THURSDAY, NOVEMBER 25, 1909.

THE "ORIGIN OF SPECIES" AND ITS LESSONS.

Charles Darwin and the Origin of Species; Addresses, &c., in America and England in the Year of the Two Anniversaries. By Prof. E. B. Poulton, F.R.S. Pp. xvi+280 and index. (London: Longmans, Green and Co., 1909.)

ON November 24, 1859, appeared the first edition of that immortal work—the outcome of twenty years' research—which was destined to revolutionise scientific thought, first in the domain of organic nature, and ultimately in every department of intellectual activity. The celebrations of the jubilee of this publication and of the centenary of the birth of its illustrious author, held at Baltimore in January, at Oxford in February, and at Cambridge in June of the present year, have been the means of directing public attention in such detail and in such forcible terms to the magnitude of Darwin's achievements and to the far-reaching consequences of his labours that it may well be doubted whether any further tribute can be paid to the memory of our great countryman. Nevertheless, on the present occasion, practically coincident with the fiftieth anniversary of the publication of the "Origin," it is only appropriate that we should direct attention in these columns to the latest contribution to Darwinian literature, the above work by Prof. Poulton, which the author has happily contrived to issue on the exact date of the anniversary. The readers of NATURE may be reminded that in these pages, to which Darwin himself was a rare contributor, some of the greatest questions raised by the publication of the "Origin" have been fought out by the leaders of science in that field of natural knowledge which, at the touch of what Helmholtz designated the "new creative thought," became reduced from a state of chaos to one of scientific order.

Of that generation of naturalists who were active workers before the publication of Darwin's book, there are but few survivors. Alfred Russel Wallace, to whom the present volume is appropriately dedicated, Sir Joseph Hooker and Sir Francis Galton are happily with us. But the later generations, who have been taught to accept organic evolution as an established doctrine, are apt to overlook the extent of their indebtedness to that memorable publication of Darwin's half a century ago. Before the appearance of that work the group of sciences now comprised under the general term Biology were still under the thraldom of an ancient cosmogony from which the physical sciences had been emancipated, if not completely at least to a very large extent. The year 1859 marked the beginning of what may fairly be described as the Reformation Period of biological science. At some future period, when the progress of knowledge shall have enabled a still later generation to obtain a just perspective of the bearing of Darwin's work upon the current thought of his time, a re-publication of some of the arguments that were urged against his teachings will furnish most instructive material for the historian of science. What impression would be produced now, for example, by a critic who in a scientific journal gravely opened an attack upon the "Origin of Species" with the remark:—

"It will not be denied, we presume, that animals were created for the use of mankind. Man was to have dominion over them" (Edinburgh New Philosophical Journal, 1860, vol. xi., p. 283).

The reviewer concludes with a general appeal to the churches to unite in demolishing the new heresy.

The work now under consideration which has prompted the foregoing retrospection is by an author so well known as one of the soundest of the modern interpreters of Darwinism that a brief summary of its contents will suffice to commend the book to the serious consideration of all naturalists. More especially do we commend this, as also Prof. Poulton's other writings, to those who have caught up the cry, popular in some circles, that although evolution is established Darwinism is dead, or, to quote from the preface, to those who "recognize a prophet in every reed shaken with the wind." Of the seven chapters in this new memorial volume, the first ("Fifty Years of Darwinism") is revised and extended from the address given at the centenary in Baltimore in January; the second ("The Personality of Charles Darwin") is compiled from notes of a speech delivered on the same occasion; the third gives an account of the centenary celebration at Oxford and the speeches made on that occasion; the fourth gives the speech delivered by the author at the banquet at Cambridge in June, and the fifth ("The Value of Colour in the Struggle for Life") is reprinted from the Cambridge memorial volume, which was noticed in these columns at the time of the international celebration last June vol. lxxx., p. 481). Chapter vi., which will be new to most of our readers, is on the mimicry in the butterflies of North America, and is compiled from notes of the anniversary address delivered to the Entomological Society of America at Baltimore in December, 1908. The seventh chapter contains a number of letters written by Darwin to Mr. Roland Trimen and hitherto unpublished. As with all Darwin's correspondence, it is perhaps hardly necessary to say that these letters will be found most delightful reading, and their interest is enhanced by Mr. Trimen's own reminiscences of Darwin and by the recording of the most severe and perhaps the only severe thing that our magnanimous leader ever said of a scientific contemporary.[1]

In addition to these chapters, there are four appendices which are by no means the least interesting sections of the work. In the first of these, Darwin's views on the hypothesis of multiple origins are summarised, and in the second his conclusions with respect to what are now called "mutations" are marshalled in systematic order, and leave no doubt that this mode of evolution had over and over again been considered by him and always rejected as a *modus operandi* in nature. The mutation theory is happily paraphrased by Prof. Poulton in the preface

[1] The remark referred to (p. 28, note) is quoted from Prof. Poulton's article in the *Quarterly Review* of last July.

as "based on the conception of an inborn transforming force violently discharged at regular intervals by every species of times past, present and to come"—a view on all fours with that upheld by the late Duke of Argyll, and which formed the subject of a criticism in these columns by the present writer at the time of its promulgation ten years ago (vol. lix., p. 217). It is the old "internal developmental force" let off sporadically instead of continuously, only subject, according to the founder of the theory, to control by natural selection.

In the third appendix, as in his Oxford speech, the author refutes once and for all the absurd and unwarrantable conclusions respecting the mental degeneration due to the exclusive pursuit of science which certain writers have based upon Darwin's description of his declining artistic faculties with the advance of age. The last appendix is particularly striking, as it brings out for the first time a remarkable discrepancy between the views of the founder of the modern theory of mutation (de Vries) and certain English supporters of that theory (Bateson and Punnett) respecting the fundamental question of the transmissibility by inheritance of individual differences or "fluctuations." According to de Vries these fluctuations are transmissible; if they are not, the whole fabric of the Darwinian theory is, it is needless to point out, overturned. The elucidation of this point seems to be one of the most urgent problems awaiting attack by experiment.

The valuable contributions to the Darwinian theory with which the author of the present work has been for so many years identified have been mainly in that most fascinating field of the relationship between the colours of animals and their environment—a subject which first led the present writer to the serious study of the "Origin of Species" more than thirty years ago. In this class of phenomena, adaptation is obvious to those who do not wilfully close their eyes to the evidence. If this adaptation is not explicable by natural selection, then that principle can be applicable in no other department of organic nature. It is not going too far to say that with the proof or disproof of the utility of these resemblances in colour, form, pattern and habit which are so abundant in the insect world, the whole question of the validity of the Darwinian theory is bound up. Darwin himself foreshadowed this application; so also did Wallace. Bates, Wallace, and Roland Trimen applied it to mimetic resemblances, Thomas Belt was a contributor, and Fritz Müller in 1879 gave us a new and important lead. Its application to the development and use of the markings of caterpillars was among the early and by no means least important of the contributions to biological science by August Weismann. No writer in modern times has done more than Prof. Poulton to place this application of Darwin's theory upon a sound scientific basis, and not the least interesting of his contributions is to be found in the sixth chapter of the present work, wherein he traces with masterly hand the mimetic influence exerted by certain Old World butterflies upon the insects of the New World into which they are comparatively recent immigrants. Such a clear case as this, in which the direction of modification is not open to doubt, disposes at once of the theory that similar environmental influences produce similarity of colour and pattern, for here it is the old inhabitants of the country and not the later immigrants that have been modified in the direction of mimetic resemblance.

It may be permissible on the present occasion to extend one's contemplation of the book immediately under notice to certain wider considerations which arise from the work which has for so many years been carried out in the Hope Department of the University of Oxford. That work bears throughout the stamp of Darwin's influence, and stands as living testimony that the central doctrine proclaimed in the "Origin of Species" half a century ago is still a vitalising power. It will not be considered presumptuous to recommend to a generation which has been told that the species question is not even ripe for discussion a critical re-perusal of Darwin's classic. Thereby it will be made evident that for the author of that work, nature was a living whole—a frame of mind from which modern specialisation is unfortunately leading many of the younger workers astray. The breadth of view which enabled the author of the "Origin" to mould whole branches of science into his service must for all time be a matter for admiration and wonderment. How comprehensive that view really is may be inferred from the circumstance that there is scarcely one modern development of the species question—perhaps none with the exception of the long neglected work of Mendel—which in principle, if not in detail, is not foreshadowed in the "Origin." Even the all-important question of the transmission of acquired characters appears to have been raised, and to have been considered by Darwin, as may be gathered from an apparently forgotten passage in the "Origin" to which the writer has directed Prof. Poulton's attention, and which is quoted fully in the last appendix to the volume under consideration (p. 273).

Some other lessons conveyed by Darwin's "Origin of Species" may perhaps be worthy of consideration at the present time. We have heard much of late years about the want of public interest in science being due to the technical and popularly unintelligible language in which investigators express their results. The answer to that charge can best be given by pointing to Darwin's writings as a whole; these, although scientific in the technical sense, being nevertheless popular in treatment and commanding a sale never before realised by any set of treatises on purely scientific subjects. From this experience it is fair to conclude that unintelligibility is at any rate not a necessary accompaniment of sound scientific exposition.

The tendency to specialisation which is becoming more and more characteristic of modern scientific work is not in itself an unhealthy sign. It is the necessary consequence of the growth of knowledge on the one hand and of the limitation of the human intellect on the other. All the good work turned out by our investigators at the present time is the result of such specialisation. As time goes on, the increase in the mass of material and in the number of workers

must reduce still further the limits within which the individual worker can hope to make substantial contributions to the knowledge of his subject. The danger to be guarded against is the unhealthy development of the effects of specialisation. Although it may no longer be possible to obtain a comprehensive grasp of a whole group of sciences, there still remains the lesson conveyed to the scientific world by Charles Darwin's work—that extreme concentration upon one particular investigation need not produce mental atrophy in other directions. There may be a narrowness of outlook produced by extreme specialisation which, if not guarded against, may easily pass from mere narrowness to actual illiberality of mind. This in its way is quite as unscientific, as it is certainly more dangerous in its immediate effect upon our younger contemporaries, as the shallowness arising from too great a diffusiveness.

R. MELDOLA.

ALPINE HYDROLOGY.

Service d'Études des grandes Forces hydrauliques (Région des Alpes.) Tome iii. Résultats des Etudes et Travaux au 31 Décembre, 1907. Pp. 688; with maps, photographs, and diagrams. (French Ministry of Agriculture, 1908.)

IN May of last year (vol. lxxviii., No. 2010) there were reviewed in these columns two volumes rendering an account of the initiation of a hydrological service in France, formed for the purpose of studying the rivers and watercourses of that country, which were capable of developing power for, and otherwise benefitting, industrial and agricultural pursuits. The purview of the inquiry was to be restricted, in the first instance, to the region of the Alps, to be extended later to the Pyrenees, and ultimately, no doubt, to include the Vosges and the hilly districts of the north and west. At the time of the issue of the volumes in question, the results of these investigations were only forthcoming in systematised form so far as the close of the year 1905, and operations had been confined to a certain portion of the Alpine watershed, the work being carried out under the supervision of two engineers, MM. de la Brosse and Tavernier, the former of whom reported on the basins of the Arve and the Isère, and the latter on the regions of the Durance and the Var.

The book before us is the third volume of the series, and it forms a compendium of figures and statistics no less impressive than its predecessors. It continues the account of the studies prosecuted by M. de la Brosse during the years 1906 and 1907. These relate to the northern district of the Alps, included between the bed of the Rhone and the Italian frontier on the one part, the Lake of Geneva and the basin of the Durance on the other part.

The southern district, from the basin of the Durance to the Mediterranean littoral, under the direction of M. Tavernier, is to form the subject of a subsequent volume.

M. de la Brosse commences his report with an enumeration of the gauging stations within his district of 26,000 square kilometres (10,000 square miles), showing that they have increased in number from 30 in 1903 to 60 in 1905, and to 100 at the present time. The number of separate gaugings taken in 1907 was more than a thousand. Nearly all the stations, he remarks, are of the foot-bridge type, the exceptions being in watercourses of considerable width, where barges were employed, and in places of considerable difficulty of access, where the only available method was to employ a skiff suspended from a cable fixed at some suitable level. The foot-bridge, from its greater security and convenience, proved by far the best system, and a number of interesting photographs show the variations in design at different stations to meet local peculiarities.

The instruments used for gauging were described in some detail in the first volume, and the only comments now made in connection with them, after some experience of their working, relate to a few trifling modifications and minor improvements in design. A calibrating station for testing current-meters was established at Grenoble in 1906, and this has been found a considerable convenience, as, prior thereto, the instruments had to be dispatched to the hydro-technical laboratories of Berne or Munich.

The station in question comprises an electrical apparatus, mounted on a framed platform, set in a quiescent sheet of water forming part of a fortification moat. The apparatus is actuated by a triphase motor of 5 horse-power, which enables various degrees of speed to be imparted to a movable arm carrying the instrument to be tested, ranging from a few centimetres to nearly 5 metres (say, an inch to 16 feet) per second. By a circuit connection the number of revolutions of the screw is signalled at periods of from 25 to 50, and a simple calculation therefrom determines the relative speed in a moving medium. The process requires the services of two operators and two assistants, lasts from one to two hours, and (including the cost of the electric current) involves an expense of *il.* per instrument dealt with.

During the two years 1906–7, surveys have been made of the basins of the Dranses, the Usses, the Fier, the lake of Bourget, the Guiers, the Bourbre, the Gère, the Collières, the Galaure, the Drôme, the Roubion, the Lez, and the Eygues, all tributaries of the Rhone, and comprising an area of 918,643 hectares (2,300,000 acres). These basins are all separately delineated in the volume under review in a series of charts to a scale of 1/200,000, which are accompanied by tables recording various analytical particulars of the component sections, according to superficies and altitude.

A noteworthy feature of several of the smaller basins (especially that of the Collières) is the disappearance and reappearance of streams in and from subterranean passages, resulting oftentimes in several changes of name for a single watercourse, the identity of which can be established without serious difficulty throughout its apparently disconnected track. For example, the same waters feed successively the Reval, the Orou, and the Collières, which thus constitute really a single stream.

An interesting extension of these topographical investigations has been made in reference to some of

the principal glaciers, which the commission rightly regard as important reservoirs. The glaciers of Vallouise were surveyed in 1904, those of the Grandes Rousses in 1905, and the glacier of Mont de Lans in 1906–7.

It would be impossible within the limits of a short article to touch upon all the points of interest in M. de la Brosse's report, and the foregoing constitute simply a few random notes culled from pages which are replete with valuable information on all branches of hydrographical research amid the Alps. Mention must, however, be made of two supplementary notes by M. Mougnié, of Moutiers, the first on the subject of controlling the discharges of the Isère, and the second on variations in the bed of the same river. Then follows the second part of the volume, a compendium of more than 600 pages of tabulated data covering the whole area of operations.

The admirable manner in which these observations are being made and recorded reflects the highest credit on the Direction de l'Hydraulique, and abundantly justifies its formation and support. It is evident that there is being collected a wealth of data which must prove of incalculable value in estimating the hydrological resources of the country and in utilising them to the best advantage and to their fullest extent. Further volumes of the series will be awaited with undiminished interest by all who are concerned in any way in the development of hydro-technical studies. B. C.

THE SCIENCE OF PATHOLOGY.

The Principles of Pathology. By Prof. J. George Adami, F.R.S. Vol. I., General Pathology. Pp. 948. (London: Henry Frowde and Hodder and Stoughton, 1909.) Price 30*s.* net.

WE congratulate Prof. Adami on the completion of this exhaustive work, of nearly 1000 pages, on general pathology, more particularly as he had the misfortune to lose his library, the manuscript of the concluding chapters, and the illustrations collected over a period of many years for the purposes of the book, in the fire by which the medical buildings of McGill University were destroyed in April, 1907.

The book is divided into three sections, section i. dealing with prolegomena, and in particular with the cell and its relation to disease, section ii. with the causes of disease, and section iii. with the general morbid and reactive processes.

In the opening chapters an excellent summary is presented to the reader of the various theories of cell structure and connections, and of the physiology and chemistry of the cell, including enzymes and their mode of action. In these considerations the author adapts the "side-chain theory" to explain the relationship of the protein molecule to life and metabolism and to enzyme action. Whether correct or no, this conception has the advantage of visualising the subject, and gives the student concrete ideas which he can grasp, in place of abstract ones.

Growth, states of cell activity, cell multiplication, adaptation, and differentiation are next considered, and the important subject of inheritance has, rightly, considerable space devoted to it; and Mendel's and Galton's laws, mutations, and the inheritance of acquired characters all receive adequate treatment.

Having thus cleared the ground by a consideration of these general biological problems, the author passes on to the subject-matter proper, commencing with a discussion of the causes of disease, in which inheritance is again considered, and the various anomalies of development and the monstrosities are very fully described. The bacterial, protozoan, and metazoan parasites are then discussed, but only in a general way, as causes of disease—a wise limitation, as the parasites themselves and their general biology and activities are fully described in various other text-books. Referring to the presence of bacteria potentially pathogenic in and upon the healthy body, the author mentions that streptococci are present in the mouth in 80 per cent. of healthy people, but it is to be noted that Gordon has shown that the species present in the mouth, and so abundant there, is non-pathogenic, and differs from the disease-producing streptococci.

In the section on malaria it would have been more correct to speak of "anopheline" rather than "anopheles," mosquitoes as agents of transmission.

Chapter xi. is devoted to endogenous intoxications due to abnormalities of internal secretion (*e.g.* of the thyroid, adrenals, pancreas, &c.), which, it is true, gives the essentials of the subject, but fourteen pages seem to us inadequate space in a work of this kind to discuss so important a subject.

In the section on the morbid and reactive processes, the local and systemic reaction to injury and inflammation are dealt with very fully, and altogether in a judicious and instructive manner. Immunity and its various problems are similarly well treated, and a survey is given of every branch of the subject; Ehrlich's "side-chain theory" in particular is well described, and at some length. As regards anaphylaxis—the *increased* susceptibility conferred by an injection of blood-serum—we cannot help thinking that the suggested explanation is laboured, and, involving as it does the ionic hypothesis, beyond our present knowledge of the phenomenon.

The progressive tissue changes—hypertrophy, regeneration, and new growths—are next discussed in a very complete manner. We are glad to note that the author emphasises the futility of attempting to graft the tissues of lower animals on man for purposes of repair.

In speaking of placental moles, the inexact, if not incorrect, appellation "hydatid" is retained; "hydatidiform" is preferable.

The characters of neoplasms (tumours or new-growths) are given at considerable length. The classification of neoplasms adopted is the histogenetic one supported by the author. A principal objection urged by Prof. Adami against the embryogenetic classification is that it separates new growths histologically similar, *e.g.* glioma of epiblastic, and sarcoma of mesoblastic, origin. We venture to think that too much stress should not be laid on this argument, for even now the minuter structure of new growths is only beginning to be studied. Nor are we

as yet absolutely certain of the developmental origin of many structures in the body, and further research may clear up some of the apparent discrepancies now incidental to the embryogenetic classification. The histogenetic classification itself is not altogether free from the reproach levelled at the embryogenetic one by Prof. Adami.

As regards the genesis of new growths, the various hypotheses are discussed at considerable length, and an admirable survey of this vexed and complex question is presented to the reader. Prof. Adami considers that no parasitic hypothesis suffices, that Beard's hypothesis of aberrant and misplaced germs and trophoblastic cells (so much in evidence lately in connection with a certain form of treatment) is inadequate, seeks for an explanation in the hypothesis of a change (? a mutation) in the biological properties of the cells giving origin to tumours, and considers that there is no one specific cause; with all these we cordially agree.

The concluding portion of the book deals with the regressive changes, the degenerations and infiltrations, calcification, pigmentation, &c. The book altogether is an inspiring one, and the careful reader will not only gather what is already known, but will be led to infer in what directions further progress lies. A notable feature of it is the attempt made, usually successfully, to ensure a basis on a sound foundation of general biology. It is carefully and adequately illustrated, and the numerous diagrams and schemata serve to render many of the more abstruse conceptions clear and intelligible.

A NEW WAY IN ARITHMETIC.

Theorie der algebraischen Zahlen. By Dr. Kurt Hensel. Erster Band. Pp. xii+350. (Berlin and Leipzig: Teubner, 1908.) Price 14 marks.

IN this volume Dr. Hensel gives the first instalment of a treatise on algebraic numbers, embodying an independent method on which he has been engaged for the last eighteen years. Its leading idea may be illustrated by the following example. Let us take the solvable congruence, $x^2 \equiv 2 \pmod 7$, the roots of which are $x \equiv 3$ and $x \equiv 4$. The same congruence can be solved with respect to the moduli 7^2, 7^3, 7^4, &c., and we obtain the solutions, in least positive residues, (3, 4), (10, 39), (108, 235), (2116, 285), and so on. Taking the first number in each bracket and expressing it in the septenary scale, only writing the digits in the reverse of the usual order, we obtain the associated solutions, 3, 31, 312, 3126; and it is clear that if $x = a_1 a_2 \ldots a_n$ is a solution of $x^2 \equiv 2 \pmod{7^n}$, we can find a number $a_1 a_2 \ldots a_n a_{n+1}$ which is a solution of $x^2 \equiv 2 \pmod{7^{n+1}}$. There is thus a definite sequence of digits, 3, 1, 2, 6, . . . a_n, . . . such that each is a least positive residue of 7 (or zero), and such that 3126 . . . a_n is a solution of $x^2 \equiv 2 \pmod{7^n}$. This sequence may be said to be the symbolical septenary representation of $\sqrt{2}$. But conversely we may take any such sequence, $a_1 a_2 \ldots a_n \ldots$ and define it as a septenary number, in an extended sense. All such numbers form a corpus, provided we introduce septenary fractions of the same type. Since $-1 \equiv (7^n - 1) \pmod{7^n}$, the symbolical form of -1 is $666 \ldots$ or $\dot{6}$; hence every ordinary positive or negative integer or fraction has a symbolic expression which is wholly or partly periodic, *e.g.* $2/3 = (3+\dot{6})/3 = 3\dot{2}$, and so on. Similar results hold for any prime modulus; when the modulus is composite, some curious anomalies occur.

