The Hall effect in hydrogen is found to be capable of being represented by the equation

$$z = 2{\cdot}65 \times 10^{-2} \frac{H}{p},$$

where z is the transverse electric intensity or Hall effect, H the magnetic field and p the pressure in millimetres of mercury. The corresponding equation for oxygen is found to be

$$z = 3{\cdot}8 \times 10^{-3} \frac{H}{p}.$$

The electric intensities in hydrogen and oxygen are found to be given by the equations

$$X = 28\sqrt{p}$$

and

$$X = 26{\cdot}9\sqrt{p} \text{ respectively.}$$

The results on the variation of the Hall effect along the discharge are shown by curves which resemble the curves showing the variation of the electric intensity along the discharge. The paper concludes with some theoretical discussion of the results.—On the extraction of the gases from one cubic centimetre of blood, by Mr. J. Barcroft.—On the coefficient of mutual induction between a circle and a circuit with two parallel sides of infinite length, by Mr. G. F. C. Searle.—Notes on Semper's larva, by Mr. K. Ramunni Menon.

EDINBURGH.

Royal Society, February 17.—Prof. Geikie in the chair.—Major W. B. Bannerman, superintendent of the Plague Research Laboratory, Parel, India, gave an account of the work carried on in the laboratory of which Mr. Haffkine is director in chief. A staff of fifty-three, of whom five are European, now occupies a huge building which has been in succession a Roman Catholic seminary, a Governor's residence, and a plague hospital. A detailed account was given of the preparation of Haffkine's prophylactic, which the Indian Government had adopted as a vaccine for the plague. Some interesting statistics were given showing that under precisely similar con-

ditions persons who had been inoculated were distinctly less liable to attack than those who had not been inoculated, that of the inoculated patients who were attacked by the plague a much smaller percentage of cases proved fatal, that the prophylactic was not harmful during the incubation stage of the disease, and that protection began to be effective twenty-four hours after injection, but was not complete until the tenth day. Profs. Fraser, Greenfield and Hunter Stewart took part in the after discussion, Prof. Fraser commenting especially on the fact that the vaccine, valuable though it had been proved to be, had not been shown to be able by itself to control a real epidemic of plague. He believed that more effective control would result from the policy of isolating patients and of enforcing better sanitation. Moreover, Haffkine's vaccine always produced a reaction which, he could not help thinking, might actually convert a case which would otherwise have terminated in recovery into a case which terminated in death. In reply Major Bannerman said he would never decry sanitary measures, but it was at present impossible to get the natives of India to appreciate the blessings of sanitation and the necessity of ventilation. The Government should be induced to introduce the teaching of hygiene into the schools, and it was an extraordinary fact that there was not a medical representative on the Viceroy's Council.—Dr. Hugh Marshall communicated a paper by Mr. J. K. H. Inglisand himself on the action of silver salts on solution of ammonium persulphate. The paper gave the results of measurements of the reaction velocity and of the influence exerted by other salts present in the solution. From these it would appear that the first part of the reaction, giving rise to the formation of peroxide of silver or similar compound, is much slower than the second part, which results in the formation of nitric acid.