Now let $w_1, w_2, \ldots w_n$ be a basis of an algebraic corpus; we may form symbols of the type $A_1 w_1 + A_2 w_2 + \ldots + A_n w_n$, where $A_1, A_2, \ldots A_n$ are numbers of the kind just described. These new symbols may be called "numbers," and by making use of them Dr. Hensel obtains all the most important known properties of algebraic numbers with surprising facility; he also adds results of his own which are of great interest and beauty. Calling a symbol such as A_1 a p-adic number, we may call $F(x) = A_1 x^n + \ldots + A^n$, a p-adic function; it is shown how to determine, by a finite process, the irreducible p-adic factors of $F(x)$, and by a series of propositions we are led up to the remarkable theorem (p. 159) that if $f(x) = x^\lambda + a_1 x^{\lambda-1} + \ldots + a_\lambda$, the coefficients being integral p-adic numbers, and $f(x)$ irreducible, then if p^δ is the highest power of p which divides the discriminant of $f(x)$, and if α_1 is a root of the ordinary equation

$$\phi(x) = 0$$

obtained from $f(x)$ by omitting all the digits of $a_1, a_2, \ldots a_\lambda$ beyond the $(\delta - 1)$th place, the equation $f(x) = 0$ will have precisely λ conjugate roots $\xi_1, \xi_2, \ldots \xi_\lambda$ expressible as conjugate p-adic numbers in the corpora $(a_1), (a_2) \ldots (a_\lambda)$. This fundamental fact leads to a host of consequences, among them a comparatively simple treatment of a well-known problem, namely, the resolution into their prime ideal factors of the real primes which divide the discriminant of a given corpus. It also leads to a complete theory of congruential roots of unity; the theory of units in a given corpus is not discussed in this volume.

On pp. 308 and following will be found a complete solution of the problem of resolving a given real prime into its ideal factors within a given corpus; this involves the Kronecker method, in which *umbrae* are used, and probably there is no certain practical way which can dispense with them. As an illustration, it is shown that in the corpus defined by the equation $\alpha^3 - \alpha^2 - 2\alpha - 8 = 0$, the number 2 is the product of three ideal primes, which are actually determined.

One of the last theorems proved in this volume may be stated in the following terms:—If a corpus is defined by an equation $f(x) = 0$, which is not Galoisian in the field of ordinary numbers, we cannot make the field Galoisian by the introduction of p-adic numbers.

The value of the treatise can hardly be overrated, and its completion will be anxiously expected. It is interesting to compare it with Hensel and Landsberg's treatise on algebraic functions, and observe the points of contact. A special feature is that in the arithmetical work, like the other, there are expansions in

fractional powers; in the algebraic theory it is almost impossible to avoid this, except by tedious divagations, but in the theory of numbers such symbols ought to be avoided if possible, and their occurrence here may cause some readers a shade of regret. G. B. M.

LISSAJOUS'S FIGURES.

Harmonic Vibrations and Vibration Figures. By J. Goold, C. E. Benham, R. Kerr, and Prof. L. R. Wilberforce. Edited by H. C. Newton. (London: Newton and Co., n.d.) Price 6*s.* net.

THE four authors of this book have each contributed an account of the construction and use of apparatus which they have invented or brought to perfection, the several parts of the book being independent of one another, but related by the similarity of the subject-matter. Lissajous's figures were originally introduced as a convenient method of illustrating optically or mechanically acoustic phenomena, but the beauty and perfection of the results obtained by the compound pendulum of Tisley, and later by the twin elliptic pendulum of Goold, have made the subject sufficiently attractive to be pursued for its own sake. As two leading scientific publishers declined to take the book on the ground that it could not pay, we are indebted to Messrs. Newton and Co. for rescuing and producing a book which will be valued in many quarters.

Mr. Benham writes the history of the harmonograph, and describes his own triple pendulum and his own modification of Goold's twin elliptic pendulum. He also gives valuable information to anyone who would construct his apparatus as to the details which are necessary for success. The construction of the ruling pen, choice of inks or dyes, the selection of suitable paper, interesting dodges with photographic plates or with successive chemicals, are a few only of the tips or dodges described. The extremely beautiful stereoscopic effects obtained by viewing two nearly identical harmonograph figures with a stereoscope are described and illustrated, as is the curious change which occurs when such a pair of figures are slowly turned round at the same time, so as to change their relative aspect, the series of lines all appearing on the surface of a cylinder in the one position, and gradually merging into a series, each of which lies between the last one and the axis in the other position. In the case of figures drawn by the twin elliptic pendulum, where it would be next to impossible to draw two successive figures which should be sufficiently alike, the ingenious plan is adopted of selecting those which have a two-fold symmetry, but in which the two halves on opposite sides of the centre are not quite identical, and then simply turning one upside down, in order to obtain stereoscopic shell-like structures of wonderful beauty. Several examples of the marvellous beauty of the twin elliptic pendulum's work are given, in which it is difficult to know whether the forms of the curves or the water-mark patterns are the more to be admired.

Visitors at soirées of the Royal Society will remember the curves drawn by Mr. Goold's big twin elliptic pendulum, as also that queer vibrating and droning steel plate, which gave rise to so many curious phenomena. One passage from Mr. Goold's description may here be quoted.

"If . . . a small chain be thrown on the vibrating plate, it will immediately settle itself on the curved line between the vortices and . . . will crawl away to the nearest vortex, and there coil itself up like a serpent, continuing to rotate as long as the plate remains sufficiently excited."

This is one only of a number of curious results obtained by Mr. Goold.

Mr. Richard Kerr describes a form of geometric pen, capable of producing very beautiful patterns. This is followed by an account of Mr. Lewis Wright's method of projecting Lissajous's figures on a screen, using reeds in the place of tuning forks, and Prof. Wilberforce describes his well-known sympathetic vibrations obtained by the aid of one or two torsion springs.

This is an excellent book for the Christmas holidays.

C. V. Boys.

OUR BOOK SHELF.

Cattle of Southern India. By Lieut.-Col. W. D. Gunn. Department of Agriculture, Vol. III., Bulletin No. 60. Pp. 65; plates. (Madras: 1909.) Price 3*s.*

ALTHOUGH the existence of a number of local breeds and sub-breeds of Indian humped cattle (*Bos indicus*) is familiar to Anglo-Indians, comparatively little is known about them in this country, and it is, therefore, highly satisfactory that Col. Gunn, Superintendent of the Indian Civil Veterinary Department at Madras, has furnished us with this elaborately illustrated account of the various types to be met with in southern India. It is, however, a matter for regret that the author did not see his way to make his work complete by including the breeds found in other parts of India. As to the origin of humped cattle, the author is silent, and perhaps wisely so, since, so far as we are aware, nothing definite has hitherto been ascertained with regard to this subject.

If we rightly understand him—and his classification is by no means so clear and unmistakable as it might be—the author considers that there are two main types of large-humped cattle in southern India, namely, the Mysore and the Ongole, or Nellore. The former, which are characterised by the long, more or less upwardly directed, slightly tapering horns, and generally iron-grey or bluish colour, are, however, divisible into a number of sub-breeds, such as the Amrat Mahal, Hallikar, Alumbadi, &c., all of which come under the native designation of Doddadana, or large cattle, in contradistinction to the Nadudana, or ordinary small village cattle. The finest of all are the cattle of the Amrat Mahal breed, which were formerly owned by Tippu Sultan, but became the property of the British Government after the fall of Seringapatam, although the management of the herds remained for a time under the control of the Maharaja of Mysore, on condition of his supplying a specified number of bullocks. In the old days of Indian warfare these cattle were of the greatest value for transport-purposes on account of their rapid pace.

The Nellore, or Ongole, cattle, on the other hand, carry short and somewhat stumpy horns, which are, however, longer in cows than in bulls, and have an outward and slightly backward direction. Formerly black-and-white was in fashion, but white is

now the favourite colour for these cattle, the ears of which droop more than in the Mysore type. Although probably less hardy than the Mysore breeds, these cattle are unsurpassed for slow work, a pair, it is stated, being capable of drawing a load of five tons.

The volume closes with a notice of the domesticated buffaloes of southern India, special mention being made of the Toda customs associated with the cult of these animals. R. L.

Flora of Cornwall. Being an Account of the Flowering Plants and Ferns found in the County of Cornwall, including the Scilly Isles. By F. H. Davey. Pp. lxxxviii+570. (Penryn: F. Chegwidden, 1909.) Price 21*s.* net.

ON account of its extreme situation, the mildness of the climate, and the interesting rock formations, notably round the Lizard, the county of Cornwall exercises a great fascination for students interested in natural history. It is rather strange, therefore, that a county flora should only now be compiled, especially as many botanists—natives, aliens, and others—have found it a profitable hunting ground. Six years ago Mr. Davey published a preliminary list of plants which was deserving of the title of a flora, but this was only intended to form a basis for a more complete survey and to arouse interest in the undertaking; the intention has been entirely successful, and the author's subsequent labours, assisted by energetic and able co-workers, have culminated in the volume under notice, in which the total number of plants is computed at 1180; and of these, 953 are considered to be native.

The greater part of the book is devoted to the enumeration of species, with detailed list of localities for all but very common plants; in this matter the author has been over-bountiful, and space could have been saved by the elimination of the long list of localities for certain species that are in no sense critical, such as *Spiranthes autumnalis* or *Centranthus ruber*. The number of species found in Cornwall, but not recorded for any other county in Britain, amounts to twenty, while a comparison with Devonshire shows that fifty-three plants growing in Cornwall have not been collected in Devonshire, as against 103 confined to the latter county.

A considerable part of the introduction is given up to a history of botanists who have contributed to the county records, and a few photographs of notable local botanists are included; there is also a short account of eight botanical districts which are indicated on an accompanying map, and a list of a few plants peculiar to each, but the author has not attempted an ecological sketch of the chief formations. Among the Cornish botanists the best-known name is that of the Rev. C. A. Johns, the author of "Flowers of the Field" and "A Week at the Lizard," while William Curnow, T. R. Archer Briggs, and Richard Tellam were even more zealous field workers. Mr. Davey, too, has added his quota of records, for which he deserves to rank among the honoured list of local botanists, as also for the strenuous work in connection with this publication. The volume is worthy to rank with the standard county floras, more particularly in the verification of records and critical compilation.

The Elements of Animal Physiology. By Prof. W. A. Osborne. Pp. 152. (Melbourne: Thomas C. Lothian, 1909.)

THE size of this little book will indicate that it contains a mere sketch of the large subject of which it treats. It is written for the purpose of supplying non-medical readers with an introductory account of mammalian physiology, in the hope that they subsequently will take up the question more fully. Prof. Osborne has in Melbourne to teach students of agriculture and veterinary science, in addition to those who are taking full medical or science courses, and it is to the former class of students that the work is specially addressed. One can hardly doubt that agriculturists, especially in Australia, where the breeding of domestic animals forms such a large part of their work, will benefit greatly if they have a rational substratum of physiological facts at their disposal.

The book is trustworthy and free from errors; it is specially full on its biochemical side, which is what one would anticipate from Prof. Osborne's research work. Complex questions, such as those dealing with the nervous system, are treated with extreme brevity, and this is to be regarded as judicious, seeing what class of readers are specially catered for. We wish the book the success it deserves.

A Text-book of Experimental Physiology for Students of Medicine. By Dr. N. H. Alcock and Dr. F. O'B. Ellison. With a preface by Prof. E. H. Starling, F.R.S. Pp. xii+139. (London: J. and A. Churchill, 1909.) Price 5*s.* net.

To some extent this little book is the outcome of a conference of the London teachers of physiology. They have for long felt that a revision of their practical courses was necessary, and the present work, which is issued under the ægis of Prof. Starling, indicates the kind of reform considered desirable. One understands that in the future the practical examinations in the University of London, at any rate, will be largely modelled on the kind of course here presented. The main underlying new idea is that medical students should be taught physiology so as to fit them for being, not expert pure physiologists, but medical men with a knowledge of those portions of the vast subject which will be immediately useful to them in their study and treatment of diseased conditions. The frog is therefore relegated to a position of subsidiary importance, and as many experiments as possible are given in which the mammal, and especially man himself, is the *corpus vile*. It would be ungracious at this stage to point out faults of omission and commission of which the authors, Drs. Alcock and Ellison, have been guilty in their praiseworthy attempt to carry out the new idea. It will only be possible to do so when the book has been tried as a practical guide, and future editions will no doubt, show various improvements, after the present one has been subjected to this test. W. D. H.

Elementary Photo-micrography. By Walter Bagshaw. Second edition. Pp. 103. (London: Iliffe and Sons, Ltd., 1909.) Price 2*s.* 6*d.* net.

THE object of this little book is to arouse interest in, and give instruction to, those to whom such a study would otherwise possibly appear far too abstruse and full of difficulty. It is most clearly and lucidly written, and there is an evident desire to avoid unnecessary detail. It would be easy to criticise and to point out the many omissions of essential detail that to an advanced worker are only too obvious; but it must be admitted that for the beginner and intelligent worker the instructions would prove, in the majority of cases, ample. Nearly the whole of the course of work suggested may be carried out with simple apparatus: in fact, it is much to the credit of the writer that simplicity, and the absence of any recommendation to use complex apparatus, is the keynote of the entire book. It is perhaps to be regretted that, having gone so far, he has not in some directions slightly extended the work. The instructions in the use of the microscope itself are perhaps unneces-

sarily meagre, whereas such matter as a list of photographic chemicals required, with the prices—information that can be obtained from any trade catalogue—might easily have been omitted. On the whole, however, the object of the book is fulfilled, and it will form, to those who have a microscope of simple construction, or who, having a camera, wish to apply it for microscopic work as well, a most useful guide. The illustrations are in all cases of a high order, and have been selected, not merely as pictorial examples of photo-micrographic work, but, so far as possible, to bring home to the student the difficulties to be encountered and the results to be attained.

J. E. BARNARD.

LETTERS TO THE EDITOR.

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

The Inheritance of Acquired Characters.

IN reviewing Prof. Eigenmann's book on the cave vertebrates of America (NATURE, November 11, p. 40), the reviewer quotes the author's opinion that "The bleached condition of animals living in the dark, an individual environmental adaptation, is transmissible, and finally becomes hereditarily fixed. . . . Natural selection cannot have affected the coloration of the cave forms, for it can be of no consequence whether a cave species is white or black." Your reviewer further dismisses Romanes's supposition that colour may be correlated with other structures which are subject to selection.

Is it not probable that the *mere cessation* of natural selection with regard to colour would produce this colourless condition quite apart from light or other environmental factor?

In the silkworm moth, *Bombyx mori*, we have a similar absence of colour in both moth and larva, solely, I take it, because no attention has been paid to the colour of either during the many centuries that the species has been *selected for its silk-producing qualities* alone under semi-domestication.

While on this subject, I may perhaps refer to Mr. Wm. Wood Smyth's letter in NATURE of May 6 last (vol. lxxx., No. 2062, p. 277), with reference to the drone breeding habits of some workers of the hive bee affording a possible channel for use inheritance in regard to neuter characters.

I had hoped that this important point would have been the subject of further correspondence by the acknowledged authorities on apiculture.

I thought that this feature of egg-laying workers was, as a rule, confined to queenless hives that were more or less *in extremis*. Presumably the habit would be subject to heredity, and if, as I understand, it is not only a detriment but a source of danger to any community of bees to have any number of egg-laying workers, it seems reasonable to suppose that in wild stocks such a habit would be so stringently restricted by natural selection as to deprive its occasional occurrence in domesticated stocks of any significance in the production of the structural differences or special habits which differentiate workers from queens. It would be of very great interest to know if neuter ants of any species retain the power of laying occasional eggs.

A. BACOT.

MR. BACOT'S suggestion with regard to the cessation of natural selection in relation to the bleaching of cave animals has been fully dealt with by Prof. Eigenmann himself in the work under review. It will be only fair to Prof. Eigenmann to quote his own words:—"Panmixia can not account for the discharge of the colour, since it returns in some species when they are exposed to the light and disappears to a certain extent in others when kept in the dark. Panmixia, Romanes thinks, may have *helped* to discharge the colour. In many instances the colour is a protective adaptation, and therefore maintained by selection. Panmixia might in such instances lower the general average to what has been termed the 'birth-mean.' *Proteus* is perhaps such an instance. But in this species the bleached condition has not yet been hereditarily established, and since each individual is independently affected, 'the main cause of change must have been of that direct order which we understand by the term climatic.' Since, however, the bleached condition, which in the first instance is an individual reaction to the absence of light, has become hereditarily established in *Amblyopsis* so that the bleaching goes on even when the young are reared in the light, it is evident that in *Amblyopsis* we have the direct effect of the environment on the individual hereditarily established."

If Mr. Bacot will read the notice again he will see that the reference to "Romanes's supposition that colour may be correlated with other structures which are subject to selection" is a quotation. The reviewer still considers, however, that Prof. Eigenmann has made out a strong case.

ARTHUR DENDY.

Radio-activity and the Rocks.

MR. F. P. MENNELL, in NATURE of November 18, raises the question whether the more strongly active of the rock-forming minerals owe their activity to thorium. I have a considerable number of data on this subject obtained by direct experiment, estimating radium and thorium by their emanations. I find, by this method, that zircon, sphene, and apatite usually contain some thorium, but that it generally contributes less to the activity than the substances of the uranium-radium series.

R. J. STRUTT.

Imperial College of Science, South Kensington,
November 20.

The Auroral Display of October 18.

THE aurora of October 18 was observed at Allegheny Observatory under conditions somewhat similar to those mentioned by Mr. Ernest Baty in NATURE of October 28 (vol. lxxxi., p. 518). Here, however, the whole sky was dull, hazy, and cloudy at the beginning of the display, gradually clearing toward midnight. No stars whatever could be seen in the region covered by the aurora, which was very bright. This fact might lead us to think that it had its origin in the lower layers of the atmosphere.

The aurora consisted of the usual arch, from which arose streamers at various points, some of them extending to an altitude of about 45°. These drifted westward and gradually diminished in brightness, while they were followed by others in rapid succession. The streamers had at times a reddish tint.

The aurora was still faintly visible at 1 a.m., by which time the sky had become perfectly clear.

F. C. JORDAN.

Allegheny Observatory, Allegheny, Pa.,
November 9.

Large Flying-fish.

A FLYING-FISH flew on to the lower deck last night about 8.30 p.m. The deck is 20 feet above the water-line, and the railing is 4 feet 6 inches above the deck, but it is possible for it to have flown through the railing; the fish measured 17½ inches from tip of nose to tip of tail. I forgot to weigh it before it was cooked. It was the largest flying-fish I have ever handled. Could any reader of NATURE kindly inform me what is the largest size known? We were about fifty miles north of Teneriffe when it came on board. The species up here appear to be larger than those in the tropics and near South America. I have seen large ones in the Gulf of Aden, but never caught one, though I am inclined to think this was a larger species. The longest flyers always appear to be the largest fish; the longest flight I have seen has been about 400 yards.

C. HOWARD TRIPP.

S.S. *Kaipara*, October 15.

SPINAL ANÆSTHESIA.

THE visit of Prof. Thomas Jonnesco, of the University of Bucharest, to the Seamen's Hospital, Greenwich, has brought prominently before the public the method of producing local anæsthesia by the injection of anæsthetic solutions into the spinal canal.

Cocaine was introduced years ago as an anæsthetic for local application; it was welcomed by the medical profession, and equally by patients, on account of its invaluable services in operative procedures upon the eye, the nose and the throat. By merely placing a drop or two of a solution of cocaine (or one of its salts) into the eye, or by painting a similar solution upon the mucous membrane of the nose or throat, it is possible to produce anæsthesia so complete as to enable surgical operations to be performed upon these parts without inflicting the least pain or discomfort upon the patients. Certain objections to the use of cocaine were not long, however, in showing themselves. Cocaine is a powerful alkaloid; and if the usual dose be exceeded, very grave results follow, a number of patients having actually died as the result of cocaine poisoning. Investigators were therefore led to search for other substances, either like cocaine occurring naturally, or prepared synthetically, which would possess the properties of cocaine while being less poisonous.

In this way a number of anæsthetic drugs has been introduced, including alypin, holocaine, eucaine (alpha and beta), scopolamine, novocaine, stovaine and tropacocaine. Of these the three latter have been chiefly employed in producing spinal anæsthesia. The method consists in injecting, by means of a syringe and needle, a quantity (usually about 1 c.c.) of a solution of one of these substances into the spinal canal. The injection is made in the back, close to the middle line, the needle being inserted between two of the vertebræ. With regard to the details of the method, various procedures have been described, and no agreement has yet been reached as to which of these is to be considered the best. There is no doubt that modifications are desirable to suit particular requirements. Thus, many operators direct that the drug be dissolved in cerebro-spinal fluid or else in a saline solution having the same specific gravity and the same osmotic tension as the blood-serum. Others consider that the anæsthetic solution should be considerably denser or more viscous than the cerebro-spinal fluid, and for this purpose recommend the addition of glucose or of gum-acacia to the solution. These thicker solutions tend to remain at the spot at which they are injected, while solutions in cerebro-spinal fluid or in normal saline tend to spread up and down the spinal canal, and thus have a more widespread anæsthetic effect. It is usual to withdraw a few c.cm. of cerebro-spinal fluid from the spinal canal before injecting the anæsthetic fluid. There are two reasons for this—first, the surgeon is assured that he has actually introduced his needle into the spinal canal, and secondly he is certain to avoid increasing unduly the cerebro-spinal pressure when he introduces the anæsthetising fluid.

On introducing the fluid into a particular part of the spinal column, anæsthesia is produced of all parts of the body deriving their nerve supply from this part of the spinal cord, and all parts below. If the fluid be allowed to ascend the spinal canal (*e.g.* by raising the hips) the anæsthesia rises higher and higher as the anæsthetic fluid reaches the trunks of the nerves arising from the higher parts of the spinal cord. If the patient be placed on one side while the injection is being performed, the anæsthetic fluid can be made to enter one lateral half of the spinal canal, and in this way it is possible to limit the anæsthesia to one lateral half of the body.

The anæsthetic fluid can be allowed to ascend almost to the top of the thoracic spine without fear of untoward consequences. When it reaches the base of the neck, however, the phrenic nerve, concerned with the movements of respiration, becomes involved, and it was deemed impracticable to produce anæsthesia of the head and neck by the spinal method. Prof. Jonnesco, however, has shown that the addition of strychnine to the anæsthetic solution produces so powerful a stimulant effect upon the respiratory centre in the brain that it is possible to introduce an anæsthetic fluid into the upper part of the thoracic spine, and to allow the fluid to ascend the spinal canal in the neck so as to enable operations to be performed upon the neck and throat. But it is as yet too early to say whether this method may be considered a safe one.

Of the three drugs which are now chiefly used for the production of spinal anæsthesia, stovaine is found to produce the most deleterious effect upon the kidneys, acute nephritis having followed its injection in quite a number of cases. Novocaine and tropacocaine are less injurious in this way, while they are equally efficacious as anæsthetics. It thus appears likely that they will supplant stovaine in the near future, and, in fact, tropacocaine in a one per cent. solution is already being largely used for the purpose in this country, the usual dose injected being about 1¼ grain.

No doubt further experience will lead to modifications in the present method of performing spinal anæsthesia which will result in its widespread use, as there are a great many cases in which a local anæsthetic is far more advantageous to both patient and surgeon than a general anæsthetic.

A. C. J.

THE CAUSES OF THE GERMINATIVE PROCESSES OF SEEDS.

ONE of the most remarkable phenomena of vegetable life is the occurrence in its cycle of a resting period of varying duration, a period during which the vital functions seem entirely suspended or dormant, and the condition of the organism is hardly distinguishable from death. This stage is most common in connection with the reproductive processes, and can be seen to belong to the constitution of both spores and seeds. The more highly differentiated the structure which shows it, the more prolonged, apparently, can be this resting period, but sooner or later it gives place to the resumption of growth and vital activities.

The interpretation of the occurrence of this phase is rather a matter of inference than proof; probably it was originally concerned in the protection of the reproductive structure from adverse conditions of the environment, for not only is the life rendered dormant, but the resting organ is for the most part protected by modification of its tegumentary covering. In this condition it is able also to bear the severance of its organic connection with its parent, and to subserve the purposes of dispersal. It may, indeed, have arisen with special reference to the latter process alone.

The resumption of the growth and development of the reproductive body after the period of rest may be explained in a similar manner by the reversal of the adverse conditions, these being for the most part secured when its dispersal has been effected.

These superficial considerations are found, however, on reflection, to have others underlying them. Is the resting period of any advantage to the living substance of the reproductive structure, whether spore

or seed? Does the cessation of the vital activity afford it any increased power of growth or vigour of constitution? Is it only a condition induced by circumstances, or does it speak of a rhythmic tendency inherent in the plant?

More interesting still—Is the resumption of life which we call germination an evidence of the attainment of such increased vigour, or is it merely the resumption of ordinary chemical change when inhibiting conditions are removed? In the latter case, is the living substance concerned in setting up such chemical changes, or do these arise without such initiation?

If we study the germinative changes we find them associated universally with the existence and activity of enzymes. The resting germ, whether the structure be seed or spore, is surrounded by food material deposited for its ultimate nutrition, but needing enzymic action to render it suitable for actual assimilation. The number of such enzymes known to physiologists has increased most remarkably during the last decade, and though they have been found to be most plentiful in seeds, the study of the spore has shown that it is similarly equipped, though from its unicellular character the distribution of the enzymes is much simpler. At a certain moment the germ starts into life, simultaneously the enzymes are found at work, and nutritive pabulum is presented to it in assimilable form. Which is cause and which effect? Does the living substance, awaking from a sleep, start the enzymic activity, or do the enzymes originate the change? Is the activity of the living substance itself due to enzyme action? In other words, is life a question of the existence and activity of enzymes?

These subjects can be studied more advantageously in a seed than in a spore on account of the physiological as well as anatomical differentiation which it presents. It is easy to distinguish the germ which, after resumption of growth, becomes the new plant, and to separate it from the stores of food which are laid up for its nutrition, and which will be the sphere of activity of the digestive enzymes. These stores may be within it or lying around it, but they in any case are well away from its actual growing points. In such a seed, then, we can distinguish the germ, or embryo, the new plant, and the remains of the parent which has given it origin, this being sometimes large, sometimes small, in proportion to the former.

At the outset we may ask, what is the actual condition of these two parts? How far can we find evidence of life in either during the period that elapses between the severance from the parent plant and the resumption of growth and activity after the resting stage? If we study the phenomena of life in the seed as a whole, we are led to apply to it the test of the existence and maintenance of respiration, this being the inseparable accompaniment of metabolic change and hence a constant feature of life in the various conditions with which we are acquainted. If we rely on either the absorption of oxygen or the exhalation of carbon dioxide, however, we shall be obliged to deny the presence of life in the seed at all. Many and careful examinations have been made of the respiratory processes in seeds of many descriptions. Perhaps the most exhaustive of them were those of Romanes in 1893. Seeds of various plants were kept in glass tubes which had been exhausted so completely that they contained only one-millionth of an atmosphere, and were left for upwards of a year. This treatment did not hinder their subsequent germination. Some of them were afterwards immersed in various inert gases, such as hydrogen and nitrogen, others placed in carbon monoxide, sulphuretted hydrogen, vapours of ether and chloroform, and kept thus for twelve months, still without any deleterious effects. It seems hard to suppose them living in the usual acceptation of the term. In 1892 Jodin imprisoned some seeds in ordinary air in hermetically sealed flasks; he kept them so for four years, and examination of the air at the conclusion of this term showed its composition absolutely unchanged, no exhalation of carbon dioxide having taken place. Respiration, as ordinarily understood, thus seems to be quite in abeyance.

The suspension, if not disappearance, of life during this resting period is emphasised by the behaviour of the seeds under exposure to extremes of temperature. Observations made by Wartmann so long ago as 1860 showed that germination was not prevented by preliminary exposure of the seeds to temperatures ranging from −40° to −78° C. This does not seem, however, to prove the point, for the normal temperature of agricultural land in Siberia in winter is almost as low, often reaching −60° C. Experiments were made by de Candolle and Pictet in 1879 which carried the range of temperature a little further, but the most drastic treatment was rendered possible by the liquefaction of air. Experiments with the aid of this powerful reagent have been made in France by Pictet, and in England by Brown and Escombe and by Sir W. Thiselton-Dyer, with the result that such extreme cold had very little effect in inhibiting the power of subsequent germination.

At the other end of the thermometric scale strange results have been found, many seeds having been proved capable of germinating after being exposed for a short time to temperatures higher than the boiling point of water. So long ago as 1877, Just heated seeds of a species of Trifolium to 120° C. without injuring their power of development. Some years later a more extended series of experiments was carried out by Dixon on seeds selected from several natural orders, all of which withstood, without injury, a temperature of about 105° C. prolonged for several hours. Their vitality and power of development were, however, much more easily affected by heat than by cold.

This resistance to great extremes of temperature has been found to be correlated in a considerable degree with the state of desiccation which was characteristic of the seeds. Hence is lent some support to the view of the dependence of germination on enzymic action, for the latter can only be exercised in the presence of water. Some experiments carried out by Acton in 1893 seem to show that even the small amount of water in the wheat grain enables a certain amount of digestive change to take place in both the proteins and the carbohydrates of the grain. In the absence of all moisture the enzymes remain quiescent.

As it is generally accepted that chemical action cannot take place at temperatures so low as those specified, and as chemical change or metabolic activity is an inevitable accompaniment of life as defined by Herbert Spencer, the idea that germination is dependent upon the continued and permanent life of the protoplasm in the resting seed, there have been many efforts made to explain these anomalous manifestations. C. de Candolle concluded that after a certain time the protoplasm of the ripe seed passes into a state of complete inertness, in which it is incapable of either respiration or assimilation, and that while in this condition it can support, without detriment to its subsequent revival, rapid and considerable lowering of temperature. Indeed, the access of cold to a seed seems to be only injurious as it can bring about the freezing of the water remaining in it, with the subsequent thawing as the temperature

rises again. This freezing once brought about, further and more intense cold has no effect. Brown and Escombe endorsed de Candolle's idea, suggesting that protoplasm may exist in two conditions, the *static* and the *kinetic* in the former becoming so stable as to be absolutely inert, devoid of any trace of metabolic activity, and yet conserving the potentiality of life.

It is extremely difficult to decide which of the two theories provides the most satisfactory explanation of the observed phenomena. The conditions which mark the commencement of germination help us, however, to come to a conclusion, though difficulties are met with in either hypothesis. For germination to occur, moisture must be absorbed by the seed; absorption of oxygen and exhalation of carbon dioxide speedily follow, enzymic action supervenes, and the digestive changes in the reserve food materials can be readily traced. But what is the first result of the absorption of water is not so clear; is it the resumption of the kinetic condition by the protoplasm, the life of which in all other parts can be seen to be dependent on water, or is it the setting up of the activity of the enzymes, which enables metabolic, and possibly respiratory, changes to take place, such chemical action stimulating the latent life to manifestation?

Certain observations tend to show that the activity commences with changes in the embryo or germ. Van Tieghem, many years ago, endeavoured to excite into activity the endosperm of the castor-oil bean after removing from it every particle of the embryo. In most cases he failed, but in some he claimed to have been successful. The writer, many years afterwards, repeated his experiments, and found that the endosperm could only be quickened when a small portion of the germ was left in contact with it. The changes in this case originated in the embryo. Further observations showed that the earliest sign of germination in the latter is a change in certain cells of its epidermis, which take on the appearances that usually indicate the conversion of a zymogen into an enzyme. The germ appears to start the change by the secretion of an enzyme. It seems justifiable to associate this secretion with the re-assumption of life by the embryo, because, though many enzymes occur in the seed outside the latter, they do not initiate their changes until later. In this particular seed, vital activity is subsequently soon manifested in the tissue of the endosperm, which becomes the scene of very active chemical change, its residual protoplasm growing and secreting certain constituents, particularly sugars, which the resting cells do not contain.

Brown and Morris showed that a somewhat similar procedure can be observed in the barley grain. The first visible changes are the secretion of enzymes by the scutellum of the germ. The germination once started, other enzymes make their appearance in the endosperm, some arising especially from the aleurone layer underlying the testa.

A scrutiny of the results of Dixon's experiments on heating the resting seeds points also to the protoplasm as the initiator of the changes. Exposure of his seeds to 105° C. must have destroyed any preformed enzymes unless the cells were absolutely devoid of water, a condition hardly likely to be reached. The germinative power fell gradually, or nearly regularly, as the heating was raised to this point, but much remained. When, however, a very slightly higher temperature was reached, about 107° C., the seeds lost it with great suddenness and very irregularly. The injury inflicted by the last two degrees was very different from that which was sustained as the temperature gradually rose to 105° C., and was hardly explicable on the theory of enzyme destruction. It did not, at any rate, correspond to the progress of their destruction in the laboratory.

Some experiments recently carried out by Miss White in Prof. Ewart's laboratory at Melbourne bear upon this aspect of the problem. She endeavoured to accelerate the germinative processes in seeds which had but little power of germination by supplying them with additional quantities of enzymes dissolved in the water with which they were kept moist, the coats of the seeds being perforated here and there to allow absorption to take place. Though she examined many in various conditions, the result was always negative. It proved impossible to accelerate germination by supplying additional quantities of enzyme.

Experiments made by supplying resting seeds with reagents such as dilute organic acids, which stimulate their secretion of enzymes, also have been found to be without result.

The idea that enzymes initiate and maintain the process of germination appears, therefore, to be erroneous, and the older view of the sufficiency of the idioplasm of the cells still holds the field, in spite of the difficulties that have been raised by the experiments with temperature. The theory of static and kinetic states of protoplasm explains little or nothing; it is really scarcely more than a statement of the problem in new terms.

J. REYNOLDS GREEN.

DR. W. J. RUSSELL, F.R.S.

WILLIAM JAMES RUSSELL was born in May, 1830, at Gloucester, where his father was a banker. He was educated at private schools—Dr. Wreford's at Bristol, and afterwards at Mr. Bache's at Birmingham. In passing, it may be noted that this was before the educational revival that produced and was furthered by the Public Schools Commission of 1859, and that in those days there were very many private schools where scholarship was carried to quite as high a level, and when the conditions of out-of-school life were in some respects much better than in most of the public schools of the time.

After leaving school in 1847, Russell entered University College, London, where he studied chemistry under Thomas Graham and Williamson. In 1851 he was appointed the first demonstrator of chemistry under Frankland in the then newly-founded Owens College, and helped to plan and superintend the building of the first chemical laboratory of the college. This laboratory, built on what had been the garden attached to the original college building (Mr. Cobden's old house in Quay Street), was the cradle of the great Manchester School of Chemistry, which has become as famous in its way as the Manchester School of Politics. After two years at Owens College, Russell went to Heidelberg, where he worked under Bunsen from the autumn of 1853 to the end of the session 1854–5. During his stay at Heidelberg, he graduated as Ph.D. After his return to England, he lectured at the Midland Institute, Birmingham, and near the end of 1857 came again to London to act as assistant to Williamson, his former teacher, at University College. He was associated with Williamson for several years, a considerable part of the time being occupied with working out and bringing to a convenient practical form a method of gas-analysis whereby the corrections involved in taking account of variation of pressure and temperature were in great measure eliminated. The results of this investigation were embodied in several papers published in the Journal of the Chemical Society and elsewhere, and the form of apparatus finally arrived at was the forerunner of the most improved modern types of gas-analysis apparatus and

instruments for the application of the measurements of gases to quantitative analysis.

From 1868 to 1870, Dr. Russell was lecturer on chemistry in the Medical School of St. Mary's Hospital. In the latter year he was appointed to a similar office at St. Bartholomew's and retained this appointment until 1897. After his retirement, he continued his experimental work, and until very recently was actively occupied at the Davy-Faraday Laboratory. He died at his house at Ringwood, after a very short illness, on the twelfth of the present month (November, 1909).

At the time of his death, Dr. Russell was one of the oldest Fellows of the Chemical Society, having been elected in 1851. He served on the council from 1863 to 1867, and from 1870 onwards his official connection with the society was unbroken: he was a member of the council from 1870 to 1872; vice-president, 1872 to 1873; secretary, 1873 to 1875; treasurer, 1875 to 1889; president, 1889 to 1891, and since the last date a permanent vice-president. The society, which was only ten years old when Russell joined it, celebrated the jubilee of its foundation in 1891, during his term of office as president. It naturally devolved upon him to take the leading part in the proceedings, and all who were present must have been struck by the admirable manner in which he acquitted himself. He had to make many speeches, long or short, and they were always simple and appropriate. Without wasting words, or any apparent striving after effect, he managed every time to say exactly what wanted saying.

He was elected a Fellow of the Royal Society in 1872; he served twice on the council, and was a vice-president from 1897 to 1899. He was an original member of the Institute of Chemistry, founded in 1877, was president from 1894 to 1897, and served various other offices between 1878 and 1904.

Dr. Russell's connection with Bedford College (London) extended over many years of his life, and was of very great value to the college. It began with his being appointed professor of natural philosophy in 1860. He retained this office until 1870, and opened in 1860 the first laboratory accessible to women-students for practical work at science. He was a member of the council of the college from 1878 to 1903, being chairman from 1887, and also chairman of the college board of education from 1895. During Dr. Russell's chairmanship, the college was twice enlarged, and at the end of his term of office the necessity for still further extension had become so pressing that it was decided to start a fund to provide an entirely new building. He was an active supporter of this movement, and contributed liberally to the fund.

Dr. Russell's contributions to the methods of gas-analysis have been mentioned already. Among other investigations, we may refer to those relating to the atomic weights of nickel and cobalt (1863 and 1869), which were important in consequence of the way in which results obtained by very different methods were employed to check each other; a series of papers in conjunction with Dr. Samuel West, F.R.S., on a new method of estimating urea, which gave rise to a valuable clinical method; papers (conjointly with Mr. Lapraik) on absorption spectra, and notably one on the absorption bands in the visible spectra of colourless liquids, which was the pioneer paper in a branch of inquiry that has been most ably followed up by Prof. Noel Hartley, F.R.S., Mr. E. C. C. Baly, F.R.S., and others; a remarkable series of papers on the action of metals, resins, wood and other materials on a photographic plate in the dark. Some of the results of this investigation were given to the Royal Society as the Bakerian lecture for 1898. By well-directed and persevering experiments, the effects observed were traced to the generation of peroxide of hydrogen. In another set of experiments on the figures formed by the deposition of dust, Dr. Russell demonstrated the curiously definite course of the convection currents of air that rise from a heated solid body.

A report made to the Science and Art Department, in conjunction with Sir William Abney, on the action of light on water-colours was published as a Blue Book in 1888. It involved a very careful investigation of the subject, and was highly appreciated by artists. A committee consisting of the president and other prominent members of the Royal Academy in reporting on it said that they "unanimously desired to record their sense of the very great value and of the thoroughness and ability with which so laborious an inquiry had been conducted."

In manner, Russell was quiet and entirely free from anything approaching self-advertisement, but he was genial and hearty with his friends, and was gifted with a sympathetic laugh that it was always refreshing to hear. As some indication, both qualitative and quantitative, of the estimate formed of him by his fellows, it may not be out of place to mention that, as a young man, he was the first secretary, treasurer, and keeper of the archives of the B Club—originally a society of young chemists which grew out of Section B of the British Association, first took definite shape at the Oxford meeting in 1860, and kept itself alive between the meetings of the Association by consuming monthly beef-steak puddings at the "Cheshire Cheese"—and that, in later life, he was elected to serve on the committee of the Athenæum Club. His death will be felt as a sore personal loss by very many. He was liked by all who knew him, and by all who knew him intimately he was held in affectionate esteem.

Dr. Russell married, in 1862, Fanny, daughter of the late A. Follett Osler, F.R.S., of Edgbaston. He leaves one son, and a daughter married to Dr. Alexander Scott, F.R.S. G. C. F.

NOTES.

THE *Standard* for November 22 contains a full list of the House of Lords, classified according to their qualifications. It is disappointing to find only two names—those of Baron Rayleigh and Baron Lister—under the heading "Scientists," while "Educationists" are only represented by Baron Ashcombe, member of council of Selwyn College; Baron Killanin, member of Senate of Royal University of Ireland; and the Earl of Stamford, formerly professor of classics and philosophy at Codrington College, Barbados. There are thirty-five railway directors, thirty-five bankers, and thirty-nine so-called "captains of industry" on the list, and a column and a half under "Military and Naval Services."

AT the meeting of the Royal Society of Edinburgh on Monday, November 22, the Makdougall-Brisbane prize for the biennial period 1906–8 was presented to Mr. D. T. Gwynne-Vaughan for his papers (1) "On the Fossil Osmundaceæ," and (2) "On the Origin of the Adaxially Curved Leaf-trace in the Filicales"; and the Gunning Victoria Jubilee prize for the third quadrennial period 1904–8 was presented to Prof. G. Chrystal, for "A Series of Papers on 'Seiches,' including 'The Hydrodynamical Theory and Experimental Investigations of the Seiche Phenomena of Certain Scottish Lakes.'"

THE Livingstone gold medal of the Royal Scottish Geographical Society has been presented to Sir Ernest Shackleton, in recognition of his work in the Antarctic.

PROF. W. BATESON, F.R.S., professor of biology in the University of Cambridge, has been appointed director of the John Innes Horticultural Institution at Merton, Surrey.

LIEUT.-COLONEL D. PRAIN, F.R.S., director of the Royal Botanic Gardens, Kew, and Prof. F. O. Bower, F.R.S., regius professor of botany in the University of Glasgow, have been elected corresponding members of the Munich Academy of Sciences.

THE council of the Royal Meteorological Society has awarded the Symons gold medal to Dr. W. N. Shaw, F.R.S., in recognition of the valuable work which he has done in connection with meteorological science. The medal will be presented at the annual general meeting of the society on January 20, 1910.

THE King has approved of the Polar medal, with a clasp, inscribed "Antarctic, 1907–1909," being granted to members of the Shackleton Antarctic Expedition, 1907–9, the clasp alone being awarded to those who already possess the Polar medal; the medal and clasp to be in silver for the shore party and in bronze for those who remained with the ship.

DR. T. G. LONGSTAFF writes to the *Times* from Kashmir to correct a statement made in the issue of October 1, and referred to in NATURE of October 7, to the effect that he had found that the source of the Tarim River of Kashgaria is in the Siachen Glacier of Nubra. He says that what he has just been able to prove is that the Siachen Glacier of Nubra is merely the lower portion of the glacier found beyond the Saltoro Pass by Dr. A. Neve, Lieut. Slingsby, and himself in June last, and temporarily designated the Terim Glacier.

A MEETING of subscribers, both ladies and gentlemen, will be held at 5 p.m. on Tuesday, November 30, at the rooms of the Society of Antiquaries, Burlington House, London, to determine in what manner the fund which has been raised as a memorial to the late Prof. Arthur Gamgee should be applied to serve the object for which it was collected. Subscriptions may be sent to Prof. Arthur Schuster, Victoria Park, Manchester; Dr. A. D. Waller, Physiological Laboratory, University of London, S.W.; or Dr. G. A. Buckmaster, University College, London, W.C.

THE annual meeting of the Iron and Steel Institute will be held on Wednesday and Thursday, May 4 and 5, 1910. The proceedings will begin by the induction of the new president, the Duke of Devonshire, into the presidential chair by the retiring president, Sir Hugh Bell, Bart. Under the new bye-laws the council now has the power to elect honorary vice-presidents from among distinguished members of the institute who, by reason of their residence out of Great Britain, are unable to take a very active part in the affairs of the institute. The council has accordingly elected the following to the office of honorary vice-president:—Mr. John Fritz, United States; Mr. William Kestranek, Austria; Baron Fernand d'Huart, France; Mr. F. W. Lürmann, Germany; and Mr. E. J. Ljungberg, Sweden.

THE summary of the weather for the week ending November 20, issued by the Meteorological Office, shows that the conditions for the period were generally dry and fine over the entire kingdom. The temperature was everywhere below the average, the deficiency amounting to 11·6° in the west and east of Scotland, 9·6° in the north of Scotland, and 8·7° in the north-west of England. The minima, which occurred in most places about the middle of the week, were extremely low in Ireland and Scotland, making a record for November in parts. At Balmoral the sheltered thermometer on November 16 fell to 3°. The radiation temperature on the grass fell to −5° at Crathes, in the east of Scotland, to zero at Balmoral, and to 8° at Markree Castle. At Greenwich frost occurred only on one night in the shade during the period, but in the open, on the grass, there was a frost each night. The rainfall was less than the average in all parts of the kingdom, and in many parts the week was rainless.

ON November 18 and succeeding days the famous volcanic mountain Pico de Teyde, on the north-west of the island of Teneriffe, was in eruption from four craters lying from east to west. The two inside craters are reported to be active alternately, emitting liquid lava only. Owing to the configuration of the ground it is not possible to dam the lava streams or to divert them into channels where they would do less damage. On November 21 the lava stream is said to have travelled 3¾ miles since the beginning of the eruption. An official telegram from Teneriffe on November 23 reports:—"The chief crater continues to throw out large quantities of incandescent matter to a height of above 2000 feet. The flow of lava is increasing in volume. The stream running down the Santiago Valley has divided into two, each 12 feet deep and of constantly increasing breadth. The stream flowing in the direction of the Tauranno is advancing more rapidly, and will shortly be swollen by its junction with another stream which has branched off from the main flow. The lowest point of the stream flowing towards Tanque has made no progress since yesterday, and there appears for the moment to be no fear of its resuming its advance, as the crater by which it is fed is becoming less active. On the other hand, the activity of the craters from which the lava flows towards the Santiago Valley is increasing."