March 3.—Sir William Turner in the chair.—Dr. Masterman read a paper on the early development of *Cribrella oculata*, Forbes, of which the leading points may be thus summarised. The segmentation is very variable, but always culminates in a solid morula, which is converted into a blastula by a remarkable process termed multiple egression. A normal gastrula is then produced and the blastopore closes. A process of cell-prolification then causes the formation of mesenchyme and hypenchyme (the latter filling the archenteron). In the bilateral larva the anterior cœlom gives rise to the pre-oral cœlom and to paired lateral cœloms as well as a small central cœlom; the posterior cœlom gives rise to left and right halves which fuse later. The left lateral cœlom becomes the hydrocœle; the right lateral the epigastric cœlom; the central cœlom forms the pericardium or dorsal sac; and the posterior cœlom forms the hypogastric cœlom. The transition from bilateral to radial stages throws light upon the peculiar torsion found in asterids and upon the homology of the mesoderm in echinoderms. A close comparison was drawn between the Cribella larva and Balanoglossus.—Messrs. A. E. Shipley and Edwin Wilson, in a paper on a possible stridulating organ in the mosquito, drew attention to a curious apparatus at the base of the wings of *Anopheles maculipennis*, an apparatus which had escaped the notice of both the systematist and morphologist. The structure is very complex, but consists essentially of a slightly movable bar provided with a series of well-marked teeth which in certain circumstances rasp across a series of ridges. It seems probable that as the wings are raised and depressed the movement of these two surfaces over one another may account for some of the characteristic buzzing of the mosquito.—Dr. Noel Paton gave an account of some observations on the amount of dissolved oxygen in water required by young Salmonidæ.—A paper was also read by Dr. James Scott on the influence of subcutaneous injections of large quantities of dextrose on the metabolism in the dog. It was found that dextrose injected in amounts varying from 5 to 7 grms. per kilo. was as far as possible acted upon by the general tissues of the body and not dealt with by the liver or at once secreted by the kidneys, and the result was a marked increase in proteid metabolism.

DUBLIN.

Royal Dublin Society, March 19.—Prof. Grenville A. J. Cole in the chair.—On the progressive dynamo-metamorphism of a porphyritic andesite from co. Wicklow, by Henry J. Seymour. The author described the gradual alteration of a coarsely porphyritic andesite into a finely banded crystalline schist, as the result of earth movements connected with the intrusion of the Leinster granite. The light-coloured bands in the schist consisted of the very much elongated felspar phenocrysts, which are drawn out partly by granulation and partly by recrystallisation into flat lenticles seven or eight times the length of the original crystal from which they were derived. The dark bands are composed of the altered matrix containing abundant secondary biotite.—Prof. E. J. McWeeney, on a method of air-examination by bacteriological procedure. The problem to be solved was whether the air on a certain part of the premises of a Dublin manufacturer was liable to contamination by micro-organisms carried by air currents from a refuse-heap on the premises of a neighbour, the intervening distance being 800 feet. The method consisted in liberating on the refuse-heap a readily recognisable form of micro-organism that does not normally occur in Dublin air, and exposing large Petri dishes (diameter 20 cm.) at various heights at the place where contamination was suspected. The organism used was one that formed red pigment, and was intermediate in character between *B. prodigiosus* and *B. Riliensis*. A thick suspension of this in normal saline was thrown into the air at the refuse-heap by means of a spray apparatus, at the rate of a litre per hour. This was kept up for three hours on a day when the wind was blowing in the required direction. Meanwhile six culture dishes were exposed in the perpendicular position, and at heights varying from about 12 to 60 feet above the ground. Afterwards they were closed and the colonies allowed to develop. On four of the six plates red colonies appeared, viz. on those exposed at the heights of 30, 40, 50 and 60 feet, and subculture showed the organisms composing them to be identical with those that had been sprayed. The success of the experiment was rendered the more remarkable by the fact that rain was falling in torrents throughout the three hours' exposure. The author proposed to develop the method and apply it to other problems of the like kind.

PARIS.