THE board of anthropological studies of the University of Cambridge recently re-appointed Mr. A. R. Brown, of Trinity College, to the Anthony Wilkin studentship. This studentship was founded in 1905 in memory of Anthony Wilkin, of King's College, Cambridge, by his parents, for the encouragement of research in ethnology and archæology. Mr. Brown was elected to the first studentship in the same year, having intimated his desire of studying the social structure and religion of the Andaman Islanders. He returned about eighteen months ago, and since that time has been occupied in writing up his field notes. It is expected that his monograph on the Andaman Islanders will be published next spring. Dr. A. C. Haddon informs us that Mr. Brown's next expedition will be to Western Australia. Extremely little is known about the ethnology of the whole western portion of Australia, and as Westralia is being rapidly developed it is essential that the natives should be thoroughly studied before it is too late. From what little is known, it is evident that the social system of the natives is not uniform, and it is to be hoped that the transition from one form of social organisation to another may be discovered. Mr. Brown proposes to make a general survey of the social and religious conditions of as many tribes as possible, and to make a minute study of one or two of them. If funds permit, he will traverse the continent so as to link up his observations with those of other ethnologists, and at the same time he may be able to clear up some disputed points in the results obtained by previous workers in the field.

THE eighth exhibition of motor-cars arranged by the ociety of Motor Manufacturers and Traders was held at Olympia during last week. The principal point regarding the many cars exhibited is the almost entire absence of chain drive; in almost every case the live axle is adopted.

In several cases the gear-box is secured rigidly to the engine, thus securing correct alignment should warping of the frame of the car occur. Many of the cars are fitted with front-wheel brakes; the Allen-Liversidge arrangement consists of band brakes on drums secured to the steering wheels on the steering bracket sides, and operated by means of cables passing over pulleys mounted on the steering pivots. The risk of side-slip is much reduced by having the brakes on the front wheels. Most of the cars are petrol driven, steam and electric cars being represented by a few examples only. Among the many accessories shown, the Bowden speed indicator is worthy of notice. In this indicator five steel balls move in radial slots in a rotating disc, and as the speed increases they move outwards and also upwards, being guided by a cup-shaped disc, on which they rest. Another disc, resting on the top of the balls, thus has an upward movement communicated to it, and actuates a pointer through a rack and pinion gearing. The indicator has great sensitiveness and freedom from lag, and, owing to the absence of revolving links, springs, &c., should be applicable to the indicating of much higher speeds of rotation than most instruments at present available are capable of dealing with.

THE subject of the prehistoric antiquities of Scandinavia continues to receive attention in *Naturen*, Prof. A. W. Brøgger contributing an article to the November number in which objects of this nature are figured. Attention is directed to the light thrown on Scandinavian antiquities by those of other countries. Among the figures are copies of two excellent prehistoric representations of reindeer and another of a bear.

THE progress of the plan for marking young birds in this country, initiated by the editors of *Witherby's British Birds*, forms the subject of a note in the November issue of that serial. Out of 4750 rings issued, only 2200 are reported as having been used, this comparatively small proportion being largely due to the late date on which the distribution was made. Taking this fact into consideration, the originators of the scheme consider that the number of birds ringed is satisfactory, and lend to expectation of interesting results, which it is hoped will be exceeded next year, when the rings will be issued sooner.

IN the report of the Museums of the Brooklyn Institute of Arts and Sciences for 1908, Dr. F. A. Lucas is enabled to record a marked improvement in the exhibition series owing to the completion of the east wing of the main building. Great stress is laid on the importance of displaying the exhibits in a picturesque and attractive manner, which can be done, if proper care be exercised, without in any way impairing their scientific interest. It is intended to add pictures of invertebrate life above the cases devoted to the lower organisms, and a beginning has been made in the shape of a sketch of a coral-reef. Other paintings are to be devoted to the beach of a coral-island, the purple jelly-fish, and the Portuguese man-of-war. Attention is directed to a recently mounted group of hoatzias, of which a photograph forms the frontispiece to the report.

IN the September number of the Biological Bulletin of the Woods Hole Laboratory Prof. Raymond Pearl and Miss M. R. Curtis give an account of a partially hermaphrodite Plymouth rock fowl hatched at the Maine Agricultural Station in the spring of 1907, and killed in August, 1908. As regards colour and bodily shape, this bird resembled a normal female of the breed, but the head and neck, especially in respect of the development of the comb and wattle, recalled a young cock. In general behaviour it resembled a hen rather than a cock, although it occasionally made unsuccessful attempts to crow. Internally a large lobulated gland on the left side occupied the position of the normal ovary, while there was also a complete and functional oviduct; but on the opposite side occurred a small organ representing a testicle, with a normal efferent duct leading to the cloaca. The sexual glands of each type were in a degenerate condition, and apparently incapable of developing their proper sexual elements. The authors of the paper cite another instance of incomplete hermaphroditism in domesticated fowls, as well as one in which the hermaphroditic character was fully developed.

AFTER describing certain new forms of the remarkable fossils typified by those named Edestus, Prof. O. P. Hay, in No. 1699 (vol. xxxvii., pp. 43–61) of the Proceedings of the U.S. National Museum, discusses the nature of these spiral serrated structures. It has been generally considered that these structures represent the spines found on the tails of rays like Trygon. Dr. Hay is, however, of opinion that they should be associated with the dorsal fin. Their structure may be most easily explained "by supposing that some ancient elasmobranchs developed in front of a median dorsal fin, or in place of it, not a single spine, but a succession of them. The new compressed spine, serrated in front and behind, arose in front of the older ones. Nevertheless, the root of the new spine became directed backward beneath and on each side of the preceding one, so as partly to embrace it. At first probably the older spines were shed, but in time they began to cohere and thus form a compound spine. In Edestus this was straight or slightly bent. All, or nearly all, of it, except the serrated teeth, was buried in the flesh. As more and more elements were added, the organ became more curved, and finally in some species formed a spiral, which was directed backward and the last turn of the shaft of which was elevated enough to keep the teeth from cutting into the skin. Such a weapon could be brought into action if only its possessor had dived under its victim and brought the spine across its abdomen, thus disembowelling it. . . . It is in this way that Gasterosteus attacks its victims."

THE abnormality known as vivipary, in which young shoots are formed in place of flowers, is described by Mr. G. N. Collins in Contributions from the United States National Herbarium (vol. xii., part x.) for some varieties of the maize plant imported from Mexico and Central America into the States. The shoots arise in the axil of a glume in the position of staminate spikelets, and roots are developed at the base; plantlets placed in the ground made some growth, but failed to mature. The phenomenon is attributed to the excessive vegetative growth shown by tropical varieties of corn when transported to a temperate region. The title-page and index to the volume have now been issued.

AN account of the pear thrips, *Euthrips pyri*, prepared by Mr. D. Moulton, and published by the United States Department of Agriculture as Bulletin No. 68, part i., of the Bureau of Entomology, is the outcome of the writer's investigation of a pest which flourished for two years in the San Francisco region. There is an instructive comparison of the light ravages on the early flowering almond, with the destruction caused on the later blooming prunes, cherries, and pears, that open their flower buds just as the thrips reach their active feeding stage. During the second larval stage the insect enters the ground, where it pupates, and finally emerges as an adult thrip in the spring.

The underground hibernation provides an opportunity for killing the larvæ by ploughing; also the insect has various natural enemies in the shape of spiders, mites, and an unidentified fungus.

An article on *Cornus macrophylla* and other species of the genus is communicated by Mr. B. Hemsley to the *Kew Bulletin* (No. 8). He points out that two evidently different species are passing under the name of *Cornus macrophylla*, the one with opposite leaves, correctly named, the other with alternate leaves, for which he proposes the name *Cornus controversa*. He also describes three new Asiatic species, and discusses the nomenclature of some recent determinations. A short note that deserves mention, partly with the view of eliciting more information, refers to the reported use of plant extracts in Siam as remedies for snake-bite. The evidence depends upon the testimony of natives, who supplied specimens of the plants, which have been identified as *Barleria lupulina* and *Justicia Gendarussa*, both members of the Acanthaceæ. The extract gave characteristic alkaloidal reactions, and contained a quantity of calcium and potassium; these properties are possessed by several plants of this family.

The Journal, formerly called the Bulletin, of the Tokyo College of Agriculture, recently received, contains several papers on the availability of various phosphatic manures and on the influence on crop-yields of different ratios of lime to magnesia in the soil, a subject to which considerable attention has been paid in Japan. One of the most striking results obtained was that the manurial value of lecithin is about equal to that of sodium phosphate, whilst phytin is nearly equivalent to ferric or aluminium phosphate; nuclein possesses very little manurial value. The experiments were made in soil culture, but similar results are said to be obtained in sand culture also. Of these three compounds, phytin occurs most commonly in plants, and the other two in much smaller quantities. The experiments were devised to throw light on the changes taking place when vegetable matter is dug into the ground, and to explain the beneficial effect on the succeeding crop.

The Department of Agriculture, Madras, has issued a bulletin describing improvements in paddy cultivation on a farm under the management of the Court of Wards. The best and cheapest fertiliser was found to be farmyard manure, but a sufficient quantity is not available, and recourse is therefore had to other fertilising materials. Certain plant residues, leaves, poonacs, &c., may be used, but they are too expensive if they have to be brought from any distance. The most successful plan has been to cultivate leguminous crops on the wet land itself during the dry season and in the season in which there are only occasional showers of rain, then to pull up and trample in the crop after ploughing the land.

The Bulletin of Agricultural Information of the Department of Agriculture, Trinidad, contains numerous notes on cacao. The maintenance of the fertility of the soil is likely to become an important problem before long; at present it is not unusual for a few acres of land to be rented, and when they cease to be remunerative for the tenant to go elsewhere. The land is then abandoned for a few years, covers itself with bush, which is subsequently cleared and burnt, cropped for a short time, and again abandoned. Another source of loss is found in the heavy tropical rain, which washes away finer soil particles as well as some of the plant food. This and other local problems are dealt with at some length.

The geological age of *Homo heidelbergensis* is discussed by Dr. Emil Werth in *Globus* (xcvi., p. 229); Schoetensack allocates this find to the earliest Diluvium (NATURE, July 29, p. 132), but Werth, arguing from the associated remains, attributes it to the last but one inter-Glacial age, the Mindel-Riss-Interglazial of Penck. To this period belong the Mauer sand and the high terrace of the Rhine, since both lie below the later loess of the last (Würm) Ice age and the older loess of the last but one (Riss) Ice age. The Gravel of Süssenborn belongs to the same period, as it yields *Rhinoceros etruscus, Elephas trogontherii* (like the high terrace of the Rhine and the Norfolk bed), *Elephas meridionalis* (as found in Mindel-Riss-Interglazial stratum on the south side of the Alps), and also a horse allied to *Equus stenonis* of the Mauer sand. At St. Acheul, as at Mauer, there are three terraces, the middle one corresponding to the middle one on the Neckar, as it is covered by both sorts of loess. In the lower sand and gravel of this terrace of St. Acheul is human handiwork of characteristic Chellian form, which, according to Penck, belongs to the Mindel-Riss-Interglazial time. *Homo heidelbergensis* then lived exactly in the middle of the Ice-age period; the end of the Tertiary age was as remotely behind him as the old Palæolithic Chellian culture of his times is behind us. He does not represent the old diluvial Eolithic age, still less is he a type of Tertiary man. Werth considers that this conclusion modifies the arguments which have been based upon the character of the jaw, and he disputes Schoetensack's view that it is of a type prior to that of the anthropoids. He attributes the powerful development of the jaw to have arisen in response to an earlier stronger dentition, and accounts for the deterioration of the teeth by the discovery of fire to soften the food and the employment of stone implements, which did the work for which teeth were previously used.

The first section of an important paper by Prof. C. F. Marvin, on methods and apparatus for the observation and study of evaporation, appears in the *U.S. Monthly Weather Review* for April. The author points out that while, instrumentally, it is very easy to measure evaporation under certain conditions, it is very difficult to correlate the results obtained by different observers, not that the contributions are necessarily inaccurate, but because they are solutions of a complex problem not yet fully understood. In this section Prof. Marvin deals with the customary methods and their failings, and with the various equations, which he separates into two classes—(1) those developed from mathematical equations representing the phenomena of pure diffusion, and (2) partly rational and partly empirical equations intended to express the relation between evaporation and the meteorological conditions by which it is influenced. Section ii., which will be published subsequently, will deal with apparatus; the author will then describe a special instrument, devised by himself, which records simultaneously on the same sheet the wind, evaporation, and rainfall (if the evaporation pan is not sheltered from precipitation).

In the *Revue générale des Sciences* of October 30, M. L. Teisserenc de Bort gives an interesting account of an investigation of the meteorology of the tropics, based chiefly on observations with kites and registering balloons in the Atlantic between 35° N. and 8° S., and between the coast of Europe and 47° W. longitude. The author goes at some length into the history of the subject and the methods of launching and recovering the balloons, but we can here only briefly refer to the general results obtained. The N.E. trade wind was found to extend, on an average, to about a height of 1000 metres, then a zone was met with in which the winds came generally from N.W. These N.W. winds appeared to cease at about 10° from the

point of convergence of the trade wind, which in summer is about 8° N. At a greater height the zone of winds with a southerly component, forming the anti-trade, was met with; on approaching the equator this zone was found at a lower altitude, being at about 1800 metres near Cape Verde Islands. Temperature first decreased rapidly with height; above 500–600 metres a zone with slight decrease, and extending with or without inversion up to about 2500 metres, was met with, as previously pointed out by Prof. Hergesell. In the neighbourhood of the anti-trade the temperature commenced to decrease regularly up to 14 or 15 kilometres. Above this height the so-called isothermal zone was found, the existence of which was pointed out by the author some years ago. These characteristics are analogous to those observed in temperate regions during a well-formed area of high barometrical pressure.

THE Bausch and Lomb Optical Company, 19 Thavies Inn, Holborn Circus, has published a new microscope chart for use in laboratories where instruction is given in practical microscopy. This appears to be becoming a recognised method of advertising with Continental and American microscope makers, although we are not aware that any English firm has yet issued such a chart. It is extremely well got-up, shows the mechanical and optical essentials of the instrument very well, as well as diagramatically representing the direction and path of the rays of light which pass from the illuminant and go to form the microscopic image. The chart may be obtained gratis by any college or medical institution, and it can be used with advantage wherever work is done with the microscope.

MESSRS. ERNEST LEITZ, of Wetzlar, Germany, and 9 Oxford Street, W., have issued a new edition of their catalogue of microscopes, and a separate one of microscopical accessories. It is interesting to note that Messrs. Leitz are always more nearly approaching the English type of stand in their new model microscopes; in one at least of their recent instruments the English type has been entirely adopted. They are also bringing out new achromatic condensers, and providing much more efficient arrangements for the centration of these on the microscope. Their new reflecting condenser for dark-ground illumination, which differs from any other in that it consists of spherical reflecting surfaces, is among the best to be obtained. They claim for it that not only is its correction of the highest order, but that the amount of light that actually reaches the object is greater than in any other appliance of a similar nature. In general, the character of the productions of this firm is such that workers who wish to obtain instruments for microscopy may well give attention to these new catalogues.

IN the course of his address to the Northern Architectural Association, an abstract of which appears in the *Builder* of November 13, the president, Mr. G. T. Brown, dealt with the question of architectural copyright. The law, as it stands at present, is that the client may demand, not only the whole of the drawings and specifications, but also the studies and detailed calculations, and there is nothing to prevent his making what use of them he pleases. Other buildings may even be carried out by their aid without the architect receiving any compensation for them whatever. Means are taken in other countries to protect the interests of the architectural profession, and the hope is expressed that a Government Bill will be introduced at an early date to deal with the matter.

AN interesting article on New York City bridges, by Mr. T. Kennard Thomson, appears in the *Engineering Magazine* for October. Among other bridges illustrated and described is the Williamsburg Bridge, which is claimed to be the most rigid long-span suspension bridge ever built. The main span is 1596 feet, and the total length of the bridge is 7250 feet, nearly one and a half miles. The stiffening trusses are about 40 feet deep; the four main cables are each made up of thirty-seven strands, each strand containing 208 wires, making a total of 31,784 wires in the four cables. Expansion and contraction and the effect of the live load produce a deflection at the centre of the span of 6 feet 9 inches, and yet this is a very rigid suspension bridge. The Brooklyn suspension bridge has a river span of 1595 feet, the total length being 6000 feet. Its centre rises and falls about 9 feet each way (18 feet in all), partly owing to the loading and partly to fluctuations in temperature. The extreme deflection of the new Blackwell's Island bridge is expected to be about 20 inches. This latter bridge is unique among long-span bridges in respect of the cantilever arms meeting in the centre without any intervening span.

MESSRS. CONSTABLE AND CO., LTD., have just published a cheap edition (2*s*. 6*d*. net) of Prof. H. H. Turner's "Modern Astronomy," originally issued in 1901, and reviewed in NATURE of March 21 of that year (vol. lxiii., p. 488). The book gives an admirable account of instruments, methods, and results of astronomy during the last quarter of the nineteenth century, and should now reach a wide circle of readers.

THE fifteenth volume of the new series of the "Reliquary and Illustrated Archæologist" has been published by Messrs. George Allen and Sons at the price of 12*s*. net. The volume contains the four quarterly parts issued this year, the contents of which have been referred to in these columns as the parts first appeared. It forms a handsome, well-illustrated book, which should appeal to all readers interested in early Pagan and Christian antiquities, mediæval architecture, the survivals of ancient usages, and similar subjects.

MESSRS. WITHERBY AND CO. have published a second edition of Mr. M. J. Nicoll's "Three Voyages of a Naturalist," being an account of many little known islands in three oceans visited by the *Valhalla*, R.Y.S. The original issue of the book was reviewed in NATURE for May 14, 1908 (vol. lxxviii., p. 32), when one of its numerous illustrations was reproduced. The only material alteration in the second edition is in chapter xx., where the statement has been corrected that Easter Island, when first discovered, was uninhabited.

A SECOND edition of "A Treatise on Concrete, Plain and Reinforced," by Dr. F. W. Taylor and Mr. S. E. Thompson, with chapters by various other writers, has been published by Messrs. John Wiley and Sons in New York, and by Messrs. Chapman and Hall, Ltd., in this country. The first edition was reviewed in our issue of March 15, 1906 (vol. lxxiii., p. 457). The second edition aims to cover the developments in the design and construction of reinforced concrete since 1905, and to this end more than two hundred pages of new matter have been added. The price of the new edition is five dollars.

MESSRS. BAIRD AND TATLOCK (LONDON), LTD., have sent us a copy of their latest catalogue of general apparatus. The comprehensive character of the catalogue will be gathered from the fact that it runs to 848 large pages. Sections are included in the list dealing with different types of laboratory and other benches, fume cupboards, and other fittings; the special apparatus required for physico-chemical experiments, and instruments necessary for milk,

oil, paper, and water analysis, in addition to general bacteriological and chemical apparatus. The volume will make a very useful addition to the laboratory library of working books; its numerous illustrations, concise descriptions of the more complicated instruments, and orderly arrangement will prove real aids to the selection of laboratory apparatus.

THE librarian of the Library of Congress, Washington, has issued two "Want Lists," each running to more than two hundred pages, one dealing with the publications of societies and the other with periodicals. In a prefatory note to each volume, librarians and secretaries of institutions receiving copies of the lists are asked to check them and to notify the Library of Congress of any duplicates at their disposal which may help to complete the files of the Washington library. We observe that certain copies of NATURE are in request; perhaps some of our readers may have duplicate copies of the following issues, now out of print, which the librarian of Congress would be glad to receive:—1899—May 4, June 15, 22, July 6 to August 10, September 14, and title and index; 1901—August 1, 16 to October 10, 24, 31, and title and index. Librarians are invited to send to the Library of Congress lists of their wants, as there is at Washington a stock of duplicates available for exchange.

OUR ASTRONOMICAL COLUMN.

ATMOSPHERIC REFRACTION.—The Rev. W. Hall, Chaplain Instructor, R.N., has circulated a typescript article on "Refraction in Relation to Astronomical Navigation." It is short and clearly expressed; nothing is assumed as already known, and yet the reader is taken to the furthest limits required for the writer's purpose. The article is therefore a model of what such articles should be.

For purposes of refraction, rays fall under three classes:—(1) a ray from a high star; (2) a ray from a low star; (3) a ray from the horizon finally reaching the observer's eye a few feet above sea-level, but ten miles from his horizon. The second ray is outside the scope of the article, as navigators ought not to observe low stars. The other two rays are considered in detail, and full advantage is taken of the simplifications rendered possible in one case by the altitude of the star and in the other by the thinness of the stratum of the atmosphere traversed. Proper warning is given that the state of the atmosphere at the horizon may not correspond to the barometer and thermometer readings on board ship.

THE SPECTRUM OF HALLEY'S COMET.—Using a slitless spectroscope, attached to the Crossley telescope, Mr. W. H. Wright succeeded in photographing the spectrum of Halley's comet on October 22, about 180 days before the computed perihelion passage.

Two hours' effective exposure was given, the guiding being effected by a movable micrometer attached to the telescope. The plate shows a faint continuous spectrum extending from about λ 3750 to λ 5000, and there is no evidence of the existence of any bright lines or bands characteristic of most cometary spectra; the spectrum is too faint to determine the presence, or absence, of dark lines (Lick Observatory Bulletin, No. 167).

SEASONAL CHANGE ON MARS.—Through the Kiel Centralstelle (Circular No. 115, November 18) Prof. Lowell announces that the first apparent Antarctic snowfall of the season has taken place on Mars. Two patches have appeared in latitude 65°, one in longitude 100°, the other in 190°.

Other changes and new features are announced by MM. Antoniadi, Quénisset, and J. Comas Sola, respectively, in the November number of the *Bulletin de la Société astronomique de France*. M. Antoniadi reproduces, on four plates, four drawings of the planet made during September and October, and gives several conclusions to which he has been led by his observations at this opposition. Among these we notice that he affirms the superiority of larger instruments in observations of Mars. He also finds that the grey areas are subject to great modifications of contour, although the Syrtis Major now has the same aspect as in 1864. As regards the objective existence of "canals," M. Antoniadi urges that care should be taken in the nomenclature; some of these features are undoubtedly real and persistent, others have an undulated appearance and are more or less fugitive. He concludes by suggesting that with more powerful equipment the apparent geometrical arrangements would give place to irregularities both of form and tone.

Among other observations, M. Quénisset directs attention to the unusual dimensions of the Lacus Mœris and to the apparent periodicity of a canal to the south-west of Nectar.

M. Sola describes his observations of the Lacus Solis, and believes he has seen it triple, while he suggests that the two canals, Nectar and Bathys, are really made up by alignments of small "lakes" imperfectly seen, the latter canal being much more easily seen than in many previous oppositions. Fons Juventæ, seen in 1907, has remained absolutely invisible to him during the present opposition.

THE PERSEID METEORS IN 1909.—During July and August watch was kept, at the Lick Observatory, for the August meteors, and on nine nights 755 meteors were seen. A special watch was kept on August 10 and 11, and 220 meteors were seen. July Perseids were exceptionally scarce and faint, and the maximum of the shower occurred on August 11, the horary rate, during a continuous watch lasting from 11h. 17m to 14h. 41m., being 117. Mr. Oliver states that the radiant appeared to cover a large area, and there was difficulty in separating it from the radiants of the contemporaneous minor showers.

A DAYLIGHT METEOR.—Dr. Palisa records the telescopic appearance of a meteor on September 4 at 10.30 a.m. Whilst making a daylight observation of Castor he was looking through a 1·5-inch finder, having a field of 2°, and saw a bright object cross the field. The velocity was small, and the shape was rather square than circular; the direction was from east to west, and the object was surprisingly large, appearing at least as bright as Venus (*Astronomische Nachrichten*, No. 4367).

SPECTROSCOPIC BINARIES.—In No. 3, vol. xxx., of the *Astrophysical Journal*, Dr. S. A. Mitchell publishes particulars of seven spectroscopic binaries, determined from plates taken at the Yerkes Observatory and measured at the Columbia University. The stars dealt with are β Equulei, β Trianguli, γ Lyræ, θ Virginis, *o* 78 Virginis, 24 o^2 Canis Majoris, and ζ Canis Majoris.

THE "ANNUAIRE" OF THE BUREAU DES LONGITUDES, 1910.—We have received a copy of this "Annuaire," which is too well known to require detailed description; but it should be remarked that, in accordance with the innovation of 1904, the chemical and physical data are given this year and geographical and statistical data omitted. Similarly, in the astronomical section, the tables of stellar parallaxes, double stars, proper motions, &c., are omitted, and a complete list of the elements of the minor planets is published; about 800 of these objects are now included. The "Annuaire" also contains articles on the reunion of the International Committee for the *Carte du Ciel*, and on tides.

CONFERENCE ON MALARIA IN INDIA.

A FURTHER stage in the campaign against malaria has been reached by the inauguration of a conference on malaria at Simla under Government auspices, a report of the proceedings of which appears in the *Pioneer Mail* of October 15 and 22.

The proceedings were opened with an address by the Viceroy, who, after welcoming the delegates on behalf of the Government, pointed out how grievously India has suffered from the scourge of malaria, which is probably responsible in an ordinary season for one million deaths in the year and for 100 million cases of fever that are not fatal. The prevention of malaria depended upon the extermination of the malaria-carrying mosquitoes, on the prevention of their bites, and on the prophylactic use of quinine. The extermination of the mosquito was largely a question of administration and finance and of the development of sanitation.

An address was then delivered by Colonel Leslie, I.M.S., Sanitary Commissioner with the Government of India. He

said :—" It is obvious, if malaria is due solely to the bites of anopheles mosquitoes, that the extirpation of these mosquitoes will abolish malaria. The continuous use of quinine, even for a short time, is inconvenient, unpleasant to the individual, and difficult to carry out among a community. It is therefore evident that the best way to get rid of malaria is to destroy the mosquitoes. The only questions are, Can it be done? and, if it can, At what cost? It has been successfully done at Ismailia, but in conditions which were extraordinarily favourable, such, as I fear, occur very rarely, if they occur at all, in India."

Colonel Leslie then referred to the operations against mosquitoes conducted at Mian Mir by Captain James and Lieut. Christophers. The latter reported that a distinct effect was produced upon the malaria of troops and on the endemic index of the bazaars. This was, however, only evident in the beginning of the fever season, and could not be maintained. The failure of the operations appeared to be due to the passage of adult anopheles into the area from without. All the Mian Mir experiment showed was that success in operations against mosquitoes is not so easily gained as some people say. Where drainage is perfect, as in the case of Ismailia, the inhabitants can exterminate mosquitoes with little trouble; but where drainage is non-existent or bad, as at Mian Mir, it is practically impossible, by any means at present within their reach, for the inhabitants to destroy the mosquitoes.

After dealing with the question of prophylaxis by quinine, Colonel Leslie proceeded to formulate a scheme for a permanent organisation to deal with malaria in India, viz. a committee in each province of three or more members to obtain information and supervise local inquiries, and perhaps to control the distribution of quinine. Each provincial committee would delegate one of their members to attend a meeting of a general committee in Simla, this general committee consisting of the provincial delegates, the Sanitary Commissioner, representing the Government of India, with Major James as secretary. The Government of India would appoint a scientific committee, and a certain number of workers would be under the scientific committee, and when necessary workers might be deputed to serve under the provincial committees.

Major James, I.M.S., introduced a discussion upon the distribution of malaria in India, and dwelt upon the necessity for an investigation similar to that which Captain Christophers made in the Punjab, which should be begun in every province. He concluded that there are not extensive areas in India in which anti-malaria measures are urgently required; he doubted if there were more than half a dozen considerable areas in the Madras Presidency which would come within this category.

Captain S. R. Christophers, I.M.S., read a paper on a new statistical method of mapping epidemic disease, with special reference to malaria, and confined himself to a discussion of the returns of the Punjab. He suggested that in each district a list of the more unhealthy *paraos* (rest camps) could be maintained, and operations commenced upon each in turn with a view to (1) destroy mosquitoes and larvæ and get rid of their breeding ground: (2) render the wells mosquito-proof; (3) issue quinine free to the local inhabitants, and to place it at all times within their reach free of cost. These operations should result in lessening the infectivity of such places. Captain Christophers also read a paper on malaria in the Punjab, in which he discussed quinine prophylaxis.

Major Chaytor White, I.M.S., considered that the recommendations of past malaria conferences are costly, and almost prohibitively so, if undertaken annually. More should be done in the propagation of fish which prey on mosquito larvæ.

Papers were also read by Lieut.-Colonel Thornhill, on malaria in cantonments; by Major James, on problems relating to the use of quinine; and Major Wilkinson brought forward a revised scheme for the distribution of quinine by Government.

At the termination of the conference various conclusions and recommendations were drawn up under the following main headings :—(1) scientific investigation; (2) the agency by which investigations should be made; (3) practical measures: (*a*) extirpation of mosquitoes; (*b*) quinine treatment and prophylaxis; (*c*) education; (*d*) finance.

ECONOMIC ENTOMOLOGY IN THE UNITED STATES.

MAPLE trees grown in the United States are liable to severe injury from defoliation by caterpillars. In addition to the fall web-worm (*Hyphantria cunea*, Dru.) and tussock moth caterpillar (*Hemerocampa leucostigma*, Dru.) there is a common and troublesome species known as the green-striped maple-worm (*Anisota rubicunda*, Fab.), which attacks maples of all kinds, and feeds occasionally on box-elder and oak. In a bulletin recently issued by the United States Department of Agriculture Bureau of Entomology, the latter pest is described in some detail by Messrs. Howard and Chittenden. In another publication they describe the leopard moth (*Zeuzera pyrina*, Fab.), the larvæ of which cause severe injury to many deciduous trees in northern New Jersey and eastern New York. It has been successfully combated in the public parks of New York City by injecting carbon disulphide into the larval burrows in the bark. Mr. Chittenden describes the rose-chafer (*Macrodactylus subspinosus*, Fab.), a long-legged beetle of a light yellowish-brown colour, which appears suddenly and in vast swarms in certain years, usually towards the middle of June in the northern States and about two weeks earlier in the southern, overrunning vineyards and orchards, nurseries and gardens. In about a month or six weeks from the time of their first arrival, generally after they have done a vast amount of damage, the beetles disappear as suddenly as they came. No successful means of combating them is yet known, the difficulty being that any process, to be successful, must be applied almost continuously.

The control of the pear-thrips (*Euthrips pyri*, Daniel) has been for several years the principal problem confronting the growers of deciduous fruits in portions of central California. This insect, on account of its mode of attack and habits, has presented unusual difficulties in control. Adults emerge from the ground in late February and early March, just when most trees are breaking into bloom. Eggs are usually deposited in the blossom, fruit stems, and leaf petioles. The larvæ, after hatching out, feed for two or three weeks, then drop to the ground, where they form a tiny protecting cell, within which they remain during the rest of the year. The pupal changes take place within this cell in the ground during October, November, and December. As measures of control, Mr. Dudley Moulton recommends winter cultivation followed by March and April spraying with tobacco extract.

The life-history of the greenhouse thrips (*Heliothrips haemorrhoidalis*, Bouché) is described by Mr. H. M. Russell. The damage caused by this insect is confined to the foliage of ornamental plants. Adults and larvæ both obtain their food by puncturing the epidermis of the leaf with their sharp mouth-parts and sucking out the sap. Fumigation with nicotine or with hydrocyanic acid gas were found to be effective methods of control.

Mr. A. L. Quaintance, who is in charge of deciduous fruit insect investigations, describes a new genus of Aleyrodidæ. *Paraleyrodes* (*aleurodicus*) *perseae*, Quaintance, found on orange trees and other plants in Florida. The adult is buff or pinkish in colour, and marked with white. The wings are whitish and lie almost flat along the dorsum, but do not meet along the middle line. A large amount of flocculent white wax is secreted over the leaf surface in the depressions in which the sluggish adults rest. From the same section of the Bureau is issued a description, by Mr. Hammar, of the cigar-case bearer (*Coleophora fletcherella*, Fernald), which damages the foliage and fruit of apple and pear trees. The name is given because of the curiously shaped cases, resembling cigars, made by the larvæ. Arsenical sprays were found effective in keeping it down. Messrs. Foster and Jones publish some additional observations on the lesser apple-worm (*Enarmonia prunivora*, Walsh), which is prevalent throughout the apple-growing district east of the Rocky Mountains. Late broods do a considerable amount of damage in autumn, and some of the larvæ work in the fruit for weeks after the crop is harvested. The methods adopted for keeping down the codling moth have, so far, proved effective in checking serious injury by this pest.

The regions of Virginia surrounding the Chesapeake Bay probably produce more early potatoes than any other part of the eastern States, the annual value of the crop approaching 6,000,000 dollars. Little damage is caused by blight, but the Colorado potato-beetle (*Leptinotarsa decemlineata*, Say) is a serious pest, and only very crude methods are adopted for keeping it in check, because of the prevalence of negro labour and the scarcity of capable white help. Mr. Popenoe gives a description of the pest and of the damage it does, and describes experiments in which three applications of lead arsenate mixed with Bordeaux mixture, the first about the time the eggs begin to hatch, and the others at intervals of three weeks, sufficed to control it.

Some new breeding records of the coffee-bean weevil (*Araecerus fasciculatus*, De Geer) are published by Mr. Tucker. He found the larval and pupal stages in some dried maize stalks, and obtained evidence that the insect causes injury to the maize plant. The attacks begin in the green stalks before the corn matures, and thus cause stunted ears. This weevil has also been found in the berries of the China berry tree.

Stringent laws are in operation in most of the States with regard to the importation of nursery stock. It is commonly necessary to notify the State entomologist within twenty-four hours of the arrival of the stock, and to fumigate satisfactorily. The laws of the different States are not all alike, and Mr. Burgess has collected in a short pamphlet the requirements which must be complied with by those making inter-State shipments of nursery stock. The pamphlet will form an interesting study for those who are agitating for some State supervision in this country.

THE METHODS OF MATHEMATICS.[1]

THE position assigned to mathematics in the educational system of every civilised country seems to mark it out as an essential element of mental culture, but an examination of the arguments that have been put forward from time to time to justify this position reveals a diversity of view that is at first sight disquieting.

Of those who acknowledge the value of mathematics there are many who see that value almost solely in its usefulness, in the help it brings to other sciences. Not unnaturally, those who are absorbed in the work of applied science are apt to turn away from the more abstract developments of modern mathematics; even the men whose special pursuits call for constant applications of mathematical processes, as in physics and engineering, can hardly be blamed if they lay special emphasis on those elements of a mathematical training that are of immediate application to their daily work. Yet it is not this aspect of mathematics that is usually present to the professional mathematician when he seeks to uphold the position of his subject in an educational system.

Mathematics may be assigned its place for a different reason. To those who reject the argument from utility, mathematics is not the humble auxiliary of other sciences, but is itself the one genuine science; it often comes to the aid of other sciences, but does not depend for the justification of its existence on the help it may be able to bring. From the adherents of this view come the familiar arguments for the disciplinary value of a mathematical training in which deductive logic is given a prominent place.

The question naturally arises whether these two aspects of mathematics are incompatible. To the teacher, whether in school or in college, the question is of prime importance; for the whole scheme of study and the methods of instruction will be found in the long run to be determined by the general attitude that is taken up with respect to the value of the subject. At the present time there is considerable uncertainty in the minds of teachers regarding the methods of school mathematics, and many of the older men are disposed to look unfavourably on recent changes as tending to impair the disciplinary effects of a mathematical training.

It may help us to understand more clearly the points at issue if we consider for a little the trend of mathematical inquiry during the nineteenth century. It is not necessary that I should sketch even in the roughest outline the development of mathematical science in that period; it will be sufficient for my purpose to indicate one dominant feature of the mathematical methods that were introduced in the early years of that century and that revolutionised the treatment of pure mathematics before it had reached its close.

During the eighteenth century the infinitesimal calculus and the doctrine of infinite series enabled mathematicians to investigate problems, intractable by the older methods, with a facility that led to a wide extension of the field of mathematical inquiry and to an enormous accumulation of results. In this period interest was centred less in demonstrations than in results, which were often reached by methods of a strange character, and sometimes, indeed, seem so absurd in themselves that we find it hard to understand how they were ever promulgated. Induction played a most important part in the discovery of theorems, and these inductions were often made from insufficient data and too seldom verified by subsequent tests. When the novelty of the processes had worn off, the necessity for a critical examination of their legitimacy became evident, and this examination was one of the tasks of the nineteenth century. It should be noted, however, that the great critics were also great creators; the criticism of the methods of mathematics was accompanied by a wide extension of its domain.

Of those who first saw the necessity for criticism and set themselves to the task were Gauss, Cauchy, and Abel. Gauss was first in the field, but, for various reasons, his work was long neglected. It was not until the publication in 1821 of Cauchy's "Cours d'Analyse" that the attention of mathematicians was effectively directed to the question.

Geometry in the hands of the Greek mathematicians had been reduced to a system of logically consistent truth; from assumed definitions, axioms, and postulates the various theorems of geometry were derived by the methods of formal logic, and Euclid's "Elements" were for centuries the standard of mathematical rigour. Algebra, or, in modern terminology, analysis, was of much later growth, and Cauchy's reference to the rigour that is demanded in geometry simply means that the time had come when the revision of principles and methods that the Greek mathematicians had effected in geometry should be carried out for algebra or analysis. The eighteenth century was a period of great activity in the development of analysis, and it is not surprising that the pioneers of this development should have been more interested in the resources of the country they were opening up than in the roads they followed. Their methods of mathematical inquiry were not limited by the traditional canons of Greek geometry; they included induction as well as deduction, there was constant appeal to intuition, and general theorems in mathematics were often established from physical considerations. The usefulness of mathematics as an aid in the investigation of the phenomena of the material world was the predominating feature of the period. The aim of Gauss, Cauchy, Abel, and their coadjutors was, in general terms, to do for analysis what the Greeks had done for geometry, and to make mathematics an independent science by clearly defining its province, stating the postulates from which the science starts and developing the consequences by the laws of logical operation without appeal to extraneous considerations.

The work of scrutinising the methods of analysis was vigorously pursued throughout the nineteenth century, and exerted a far-reaching influence. The notion of continuity, which seems so naturally to attach to geometrical quantity, required to be formulated in such a way that it would be amenable to calculation. Current conceptions of number were too vague, and it was found necessary to analyse more carefully the notion of numerical quantity so as to frame definitions and to establish rules of operation for the continuous variable of analysis. The so-called imaginary numbers had been long in use, but their existence was of a precarious nature, and the right to use such numbers had to be justified.

As will be easily understood, many of these discussions are of a very abstract nature, but they have provided a

[1] From the inaugural address delivered on October 11 by Dr. George A. Gibson, Professor of Mathematics in the University of Glasgow.

solid foundation for the operations of mathematics, of geometry as well as of analysis.

The movement, however, was not without its disadvantages. Mathematics gradually became more and more abstract, and the relations of mathematics to the applied sciences tended to fall into the background. On one hand it was manifestly impossible for the physicist and the engineer to keep themselves abreast of the developments of pure mathematics; on the other, the rapid extension of physics and engineering made it difficult for the mathematician, even when he had the desire, to understand the problems in the investigation of which mathematics might have been useful. The mathematics of the secondary schools was not affected to any considerable extent by the critical movement, but it probably became more formal and lost contact with the applied sciences.

Towards the close of the century complaints were rife, especially among the engineering community, that mathematics had lost touch with reality, and demands were made for a radical change in the mathematical training of the schoolboy. The feelings of dissatisfaction were not confined to any one group, and men who represented the most widely separated interests took a keen and active part in the discussions. Many of the views expressed respecting the methods of mathematics were far from new, but the emphasis with which they were urged may perhaps be taken as an indication of the extent to which, in the opinion of many competent judges, the deductive element in mathematics had overshadowed all others.

It may be conceded that, in the claims that have often been advanced for the efficiency of mathematics as an educational instrument, far too much has been made of the deductive aspect of mathematical studies; but in view of what has been said about the character of eighteenth-century mathematical methods, the assertion that mathematics knows nothing of induction is surely inaccurate. It is besides, I believe, a complete misunderstanding of the critical school to suppose that induction is barred as a mathematical method. By induction I do not here mean simply what is called "mathematical induction" or that method of demonstration which shows that if a theorem is true in one case it is true for the succeeding one; I am using the word in the sense it generally bears in speaking of scientific method. Induction as a method of discovering new truths or generalising known theorems has always been recognised to be of very great value, and is in constant use in advanced as well as in elementary mathematics. The critical objection to it was solely in respect of its use in a *systematic* development of mathematical truth (Euclid's "Elements," for example, embody a systematic development of geometry in which the theorems are linked together by a chain of deductive reasoning). As Weierstrass, one of the greatest of the critics, says, "it is a matter of course that every road must be open to the searcher as long as he seeks; it is only a question of the systematic demonstration."

In any discussion of mathematical methods it is important to bear in mind that the conviction of the validity of a theorem is not dependent on any single method of proof, even though one may strive to furnish a demonstration that conforms to some prescribed system. In mathematics, as in other sciences, conviction comes from many quarters, and one might almost say that where higher mathematics enters into the work of the physicist or the engineer the conviction that comes from the logical consistency of a mathematical demonstration is less important than the conviction that is due to insight into the physical facts and to the perception of the correspondence between the mathematical representation and the data of experiment. I think that pure mathematicians have not always given due weight to the instinct of the trained experimenter, and that, for the physicist, the true source of the conviction of the validity of "existence theorems" is often to be found in the disciplined imagination rather than in the cogency of the mathematical analysis. On similar grounds the essential accuracy of many of the results obtained by eighteenth-century mathematicians may be explained; their practical instincts prevented them from pushing a theory or method too far.

Now if it be granted that induction is a recognised mathematical method, it is hard to understand how observation and experiment can be dispensed with, because these are essential preliminaries to induction. In the development of mathematical knowledge it is quite certain that the predominance of deductive methods was of comparatively late growth, and that in the earlier stages observation played the leading part. It is unfortunate that so little of the work of the early Greek geometers has been preserved, but it is undoubtedly the case that geometry in its beginnings was essentially surveying or mensuration, and many of Euclid's theorems were known long before they were incorporated in a systematic treatise. There was, in fact, a "natural history" stage in the development of scientific geometry which the perfection of Euclid's deductive treatise has tended to obscure. The stage in which geometry appears as a logically consistent system was preceded by a period in which geometrical theorems were discovered as the result of observation and the consideration of many particular cases; in this formative period induction based on observation had full scope.

The evolution of scientific algebra has followed similar lines. The introduction of fractions in arithmetic, for example, and of negative and imaginary numbers in algebra, was due to their convenience in handling practical problems; the rules for their use were usually established, so far as proof was considered necessary, by appealing to numerous particular cases. The logical consistency of the scheme of operations was seldom discussed; so long as a rule led to results which gave a solution of the particular problems under investigation the need for a systematic presentation was not even felt. This stage —the "natural history" stage—of the development of algebra is well known to us by the works that have been preserved of the early writers on algebra; it would perhaps be true to say that a great part of elementary algebra has not advanced in actual school teaching beyond this stage.

The advance of mathematics to the position of a logically consistent system of truth has thus been governed by the same principles as regulate the progress of every science. Induction based on observation and confirmed by tests or verifications was constantly employed in extending the range of the science, and it was only gradually that deduction became the predominant, though never the exclusive, method of mathematical study.

In the recent discussions on elementary mathematics the guiding principle that has emerged seems to me to be the explicit recognition of the essential part that observation and induction play in the acquisition of mathematical knowledge. With this recognition is associated the idea that in the early training of the pupil it is scientifically unsound and practically hurtful to emphasise the deductive element; his training should, in its broad outlines, be modelled on the course that the historical development of mathematics has followed. Mathematics has now reached the stage in which it is possible to treat it as a deductive science, but it does not follow that it is either necessary or possible to teach it to beginners entirely as a deductive science. To do so is to mistake the meaning of its history and to deprive it of its place as an exponent of scientific method. Observation, classification, and induction are essential elements of scientific method, and these are well illustrated in the historical development of mathematics. The recent discussions have shown that, in the opinion of many experienced teachers, it is not only possible, but necessary, to make full use of these methods in mathematical teaching, and the conviction is widely held that they are of special importance in geometry, the branch of elementary mathematics where deduction has so long had the leading place. The excellence of the intellectual discipline to be obtained from a study of Euclid is, in my opinion, not to be questioned, but I think there is no doubt that it is contrary to all scientific order to take Euclid as our guide for an introduction to geometry. It is necessary for the pupil to acquire a knowledge of the forms of material objects before he can reasonably be expected to demonstrate the geometrical properties that are implied in the definitions of geometrical bodies. In acquiring this knowledge observation and classification are essential, and deductive reasoning will have little place. The knowledge thus gained may be quite entitled to the name of scientific; if the course is carefully planned and

carried out, it will be quite possible to obtain a system that is not a mere aggregate of isolated details, but a coherent structure. The importance of a practical course is now generally recognised in its bearing on deductive geometry; its value, however, in relation to the appreciation of scientific method is equally great.