Academy of Sciences, April 1.—M. Bouquet de la Grye in the chair.—The new organisation of the study of astronomy and the physics of the globe at the National Observatory of Athens; the presentation of the third volume of the *Annales* of this establishment, by M. Lœwy. The first branch of work developed by M. Eginitis was that of meteorology; at the present time there is one station of the first order at Athens and twenty-one stations of the second order in various parts of Greece. At the same time a systematic study of the geodynamical phenomena of Greece was organised, a network of 550 stations uniformly distributed throughout the whole country dealing with seismic phenomena. The observations from these stations up to the present time have been analysed by M. Eginitis, the results being of great scientific interest. It is clearly shown that there is no connection between the 567 seismic disturbances noted in Greece during the year 1899 and the positions of the moon. Owing to the unavoidable delay in fitting up the astronomical instruments, this branch of work is not so well developed as the others, but aided by the fine climate, valuable observations on meteoric showers have already been recorded.—On the action of human serum on the Trypanosome of the Nagana (*Tr. Brucei*), by M. A. Laveran. It would be supposed that the injection of the serum of an animal naturally immune, such as man, from the attack of the tsetse fly would be without effect in the treatment of animals suffering from the effects of the bites; contrary to expectation, however, human serum has proved to be active. Infected rats and mice, injected with human serum, lost the characteristic organism in from twenty-four to thirty-six hours after the injection. On account of the close analogy between the monkey and man, it appeared to be of interest to compare the action of serum from man and the monkey; the latter serum was found to be quite inactive. The effect of human serum as a preventive against the disease was next tried, but the immunity produced was feeble.—On surfaces of constant negative curvature, by M. Erik Holmgren.—On the heat of solidification of solid ammonia, by MM. de Forcrand and Massol.—A self-recording atmospheric electroscope, by M. G. Le Cadet. An image of the aluminium leaves of the electroscope was projected through a very fine slit on to a revolving sensitised plate. The chief difficulty was due to the extreme fineness of the leaves, this being got over by tilting the box of the electroscope with respect to the optic axis of the apparatus.—On the band spectra

of nitrogen, by M. H. Deslandres. Four distinct groups, characterised by their limits of vibration frequency, have been made out in the spectrum of nitrogen. Cuthbertson has recently shown that the forty bands of the first group can be arranged in thirteen series. Some further regularities in these series are discussed in the present paper.—The cause of the annual period of the aurora borealis, by M. Charles Nordmann. It is known that in mean latitudes the frequency of the aurora possesses a double annual periodicity such that the maxima are at the equinoxes and the minima at the solstices. The author deduces a theoretical explanation of this, which is independent of all hypotheses as to the nature or production of the aurora.—On the composition of the lodes of Kersanton, by M. Ch. Barrois. The veins of Kersanton are distinguished from ordinary veins by their composite structure; they have been slowly consolidated under the influence of pneumatolithic phenomena for a very long time. The facts observed are in accord with the theory of M. Michel Levy.—An examination of the meteoric iron of Guatemala, by M. Stanislas Meunier. Analysis showed that the Guatemala iron belongs to the Schwetzite type and is similar to the masses of Descubridora (Mexico, 1780), Werchne-Udinsk (Siberia, 1854) and Schwetz (Prussia, 1857).—The best methods of realising stereoscopic radioscopy, by M. Th. Guilloz.

DIARY OF SOCIETIES.

THURSDAY, APRIL 10.

MATHEMATICAL SOCIETY, at 5.30.—A Note on Divergent Series: Dr. Hobson, F.R.S.—Stress and Strain in Two-dimensional Elastic Systems: Prof. Love, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Problems of Electric Railways: J. Swinburne and W. R. Cooper.

ROYAL INSTITUTION, at 3.—The Oxygen Group of Elements: Prof. Dewar, F.R.S.

FRIDAY, APRIL 11.

PHYSICAL SOCIETY, at 5.—An Apparatus or Vapour-pressure Measurements: Mr. Grant.—(1) The use of Cathode Rays for Alternating-Current Measurements; (2) An Experiment on the Current Growth in an Inductive Circuit: Mr. Morris.—An Electric Heater: Dr. R. A. Lehfeldt.—Note on the Compound Pendulum: S. A. F. White.

ROYAL ASTRONOMICAL SOCIETY, at 5.—(1) Cape Double Star Results, 1901: (2) Notes on Nebulæ: Royal Observatory, Cape of Good Hope.—Explanation of Use of Tables of $\frac{1}{2}(\theta + \cos\theta)$: W. S. Aldis.—On Stationary Meteor Radiants; Third Paper: H. H. Turner.—Results of Double Star Measures at Windsor, New South Wales, in 1901: J. Tebbutt.—Saturn seen through the Cassini Division: C. T. Whitmell.—On the Probable Motion of some of the Small Stars in the Dumb-bell Nebula: E. E. Barnard.—On the Supposed Variability of κ Persei and 36 Persei and a Comparison of the Photographic and Visual Magnitudes of those Stars: W. H. Robinson.—*Probable paper:* On the Relative Number of Star Images photographed in Different Parts of the Plate, and on the Performance of Various Object-Glasses in this respect: H. H. Turner.