The early stages of algebra are usually found to be very difficult, and are too often of little scientific value; the subject is more abstract than geometry, and the temptation to let the teaching degenerate into a mere mechanical application of rules is very great. I cannot but think, however, that the spirit of De Morgan's chapter on "The Study of Algebra" in his book "On the Study and Difficulties of Mathematics," written so long ago as 1831, is in full accord with scientific method, and is worthy of being more completely realised in practice than it has yet been. I cannot refrain from quoting a few sentences that indicate his view of the way in which a reasonable conviction may be obtained. After pointing out the value of *mathematical* induction, he says:—"The beginner is obliged to content himself with a less rigorous species of proof though equally conclusive as far as moral certainty is concerned. Unable to grasp the generalisations with which the more advanced student is familiar, he must satisfy himself of the truth of general theorems by observing a number of particular simple instances which he is able to comprehend. For example, we would ask anyone who has gone over this ground whether he derived more certainty as to the truth of the binomial theorem from the general demonstration (if indeed he was suffered to see it so early in his career), or from observation of its truth in the particular cases of the development of $(a+b)^2$, $(a+b)^3$, &c., substantiated by ordinary multiplication. We believe firmly that to the mass of young students general demonstrations afford no conviction whatever; and that the same may be said of every species of mathematical reasoning when it is entirely new."

There can, I think, be no doubt that it is now generally recognised that it is in accordance with true scientific method to keep the purely deductive element in the background so far as the early training in mathematics is concerned, and that by so doing the general methods characteristic of scientific procedure are more fully illustrated. This recognition, however, does not imply that the characteristically deductive side of a mathematical training is to be neglected; it means rather that deduction, which is surely a scientific method, will be used with a fuller comprehension of its place and even of its necessity. The time and the manner of the passage to deduction are not to be easily decided; much depends on the pupil, and it is one of the hardest tasks of the teacher to determine the appropriate correlation of methods. Induction is essential as an instrument of research, but deduction is also essential to the systematic development of mathematical science, and no training in mathematics can be considered satisfactory that does not show the complete process by which mathematical knowledge advances from the stage of observation to that of a science in which deduction plays the principal part in the coordination of its contents.

In this conception of elementary mathematics we have the leading characteristics of scientific method, and have them, as I think, in great simplicity. It is on this ground that the study of mathematics seems to me to be a valuable, if not indeed an essential, factor of modern education. Science has effected a great revolution in the material conditions of life, but it has also produced a profound change in the mental attitude of all thinking men. Our civilisation is not intelligible unless account is taken of the influences, material and intellectual, that are due to the progress of science. The right study of mathematics, even in its humblest forms, offers an easily accessible road to the appreciation of the fundamental characteristics of scientific method.

It is of interest to note further that the more recent methods of treating elementary mathematics, which are inductive rather than deductive in their character, lead in a natural manner to an appreciation of some of the cardinal ideas and methods of pure mathematics. Thus the notion of a continuously varying function, the conception of a limit and the method of successive approximation, cannot fail to be impressed upon a pupil who has been adequately disciplined in graph tracing.

The complexity of the problems confronting modern scientific research, with the vast accumulation of detail so characteristic of it, demands a careful training in the discrimination of the essential from the accidental, in the search for the underlying principles that coordinate or explain the details, and in the selection of the most general points of view from which to survey the field that has been worked. In this training, quite apart from the direct utility of the more advanced mathematical processes, much assistance is to be obtained from a mathematical course; the processes of thought involved in any serious study of mechanical or physical phenomena have much in common with those developed in the study of mathematics. It is the special task of the teacher to determine the extent to which the rigorous methods of pure mathematics are to be carried. Rigour is relative, not absolute, and will always be conditioned by circumstances of subject and person, and even by the prevailing fashions of the day. Restrictions corresponding to the nature of the subject and to the intellectual development of the student have always been recognised as essential. Many assumptions are either tacitly or explicitly made, fundamental theorems the demonstration of which offers special difficulty are frankly taken for granted until the necessity or the expediency of their demonstration arises and the logical completeness of a course is therefore impaired; but progress is all but impossible on any other lines, and much may be gained from demonstrations that are in parts confessedly incomplete. The real danger to the student lies in a demonstration that has the appearance of being complete and yet conceals serious assumptions. It is a great advantage that in mathematics general theorems can often be tested by particular cases that are easily handled, and practice of this kind will often produce that working conviction which is so essential for fruitful applications. One is reminded in such cases of the saying attributed to D'Alembert, "Go forward and faith will come to you."

Up to this point I have been considering the methods of mathematics almost solely in relation to the function of mathematics as a factor of general education or as the auxiliary of the applied sciences in their more elementary stages. The considerations that I have thus hastily sketched seem to me to involve the conclusion that this phase of mathematics is to be justified neither by its usefulness alone nor by its disciplinary power alone, but by the degree to which the training combines these elements. In a properly balanced mathematical course the characteristic features of scientific method will receive due recognition, and the mental horizon of the learner will be gradually enlarged; but the choice of material and of method will prepare him for the application of mathematical processes in various fields, and the study as a whole will powerfully react on his mental development.

It must not be forgotten, however, that the claims of mathematics are not exhausted by such developments as I have indicated. I have deliberately avoided all reference to what is called pure mathematics, and have confined myself to those aspects of mathematical study that are of general interest. It is difficult for anyone who is not a professed student of mathematics to realise the position of the subject in its modern developments. The great critics of the nineteenth century were not less successful in extending the boundaries of mathematical science than in securing by a just title the territory acquired, and to-day the range of subjects that fall properly within the domain of mathematics has an extent that the contemporaries of Newton and Leibnitz never dreamed of. As the result of their labours mathematics ranks as a science worthy of cultivation for the intrinsic value of the conceptions which it embodies, for the appeal it makes to the constructive imagination, for the light it casts on the processes of thought, and for the inherent beauty of form that characterises many of the theories comprised within its domain; but any attempt at reviewing, within the limits of time allotted to me, the present state of the science would certainly fail to give any adequate conception of the nature of its contents. To the mathematical student, however, the assurance can be given that he need not fear

that the science is complete and that all the problems it presents have been finally solved. Abstract as these investigations often are, there is ample room for the application of those general principles of scientific research which his earlier training will have helped to develop, and the final test of his mathematical powers will be found in the success with which he extends the scope and methods of the science.

Mathematics as we know it to-day is in living contact with experimental science on the one side; on the other it borders on the domain of philosophy; to each it has some contribution to offer, and in the words of Weierstrass "a mathematician who is not something of a poet will never be a complete mathematician." Is it not, then, a subject worthy of a place in university studies?

DEVELOPMENTS OF ELECTRICAL ENGINEERING.[1]

THIS address deals with a few only of the many recent developments in electrical plant and its application to industrial purposes.

Generators.

The modern tendency is to instal very large units. This is partly due to the large demand made on the power house and the desire to restrict the number of units, and partly to the fact that the advantages of the steam turbine over the reciprocating engine become more pronounced with the increased size of the unit. The General Electric Company of New York have built several turbo-alternators of 14,000-kw., and the British Westinghouse Company inform me that it would be quite feasible to build sets of 15,000 kw. up to 15,000 volts pressure. In water-driven alternators, also, the tendency is towards large units. Thus the power house of the Norwegian Nitrogen Company at Svälgfos, near Notodden, has been fitted with four turbine-driven three-phasers, each for 10,500 kilovolt-ampere, and developing 7000 kw. at 10,000 volts. It is obvious that in these circumstances special ventilating arrangements become necessary. Dr. Kloss, in a paper read before our Institution about a year ago, has pointed out that the scientific way of ventilating turbo-dynamos is to take the air from the outside and discharge it to the outside of the engine-room. It is important that only clean air be used, and for this reason air filters are built into the inlet ducts. These are formed of pockets of porous cloth extended over wooden frames, and so placed that the dust which settles on the cloth may be removed by beating or with a vacuum cleaner. Washing or chemical cleaning is only required after some years of use.

In most modern electricity works the circulating and air pumps are driven by electric motors, but this method has been replaced at the works of the Allgemeine Elektricitäts Gesellschaft by turbo-driven centrifugal pumps. No piston pumps at all are used, and the feed may be regulated without paying attention to the feed pump. The feed water obtained by this method is absolutely free from air, and only 5 per cent. of make-up for the feed is required. Since no piston engines of any kind are used, there is no need for oil filters.

An important development in turbo sets was initiated about ten years ago by Prof. Rateau with his exhaust steam turbine. The cost of adding exhaust steam turbo sets to an existing installation of large size may be taken at from 6*l*. to 10*l*. per kilowatt exclusive of thermal storage. The commercial advantage is considerable. Thus in the Osterfeld Mine a Rateau plant installed at a cost of 53,000*l*. has resulted in an annual saving of about 20,000*l*.

The desire to reduce the cost and complication of switch-gear and to make paralleling easy has led to the use of non-synchronous machines as generators. The rotor may be a squirrel-cage of very simple construction and requiring hardly any insulation, no matter how high the pressure produced by the stator may be. The mechanical construction is easier than that of the revolving field of an ordinary turbo-alternator, and since the air space can be made small, the power factor is high. A 5000-kw. non-synchronous generator was last year added to the plant of the Inter-borough Rapid Transit Company, New York.

There is some difficulty in the design of turbo-alternators for very low periodicity, since the speed becomes insufficient for the satisfactory working of the turbine. To meet such cases Mr. E. Ziehl has devised a type of alternator which he calls a "double-field generator." The principle may be explained as follows: Imagine a non-synchronous motor having precisely the same three-phase winding in stator and rotor, and let the circuits be connected either in series or parallel in such way that a three-phase current sent through the machine will produce fields which in stator and rotor revolve in opposite sense. If now the rotor be driven by power in a sense opposite to that of its own field and with a speed corresponding to twice the frequency, the field produced by the rotor currents will in magnitude and direction of motion be identical with that produced by the stator currents. Thus each of the two windings contributes one-half the field common to both. At the same time the demagnetising action of each winding is eliminated by that of the other. Since the E.M.F. is generated in both windings, only half the flux as compared to a synchronous generator is required; hence less hysteresis loss, smaller radial depth of stampings, and less copper weight. The paralleling is easy; the speed need only be approximately right, and if coupled up in a wrong phase position no damage is done, since the inductance is then very great.

Transformers.

In transformers also there is to be noticed a general tendency towards large units, which is not surprising if one considers that for the calcium-carbide industry alone about half a million horse-power in generating plant has been installed throughout Europe, and that most of the power has to flow through transformers to the carbide furnaces.

The General Electric Company of America have built several 10,000-kw. three-phase transformers working at 60 frequency, and giving a pressure of 100,000 volts. The largest European transformers of which I could find a record are some made by the Siemens-Schuckert Werke. They are three-phase 6750-kilovolt-ampere capacity oil cooled, for 66,000 volts on the high-pressure side. The use of oil as a filling medium has made it possible to build transformers for very high pressure. In one American power-transmission plant now under construction the step-up transformers are intended to raise the pressure to 110,000 volts, but even higher pressures can be obtained. Transformers giving extremely high pressure on the secondary are used for testing insulators and insulating material. A transformer of this kind has recently been made by Messrs. Brown-Boveri. It is a 50-kilovolt-ampere transformer wound for a primary pressure of 1000 volts and giving on the secondary 250,000 volts, but even this has been exceeded when the transformer was used in testing the dielectric strength of insulators. From a curve referring to such tests which the makers have sent me I find that the highest pressure recorded was 310,000 volts.

The reduction in weight of transformers due to the use of alloyed iron, large units, and vigorous cooling is very remarkable. As an example of good modern practice, I take a Brown-Boveri transformer where the active material weighs only 3·1 kg. per kilowatt, and the efficiency is 98·6 per cent. at full non-inductive load. In an Oerlikon 3500-kw. transformer the active iron only weighs 7 tons, being at the rate of 2 kg. per kilowatt output. The largest self-cooling oil transformers of which I know are some 1200-kw. three-phase 40-frequency 5000-volt transformers made by the British Westinghouse Company, but for larger unit artificial cooling becomes necessary.

For furnace work it is well to allow a rather large inductive drop so as to reduce the rush of current in the event of a short circuit in the furnace. This means wide spaces between primary and secondary coils, but it also involves the necessity for good mechanical support. The mechanical forces acting on the individual coils may become considerable, and this is probably the reason why some makers prefer the core type with concentric cylindrical coils, the cylinder being the best shape for resisting radial forces.

[1] Abridged from an address delivered before the Institution of Electrical Engineers on November 11 by Prof. Gisbert Kapp, president of the institution.

Motors.

In three-phase motors for railway work, speed regulation has hitherto been obtained either by some kind of cascade arrangement or by changing the number of poles. In either case the rotor has slip-rings, a complication one would gladly avoid. This is now possible, thanks to an ingenious design worked out by Mr. Aichele, the chief designer of Messrs. Brown-Boveri. The motor has been applied in their latest Simplon locomotives. Its rotor is simply a squirrel-cage, and has no slip-rings and no outside electrical connections whatever. The stator has two distinct windings, one for 16 and the other for 12 poles, and each winding can by means of a pole-changer be so grouped as to produce half its normal number of poles. There are thus four normal speeds possible, corresponding respectively to 16, 12, 8, and 6 poles, or to a train speed of from 26 to 70 km. per hour.

A remarkable improvement in single-phase motors has been devised by Mr. Deri, and practically developed by Messrs. Brown-Boveri. Mr. Deri's motor is a "repulsion-motor," with movable *and* fixed brushes. The effect of shifting the former is analogous to changing the impressed voltage on an ordinary continuous-current series motor, and thus by adjusting the brushes the torque and speed may be regulated. This property renders the Deri motor valuable in all cases where delicate speed regulation is essential. It is largely used for working passenger lifts and other hoisting machinery, and also for driving ring-spinning frames, the speed regulation in the latter case being automatic. The result of automatic speed regulation is an increased output from the ring-spinning frames. Another application is for electric railway working, to which I shall refer later.

The Electric Transmission of Power.

There has been a considerable development in this branch of applied electricity in late years, but the development has been on different lines in different countries corresponding to their various topographical, industrial, and commercial conditions. With us it is not so much a question of carrying power a long way as of distributing large amounts of power at numerous points within a restricted and densely populated area. In so-called water-power countries the distance between the source of the power and the points of its delivery is very much greater than in England, and hence the necessity of using much higher pressures in the transmission lines. In raising the pressure a limit is eventually reached at which dispersion of power becomes serious. This critical potential difference in virtual kilovolts is :—

$$\mathrm{KV}=\frac{0{\cdot}115b}{0{\cdot}5+r}\left(\frac{1}{1+0{\cdot}013v}\right)r\log\frac{s}{r}.$$

Here b is the barometric pressure in mm. of mercury, r is the radius of the wire in cm., s the distance between the two wires in cm., and v is Mershon's "vapour product," namely, the pressure of saturated steam in mm. of mercury at the given temperature multiplied by the relative humidity, or the ratio $\frac{\text{actual moisture}}{\text{possible moisture}}$.

The protection of power lines against pressure surges due to atmospheric or other causes is a very important matter.

It is well known that the connection of an underground cable with an overhead line constitutes a special danger to the cable from atmospheric discharges. To protect the cable, Mr. Semenza, of Milan, uses a kind of gigantic Faraday cage surrounding the point where the overhead lines are connected to the cables by transformers. The iron parts of the structure are earthed, the roof and the window-frames are of iron, and under the plastering of the walls there is iron netting. If a capacity and inductance tuned to somewhere near the frequency of the surge are placed in series and connected to line and cage, a current of that particular frequency will flow to earth as if the connection were direct. Even if the frequency were only approximately that to which the set was tuned, the reactance would not be excessive and the protection would be sufficient. Thus a set tuned to 1 million frequency would at 10 million frequency have a reactance of 158 ohms and at 100,000 frequency a reactance of 165 ohms. A set tuned to 100,000 frequency would at 20,000 frequency have a reactance of 192 ohms. A set for 1 million frequency may conveniently be formed of two Moscicki condensers in parallel, having together a capacity of 0·01 mf. and an inductance of 2·54 microhenry. The latter is obtained by two turns of 2 mm. copper wire 50 cm. in diameter. A set for 100,000 frequency would require eight condensers in parallel and a coil of ten turns. For the ordinary working frequencies up to 50 either set has of course a practically infinite reactance, that is to say, it has no effect on the power current. The Milan translating station has been at work now for about two years with perfect success. It should be noted that the system not only protects against lightning discharges, but against any abnormal rise of pressure, in so far as this is caused by a high-frequency surge.

Whilst on the subject of safety devices in connection with power transmission, I must refer to another recent invention, the object of which is the prevention of the infiltration of high-pressure current into low-pressure lines. That such a device is urgently needed is shown by the lamentable accident which happened last August in Olgiate, where several persons were killed by contact with nominally low-pressure lighting circuits. The danger of a short or a leak between high- and low-pressure circuits does not lie in the transformer. This can be made absolutely safe; but the switches and leads to the transformer, and especially the outside lines where there are miles of them, are a source of danger. A broken wire or a branch of a tree blown across two lines by the wind are possibilities from which no excellence of workmanship can guard us. Some means should therefore always be provided to cut off the current automatically in the low-pressure circuit as soon as its potential to earth exceeds a predetermined limit. Such an instrument was perfected last year by Mr. Arcioni, of Milan, and is now being gradually taken up on the Continent. Last year I tested the Arcioni safety device on the Milan system, making artificial leaks from the 6000-volt network to a local secondary lighting circuit, and found the action absolutely trustworthy.

The commercial development of electric power distribution on a large scale in this country by companies established for this purpose may be said to have begun with the present century. The public generally, and even some engineers, are still under the impression that a country of abundant water-power offers better opportunities for electric power distribution than a country of cheap coal, but that this is in reality not so is demonstrated by the great development which power supply has reached in this country. In the country of waterfalls industries have to be introduced in order to utilise the power made available through electric transmission, whilst in the coal country highly developed industries of different kinds are already there. As regards capital outlay, the advantage lies generally with the thermal station, quite apart from the extra cost of a steam reserve, which, for at least part of the power, in many cases is unavoidable. If, then, we speak of the cheap water-power of Swiss and Italian hydro-electric works, we do not mean that those works can produce power more cheaply than English thermal stations, but that they can produce it more cheaply than if they had to use imported coal.

Although in this country we have only little water-power, the deficiency is made up by other sources of energy which now mostly run to waste. Mr. C. H. Merz estimates that within the area served by the North-east Coast Power System the gas obtained as a by-product of the coke ovens could be made to yield continuously 150,000 horse-power if burned under boilers, and 250,000 horse-power if used in internal-combustion engines. It is the merit of Mr. Merz to have recognised the enormous commercial importance of these sources of energy, and to have already made a beginning with their utilisation by the establishment of what he calls "waste heat stations."

Electric Railways.

For main lines alternating current is unavoidable, and the only question on which there may be still difference of opinion is whether the current shall be three-phase or single-phase. Electricians prefer the former, railway men the latter mainly on account of the greater simplicity of the overhead work. As the railway men are in reality the

customers who give the order to the electrical engineer, it seems likely that the single-phase system will be the one more generally adopted; and, indeed, a very respectable beginning has within the last four years already been made on the Continent, where single-phase vehicles aggregating more than 100,000 horse-power are at work or on order.

In Italy considerable progress is also being made. The Government has decided to electrify eleven sections on the State Railways, aggregating 337 miles of track, but on the three-phase system. Thus the battle of the phases is still undecided. The decision of the Italian State Railways to use three-phases, whilst in Germany, Austria, England, Sweden, and America the single-phase system is preferred, is highly interesting. Mr. Verola, the chief engineer of the electrical department of the Italian State Railways, was good enough to explain the reason for this choice. The following is an abstract of his letter:—

"In the case of the three lines (Pontodecimo-Busalla, Bardonecchia Modane, and Savona-Ceva) which are about to be opened, the service is extremely heavy, trains of 400 tons and over having to be hauled up on long grades of 25 to 35 per mil. at a speed of 45 km. per hour. With the three-phase system it is possible to comply with these conditions by using two locomotives. These weigh each 60 tons, and develop each at the 1-hour rating 2000 horse-power. With the single-phase system the weight of the motors would be at least doubled, resulting in a greater expenditure of energy. The advantages of wider speed adjustment in running and better efficiency in starting are not of importance on these lines. It is probable that also some future electrifications will be on the three-phase system, notably that of the prolongation of the Valtellin line to Milan, which will shortly be taken in hand. It is, however, highly probable that some other lines will be worked single-phase. One of these is the line Turin-Pinerolo-Torre-Pelice, where widely different speeds are necessary, the maximum being 80 km. per hour for 100-ton passenger trains."

In Switzerland the Federal Government appointed some years ago a committee of electrical and railway engineers to report generally on the question of electrifying the Swiss railways. The first report dealt with the amount of power required, the second some standards connected with the future electrical service, whilst a third report dealt with the question of a standard frequency, but on the question whether the single- or the three-phase system is to be chosen the committee has not yet pronounced an opinion. From private conversations I have had with Swiss railway men, I incline to the belief that the decision will be in favour of the single-phase system, especially since, by the use of the Deri type of motor, it has been found possible greatly to simplify and also lighten the accessory equipment. The first test of this motor for traction was made on the three-phase Engelberg railway, one phase only being used. No resistances, auto-transformer, contactors, regulating switches, or controllers of the usual construction are required. The starting and the regulation of the tractive force and speed is effected simply by shifting the brushes. Thus all the driver has to do is to attend to a hand-wheel, the motion of which is transmitted to the brush rockers by positive mechanical gearing.

Winding Engines and Rolling Mills.

Dynamic storage in some such way as first applied by Ilgner to winding engines, and voltage regulation on what may broadly be called the Ward-Leonard system, have made it possible to satisfy the very severe conditions under which winding engines and rolling mills have to work. A good example of modern English practice in direct-current rolling-mill electrification is the plant supplied by the Electric Construction Company, Ltd., of Wolverhampton, to the steel works of Sir Alfred Hickman, Ltd., of Bilston. The makers have given me the following particulars:—The flywheel set consists of a 2000-horse-power direct-current motor, two 28-ton flywheels and two generators capable of giving any voltage between −1000 and +1000 volts. The excitation of the motor is adjusted automatically so as to produce a speed variation of the flywheels between 290 and 350 revolutions per minute. The energy given out when dropping from the higher to the lower speed is 46,000 horse-power seconds. This set supplies power to a cogging and a barring mill. The cogging-mill motor works a 30-inch mill, and when cogging down ingots of 3 tons weight has to develop 4800 horse-power, and for two-second periods once an hour 9600 horse-power. The barring-mill motor works a 24-inch mill, and has to develop 6000 horse-power, and for two-second periods once an hour 12,000 horse-power. The maximum speed is 120 revolutions per minute, and the time occupied in reversing from maximum speed in one direction to that in the other direction is six seconds. As an example of a reversible mill driven by three-phase current I take that supplied by the British Thomson-Houston Company, Ltd., to Messrs. Dorman, Long and Co., Ltd. It is a cogging mill with rolls 28-inch centres, and the normal speed is 70, the maximum speed 90, revolutions per minute. The flywheel set consists of a three-phase 950-horse-power non-synchronous motor, coupled to a 1000-kw. 400-volt direct-current generator and a 30-ton flywheel. The speed limits are 400 and 480 revolutions per minute, and the maximum peripheral speed of the flywheel is 295 feet per second. The mill motor is rated at 1200 horse-power, and has an overload capacity for short periods of 3600 horse-power. The time required for reversing from full speed in one direction to full speed in the other direction is four seconds. The mill deals with 1800-lb. billets 12 inches square, reducing them to 3-inch square bars in fourteen passes. The output is 15 tons per hour.

Electric Steel Furnaces.

In the manufacture of steel from pig and the refining of steel electrically the experimental stage has long been passed, and the practical results obtained are eminently satisfactory. Even where, owing to the price of power, the electric process is no cheaper than the thermic process, the former enables the steel refiner to achieve results with certainty and regularity which under the old methods are hardly attainable at all, or only, so to say, by good luck.

In the furnace electricity is merely used to produce a large amount of heat locally. All furnaces are worked with alternating currents, the heat being produced either in an arc or by the passage of the current through the metal itself. In an arc furnace for a capacity of 2 to 3 tons the average energy required per ton of finished steel is about 1000 kw.-hours when the charge is introduced cold, and about 400 kw.-hours when it is introduced in a molten state.

A drawback inseparable from the employment of electric arcs is the great fluctuation in the load, making it impossible to work an arc furnace from a circuit which supplies other consumers. This difficulty is overcome with the so-called "induction furnace," where the heating is by ohmic resistance. In the latest type of induction furnace the energy required per ton of steel if the charge is introduced in a molten state is 125 kw.-hours for rails and 250 kw.-hours for tool steel.

The electric furnace for steel making and steel refining is now an important accessory in steel works, and thousands of tons of steel are produced annually, both in furnaces of the arc and in those of the induction type.

Fixation of Atmospheric Nitrogen.

Of the many methods devised for fixing atmospheric nitrogen with the object of producing a fertiliser to replace Chili saltpetre, I can only refer to three which have attained considerable importance.

The Birkeland-Eyde process is in use in the Notodden factory. This is fitted with four 7000-kw. generators and thirty-two furnaces, and has a yearly production of 20,000 tons of nitrate of lime, and a second factory on the Rjukan Fall is in course of construction.

The Frank-Caro process is not, strictly speaking, electrical, yet it has only become commercially possible by the aid of electricity. The raw materials for this process are calcium carbide and nitrogen, the former being produced by electricity in the well-known way, and the latter by liquefying air in a Linde machine and subsequent fractional distillation. The carbide is brought to glowing heat in a closed, externally fired retort, and the nitrogen passed through. The reaction is $CaC_2 + N_2 = CaCN_2 + C$.

A new process for the production of nitrous compounds, which is the invention of Messrs. Schoenherr and Hesz-

berger, is being introduced on a large scale in Norway by the Badische Anilin- und Sodafabrik. In this process air is passed through an iron tube in which an alternating-current arc of 5-metre length is maintained under a pressure of 4200 volts. The air enters one end of the tube by a series of tangential holes, and the rotary motion thus produced keeps the arc confined to the axis of the tube. Each arc absorbs 600 horse-power.

Electricity in Agriculture.

The discovery that electrification of the atmosphere immediately above the plant stimulates in certain cases its growth is now being utilised practically under a system worked out by Sir Oliver Lodge, in collaboration with Mr. J. E. Newman and Mr. R. Bomford. A network of galvanised iron wires is stretched over the field to be treated, and suspended 18 feet from the ground from wooden posts and oil insulators. The posts are placed 70 yards apart, so that about one post per acre is required. The network is positively electrified to from 60,000 to 100,000 volts by means of an induction-coil mercury gas break and Lodge rectifying vacuum valves. The induction coil is worked on the primary side by continuous current obtained from an ordinary dynamo. The amount of primary power required per acre is very small, namely, from 10 to 20 watts. The installation is run for five or six months during eight to ten hours each day, and the total expenditure of energy is only about 20 B.O.T. units per annum per acre. Under this treatment the increase in the yield per acre is about 30 per cent., but under certain conditions it may be even more. The system is in use on several farms in this country, on six farms in Germany, and on one farm in Holland.

In the time at my disposal I have only been able to refer to a few of the industries which have benefited by the application of electricity; but when one reflects that nearly every industry in the country has been, or might be, furthered by the use of electricity in one form or another one comes to see that an enormous field of useful work is open to the electrical engineer—not only useful to himself, but even more so to the interests that employ him. How, then, comes it that electrical engineering is not so prosperous as it might be? Some of our members say because we are backward as compared with our foreign competitors. If by that term they mean that our electrical engineering works cannot produce equally good plant as our rivals, I cannot agree. I have frequently visited Continental shops, and, although I am quite willing to admit that excellent work is done there, I am also convinced that British shops can turn out work equally well and generally at a slightly lower prime cost. There is certainly no justification in reproaching the makers of electrical plant with backwardness; and, moreover, it is bad business policy. If, however, the reproach is levelled against the potential users of such plant there is some justification, and also a reason. Our great staple industries are old-established and have been fairly prosperous for generations; those on the Continent are of recent growth, and had to struggle into existence against English competition. To become successful they had to adopt every improvement which science put at their disposal. With them the application of electricity is almost a vital matter; with us only a desirable improvement. Is it, then, to be wondered at if a works manager or owner, who has grown up in the pre-electric days, and has been doing a prosperous business ever since, should be rather slow in embarking in new methods of working which, to his thinking, might entail the possibility of risk and the certainty of greater mental exertion? There are, of course, exceptions, and a good many of them, as witnessed by the great strides which electrical methods applied to our staple industries have already made; but, compared to what the development might be, we must admit that we have as yet only touched the fringe of this vast field. There is progress, but it is not fast enough, and to accelerate it we must educate the potential users of electrical plant. A beginning in this direction has already been made by the managers of electric-light stations. They are educating the householder by local exhibitions and literature that he can understand. On the Continent every large electrical engineering firm has a literary department, the business of which it is to educate possible customers. No sooner is a new winding plant started, or a cotton mill electrically equipped, than well-written, well-printed, and beautifully illustrated leaflets are sent out into the world to tell possible clients of the work done by the firm. Here, such literary departments are the exception; and thus it comes about that we hear so much of the great advances made on the Continent and so little concerning equally good work done here.

Our institution can also do something to accelerate the introduction of electricity into our great industries. It is no doubt very useful if we in our meetings read highly technical papers, and thus educate each other; but this is only part of our work. The other part is to educate the customer, and for this purpose we possess in our organisation of local sections the requisite machinery. By arranging for papers which shall be of interest to the particular industries carried on in the district of each local section, our institution can further the adoption of electricity in these industries, and this will not only be to our own advantage, but even more to the advantage of those whom we serve.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The professorship of biology will be vacant on January 1, 1910, by the resignation of Prof. Bateson as from that date. Candidates for the professorship should communicate with the Vice-Chancellor on or before Monday, January 10. The professor will receive a stipend of 700*l.* a year, with the usual deductions in case he holds a fellowship. It will be the duty of the professor to promote by teaching and research the knowledge of genetics.

The Balfour studentship will be vacant at Christmas, 1909. The names of applicants, together with such information as they may think desirable, should be sent on or before January 15, 1910, to the secretary, Mr. J. W. Clark, Registry of the University, Cambridge.

Dr. Whitehead has been appointed chairman of the examiners for the mathematical tripos, part i., 1910.

Mr. W. B. Hardy has been nominated a manager of the Quick fund from January 1, 1910, to December 31, 1915.

The electors to the Isaac Newton studentships give notice that, in accordance with the regulations, an election to a studentship will be held in the Lent term, 1910. These studentships are for the encouragement of study and research in astronomy (especially gravitational astronomy, but including other branches of astronomy and astronomical physics) and physical optics. The studentship will be tenable for the term of three years from April 15, 1910. The emolument of the student will be 200*l.* per annum, provided that the income of the fund is capable of bearing such charge. Candidates for the studentship should send in their applications to the Vice-Chancellor between January 16 and 26, 1910, together with testimonials and such other evidence as to their qualifications and their proposed course of study or research as they may think fit. Candidates are recommended to send with their applications an account of any work bearing on astronomy or physical optics on which they may have been engaged, and to forward copies of any papers they may have published on these subjects.

The special board for moral science directs attention to the urgent need of more adequate accommodation for the laboratory of experimental psychology. Since 1897, when the lectureship in experimental psychology was first established, this department has been successively housed in various temporary quarters, all totally unfitted for the purpose. At Oxford an excellent laboratory devoted to experimental psychology has recently been erected, presided over by a reader, who is a Cambridge man. This laboratory was built and is maintained at the expense of the University. The board is of opinion that it is essential that a similarly permanent and satisfactory building should be provided without delay in Cambridge if instruction and research in this important new subject are not to cease.

BIRMINGHAM.—The Huxley lecture this year is to be delivered on December 1 by Prof. W. Bateson, F.R.S., who has selected "Mendelian Heredity" as the subject of his address.

MR. FRANCIS DARWIN, F.R.S., Prof. Westlake, of Cambridge, and Prof. Holland, of Oxford, have been created Doctors of the University of Brussels. Mr. Darwin has also been made a corresponding member of the Institut National of Geneva.

THE Brussels correspondent of the *Times* states that a great scientific meeting was held on November 21 at the Solvay Institute in connection with the Brussels University celebrations. A cheque for 160,000*l.* was presented on November 19 by the friends of the University.

DR. D. WATERSTON has been appointed professor of anatomy in King's College, London, in succession to Prof. Peter Thompson, appointed professor of anatomy in the Birmingham University. Dr. G. C. Low has been elected lecturer in parasitology and medical entomology.

THE new botanical laboratories at University College, London, will be opened on Friday, December 17, by Dr. D. H. Scott, F.R.S. The Vice-Chancellor (Prof. M. J. M. Hill, F.R.S.) will preside. Applications for tickets of admission should be made to the secretary, University College, London, W.C.

AT a meeting of the East London College committee on November 16 a subcommittee was constituted to administer the fund for the encouragement of research work at the college, upon which Mr. H. F. Donaldson, C.B., Dr. H. A. Miers, F.R.S. (principal of the University of London), and Sir William White, K.C.B., F.R.S., were asked to serve.

A COPY of the October issue of the *Battersea Polytechnic Magazine* has been received. The periodical provides an interesting record of the doings of the various societies and clubs in connection with the institution, as well as readable articles by members of the staff and students. Great prominence is given to the work of the day section of the Engineering Society; the issue of the magazine before us, for example, contains full descriptive accounts of four visits to important engineering undertakings, in addition to complete particulars of the annual meeting of the society.

THE School Board of Hartford, Connecticut, has decided to establish a "tent school" for children from homes where there is tuberculosis, and for children who suffer from anæmia or curvature of the spine. The tents will be put up on some vacant ground in the neighbourhood of one of the city's school buildings. Accommodation will be provided for sixty or more children, who will spend about seven hours a day in the tents. Books and furniture will be supplied by the School Board, but the Hartford Society for the Prevention of Tuberculosis will furnish meals and the especially warm clothing that will be needed for such an experiment during the winter.

DR. RICHARD ARTHUR, president of the Immigration League of Australasia, points out in a circular letter that the Government agricultural colleges in Australia offer exceptional advantages in the way of a scientific and practical education in the various forms of agriculture, stock-breeding, dairying, and fruit-growing. He has been able to make arrangements for the reception of students from the United Kingdom at them, and informs us that any lad going to Australia can now be guaranteed entrance at one or other of these institutions. The course is a two-year one, and the fees are exceedingly moderate, ranging from 18*l.* to 30*l.* a year, which sum includes board and lodging.

WE learn from *Science* that by the will of the late Mr. John S. Kennedy, banker, of New York City, who died last October in his eightieth year, bequests are made for public purposes amounting to nearly 6,000,000*l.* A bequest of 445,000*l.* is made to Columbia University; another of 300,000*l.* to Robert College, Constantinople; and a bequest of 150,000*l.* to New York University. Gifts of 20,000*l.* are made to the University of Glasgow, Yale University, Amherst College, Williams College, Dartmouth College, Bowdoin College, Hamilton College, the Protestant College at Beirut, the Tuskegee Institute, and Hampden Institute; and of 10,000*l.* to Lafayette College, Oberlin College, Wellesley College, Barnard College (Columbia University), Teachers College (Columbia University), Elmira College, Northfield Seminary, Berea College, Mt. Hermon Boys' School, and Anatolia College, Turkey. Bequests of 5000*l.* are made to Lake Forest University and Center College.

A UNION has recently been formed by graduates of the University of London to promote the Parliamentary enfranchisement of women on the same terms as men. Since 1878 the University of London has admitted women as candidates for all degrees, honours, and prizes on precisely the same terms as men, and at the present day in all university affairs men and women are accorded the same electoral and other rights, and acquire them through identical qualifications. Graduates of a certain standing are entitled to become members of Convocation, and the register of Convocation would constitute the Parliamentary electoral roll were it not for the condition imposed by Act of Parliament that a Parliamentary voter must be of the male sex. About one-sixth of the members of Convocation are thus deprived of any share in the choice of the representative of their university in Parliament. That such exclusion of an intellectual section of the nation from representation in its councils is contrary to public policy cannot be denied. The university qualification for the vote is a purely intellectual one, and those who do not recognise its sufficiency in the case of one sex would have a difficult task to maintain the right of the other to the privilege attaching to that qualification. All graduates of the University of London—both men and women—who are in sympathy with the objects of the union are urged to join it. Particulars and forms of membership can be obtained from Miss Jessie W. Scott, hon. sec. London Graduates' Union for Woman Suffrage, 114A Harley Street.

THE prospects in the matter of the inauguration of a Teachers' Registration Council are much brighter as a result of a conference held on November 13, when representatives of all the important teachers' associations met together, under the presidency of Sir Herbert Cozens-Hardy, Master of the Rolls, to discuss the whole question of registration and to pass resolutions expressing the general feeling of teachers throughout the country. The proposals agreed upon include the establishment of a council on which elementary, secondary, and technical education are represented equally, each by nine representatives, and associations of teachers not included under these three heads by three representatives. Technological education is given a very wide interpretation in the proposed scheme, and includes the work done in technical schools, schools of art, and by teachers of music, of commercial subjects and physical education in its various branches. There were few points on which the meeting had difficulty in coming to practically unanimous conclusions, and armed with the resolutions now adopted the representatives of the conference should have little trouble in convincing the Board of Education that the time has arrived when the provisions included in Education Acts, which long since came into force, for the establishment of a Teachers' Registration Council should be put into force. The work of education is, from the national point of view, of prime importance, and any procedure deserves encouragement which will improve the status of the teaching profession.

SIR JOHN HEWETT opened the new laboratories and workshops at Thomason College, Roorkee, at the end of October last, and the address he gave on that occasion is printed in the *Pioneer Mail* of November 5. The speech was the first statement of the general policy accepted by the provincial Government for the development of technical and industrial education. The encouragement of education in applied science was taken up by Sir John Hewett at an early stage of his administration, his first step being the promotion of a technical conference. The proposals of the conference included the provision of industrial and trade schools at important centres and the improvement of the existing industrial school at Lucknow. These were to provide for the lower stages of industrial training. Our contemporary states that this scheme has been adopted by the Government, and is being given effect to as funds

are available. Eventually these establishments may be expected to provide a regular supply of trained artisans and mechanics able to adapt themselves readily to western processes. The proposals of the conference referred also to the creation of a technological institute. This institute was to have two branches—at Roorkee and Cawnpore respectively; it was intended that Roorkee should deal only with industries mainly dependent on engineering, while Cawnpore provided for those dependent on chemistry. The proposals allotted 2 lakhs capital expenditure with Rs. 88,000 annually to Roorkee, and 8 lakhs capital with 2½ lakhs annually to Cawnpore. Sir John Hewett said in his speech that the Cawnpore part of the scheme has been deferred, but that a commencement will be made at once with the development of a technological institute at Roorkee. Thomason College is to have the difficult task of working out the lines on which the functions of a technological institute can be carried out in India.

SOCIETIES AND ACADEMIES.

LONDON.

Geological Society, November 3.—Prof. W. J. Sollas, F.R.S., president, in the chair.—S. S. **Buckman**: Certain Jurassic (Lias-Oolite) strata of south Dorset, and their correlation. Descriptions of certain strata (Lower Bathonian to Pliensbachian) on the Dorset coast. Comparison is made with similar strata inland. The strata described are classified according to the scheme introduced for these strata in 1893. The strata are arranged among thirty-six zonal (hemeral) divisions. The Upper Lias part of the junction-bed of Down Cliffs, Chideock, is a very condensed, imperfect epitome in 20 inches of about 80 feet of strata on the Yorkshire coast. Between the *bifrons*-layer and the *striatulus*-layer of the junction-bed there is occasionally a 2-inch layer, which is all that represents some 250 feet of deposit in the Cotteswolds. The Upper Toarcian makes a great showing at Burton Bradstock and Down Cliffs as the Down Cliffs Clay and Bridport Sands. The sequence of *aalensis*-strata above *moorei*-beds is demonstrated at Chideock Quarry Hill, in the upper part of the Bridport Sands. The Inferior Oolite strata of Burton and Chideock are not counterparts of one another; they supplement each other to a certain extent. Mr. Thompson's zonal scheme for the Upper Lias is considered.—S. S. **Buckman**: Certain Jurassic ("Inferior Oolite") Ammonites and Brachiopoda. The paper describes certain species of Ammonites and Brachiopoda which are important for the identification, the correlation, or the dating of Inferior Oolite deposits, and certain other notable species which, having frequently attracted attention in the field, require naming in the interest of future workers.—Dr. W. F. **Hume**: The granite-ridges of Kharga Oasis: intrusive or tectonic? The author quotes the records given by Mr. Beadnell in his paper published in February, 1909, and although in agreement with the facts there stated, differs with regard to the interpretation of those facts. Whereas Mr. Beadnell regards the granite as intrusive, on account of the high dip of the sedimentaries, and the changes which they exhibit as regards colour and hardness, near the granite, the author considers that the dips are due to fold-movements almost at right angles to one another, since they lie on the same line as the crater-like basins, the rims of which are formed of the compact and steeply dipping limestones of the Lower Eocene, and he adduces as further evidence the fact that dykes and quartz-veins penetrating the crystalline rocks cease abruptly at the edge of the sandstone.—Dr. W. F. **Hume**: The Cretaceous and Eocene strata of Egypt. The fossiliferous Cretaceous strata are divided into three series:—(1) A northern Antonian type, marked by Cenomanian species, including typical Turonian strata. (2) A central Egyptian or Hammama type, Cenomanian strata being absent, Campanian marked by abundance of *Ostrea villei* and *Trigonarca multidentata*, and phosphatic beds; the Danian portion having an eastern facies, in which Pecten marls are a characteristic feature, and a western chalky limestone indicating a close affinity with the white chalk of northern Europe. (3) A southern or Dungul type, having close affinities with (2), but in the Campanian the phosphatic beds are inconspicuous, and the fauna consists of a group of specialised sea-urchins and of gastropods, among which Turritellæ are very prominent. The uniformity of the Lower Eocene throughout Egypt is emphasised, its triple subdivision being recognisable over vast areas. In the Middle Eocene this uniformity is replaced by differentiation. Five zones have been recognised in the lower division, while in the Upper Moqattam the Turritella-beds and the strata rich in *Carolia placunoides* and *Plicatula polymorpha* are of zonal importance. The Lower Moqattam is considered as beginning with the *Nummulites gizehensis* zone and closing with the Gistortia-bed. The relation between the Cretaceous and Eocene beds is discussed. Palæontologically, great groups such as the Ammonites, still abundant in the Upper Cretaceous, disappear in the Eocene, and are replaced by the characteristic nummulinid Foraminifera. Both periods bear a resemblance to each other in the dominance of oysters and sea-urchins. A notable feature is the rarity of Brachiopoda in Egypt throughout both periods, nor have belemnites been recorded from the Egyptian Cretaceous. Among post-Eocene formations the calcareous grits are shown to have a wide extension, but in the desert they differ in character from the mammal-yielding beds of the Fayûm. The Cretaceous period in Egypt was one, in the main, marked by the gain of sea over land, the Eocene was one of rest, while at the close of the Eocene and during the Oligocene the approach of a continental phase is clearly indicated.

Linnean Society, November 4.—Dr. D. H. Scott, F.R.S., president, in the chair.—Cecil **Carus-Wilson**: Natural inclusion of stones in woody tissue. About twenty-three years ago a gravel-pit was started in the valley-gravels occurring some three miles from Faversham, in Kent. Part of a wood covered the deposit; as the work progressed oak trees were felled, and the stumps and roots dislodged. The gravel consists of subangular, water-worn flints and occasional blocks of Sarsen-stone, the whole being mixed with flint grit and quartzose sand. The roots and stumps were distributed as the gravel in which they were embedded was removed. The work of excavating ceased about ten years ago, so the roots still remaining have been exposed for that length of time, the others having been cut up for fuel. Most of those now found were left intact because of the stones enclosed in the wood. Not only did these resist the work of saw and axe, but when burnt they burst asunder with force, becoming a source of danger. The stones are actually embedded in the solid oak. The tissue of the wood appears to have grown around the stones and enveloped them, indicating that the process was carried on under conditions of pressure. There are dozens of stones embedded in some of these roots, so that the substance may be described as "a conglomerate formed of flints enclosed in a woody matrix." In one specimen no fewer than sixty-seven flints were counted, the largest being several pounds in weight, and there are innumerable empty cavities showing where others existed before the shrinkage of the wood after exposure. Odd stones have been occasionally seen thus embedded in the trunks of trees. In Norton Churchyard, a few miles from Faversham, are three old yew trees, and in two of them flints and fragments of tiles have been seen embedded in the wood of the trunk 7 feet above the ground. In Molash Churchyard, six or seven miles south of Faversham, there are six very old and large yews. Some of these have flints embedded in their trunks 7 feet or 8 feet above the ground. The examples first described are unique, and if trees can enclose stones in such quantities, and retain them within their substance so tenaciously, we have transporting agents capable, under certain conditions, of distributing terrigenous material over sea-beds to an extent not hitherto appreciated.—Dr. A. B. **Rendle**: Specimen of heather (*Erica cinerea*) found near Axminster in which the flowers were replaced by dark red leaf-buds of about the same size as the flowers. The red leaf-buds, which occupy the position of flowers, consist each of short, strongly ascending leaves arranged in superposed whorls of four; the four lines have often a spiral twist in the upper part of the bud. The leaf-arrangement resembles that of the flower, not of the foliage leaves. The leaves of these special buds differ in form from the foliage leaves in that they are upwardly concave with a bluntly keeled back. They are thirty-two or more in

number, and thus considerably outnumber the parts of a typical flower (twenty-four, including bracteoles). The tip of the bud was always damaged, but in many a shrivelled pistil was present, and sometimes below this semi-foliaceous stamens were found. The specimen is of interest as resembling a teratological form of *Erica cinerea* described by Maxime Cornu in 1879.—Prof. H. H. W. **Pearson**: Types of the vegetation of Bushmanland, Namaqualand, Damaraland, and South Angola (a preliminary report of the Percy Sladen Memorial Expedition in South-west Africa, 1908–9). The floras of the regions named in the title are distinctly related if the vegetation found on the Huilla plateau in South Angola be excluded. Otherwise the differences that are observed are to be accounted for mainly as a result of differences of (1) elevation; (2) atmospheric humidity; (3) depth at which permanent supplies of underground water are available; (4) geographical position. In all the rainfall is scanty and inconstant, and there is a prolonged drought in the winter season. Near the coast, in some places up to elevations as great as 2700 feet, the total annual rainfall is never more than a few millimetres, and frequently fails altogether. The affinities of these floras are with those of the South Central African highlands. In South Angola many species are derived undoubtedly from the coast and Montane regions of West Tropical Africa. Throughout, the vegetation is xerophytic in character, and is marked either by a short period of duration or by the possession of those structural peculiarities which are found in dry climate perennials. Of these, hairiness is not a conspicuous feature; except in Lower Namaqualand, succulence is not common. A round, bushy habit is marked throughout. The root system is deep; the leaves are simple and of small size, and with a strongly developed cuticle. The formations and associations indicated are predominant by reason either of their great extent or of striking peculiarities of the plants composing them. They are arranged in the main geographically from south to north.