MALACOLOGICAL SOCIETY, at 8.

ROYAL INSTITUTION, at 9.—Problems of the Atmosphere: Prof. Dewar, F.R.S.

MONDAY, APRIL 14.

SOCIETY OF ARTS, at 8.—Glass for Optical Instruments: Dr. R. T. Glazebrook, F.R.S.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—A Journey from Omdurman to Mombasa *viâ* Lake Rudolf: Major H. H. Austin, C.M.G.

TUESDAY, APRIL 15.

ZOOLOGICAL SOCIETY, at 8.30.—Contributions to the Osteology of Birds; Part V. Falconiformes: W. P. Pycraft.—On the Windpipe and the Heart of the Condor: F. E. Beddard, F.R.S.—Field-notes upon some of the larger Mammals of Patagonia: Hesketh Pritchard.

ROYAL INSTITUTION, at 3.—Recent Methods and Results in Biological Inquiry: Dr. Allan Macfadyen.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Discussion:* The Greenwich Footway-Tunnel: W. C. Copperthwaite.—Subaqueous Tunnelling through the Thames Gravel, Baker Street and Waterloo Railway: A. H. Haigh.—*Paper to be read:* On Locomotive Fire-box Stays: F. W. Webb.

ROYAL STATISTICAL SOCIETY, at 5.—Factory Legislation considered with reference to the Wages, &c., of the Operatives protected thereby: Geo. H. Wood.

WEDNESDAY, APRIL 16.

SOCIETY OF ARTS, at 8.—Photography as applied to Architectural Measurement and Surveying: J. Bridges Lee.

GEOLOGICAL SOCIETY, at 8 (1) The Carlisle Earthquakes of July 9 and 11, 1901; (2) The Inverness Earthquake of September 18, 1901, and its Accessory Shocks: Dr. Charles Davison.—The Wood's Point Dyke, Victoria (Australia): F. P. Mennell.

ROYAL MICROSCOPICAL SOCIETY, at 7.30.—Exhibition of Pond Life.

ENTOMOLOGICAL SOCIETY, at 8.—On the Economic Importance of the Parasites of Coccidæ: Alice L. Embleton.—Eastern and Australian Geometridæ in the British Museum Collection: Colonel Charles Swinhoe.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—Clouds: Capt. D. Wilson-Barker.

THURSDAY, APRIL 17.

ROYAL INSTITUTION, at 3.—The Oxygen Group of Elements: Prof. Dewar, F.R.S.

SOCIETY OF ARTS, at 4.30.—Recent Developments in Punjab Irrigation: Sidney Preston.

LINNEAN SOCIETY, at 8.—The Anatomy of Todea with Notes on the Affinity and Geological History of the Osmundaceæ: A. C. Seward, F.R.S., and Miss Sybil O. Ford.—On the New Zealand Phyllobranchiate Crustacea, Macrura: G. M. Thomson.

CHEMICAL SOCIETY, at 8.—Oxonium Salts of Fluoram and its Derivatives: J. T. Hewitt and J. H. Tervet.—The Influence of certain Acidic Oxides on the Specific Rotations of Lactic Acid and Potassium Lactate: G. G. Henderson and D. Prentice.—(1) The Amounts of Nitrogen as Ammonia and as Nitric Acid, and Chlorine in the Rain-water collected at Rothamsted; (2) The Amounts of Nitrogen as Nitrates and Chlorine in the Drainage through uncropped and unmanured land: N. H. J. Miller.

FRIDAY, APRIL 18.

ROYAL INSTITUTION, at 9.—The Autocar: Sir J. H. A. Macdonald.

EPIDEMIOLOGICAL SOCIETY, at 8.30.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Erewash Valley Widening and Toton Sidings: H. C. M. Austen.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—The Standardization of Pipe Flanges and Flange Fittings: R. E. Atkinson.

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