Zoological Society. November 9.—Dr. S. F. Harmer, F.R.S., vice-president, in the chair.—Sir H. H. **Howorth**: Some living shells, their recent biology, and the light they throw on the latest physical changes in the earth, i., *Mya arenaria*. The author stated that the *Mya arenaria* or clam is widely distributed in the North Boreal, European, and North American seas, and claimed to prove that it is a recent migrant into the former, and has probably not been there more than 300 years. The notion that it is an Arctic shell is a mistake. In the Arctic lists *Mya truncata*, var. *oblonga*, has been mistaken for it, and the glacial character of the beds in which it has occurred, which has been postulated from its occurrence there, has accordingly been a wrong inference. Brögger has argued that it migrated from America. It was abundant in the Crag seas, and occurs in derivative fragments in the Drift-beds, but it does not occur in the estuarine deposits or raised beaches, proving that after the period of the Crag it became extinct in Europe, and has since been re-introduced. He regarded the cause of its extinction as a mystery, since the group of estuarine shells with which it is found has lived continuously in Europe since later Crag times.—C. Tate **Regan**: The Asiatic fishes of the family Anabantidæ (including the Osphromenidæ). The author remarked that the order Labyrinthici was an isolated and terminal group, probably derived from a cyprinodontoid stock, and that it comprised two suborders, Ophiocephaloidei and Anabantoidei, the latter including the families Anabantidæ and Luciocephalidæ. The Indian element in the fresh-water fish-fauna of Celebes, including two labyrinthic fishes, was shown to consist of (1) species which had travelled by sea, and (2) species which had probably been introduced by man. The great importance of Wallace's line for fresh-water fishes was thus vindicated. The Asiatic genera and species of Anabantidæ were described, including several new forms of Betta and Trichopodus, and the Asiatic genus Anabas was shown to differ markedly from the African Ctenopoma and Spirobranchus.—J. Lewis **Bonhote**: Some mammals brought home from Egypt. The paper dealt with about twenty-eight species, chiefly small rodents, and the main points of interest were the recognition of *Procavia burtoni*, the Egyptian hyrax, as a valid species, the re-discovery of *Acomys russatus*, hitherto only known from Palestine, and the description of a small species of Dipodillus, the last two species having been taken on the Mokattam Hills within three miles of Cairo.

Mathematical Society, November 11.—Sir W. D. Niven, president, in the chair.—G. H. **Hardy**: (1) The ordinal relations of the terms of a convergent sequence; (2) the application to Dirichlet's series of Borel's exponential method of summation; (3) theorems relating to the summability and convergence of slowly oscillating series.—Prof. W. **Esson**: Notes on synthetic geometry.—H. **Bateman**: Kummer's quartic surface as a wave surface.—Prof. H. S. **Carslaw**: The Green's function in a wedge and other problems in the conduction of heat.—J. L. S. **Hatton**: The envelope of a line cut harmonically by two conics.—Rev. F. H. **Jackson**: A class of q-hypergeometric series.—Informal communications were made as follows:—Dr. E. W. **Hobson**: An extension of Abel's theorem concerning the sums of series at points on the circle of convergence to oscillatory series.—Prof. A. E. H. **Love**: The effect of the earth's rotation upon the observed values of the lunar disturbance of gravity.

CAMBRIDGE.

Philosophical Society, October 25.—Dr. Hobson, vice-president, in the chair.—A. A. **Robb**: Discussion of a difference equation relating to the tension of overhead wires supported by equidistant poles.—F. G. **Sinclair**: Note on the abnormal pair of appendages in Lithobius.—J. E. **Littlewood**: A class of integral functions.—J. A. **Crowther**: The scattering of the β rays from radium by air.—R. **Whiddington**: Note on the electrical behaviour of fluorescing iodine vapour. The note describes an experiment showing that iodine vapour is un-ionised when brilliantly fluorescing under the action of the arc light.—Rev. H. J. **Sharpe**: The reflection of sound at a paraboloid.—G. W. C. **Kaye**: The emission of Röntgen rays from thin metallic sheets. Thin metal leaf antikathodes were subjected to bombardment by kathode rays, and the (emergent) X-rays proceeding from the remote side of the leaf were compared with those which left on the near side (incident). In general, the emergent Röntgen radiation in such cases exceeds the incident in intensity, markedly so in the case of aluminium. The ratio of the emergent intensity to the incident increases with the speed of the kathode rays employed. As the thickness of the metal leaf is increased, the emergent intensity increases to a maximum and then dies away, the incident intensity meanwhile gradually increasing to a constant value.—F. **Horton**: The emission of positive rays from heated phosphorus compounds.

November 8.—Prof. Bateson, F.R.S., president, in the chair.—N. R. **Campbell**: Discontinuities in light emission. An account is given of an attempt to test the theories of Sir J. J. Thomson and of Planck as to the atomic nature of radiation by means of observations on the fluctuations in the intensity of a source of light. The experiments are similar in nature to those of Meyer and Regener, based on the theory of von Schweidler, on the fluctuations of an ionisation current due to the α rays of radium. The theory and the methods of the experiments are discussed at length, and also the nature and cause of an unexpected difficulty which has prevented, up to the present time, the attainment of definite results; but it is hoped that such results may be reached in the near future.—J. A. **Orange**: The shape of beams of canal rays. An appendix to a paper previously communicated to the society. In that paper it was suggested that the component rays in a beam of canal rays are straight, the curved boundaries of the beam being envelopes merely. This appendix describes one or two simple experiments which support that view.—H. **Bateman**: The determination of solutions of the equation of wave motion which involve an arbitrary function of three variables which satisfies a partial differential equation.—H. J. **Priestley**: The oscillations of superposed fluids.—L. B. **Turner**: The stresses in a thick hollow cylinder subjected to internal pressure.—Sir J. J. **Thomson**: The theory of the motion of a charged particle through a gas. It is pointed out in this paper that, in consequence of the "persistence of velocities," which is

especially marked when the mass of an ion is much greater than that of a molecule of the gas through which the ion is moving, methods founded on the conception of the free path are not suited for the calculation of the velocities of the ions. If we suppose that the operative forces acting between the ions are such as exist between a charged body and a conducting sphere, the force between the ions and the molecules would, except close to the molecules, be proportional to the inverse fifth power of the distance, and we can apply Maxwell's results to this case, making the slight alterations which are necessary when the force is an attraction instead of a repulsion, as in Maxwell's investigation. The expressions deduced in this way for the mobility are such that, considered as a function of M, the mass of the ion, and m, the mass of a molecule of the gas, the mobility varies as $\left\{\frac{M+m}{M}\right\}^{\frac{1}{2}}$, and thus, when M is large compared with m, varies very slowly with the mass of the ion. The diffusion of the emanations of radio-active substances through air or other gases would, since the molecules of the emanation carry electrical charges, follow the same law, so that the rate of diffusion of the emanation would only vary very slowly with the atomic weight; thus we cannot attach much importance to determinations of the atomic weight of the emanation made by observing their rate of diffusion through other gases.

MANCHESTER.

Literary and Philosophical Society, November 2.—Mr. Francis Jones, president, in the chair.—T. G. B. **Osborn**: A note on the staminal mechanism of *Passiflora coerulea*. The paper contained a record of observations made during the summer of this year on *Passiflora coerulea*, and directed attention to three staminal movements which occur in the order in which they are given below, viz.:—(1) A radial movement of the anthers on the filament of 180°, which occurs as soon as the flower opens. (2) A second movement of the anther through 90° into a plane at right angles to the first, *i.e.* into the tangential plane, in which position a special mechanism is called into play to retain it there. (3) The radial movement, in two stages, of the stamen as a whole, so as to bring it from an erect to a drooping position, the first stage of this movement being in part concurrent with (2), and coextensive with the first stage of anthesis.—D. M. S. **Watson**: A preliminary note on two new genera of Upper Liassic Plesiosaurs. The Manchester Museum contains two important skeletons of *Plesiosaurus homalospondylus*, Owen, which show that the pectoral girdle does not conform to the type of that of Plesiosaurus, but is elasmosaurian, resembling that of Cryptocleidus. The coracoids are narrow; the scapulæ meet in the middle line and pass back as a bar to join the coracoids. The clavicular arch is reduced, lying on the visceral surface of the anterior plates of the scapulæ. There is no interclavicle. A new genus, Microcleidus, is founded for the species. Another skeleton, lacking the head, also in the Manchester Museum, is made the type of the new genus and species *Sthenarosaurus dawkinsi*. The genus is remarkable for the smallness of the coracoids and the strong clavicular arch, which resembles that of Thaumatosaurus, as determined by Lydekker, but has a posterior process in the centre.

November 16.—Mr. Francis Jones, president, in the chair.—C. E. **Stromeyer**: Relative periods of revolution of planets and satellites. The author pointed out that, if the solar system has been built up out of meteorites, certain relations as regards periods of revolution should exist both amongst the planets and their satellites. The periods, not only of the planets, but also of their satellites, should be expected to stand in the ratios 1, 2, 4, 8, &c., or 1, 3/2, 2, 3, 4, &c. The first of these series is well represented by Jupiter's satellites, I., II., and III. of which stand in the exact ratio of 4, 8, 16; V. has a period of 1·1, IV. has a period of 37·8 instead of 32, and VI. and VII. combined have a period of 576, or little more than 512, which would be the tenth term of the series. The outermost satellite, the exact period of which has not yet been determined, should, if the above rule holds good, have a period of twice 260 days, say one and a half years. Saturn's satellites agree with the second series, which includes thirds. The mean periods of the several pairs are 1, 2, 3·96, —, 16·5, —, 68·1.—F. **Nicholson**: Some early correspondence between Mrs. Hemans and Mr. Matthew Nicholson, a former member of the society.

PARIS.

Academy of Sciences, November 15.—M. Bouchard in the chair.—G. **Darboux**: Congruences of curves.—M. **Gouy**: The vapour pressure of an electrified liquid. The total effect, at least for liquids having a high specific inductive capacity, is for an electric field to increase the vapour pressure. The dielectric polarisation, when the field is normal to the surface, produces an increase in the vapour pressure; the increase of the ions in the surface layer of the electrolyte diminishes the vapour pressure, and the net result is the difference of these two effects.—M. **de Forcrand**: The acid carbonates of the alkalies.—Édouard **Heckel**: The influence of anæsthetics and frost on plants containing coumarin. Plasmolysis is produced by the action of chloroform, ether, or by cold, the coumarin being immediately given off.—Édouard **Heckel**: Fixation of the cultural bud-formation of *Solanum maglia*.—M. **Idrac**: Ocular and photographic observations of the planet Mars. An account of observations made at the Meudon Observatory with the large double telescope during the recent opposition of Mars. In some instances details were shown on the photographs which could not be observed by simultaneous eye observations.—E. M. **Antoniadi**: Observations of the planet Mars made at the Observatory of Meudon. A map of the planet, on Mercator's projection, is given, summarising observations made between September 20 and November 9.—A. de la Baume **Pluvinel** and F. **Baldet**: The photography of the planet Mars. An account of work done with the new equatorial at the astronomical station on the Pic du Midi.—N. E. **Norlund**: Equations of finite differences.—G. A. **Miller**: Groups produced by two operators, each of which transforms the square of the other into its inverse.—Albert **Grumbach**: Contact electrification. A study of the electromotive forces produced by the filtration of solutions of potassium chloride, with and without an added non-electrolyte (phenol).—Vasilesco **Karpen**: Telephony at great distances.—André **Léaute**: The destructive effects of oscillating discharges of high frequency.—Gargam **de Moncetz**: A formula for sensitising plates for the extreme red, commencing with the infra-red. The solutions given, used on silver iodobromide plates, enable lines up to the calcium line λ 860 to be photographed.—Paul **Gaubert**: A new highly fluorescent substance derived from physostigmine. Physostigmine in aqueous solution is allowed to stand for several months until it has acquired a deep blue colour, and to this phthalic acid is added. The substance produced forms deep blue crystals, which in solution are intensely fluorescent.—W. **Broniewski**: The electrical properties of the aluminium-copper alloys. Twenty alloys of aluminium and copper were prepared. The measurements made on these included the electrical conductivity at 0° C., the temperature coefficient of the resistance, the electromotive force against carbon in a solution of ammonium chloride, and the thermoelectric power. The results are given both in tabular and graphical form. In addition to the definite compounds of aluminium and copper already known, the existence of Al_2Cu_3 has been brought out by these experiments.—Georges **Meslin**: The magnetic properties of liquids constituted by siderose. Aniline or carbon bisulphide containing powdered siderose in suspension exhibit the phenomenon of magnetic dichroïsm to an extent much greater than with any substances previously examined.—Abel **Buguet**: The cryoscopy of organic mixtures and addition compounds. An account of the cryoscopic study of mixtures of acenaphthene and phenanthrene with two nitrotoluenes.—H. **Baubigny**: The action of heat and light on silver sulphite and the double alkaline sulphites. The determination of the yield of dithionic acid.—V. **Auger**: The mixed halogen stannic compounds. The bromiodide $SnBr_2I_2$ was submitted to a series of slow crystallisations, and the ratio of iodine to bromine found to vary. The study of the cooling curve of the supposed $SnBr_2I_2$ showed that this also behaved as a mixture.—P. J. **Tarbouriech**: The dehydration of oxycyclohexyldimethylcarbinol.—M. **Deprat**: The eruptive and metamorphic formations of Tonkin, and

on the frequency of laminated types.—F. **Grandjean**: The optical study of the absorption of heavy vapours by certain zeolites. The substances absorbed by the crystal of zeolite affect the optical properties of the crystal to a marked extent. The optical properties found are never intermediary between those of the crystal and those of the body absorbed.—Fernand **Guéguen**: The existence of sclerotes in *Mucor sphaerosporus*.—R. **Anthony** and W. B. **Pietkiewicz**: New experiments on the *rôle* of crotaphytic muscle (temporal) on the morphological constitution of the skull and face.—Louis **Lapicque**: The theory of electrical stimulation: a hydraulic analogy.—M. **Baudran**: Artificial media capable of attenuating or strengthening the virulence of Koch's bacillus. The formulæ of the two media differ only in the use of iron in the one and manganese in the other. The one containing iron causes a marked attenuation in the virulence of the bacilli grown in it; the replacement of the iron by manganese, on the other hand, has the exactly contrary effect.—MM. **Trillat** and **Sauton**: The action of putrid gases on micro-organisms. The putrid gases arising from the decomposition of animal extracts were allowed to act on yeast, parallel cultures of the same yeast without the addition of such gases being made at the same time. The effect on the yeast was measured by the alcohol produced. Both increases and decreases in the fermentative action were observed, the effect depending on the proportion of gas present.—Alfred **Angot**: The earthquake of November 10, 1909. Details of the traces of the seismographs at Parc Saint-Maur Observatory. The epicentre was calculated to be at a distance of 8700 kilometres.—M. **Audouin**: Observations made in the course of the Tilho expedition.—M. **de Beauchamp**: The working of the apparatus for the protection of the Vienne district against hail and thunderstorms during the year 1909. The protection during the year has been very satisfactory, and the system is to be further extended.—A. **Gruvel**: *Résumé* of some scientific observations made on the coasts of Mauritania (N. Africa) from 1905 to 1909.

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 25.

ROYAL SOCIETY, at 4.30.—On the Change in Hue of Spectrum Colours by Dilution with White Light: Sir William de W. Abney, K.C.B., F.R.S.—On the Nature of the Hydrogen Flocculi and their Structure at Different Levels in the Solar Atmosphere: Prof. G. E. Hale, For.Mem.R.S., and F. Ellerman.—The Boiling Point of Sulphur corrected by Reference to New Observations on the Absolute Expansion of Mercury: Prof. H. L. Callendar, F.R.S., and H. Moss.—(1) On the Refraction and Dispersion of Neon; (2) On the Refraction and Dispersion of Air, Oxygen, Hydrogen, and Nitrogen; (3) On the Refraction and Dispersion of Sulphur Dioxide and Hydrogen Sulphide, and their Relation to those of their Constituents: C. Cuthbertson and M. Cuthbertson.—On Flapping Flight: Prof. M. F. Fitzgerald.—The Crystalline Structure of Iron at High Temperatures: W. Rosenhain and J. C. W. Humfrey.—The Relation of Thallium to the Alkali Metals: a Study of Thallium-zinc Sulphate and Selenate: Dr. A. E. H. Tutton, F.R.S.—On the Nature of the Diffraction Figures due to the Heliometer: P. F. Everitt.—The Motional Effects of the Maxwell Æther-Stress: E. Cunningham.—The Aberrations of a Symmetrical Optical Instrument: Dr. H. C. Pocklington, F.R.S.—The Spectrum of Radium Emanation: H. E. Watson.—The Electric Conductivity and Density of Solutions of Hydrogen Fluoride: Prof. E. G. Hill and Dr. A. P. Sikkar.—Sleeping Sickness in Uganda. Duration of the Infectivity of the *Glossina palpalis* after the Removal of the Lake-shore Population: Colonel Sir David Bruce, C.B., F.R.S., Captains A. E. Hamerton and H. R. Bateman, R.A.M.C., and Captain F. P. Mackie, I.M.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Present Aspects of Electric Lighting: H. W. Handcock and A. H. Dykes.

FRIDAY, NOVEMBER 26.

PHYSICAL SOCIETY, at 5.—The Effective Resistance and Inductance of a Helical Coil: Dr. J. W. Nicholson.—Ductile Materials under Combined Stress: W. A. Scoble.—The Recoil of Radium C from Radium B: Dr. W. Makower and Dr. Sidney Russ.—The Sun's Motion with Respect to the Æther: Dr. C. V. Burton.

MONDAY, NOVEMBER 29.

ROYAL SOCIETY OF ARTS, at 8.—Aëronautics: C. C. Turner.

INSTITUTE OF ACTUARIES, at 5.—American Railway Securities as Investments for Insurance Companies: H. Ansell.

TUESDAY, NOVEMBER 30.

ROYAL SOCIETY OF ARTS, at 4.30.—Agricultural Development in Nyasaland: S. Simpson.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—The Pit Dwellings at Holderness: Canon Greenwell, F.R.S., and Rev. R. A. Gatty.

FARADAY SOCIETY, at 8.—On the Electro-analytical Determination of Lead as Peroxide: Dr. H. J. S. Sand.—The Calorimetrical Analysis of Hydrated Salt: Prof. F. G. Donnan and Dr. G. D. Hope.—(1) On the Influence of Dissolved Gases on the Electrode Potential in the System Silver-Silver Acetate, aq.; (2) Contributions to the Study of Ionisation in Aqueous Solutions of Lead Acetate and Cadmium Acetate: A. Jacques.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Further discussion*: The Single-phase Electrification of the Heysham, Morecambe and Lancaster Branch of the Midland Railway: J. Dalziel and J. Sayers.—The Equipment and Working-results of the Mersey Railway under Steam and under Electric Traction: J. Shaw.—The Effect of Electrical Operation on the Permanent-way Maintenance of Railways, as Illustrated on the Tynemouth Branches of the North-Eastern Railway: Dr. C. A. Harrison.

WEDNESDAY, DECEMBER 1.

ROYAL SOCIETY OF ARTS, at 8.—Improvements in Resilient Wheels for Vehicles: Hon. R. C. Parsons.

SOCIETY OF PUBLIC ANALYSTS, at 8.—The Composition of Cream: R. R. Tatlock and R. T. Thomson.—Analyses of Vulcanised Rubber Goods: Clayton Beadle and Henry P. Stevens.—On the Gravimetric Estimation of Nickel in Nickel Steel: E. L. Rhead.—Notes on the Milk Supply of Two Large Towns: F. W. F. Arnaud and Edward Russell.

GEOLOGICAL SOCIETY, at 8.—The Tremadoc Slates and Associated Rocks of South-east Carnarvonshire: W. G. Fearnsides.—On some Small Trilobites from the Cambrian Rocks of Comley, Shropshire: E. S. Cobbold.—(1) The Rock of Pulau Ubin and Pulau Nanas, Singapore; (2) The Tourmaline-Corundum Rocks of Kinta, Federated Malay States: J. B. Scrivenor.

ENTOMOLOGICAL SOCIETY, at 8.—Discussion on *Agriades coridon* and *A. thetis* (*bellargus*), opened by Mr. J. W. Tutt.

THURSDAY, DECEMBER 2.

ROYAL SOCIETY, at 4.30.

RÖNTGEN SOCIETY, at 8.15.—Some Effects of Electrical Discharges on Photographic Plates: Prof. A. W. Porter.

LINNEAN SOCIETY, at 8.—Nudibranchs from the Indian Ocean: Sir Chas. Eliot, K.C.M.G.—Trichoptera von Mr. Hugh Scott, auf den Seychellen gesammelt: Dr. Georg Ulmer.—Report on the Brachiopoda obtained from the Indian Ocean by the *Sealark* Expedition, 1905: Dr. W. H. Dall.—Narrative of the *Sealark* Expedition, Part III.: Prof. J. Stanley Gardiner, F.R.S., and others.

FRIDAY, DECEMBER 3.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Design of Generating Stations: G. Ingram.

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